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AN ACCUMULATION PHASE SIMULATION FOR PENSION FUNDS

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FEHMİ OLCAY KARABİNA

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AN ACCUMULATION PHASE SIMULATION FOR PENSION FUNDS

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"I, Fehmi Olcay Karabina, confirm that the work presented in this dissertation is my own. Where information has been derived from other sources, I confirm that this has been indicated in the dissertation."

FEHMİ OLCAY KARABİNA

ABSTRACT

AN ACCUMULATION PHASE SIMULATION FOR PENSION FUNDS

F. Olcay Karabina

Doctor of Philosophy in Finance and Banking

Advisor: Prof. Dr. Ömer L. Gebizlioğlu

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The aim of this thesis is to propose a pension fund accumulation phase simulation and analysis, focusing on the Turkish Private Pension System. For this purpose, after analyzing the historical progress of global and local private pension systems, and the Turkish Capital Markets in detail, we apply some sophisticated techniques like Markov Chains and Monte Carlo Simulations on some selected financial instruments to perform our analyses.

Globally, private pension systems have a significant share in developed market economies, and there is a broad academical research related to private pension systems and pension funds, mostly focusing on the funding structures, asset liability management strategies, portfolio allocations and performances, and on the shifts from Defined Benefit (DB) plans to Defined Contribution (DC) plans.

In Turkey, Private Pension System is growing rapidly since it's inception, but the share of private pension funds relative to the size of the economy is low compared to other OECD countries. The number of researches about Turkish Private Pension System is rather scarce, mostly concentrating on operational structures, regulations, and historical fund performances. Our contributions to the matters mentioned above are fivefold:

1. **A New Perspective:** We provide an extensive pension fund accumulation phase simulation method by applying Markov Chains and Monte Carlo Simulation techniques to financial instrument returns, that to our knowledge, has never been done before on the Turkish Pension Funds sector.

2. **Analysis:** We discuss some policy proposals on the fees, portfolio allocation problem, and on the existence of state subsidies.

3. **Flexible Modeling:** Besides focusing on the Turkish Private Pension System in this thesis, our model is flexible for the inclusion of other financial instruments and investment structures of any other pension system.

4. **Practical Implications:** We believe that participants, portfolio management companies and private pension companies can all benefit from the modeling and analysis framework of this thesis.

5. **Information Scope:** We run an extensive survey on the historical progress and current attributes of the Turkish Private Pension System and Turkish Capital Markets, along with the global developments on pension funds.

Keywords: pension funds, accumulation phase, markov chains, monte carlo simulation.

ÖZET

EMEKLİLİK FONLARI İÇİN BİRİKİM SİMÜLASYONU

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Aralık, 2016

Bu tezin amacı, Türkiye Bireysel Emeklilik Sistemi özelinde, bireysel emeklilik sistemleri için geniş perspektifli ve esnek bir birikim simülasyonu yapılması ve politika belirlenmesine yönelik bir çözümleme çerçevesi sunmaktır. Bu amaçla, küresel ve yerel bireysel emeklilik sistemlerinin gelişimi ve Türkiye Sermaye Piyasaları detaylı bir şekilde incelendikten sonra, belirlenen finansal enstrümanlar üzerine Markov Zinciri ve Monte Carlo Simulasyonu gibi gelişmiş analiz yöntemleri uygulanmıştır.

Bireysel emeklilik sistemleri, gelişmiş ülke ekonomilerinde önemli bir yere sahiptir ve bu alanda çok sayıda akademik makale bulunmaktadır. Küresel olarak bu alandaki makalelerin büyük bir bölümü fonlama yapısı, aktif pasif yönetimi, portföy dağılımları, performans analizi ve tanımlanmış fayda emeklilik planlarından (Defined Benefit - DB), belirlenmiş katkı planlarına (Defined Contribution - DC) geçişi incelemektedir.

Türkiye'de Bireysel Emeklilik Sistemi kuruluşundan bu yana oldukça hızlı bir şekilde büyümesine rağmen, diğer OECD ülkeleri ile karşılaştırıldığında emeklilik fonlarının ekonomideki payı hala düşük, ve bu alandaki akademik makale sayısı oldukça azdır. Türkiye'de Bireysel Emeklilik Sistemi hakkındaki mevcut literatür genellikle sistemin işleyişi, yasal düzenlemeler ve geçmiş fon performanslarını incelemektedir. Bahsedilen alanlar ile ilgili bizim katkımız beş aşamalıdır:

1. **Yeni Bir Bakış Açısı:** Finansal enstrüman getirileri üzerine Markov Zinciri ve Monte Carlo Simulasyonu uygulayarak detaylı bir emeklilik birikim simulasyon

modeli geliştirilmekte olup, bildiğimiz kadarı ile bu yöntemler daha önce bu alanda Türkiye Emeklilik Fonları için kullanılmamıştır.

2. **Çözümleme:** Yönetim ücretleri, portföy dağılımları ve Devlet Katkısı üzerine çözümlemeler yapılmıştır.

3. **Esnek Modelleme:** Kurmuş olduğumuz model, bu tezde incelenenlerin haricindeki finansal enstrümanlar ve yatırım ürünleriyle de uyumludur.

4. **Kullanım Önerileri:** Kurmuş olduğumuz çerçeveden ve modelleme yaklaşımından bireysel katılımcılar, portföy yönetim şirketleri ve bireysel emeklilik şirketleri gelecek incelemelerinde yararlanabilecektir.

5. **Bilgi Kapsamı:** Türkiye Bireysel Emeklilik Sistemi ve Türkiye Sermaye Piyasalarının gelişimi ve mevcut işleyişinin yanısıra, küresel bireysel emeklilik sistemi hakkında da ayrıntılı bir bakış ve inceleme yaklaşımı sunulmaktadır.

Anahtar Kelimeler: emeklilik fonları, emeklilik birikimi, markov zinciri, "monte carlo" simulasyonu.

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Chapter 1

Introduction

Private pension system operates as a complementary to the government social security plans, and customers are enrolled on a volunteer basis. In addition to helping participants secure their current wealth levels at their retirement, the system also promotes personal savings through tax advantages, employer and government contributions, and lower management fees compared to other professional fund management services.

Private pension assets, having a worth of more than USD 38 trillion worldwide, are mainly financed by the pension funds. According to the data provided by The Organization of Economic Co-operation and Development (OECD), 68% of the private pensions are financed by pension funds, 20.2% by banks and investment companies' managed funds, 11.3% by the pension insurance contracts, and the remaining 0.5% by the employers' book reserves, as of 2015. (OECD, 2016b).

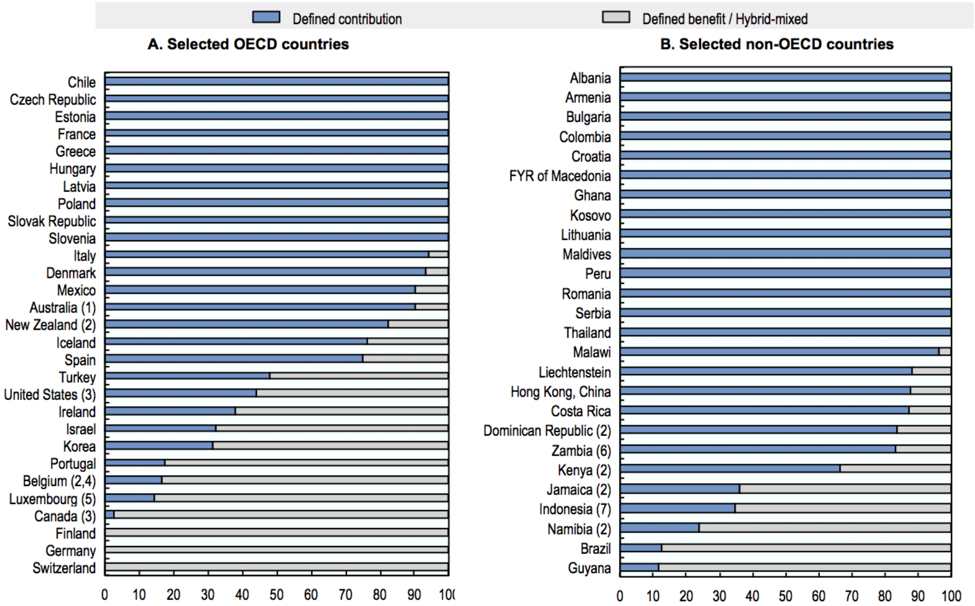
In terms of pension funds' development, average share of pension funds to GDP in OECD countries rose from 28.4% to 37.2% through the years 2004-2015, and from 12.1% to 16.4% in non-OECD countries. See OECD Statistical Database (OECD, 2016a) for details.

Given the current progress and future potential of private pension system and pension funds, we present an in-depth analysis of the types of pension plans and roles of the pension funds in those plans.

There are three types of pension plans in practice namely Defined Benefit (DB), Defined Contribution (DC), and Hybrid pension plans. In DB plans, pension benefits are guaranteed in advance by the employers or the sponsors of the plan, mostly as a percentage of final salary before retirement. In this case, the employer or the sponsor of the plan faces the income risks of the participants, mortality risk of the retirees, as well as the investment risks. In DC plans, which have gained considerable share in the world in the last decades, the amount of contributions are pre-specified and the retirement benefits solely depend on the investment returns of the pension funds. In Hybrid plans, the features of DB and DC plans are combined mostly for tax and mobility purposes, and for more predictable contribution and benefit mixes.

Ostaszewski (Ostaszewski, 2001) explains that the shift from DB plans to DC plans is due to a shift in the way relative returns are being rewarded in the economy, at least for the United States. Brown and Liu (Brown en Liu, 2001), show that Ostaszewski's hypothesis does not apply to Canada, and that pension regulation and taxation are more crucial in the preference of DB vs DC pension plans. Brown and Weisbenner (Brown en Weisbenner, 2014), show that economic and demographic factors play an important role while choosing between DB and DC plans. Broadbent et al. (Broadbent *et al.*, 2006) give some brief information for the transition of DB plans to DC plans, and examines the effect of this shift in terms of asset allocation and risk management, and Bodie et al. (Bodie *et al.*, 1988), analyze the trade offs between the two plans in great detail. Figure 1.1 shows that in both OECD and non-OECD countries, DC plans have most of the share in pension fund investments.

In DC plans, retirement income of participants solely depends on pension fund returns, thus the increasing share of DC plans also increases the importance of pension funds. Table 1.2 shows the importance of pension funds relative to the size of economy in OECD countries. It is obvious that the size of pension funds compared to GDP is relatively low in Turkey, and this reveals the growth potential of Turkish Private Pension System.



Notes: This Figure only shows the breakdown of DB and DC plans provided by pension funds. It does not take into account other plans provided by other entities such as insurance companies.
(1) Data refer to 2013. (2) Data refer to 2014. (3) Data refer to occupational pension plans only. (4) Source: Financial Services and Markets Authority. (5) Data refer to pension funds under the supervision of Luxembourg Financial Supervisory Authority (CSSF) only. (6) Data only refer to private occupational pension schemes, and do not include individual pension plans or public occupational pension schemes. (7) Data only refer to the voluntary funded pension system, and do not include funds managing mandatory plans.

Source: OECD Global Pension Statistics.

Figure 1.1: Pension Fund Investments in DC and DB plans

Elaborating on the Turkish Private Pension System, the total value of the funds of the participants in the Turkish Private Pension system is TRY 59 Billion, as of November 2016, including the state subsidy funds of TRY 7 Billion. Currently there are 18 private pension firms operating and the total number of participants is 6.6 Million, while the system has generated only 43,114 retirees until now. Table 1.1 shows the progress of the Turkish Private Pension System since its establishment.

Considering the relatively low share of pension funds to GDP in Turkey (5.5% vs 49.5% average) together with the high growth rate since its establishment (35% average annual growth rate of pension funds), the need for additional research in this field is crucial. This thesis aims to help the participants projecting their accumulations in this fast-growing investment area, and provide insight to the private pension companies and portfolio management companies, as well as the regulatory authorities, to help the industry evolve similar to developed OECD countries.

In Turkey, DC private pension plans were first deployed in 2003, and the main driver of the retirement benefits is the performance of pension funds by portfolio managers and their selection by the individuals. Although the government is working on a compulsory private pension scheme, the system currently runs on an optional basis. Citizens older than 18 years old can participate in the system and they can retire as long as they are enrolled in the system for at least 10 years and they are at least 56 years old. Individuals participate in the system through private pension companies, their contributions are invested in the pension funds established by these companies, and these funds are managed by separate portfolio management companies. When they retire, individuals have an option to take a lump-sum payment with a tax cost, or to have an annuity instead. There is also a state subsidy since 2013, which is the 25% of the individual contributions and nominally limited on the upside (annually limited at %25 of the annual gross minimum wage). However, these subsidies are monitored and managed in different funds (state subsidy funds), and their investment constraints are more strict compared to other pension funds. Therefore, these funds will be considered only in terms of policy determination framework. Some companies also provide additional contributions for their employees, in proportion to their own contributions, and deduct those contributions from company's tax assessments.

Capital Markets Board of Turkey (CMB) is responsible for the regulation and supervision of the securities market in Turkey, as well as institutions related to these markets like Borsa Istanbul, Brokerage Houses, Portfolio Management Companies, and Mutual Funds. CMB regulates the markets through Capital Markets Law (CML) and has a broad authority over capital markets in Turkey.

Investment assets in a pension fund are valued or priced in relation to the securities market where the returns on investments are determined not only by the construction, diversification mixture and the run of the investment portfolios by the fund managers, but also by the stochastic dynamics of market conditions and uncertainties that may create market risks. These market risks occur when pension fund investments, thus the participant portfolios are exposed to uncertain market fluctuations mainly due to the fluctuations in the equity, interest rate, currency (foreign exchange) and commodity prices.

The purpose of this thesis is to provide an accumulation phase simulation and some policy oriented analyses for the Turkish Private Pension System through Markov Chains and Monte Carlo Smiulations. It is obvious that the accumulation phase of a pension system is so fundamental for its distribution phase, where retirement incomes are the crucial outcomes for pensioners. That is why a simulation analytic study on a pension fund accumulation phase is critical not only for the pension plan participants, but also for the portfolio management companies and pension companies. Keeping this in mind, the following sections provide a review of the literature on pension funds and private pension systems globally and on Turkey. In connection with the existing literature relevant to this thesis, we present the theory on Markov Chains and our Markov Chain based Monte Carlo simulation approach in the next Chapter.

Year	# of Participants		Fund Size[1]		# of Retirees	Retirees over Participants
	#	growth (%)	TRY million	growth (%)		
2003	15,245					
2004	314,257					
2005	672,696	114				
2006	1,073,650	60	2,815			
2007	1,457,704	36	4,566	62		
2008	1,745,354	20	6,373	40	368	0.02%
2009	1,987,940	14	9,097	43	1,898	0.10%
2010	2,281,478	15	12,012	32	2,848	0.12%
2011	2,641,843	16	14,330	19	3,838	0.15%
2012	3,128,130	18	20,346	42	5,404	0.17%
2013	4,153,055	33	25,146	23	7,577	0.18%
2014	5,092,871	23	34,793	38	15,350	0.30%
2015	6,004,152	18	42,625	23	27,387	0.46%
November 2016	6,566,391	9	51,997	22	43,114	0.66%

Table 1.1: Turkish Private Pension System is growing rapidly since its inception in 2003. In the last ten years until the end of 2015, the number of participants grew at an average pace of 25% per year, and the size of the pension funds grew at an average pace of 35% per year.

[1]Fund Size excluding State Subsidy Funds.

Country	Pension funds (autonomous)	Book reserve (non-autonomous)	Pension insurance contracts	Other	Total all funds
Denmark	44.9	..	138.3	22.8	205.9
Netherlands (1)	178.4	..	..	..	178.4
Iceland	149.6	..	1.3	6.9	157.7
Canada	83.4	11.9	5.4	56.2	156.9
United States	79.4	..	15.9	37.7	132.9
Weighted average (2)	123.6				123.6
Switzerland (1)	123.0	..	..	..	123.0
Australia	118.7	..	..	3.5	122.2
United Kingdom (1)	97.4	..	..	..	97.4
Sweden	8.9	..	64.3	2.9	76.0
Chile	69.6	..	..	..	69.6
Finland (1)	49.4	..	9.0	..	58.4
Ireland (1)	54.0	..	1.9	0.5	56.4
Israel (3)	54.5	..	..	1.5	56.0
Simple average (2)	49.5				49.5
Japan	32.0	..	..	..	32.0
Korea	8.2	..	16.1	1.6	25.8
New Zealand	22.2	..	..	..	22.2
Mexico	15.6	..	0.1	1.1	16.7
Estonia	12.8	..	1.7	..	14.5
Spain	9.6	1.0	3.6	..	14.3
Latvia	1.4	..	..	9.6	11.0
Portugal (1)	10.1	..	..	0.8	10.9
Slovak Republic	10.3	..	..	..	10.3
Norway (1)	9.6	..	..	..	9.6
Poland	8.0	..	0.3	0.6	8.8
France (4)	0.5	..	8.2	..	8.7
Italy	6.9	0.2	1.6	..	8.7
Czech Republic	8.3	..	..	..	8.3
Slovenia	4.3	..	2.7	..	7.0
Germany (1)	6.6	..	..	..	6.6
Austria (1,5)	5.7	..	0.2	..	5.8
Belgium (1)	5.8	..	..	..	5.8
Turkey	5.5	..	..	..	5.5
Hungary (1)	4.1	..	..	..	4.1
Luxembourg (1)	2.8	..	..	..	2.8
Greece (1)	0.6	..	..	..	0.6

Table 1.2: The ratio of pension funds to GDP is above 100% in developed countries like Denmark, Netherlands, Iceland, Canada, U.S., Switzerland, Australia, and almost 100% in U.K.. The simple average for the 35 countries is also 49.5%, a very high ratio compared to the undermost 13 countries including Turkey. This fact reveals the potential for this countries to develop their pension system and increase the size of pension funds. It also reveals the need for further research about the pension funds, given the high growth potential of the sector in these countries. (Source: OECD Global Pension Statistics)

1.1 Pension Fund Literature

In the previous studies on pension plans and pension funds, Thomas et al. (Thomas *et al.*, 2014) examine the effect of pension fund investments in stocks to stock market volatility, and finds out that the stock market volatility is significantly reduced with the increasing share of pension fund investments in stocks. Blake et al. (Blake *et al.*, 2003) discuss the choices of DC pension participants at retirement. They compare life annuities with different equity exposures and find out that the most important decision in terms of cost is the level of equity investment of the plan member. Angelidis and Tessaromatis (Angelidis en Tessaromatis, 2010) and De Menil (De Menil, 2005) argue the effects of investment constraints on pension funds performances. The former shows that the investment constraints on risky assets, as well as on international diversification imposes a loss to pension funds, and the latter concludes that the optimal rate of foreign investment in pension funds should be more than zero. In terms of other macro economic variables, Kenc ad Perraudin (Kenc en Perraudin, 1997) examine the impact of pensions on savings, labor supply, retirement age and welfare and describes the attributes a well designed pension system should include.

With regards to pension fund risk management, Josa-Fombellida and Rincón-Zapatero (Josa-Fombellida en Rincón-Zapatero, 2004) analyze the optimal risk management of pension funding in DB plans, and conclude that diversification helps faster convergence of the fund's expected value to the actuarial liability, and optimal investment in risky assets is not null even if the fund's expected value is very close to convergence. Jackwerth and Slavutskaya (Jackwerth en Slavutskaya, 2015) show that adding alternative assets to pension fund portfolios increase the total benefit of the funds.

An et al. (An *et al.*, 2013) show that corporate sponsors of DB plans take on dynamic risk-taking strategies, and Haberman et al. (Haberman *et al.*, 2000) derive a model for the optimal funding and contribution rates for DB pension plans, while Binswanger (Binswanger, 2007) shows that PAYG systems are beneficial for all income levels in terms of risk management[2]. Cooper and Ross (Cooper en Ross, 2001) analyze the reasons behind underfunding of pensions from the perspective of optimal contracting theory and the link between financial markets and the underfunding of pensions. They show that besides the commitment problem of the firm, capital market imperfections also lead to underfunding.

Continuing with the DB plans, Aglietta et al. (Aglietta *et al.*, 2012) shows that active management plays an important role as a source of performance for pension funds. Josa-Fombellida and Rincón-Zapatero (Josa-Fombellida en Rincón-

[2]In unfunded pension plans, retirement incomes are financed by the contributions from the plan sponsors or participants, and this system is also known as PAYG (Pay as You Go) system.

Zapatero, 2010) analyzes the optimal asset allocation of an aggregated DB plan fund with a stochastic interest rate (Vasicek model), and Menoncin (Menoncin, 2005) studies the asset allocation problem of a PAYG pension fund. Menoncin shows that the weight of the bond increases constantly as the bond volatility approaches zero while the maturity becomes closer. Hainaut and Devolder (Hainaut en Devolder, 2007) use an ALM framework to analyze the dividend policy and the asset allocation of a pension fund, and shows that the utility choice plays an important role on the ALM policy, and positions in risky assets decrease within time. Ngwira and Gerrard (Ngwira en Gerrard, 2007) studies the optimal funding and asset allocation strategies of pension funds and Yu et al. (Yu *et al.*, 2012) presents an optimization approach for analyzing the problems of portfolio selection in long term investments to generate an effective asset allocation that reduces the downside risks of the investment.

Recently there has been an increase in DC type pension plans literature. Both Han and Hung (Han en Hung, 2012) and Yao et al. (Yao *et al.*, 2013) consider the optimal asset allocation problem of a DC pension plan with stochastic inflation, with the latter also taking into account the Markowitz mean-variance criterion. Battocchio and Menoncin (Battocchio en Menoncin, 2004) studies the portfolio problem of a fund manager in an environment of salary and inflation risk, and Yao et al. (Yao *et al.*, 2014) analyzes the asset allocation problem for a DC pension fund under stochastic income and mortality risks. Ma (Ma, 2011) extends the work of Battocchio and Menoncin (Battocchio en Menoncin, 2004) and studies the optimal asset allocation problem of DC pensions with exponential utility. Yao et al. (Yao *et al.*, 2016) investigate the portfolio selection problem of a DC pension fund, incorporating both mortality risk of the participant and a Markov regime switching market state.

Above there are numerous valuable studies about pension funds, including asset liability management, underfunding, effects of single financial instruments on pension funds, effects of pension fund investments on capital markets, and optimal allocation of pension fund assets.

Obviously, most of the studies on DC plans focus on pension funds and portfolio selections, as the main driver of these plans are pension funds and their performances. While focusing on the financial instruments invested by Turkish Private Pension Funds, the main contribution of this thesis is providing an accumulation projection model for the participants and pension fund companies, as well as providing an insight on policy determination about portfolio allocations, fee structures and state subsidies.

1.2 Pension Fund Studies on Turkey

Turkish Pension Plans have not been studied extensively and the number of academic papers is rather scarce in this area. In a study dated 2008, Akın (Akın, 2008) analyzes the Turkish social security system and private pension system in detail and compares the practical and audit standards with different countries, investigates its possible effects on capital markets and finally surveys the preferences of participants on both entering the system and on their fund selection. Being one of the most comprehensive studies about Turkish Private Pension System, it provides a general framework about how the system works and how people react to it.

In a more recent study, Gökçen and Yalçın (Gökçen en Yalçın, 2015) discuss the role of active management in pension funds, focusing on Turkish private pension system. They argue that active management of pension funds does not outperform passive index funds, and they suggest low-cost index funds for emerging market countries. Their findings contradict with Aglietta et al. (Aglietta *et al.*, 2012), in which they suggest that active management is a source of performance for pension funds. However, we are more interested in projecting the accumulations of participants and asset allocation comparisons of pension funds, rather than testing the role of active management.

Natof (Natof, 2010) compares the pension fund returns with alternative capital market instruments, Yüceer (Yüceer, 2010) compares the returns of the pension funds issued by different private pension companies with each other using performance metrics like Sharpe ratio, Treynor ratio, and Jensen's Alpha. Tezcan (Tezcan, 2010) evaluates the pension fund performances in Turkey in terms of security selection and market timing, Dinçel (Dinçel, 2010) analyzes the pension fund performances and provides suggestions for retirement planning, such as longevity and inflation, and Yener (Yener, 2006) examine the effects of private pension funds on capital markets, provide information about legal documents like Capital Markets Boards Law and Communiques, and run historical comparisons between different private pension funds.

Most of the research above about Turkish Private Pension System present the regulatory environment at the date of the publications, and analyze the historical returns of pension funds for performance comparison. Due to the dynamic and continuously changing nature of the legal policies, private pension companies and their funds, as well as portfolio managers, historical comparisons can give only limited insight about future performances and necessary policies. Hence, broader propositions about pension funds and a more general framework on private pension system are needed.

We aim to provide an extensive mathematical model for accumulation projection, and bring a new perspective to the area of interest about Turkish Private Pension System. We challenge the current allocations of pension funds, as well as the current fee structure, and provide guidance to participants on their accumulation projections.

1.3 Our Contribution

Despite the fact that there are numerous studies about private pension system and pension funds, mainly considering DB pension plans, funding structures, optimal asset allocations, and active/passive management, to our knowledge, there is a lack of studies in the area of accumulation projection, given a set of investment instruments and a time horizon. Analyzing the Turkish Private Pension System and pension funds, previous studies discussed in Section 1.2 contribute a lot in terms of operational structure and historical performances, and highlight the similarities and discrepancies with other countries.

Our objective in this thesis is to propose a general and extensive pension fund management framework for Turkish Private Pension System, rather that analyzing it's current operational structure. For this purpose, we construct a comprehensive, retirement income oriented accumulation phase simulation model focusing on the Turkish Private Pension System. Our contributions to the field through our modeling approach and simulation analysis framework are as follows:

1. **A New Perspective:** We provide an extensive accumulation phase model that participants can benefit with respect to their incomes at retirement. In our construction, we deploy some sophisticated techniques including Markov Chains and Monte Carlo Simulations. To our knowledge, there has been no study on projecting an accumulation phase for the Turkish Private Pension System using these techniques under a given a set of assumptions and portfolio allocations.

2. **Analysis:** We run different scenarios on contribution rates, portfolio allocations, and fees, as well as on the existence of state subsidy funds. We find out that increasing the contribution rates in the existence of fees help participants keep their accumulation amounts at similar levels, but overall the average annual Internal Rate of Return (IRR) until retirement decreases with the introduction of fees to the model. In this case, introducing state subsidy funds to the model increases both IRR and the total accumulations of the participants. In terms of portfolio allocations, our results show that increasing the FX exposure in portfolios improves the investment performance. Having at least 10% of FX exposure in portfolios increases the overall IRR by almost 1% in all scenarios. We provide insights on policy determination in terms of fee structures and asset allocations. This type of rigorous analyses on policy determinations about Turkish Private Pension System have never been studied before.

3. **Flexible Modeling:** Although we focus on Turkish Private Pension System, our model is applicable to other pension systems with several other financial

instruments. The Markov Chain we have defined can be useful for forecasting financial instrument returns, and the accumulation phase simulation model can be implemented to other kind of investment strategies.

4. **Practical Implications:** We believe that our model and results are beneficial not only for individual participants, but also for portfolio management companies and private pension companies. Participants may use this model for projecting their accumulation amounts towards retirement incomes, and for their fund selections through the investment period. Portfolio management companies can benefit from the estimated paths of the financial instruments, and implement the related Markov Chains to their own models. Private pension companies may use our results to provide consultancy to their customers on accumulation amount projections and portfolios selections. They can also benefit from the portfolio allocation results while making decisions on new fund establishments.

5. **Information Scope:** We analyze the historical progress and the current state of the Turkish Private Pension System (TPSS), and the global pension funds. We examine TPPS's progress in number of participants and retirees, total fund size, and asset allocations. We also provide aggregated data on Turkish Capital Markets, reflecting the depth and liquidity of the instruments.

After a review that we give here for the general principals of private pension systems globally and in Turkey, and the importance of private pension funds in the economy as well, we process with the following five chapters: Chapter 2 introduces the accumulation projection model we generate, and gives detailed information about the theory and methodology that our model relies on (Markov Chains and Monte Carlo Simulations). Chapter 3 analyzes the instruments and the depth of Turkish Capital Markets, explains the data we use, and elaborates the model and the simulations. Chapter 4 demonstrates the interim and final results of the simulations, using different scenarios for the fees, contribution amounts, state subsidies, and portfolio allocations. Chapter 5 provides discussions on the results, examines the effects of fee and contribution rate structures, state subsidies, and different portfolio allocations on investment returns, and provides some suggestions for future policy determination. Finally, we draw our conclusions in Chapter 6.

Chapter 2

The Theory And Methodology

In this Chapter, we set up our model for a pension fund's accumulation amount simulations that are based on Markov Chains and Monte Carlo methodologies. We explain the underlying theory for our simulation attempts in detail, and depict the main assumptions and equations that will be implemented in Chapter 3.

The main challenge in constructing our framework for the Turkish Private Pension System is to define an accumulation amount simulation problem that is crucial for a retirement income distribution phase outcomes. For this purpose, we present a pension fund management problem with a state-space modeling approach. A state-space model, also called dynamic linear model (DLM), is a representation of the dynamics of an N^{th} order system as a first order differential equation in an N-vector, that is also known as the state. A state is a property that changes with time. A state space model can be represented as follows:

$$Y_t = \mathbf{A_t} X_t + \mathbf{B_t} U_t \tag{2.0.1}$$
$$X_{t+1} = \mathbf{C_t} X_t + \mathbf{D_t} U_t \tag{2.0.2}$$

Here, Y stands for the observable vector variable (output) and X as the state (vector) variable with a finite state stationary Markov chain feature. U is the input, and unbiased and efficient estimates of X_t and Y_t are sought. $\mathbf{A}$ is the state-to-output matrix, $\mathbf{B}$ is the feedthrough matrix, $\mathbf{C}$ is the state matrix, and $\mathbf{D}$ is the input-to-state matrix.

To represent the above model in terms of accumulation projection, we can re-write (2.0.1) and (2.0.2) as follows:

$$\begin{aligned} Y_t &= \mathbf{A}X_t + \mathbf{B}U_t \\ &= [Y_{t-1} + c_t(1-m)] \sum_{i=1}^{n} w_t^i e^{X_t^i - p} \end{aligned} \tag{2.0.3}$$

$$X_{t+1} = \mathbf{C_t}X_t + \mathbf{D_t}U_t \tag{2.0.4}$$

Here, Y_t is the pension accumulation at time t where $Y_0 = 0$, c_t is the contribution amount at time t, n is the accumulation time in months, m is the administrative fee, p is the portfolio management fee, w_t^i is the weight of instrument i in the portfolio at time t, and X_t^i is the return of benchmark index i at time t. So, to be able to project the accumulation of a participant with known contribution amounts, administrative and portfolio management fees, we need to simulate the financial instrument returns, and the weights the participant invests in those instruments.

We assume both fixed and increasing contribution amounts (c_t) throughout the investment period. Simulating the investment weights (w_t^i) is less challenging as we will generate all possible equal weighted combinations of the 9 financial instruments we are dealing with, and assume a fixed allocation for each instrument until retirement. We use industry averages for portfolio management (p) fees, in addition to assuming no fees are charged until retirement, and assume no administrative fees (m) are charged in all scenarios, as most of the plans offer promotions and charge no administrative fees to participants in practice.

For the simulation of financial instrument returns, we define a finite state stationary Markov Process for each instrument, then apply Ordinary Monte Carlo simulation to these processes. We define a Markov Process for each index's returns, and using historical data, we calculate the parameters of the specified Markov Chain (transition probability matrix, and return and standard deviation matrices comprising all possible steps of the chain). After calculating the Markov Chain parameters for the index returns (X_t^i), we run an Ordinary Monte Carlo simulation for each index, starting from the current date until retirement. We finally calculate the cumulative expected accumulations (Y_t) and related confidence intervals using equation 2.0.3.

We explain in detail the features of Markov Chains in the next section. In Section 2.2, we represent the Monte Carlo Simulation Methods, their use in finance and how we extend our model with them to project the accumulations of participants. In Section 2.3, we review Markov Chain Monte Carlo (MCMC) methods briefly. Beside using Markov Chains in collaboration with Monte Carlo Simulation Methods, the methodology used in this thesis differs from the MCMC approach, and we refer to these distinctions also in Section 2.3. In Chapter 3, we will give more details about the data used, and construct our model based on the principals discussed in this chapter.

2.1 Markov Chains

Markov Chains have been introduced by A. A. Markov in the early twentieth century (Basharin *et al.*, 2004). A stochastic process X_n is a Markov Process, where each X_n takes values in the space θ, and each state of X_{n+1} depends only to the current state (X_n), and not to the previous states. In other words, a Markov Process needs only limited memory, and this memory-less property is called the Markov property.

Häggström (Häggström, 2002) defines a Markov chain as follows:

Let $\mathbf{P}$ be a $k \times k$ matrix with with elements $P_{i,j} : i, j = 1, \ldots, k$. A random process $(X_0, X_1, \ldots)$ with finite state space $S = s_1, \ldots, s_k$ is said to be a Markov chain with transition matrix $\mathbf{P}$, if for all n, $i, j \in \{1, \ldots, k\}$, and $i_0, \ldots, i_{n-1} \in \{1, \ldots, k\}$ we have:

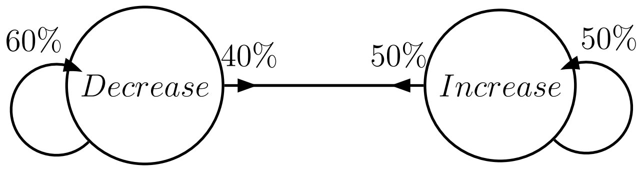
$$\begin{aligned}\Pr(X_{n+1} = s_j | X_0 = s_{i_0}, X_1 = s_{i_1}, \ldots, X_{n-1} = s_{i_{n-1}}, X_n = s_{i_n})\\ = \Pr(X_{n+1} = s_j | X_n = s_i)\\ = P_{i,j}\end{aligned}$$

The elements of the transition matrix $\mathbf{P}$ are called transition probabilities. The transition probability $P_{i,j}$ is the conditional probability of being in state s_j at time $(t+1)$ given that we are in state s_i at time t. $\Pr(X_0)$ is the initial distribution of the related Markov chain.

Every transition matrix satisfies

$$P_{i_j} \geq 0 \text{ for all } i, j \in 1, \ldots, k \text{ , and}$$
$$\sum_{j=1}^{k} P_{i,j} = 1 \text{ for all } i \in 1, \ldots, k.$$

To illustrate Markov Chains and how we use those for benchmark index returns, consider the following example of Markov Chains: If the value of a stock falls today, there is a 60 percent of chance for it to fall again the next day, and 40 percent of chance to increase. If the value of that stock increases today, there is a 50 percent chance for rising again the next day, and 50 percent of chance to fall. Now we can graph the Markov Process for this stock as follows:



In this case, the probability matrix of the return on this stock will be:

$$\mathbf{P} = \begin{array}{c} \\ Decrease \\ Increase \end{array} \begin{array}{c} \begin{array}{cc} Decrease & Increase \end{array} \\ \begin{pmatrix} 0.60 & 0.40 \\ 0.50 & 0.50 \end{pmatrix} \end{array} \tag{2.1.1}$$

This means that $p_{dd} = 0.60$, $p_{di} = 0.40$, and $p_{id} = p_{ii} = 0.50$. The process described above is a first-order Markov Process, and if the state of the variable X_n depends not only on X_{n-1} but also on X_{n-2}, i.e. the return on the stock tomorrow does not only depend on the stock return today, but also depends on it's return yesterday, then X_n is called a second-order Markov Process. We give an example of a second order Markov Process below, for more information on higher-order Markov Chains, one can refer to Ching et al. (Ching *et al.*, 2006).

A second order Markov Process:

$$\Pr(X_{n+1} = s_j | X_0 = s_{i_0}, X_1 = s_{i_1}, \ldots, X_{n-1} = s_{i_{n-1}}, X_n = s_{s_i})$$
$$= \Pr(X_{n+1} = s_j | X_n = s_i, X_{n-1} = s_{i-1})$$
$$= P_{ii',j}$$

The transition probability $P_{ii',j}$ is the conditional probability of being in state s_j at time $(t+2)$ given that we were in state $s_{i'}$ at time $t+1$ and in state s_i at time t.

We use a second order Markov Process instead of a first order Markov Process because of the intention to have a more accurate precision in estimating the future performance of instruments, and because the number of historical data we have does not allow the use of a higher order process efficiently.

Now, consider the previous example with three return probabilities: stock falls more than 1 standard deviation (fall), it stays between -1 standard deviation and +1 standard deviation (stay), and stock rises more than 1 standard deviation (rise). Assume that we calculated the transition probabilities using historical data. The probability matrix will look like:

$$P = \begin{array}{c} \\ fall, fall \\ fall, stay \\ fall, rise \\ stay, stay \\ stay, fall \\ stay, rise \\ rise, rise \\ rise, stay \\ rise, fall \end{array} \begin{array}{c} \begin{array}{ccc} fall & stay & rise \end{array} \\ \begin{pmatrix} p_1 & p_2 & p_3 \\ p_4 & p_5 & p_6 \\ p_7 & p_8 & p_9 \\ p_{10} & p_{11} & p_{12} \\ p_{13} & p_{14} & p_{15} \\ p_{16} & p_{17} & p_{18} \\ p_{19} & p_{20} & p_{21} \\ p_{22} & p_{23} & p_{24} \\ p_{25} & p_{26} & p_{27} \end{pmatrix} \end{array} \tag{2.1.2}$$

One problem about collecting historical data is that there may be no historical evidence of any 3 combination of these states. For example, if there were no historical data available for a "rise - fall - rise" days in a row, to calculate the transition probabilities, we would use the theorem introduced by Grinstead and Snell (Grinstead en Snell, 2012):

Theorem 2.1.1. *Let* $\mathbf{P}$ *be the transition matrix of a Markov Chain. The* ij*th entry* p_{ij}^{n} *of the matrix* $\mathbf{P}$ *gives the probability that the Markov Chain, starting in state* s_i*, will be in state* s_j *after n steps. i.e.:*

$$p_{ij}^{2} = \sum_{k=1}^{r} p_{ik}p_{kj}. \tag{2.1.3}$$

Here, r is the total number of states. Similar to the second order Markov Chain example with three states described above, we define four states for the financial instrument returns, and calculate probabilities for the transitions between these states using historical data. We define the transition states in our model as in Table 2.1.

State	Condition
s_1	$r < \mu - \sigma$
s_2	$\mu - \sigma \leq r < \mu$
s_3	$\mu \leq r < \mu + \sigma$
s_4	$r > \mu + \sigma$

Table 2.1: Here, r is the return of the related financial instrument, μ is the historical mean, and σ is the historical standard deviation of the financial instrument

And after modeling the financial instrument returns as a second order Markov Process, the transition probability matrix that we use will be like in the Equation (2.1.4).

$$P = \begin{array}{c} \\ s_{11} \\ s_{12} \\ s_{13} \\ \vdots \\ s_{41} \\ s_{42} \\ s_{43} \\ s_{44} \end{array} \begin{array}{c} \begin{array}{cccc} s_1 & s_2 & s_3 & s_4 \end{array} \\ \begin{pmatrix} p_1 & p_2 & p_3 & p_4 \\ p_5 & p_6 & p_7 & p_8 \\ p_9 & p_{10} & p_{11} & p_{12} \\ \vdots & \vdots & \vdots & \vdots \\ p_{49} & p_{50} & p_{51} & p_{52} \\ p_{53} & p_{54} & p_{55} & p_{56} \\ p_{57} & p_{58} & p_{59} & p_{60} \\ p_{61} & p_{62} & p_{63} & p_{64} \end{pmatrix} \end{array} \tag{2.1.4}$$

For the missing data of transition probabilities, we use equation (2.1.3). Then, using this chain, we run Ordinary Monte Carlo simulations several times, and using the contribution amounts a person makes until he retires, we create a confidence interval for his accumulation, for each portfolio choice. Calculation method for the transition probabilities, as well as other construction details of our model will be discussed in Chapter 3. We discuss the Monte Carlo Simulation method in the next section.

2.2 Monte Carlo Simulation Methods

Monte Carlo simulation is a widely used method for simulating possible values under concern in a system. In cases of quantitative analyses where randomness take part, and it is difficult to derive an exact solution, Monte Carlo simulation methods are very powerful options for estimating a solution. Being a very flexible method for accounting the risks in computations, it is widely used in areas like insurance and finance, physics, energy, transportation, statistics, engineering, etc.

Monte Carlo simulation heavily depends on the law of large numbers - a theorem saying that the average of a large number of trial results should be close to the expected value -, thus it depends heavily on repeated random number sampling.

Wang (Wang, 2012) derives a scheme of estimating the expected value of a function of a random variable ($\mu = E[h(X)]$) as follows:

1. Generate samples, or independently identically distributed (i.i.d.) random variables $X_1, X_2, \ldots, X_n$ that have the same distribution as X.

2. The estimate of the expected value of μ is defined to be the sample average:

$$\begin{aligned}\hat{\mu} &= \frac{1}{n}[h(X_1) + h(X_2) + \cdots + h(X_n)] \\ &= \frac{1}{n}\sum_{i=1}^{n} X_i \end{aligned} \tag{2.2.1}$$

In order to determine how close is $\hat{\mu}$ to μ, we calculate the confidence intervals as follows:

$$\hat{\mu} \pm z_{\alpha/2} \frac{\sigma_X}{\sqrt{n}} \tag{2.2.2}$$

In finance, main applications of Monte Carlo Simulations are on option pricing and VAR calculation. Wang and Kao (Wang en Kao, 2016) provides a general framework for the problem of searching parameter space in Monte Carlo simulations for derivative pricing. Dang et al. (Dang *et al.*, 2015) develops a really efficient Monte Carlo method for pricing European options.

Monte Carlo methods are also one of the two methods for calculating the Value at Risk (VAR), the other being the Historical simulation method. For more information on Monte Carlo Methods and their applications on finance, one can refer to Benninga et al. (Benninga *et al.*, 2008), Wang (Wang, 2012), Dagpunar (Dagpunar, 2007), McLeish (McLeish, 2011), Robert and Casella (Robert en Casella, 2013), and Chan and Wong (Chan en Wong, 2015).

We draw a path for the financial instrument returns by defining a Markov Chain and calculating the related parameters of the chains for each instruments. Then, using those parameters, we run the Markov Chains several times and use Equation (2.0.3) to calculate the accumulations for each return path. Finally, we take the average of those projected accumulations to estimate the expected accumulations and related confidence intervals for each different portfolio allocation.

Running the Markov Chain several times and averaging the outcomes to estimate the expected value of accumulation defines the integration of Monte Carlo Simulation to our model. 95% confidence intervals for accumulations are calculated for each portfolio choice. The best and worst performing asset allocations are interpreted both in terms of current allocation structure of pension funds, and in terms of economic dynamics.

2.3 Markov Chain Monte Carlo (MCMC)

Although our simulation approach in this thesis is an ordinary Monte Carlo Simulation approach, we digress here on an extended modeling approach form of it. In this way, we express that our simulation approach is flexible for further advancements.

When probability densities of stochastic processes are only partially known, Markov Chain helps to generate random samples from a target distribution (i.e. run the Markov Process sufficiently long) to successfully summarize the features of that distribution. These methods of simulating a Markov Process as a chain are also known as Markov Chain Monte Carlo (MCMC) methods.

The idea of MCMC was invented by Metropolis *et al.* (1953) and has been generalized by Hastings (1970). In 1984, Geman en Geman (1984) introduced a special case of Metropolis-Hastings algorithm using Gibbs Sampler. The main idea of MCMC is about simulating stochastic processes with proportionally known probability distributions. The algorithm is widely used for calculating multi-dimensional integrals. Geyer (2011) defines the Ordinary Monte Carlo as a special case of MCMC, where the random variables are independently and identically distributed, and the Markov Chain is stationary and reversible. For further details on MCMC, one can refer to Brooks *et al.* (2011), Karandikar (2006), Kendall *et al.* (2005), and Cappe en Robert (2000).

In this thesis, we generate a stationary Markov Chain and run an ordinary Monte Carlo Simulation using these chains. We should emphasize that this methodology is different than using MCMC. For example, we do not try to estimate the probability distribution of the financial instrument returns. We generate a Markov Chain for the return path of the financial instruments, than using these chains we run Ordinary Monte Carlo simulations until a person retires and project accumulations for participants using these results.

The methodology we use is similar to a MCMC model in a way that we use Markov Chains and Monte Carlo simulations successively to interpret the behavior of a random variable, of which we don't know the exact probability distribution. MCMC also aims to approximate a probability distribution of a random variable.

On the other side, in MCMC, the Markov Chain and the Monte Carlo simulation methods are more integrated, as the process of creating samples and averaging the results run throughout the Markov Chain. In our model, we use Markov Chains and Monte Carlo methods successively, not jointly. Another point is that MCMC tries to converge to a target distribution, so the main purpose is to determine the ending point of the simulation (the convergence point). In our model, we define the final point of the simulation (simulation ends at retirement), and our main purpose is to determine properties of the Markov Chain, not the determine the ending point.

In Chapter 3, we first explain the benchmark indices that we use in our model, examine the Turkish Capital Markets, and demonstrate the model we created in detail.

Chapter 3

The Data and The Model

In the previous chapters, we have made an introduction to the private pension system and analyzed the increasing share of DC pension types, thus the pension fund investments. We presented that although Turkish Pension Funds have been growing intensively since its inception, the share of the pension funds to the size of the economy is very small compared especially to developed markets, signaling high growth potential. The area of research related to the Turkish Private Pension System is in its emerging phase, and more studies are necessary for a healthy and successful development of the system.

For this purpose, we contribute to the field of area with a general accumulation phase simulation model, that can also be implemented to other pension funds outside of Turkey. We have explained the theory underlying our model in detail in Chapter 2, and now we will unveil the details of the used data and illustrate the model in the following Sections.

3.1 The Data

We introduce a pension fund accumulation phase simulation model for the Turkish Private Pension System, so the main sources of the data used in this thesis are trusted entities such as Capital Markets Board of Turkey (CMBT), Pension Monitoring Center (PMC), Borsa Istanbul (BIST), Central Bank of Republic of Turkey

(CBRT), Turkish Statistical Institute (TurkStat), Republic of Turkey Prime Ministry Under-secretariat of Treasury (Treasury), Istanbul Settlement and Custody Bank Inc. (Takasbank), Republic of Turkey Ministry of Finance, The Ministry of Turkey Ministry of Development, and Turkish Institutional Investment Managers' Association (TKYD).

For information and statistics about the global pension system and investment markets, as well as comparisons with global pension practices, we consulted reliable data sources such as International Money Fund (IMF), International Bank of Reconstruction and Development (IBRD), Organization for Economic Co-operation and Development (OECD), and World Bank.

In Turkey, 42% of pension fund portfolios consist of government bonds in different maturities and inflation-linked government bonds; 22% consists of money market instruments like reverse repo, time deposits, Takasbank money market and participation accounts; 11% of the portfolios are invested in stocks; and 9% is invested in corporate debt securities and 8% in eurobonds. Only 2% of the portfolios are invested in gold. Remaining 6% is invested in rent certificates and foreign equities. See Table 3.1 for historical asset allocation details of pension funds.

Fixed income securities have the biggest share in the current allocation of pension funds for several reasons. The first participants of the Turkish Private Pension System at 2003 were the people transferring their savings from provident funds, or people have some other savings and investing them into a new system Private Pension System. These participants were more risk averse at that time, partly because of demographics and bad investment experience in the past, and being risk averse lead these investors to fixed income securities. Also the high interest rate environment in Turkey leads people to investing in fixed income securities.

In terms of level of development of Turkish capital markets, we provide some details for the outstanding debt securities and equity markets. There are TRY 457 Billion outstanding government debt securities as of November 2016, including TRY 270 Billion of fixed coupon and discounted bonds, TRY 106 Billion of CPI linked

Year	Total Pension Fund Size (TRY 000)	Government Bonds and Bills	Money Market Instruments	Local Equity	Corporate Bonds and Bills
2003	42,791	56.6	15.6	8.7	1.0
2004	300,020	66.0	14.1	13.1	0.4
2005	1,216,720	75.3	8.7	11.2	0.0
2006	2,820,105	66.9	18.9	8.6	0.0
2007	4,571,115	64.2	20.3	11.4	0.0
2008	6,384,480	66.0	22.2	7.7	0.0
2009	9,106,876	65.4	21.0	9.9	0.0
2010	12,016,913	57.2	26.8	12.1	0.5
2011	14,338,386	57.2	23.1	12.1	2.8
2012	20,357,054	56.4	17.8	16.1	5.6
2013	26,280,835	57.7	16.3	13.9	7.5
2014	37,799,059	52.8	17.5	13.4	10.5
2015	47,983,073	48.9	18.6	14.0	9.3
2016	58,954,742	41.6	21.8	11.2	9.4
Year	Total Pension Fund Size (TRY 000)	FX Bonds and Bills	Rent Certificates	Gold	FX Equity
2003	42,791	18.1	0.0	0.0	0.0
2004	300,020	6.3	0.0	0.0	0.2
2005	1,216,720	4.7	0.0	0.0	0.1
2006	2,820,105	5.5	0.0	0.0	0.1
2007	4,571,115	4.1	0.0	0.0	0.0
2008	6,384,480	3.7	0.0	0.0	0.4
2009	9,106,876	3.2	0.0	0.0	0.2
2011	14,338,386	4.2	0.0	0.0	0.6
2012	20,357,054	3.7	0.0	0.0	0.4
2013	26,280,835	3.4	0.0	0.3	0.8
2014	37,799,059	4.0	0.0	0.8	1.0
2015	47,983,073	6.5	0.0	1.1	1.5
2016	58,954,742	7.6	4.5	2.2	1.8

Table 3.1: Although decreasing since 2009, fixed income securities still share the biggest allocation in pension funds. As of November 2016.

bonds and TRY 81 Billion floating rate bonds. There are also USD 59 Billion outstanding external debt securities (Eurobonds), including USD (USD 48 Billion), EUR (USD 8 Billion) and JPY (USD 4 Billion) denominated Eurobonds. Total size of the corporate debt securities are TRY 51 Billion. And for the equities market, the free float market capitalization of all stocks trading in Borsa Istanbul is TRY 176 Billion.

In light of the current allocations described above and the limitations assigned by the capital markets board, we use 9 different and extensive benchmark indices, namely repo, short term, medium term, cpi linked, and long term bond indices, USD and Euro based eurobond indices, gold index, and equity index.

The most comprehensive indices about Turkish Capital Markets are calculated by Borsa Istanbul, with cooperation of TKYD mostly on fixed income indices. Therefore, the main interest of this thesis is the indices pubilshed by Borsa Istanbul. For the money market index we use BIST-KYD Repo Index (Gross), for the bond indices, we use BIST-KYD short-term, BIST-KYD medium-term, BIST-KYD CPI Indexed, and BIST-KYD long-term Government Bond indices. For eurobonds, we use BIST-KYD

Eurobond USD/TRY and BIST-KYD Eurobond EUR/TRY indices. For gold, we use BIST-KYD Gold Price Index (Weighted Average), and finally for equity, we use BIST-100 Total Return Index. These government bond indices cover the entire government bonds market, excluding only the floating rate notes, as there is no benchmark index for floating rate notes. Most of the public companies trading in the Borsa Istanbul pay dividends, so to reflect the effective return on their shares comprehensively, we use a total return index, rather then a core equity index. The BIST-100 Index covers the 92% of the equity market with TRY 162 Billion free float market capitalization.

The securities in all BIST-KYD indices are weighted according to their issue amounts. BIST-KYD local government bond indices are named according to the maturity of securities they comprise.The duration ranges of these indices are $0-365$, $366-1,095$ and over $1,096$ days for the short-term, medium-term and long-term indices, respectively. BIST-KYD Eurobond indices represent all the USD and EUR denominated Eurobonds issued by Turkey Secreteriat of Treasury, and the returns of these indices are published in TRY terms. Repo index represents the average repo rate in the Borsa Istanbul, and the Gold Price Index (Weighted Average) represents the average traded price of gold in the Borsa Istanbul Precious Metals and Diamonds market. BIST-100 Total Return Index comprises the largest 100 companies trading in Borsa Istanbul according to their market capitalization, and it is an adjusted version of the BIST-100 Index including the dividend payments.

Even though sharing the same weight like the eurobonds in the current fund structure, corporate bonds are not in the extent of this thesis because the broad-based index covering the corporate bonds market has just been established. Previous BIST-KYD indices on corporate bonds included only the securities which are issued through public offering. However, these securities are far from representing the corporate debt market both in terms of risk-return nature, and in terms of share in total outstanding corporate debt. Securities issued through public offering have only 24.7% share in total corporate bond issues, and 90.6% of these issues are constituted by banking sector issues, which offer a lower return and risk composition compared to other issuer. See Table 3.2 for details on corporate debt issues.

Moreover, the liquidity on corporate bonds are still very poor. Table 3.3 shows the market volumes and number of traded contracts of government and corporate debt securities at Borsa Istanbul between 2000 and 2015. Although the volume fell to TRY 39,777 in the year of 2001 financial crisis, the average volume since 2000 is TRY 315,000 for government debt securities. Starting from 2006, the average volume of corporate securities is only TRY 5,340, and the volume in 2015 is TRY 14,441. Further research may expand on corporate bonds as the sector grows, liquidity improves and the corresponding indices evolve.

We use Jarque-Bera, Chi-square goodness-of-fit and Lilliefors tests at 95% confidence level to test the returns of benchmark indices for normality. These tests returns 1 if one can reject the null hypothesis that the data normally distributed, and returns 0 if the null hypothesis can not be rejected. For all instruments, at least one of the tests show that one can not reject the null hypothesis of normality. Table 7.1 in Appendix shows the results of the normality tests, and Figure 7.1 and 7.2 in Appendix also shows the histogram and normal probability plots for these instruments.

We use monthly price data for these benchmark indices starting from December 2010 and calculate monthly log-returns. We could use data starting from an earlier date for equity and eurobond indices, but to ensure that all the instruments share the same history in terms of economic and financial cycles, we use an identical date interval for each instrument. Table 3.4 shows the summary statistics of these financial instrument returns. Equity and Gold indices are the most volatile among all securities, while the Repo and Short-Term Bond indices have the least volatility. FX instruments have the biggest average return for the period of interest. We refer to the currency appreciation and depreciations in emerging countries like Turkey, in Chapter 5. It is interesting that the historical means and standard deviations of the related indices for the related time period contradict with the risk-return trade off hypothesis, which assumes that higher expected risk leads to higher expected return. See also Figure 7.3 in Appendix for historical performances of the financial securities we use in our model.

The average annual portfolio management fee of the pension funds is 1.62% as of October 2016, and has been decreasing from 3.44% since 2003, and the State Subsidy Funds have have 1% annual portfolio management fee. We calculate monthly fees by dividing these annual fees by 12. Portfolio management fees are shared out between private pension companies and portfolio management companies in practice. Please refer to Figure 7.4 in Appendix for the historical trend of fees.

Year	Public Offering (TRY Million)		# Qualified Investors (TRY Million)
	Banking Sector	Other	
2010	1,300	551	833
2011	11,250	981	1,886
2012	20,054	2,073	5,985
2013	21,619	1,735	14,220
2014	21,707	1,363	22,915
2015	17,754	1,317	28,747
2016	11,318	1,177	38,054

Table 3.2: Even though Corporate Bond issues to qualified investors reflect the risk-return structure of the Corporate Debt Market better and their share in total issues increase through time, the official index tracking those issues has just been established.

Year	Market Volume (TRY 000)		# of Contracts	
	Government Debt	Corporate Debt	Government Debt	Corporate Debt (%)
2000	166,336	0	206,453	0
2001	39,777	0	177,170	0
2002	102,095	0	292,312	0
2003	213,098	0	445,868	0
2004	372,670	0	553,359	0
2005	480,723	0	592,437	0
2006	381,760	12	550,787	124
2007	363,922	10	521,651	104
2008	300,806	174	445,843	1,693
2009	416,802	249	492,133	2,380
2010	445,837	346	382,356	3,973
2011	474,766	3,516	355,205	6,129
2012	350,119	7,248	260,945	11,684
2013	390,581	13,643	264,928	19,588
2014	306,183	13,768	221,977	21,385
2015	235,010	14,441	215,649	21,645

Table 3.3: Although increasing since 2006, Trade Volume and Number of Contracts for Corporate Debt Securities are still at very low levels.

Index	Mean	Standard Deviation
BIST Repo Index	8.02%	0.57%
BIST ST Index	8.25%	1.40%
BIST MT Index	7.56%	4.50%
BIST CPI Index	9.66%	5.90%
BIST LT Index	7.13%	9.97%
BIST Eurobond USDTRY Index	17.49%	8.35%
BIST Eurobond EURTRY Index	14.17%	8.50%
BIST GOLD Index	10.49%	18.06%
XU 100 Total Return Index	4.13%	21.48%

Table 3.4: Annual Mean and Standard Deviations of the Selected Benchmark Indexes.

3.2 The Model

The model used in this thesis depends heavily on the Markov Process and Monte Carlo simulation ideas, which we have explained in detail in Chapter 2. We use Matlab as the main programming tool, so the algorithms presented in this section will be based on its programming language.

We are using monthly data for 9 benchmark indices, namely BIST-KYD Repo Index (Gross), BIST-KYD short-term bond index, BIST-KYD medium-term government bond index, BIST-KYD CPI Indexed governnment bond index, BIST-KYD long-term bond index, BIST-KYD Gold Price Index (Weighted Average), BIST-KYD Eurobond USD/TRY index, BIST-KYD Eurobond EUR/TRY index, and BIST-100 Total Return index. These securities are named in ascending order of security type and historical volatility. We upload monthly price data for these indices, and calculate log-returns using Matlab formula *price2ret*, as well as the historical mean and standard deviations of these returns using Matlab formulas *mean* and *std*, respectively.

Although we have an option to remove outliers in our model, we prefer to proceed with the outliers, as we are deriving a financial model and believe that financial outliers should not be treated as outliers, they should be treated as possible and important risk/crisis factors or expectations on positive structural changes. We discuss our approach to outliers in detail in Chapter 5, here we should mention the methodology we suggest to handle the outliers, if anyone would prefer to remove them. For more information on outliers and other techniques for removing them, one can refer to Hawkins (Hawkins, 1980), Rousseeuw and Leroy (Rousseeuw en Leroy, 2005), Maillet and Merlin (Maillet en Merlin, 2009), Ljung (Ljung, 1993), Abraham and Chuang (Abraham en Chuang, 1989), Balke and Fomby (Balke en Fomby, 1994), Hodge and Austin (Hodge en Austin, 2004), and Tsay (Tsay, 1988).

Leys et. al. (Leys *et al.*, 2013) present an outlier detection model based on absolute deviation from the median, rather than standard deviation from the mean. The model they present relies on the "median absolute deviation (MAD)" calculation introduced by Huber (Huber, 1981):

$$MAD = bM(|x_i - M_j(x_j)|) \tag{3.2.1}$$

Here x_j represents the original observations and M_i is the median of these observations, and the scaling factor b is assumed to be 1.4826 for normally distributed data.

Assuming a retirement age of 56 (minimum required age for retirement in Turkish Private Pension System), we determine a participant entry age larger than or equal to 18 (minimum allowed age for participating in the system), and calculate the number of accumulation periods (n), given monthly contribution frequency. i.e., if the entry age of the participant is 46, $n = (56 - 46) \times 12 = 120$. We determine 4 states as explained in Table 2.1, and construct the Markov Chain accordingly.

To construct the Markov Chain, we first need to specify the states, and construct the related transition matrices, transition probabilities and related statistics (historical mean and volatility).

For each instrument, we observe the monthly occurrence of each state historically to determine transitions between states. We have $4 \times 4 = 16$ different combination of first two states (*statelag*) for a second order Markov Chain, and $16 \times 4 = 64$ total transition possibilities for passing to the next step from these steps. After calculating the number of observations of each possible transition, we create a 16×4 transition matrix as follows:

$$P = \begin{array}{c} \\ s_{11} \\ s_{12} \\ s_{13} \\ \vdots \\ s_{42} \\ s_{43} \\ s_{44} \end{array} \begin{array}{c} \begin{array}{cccc} s_1 & s_2 & s_3 & s_4 \end{array} \\ \begin{pmatrix} Obs_1 & Obs_2 & Obs_3 & Obs_4 \\ Obs_5 & Obs_6 & Obs_7 & Obs_8 \\ Obs_9 & Obs_{10} & Obs_{11} & Obs_{12} \\ \vdots & \vdots & \vdots & \vdots \\ Obs_{53} & Obs_{54} & Obs_{55} & Obs_{56} \\ Obs_{57} & Obs_{58} & Obs_{59} & Obs_{60} \\ Obs_{61} & Obs_{62} & Obs_{63} & Obs_{64} \end{pmatrix} \end{array} \tag{3.2.2}$$

Using these number of occurrences, we calculate the transition probabilities between each states. For example, if historically there has been 20 occurrences of s_1 to s_4 transition, and 10 of them ended at s_1, 5 at s_2, 3 at s_3, and 2 at s_4 (i.e., $Obs_{141} = 10, Obs_{142} = 5, Obs_{143} = 3, Obs_{144} = 2$), than the related transition probability matrix will look like:

$$P_{14} = \begin{array}{c} \\ s_{14} \end{array} \begin{array}{c} \begin{array}{cccc} s_1 & s_2 & s_3 & s_4 \end{array} \\ \begin{pmatrix} 0.50 & 0.25 & 0.15 & 0.10 \end{pmatrix} \end{array} \tag{3.2.3}$$

Here, $p_{141} = 0.50$, $p_{142} = 0.25$, $p_{143} = 0.15$, and $p_{144} = 0.10$.

If there is no observation available historically for any point of the transition matrix, we use equation 2.1.3. To evaluate this equation, we need the transition matrix and transition probability matrix for a first order Markov Chain. These 4×4 matrices are created with the same methodology described above for a second order Markov Chain. Consider that a financial instrument has never been at states 3, 1, and 4, consecutively. In this case, we would not be able to calculate historical probability for p_{314}. Hopefully, using equation 2.1.3 and the transition probability matrix created for the first order Markov Chain, we can calculate this probability as:

$$p_{ij}^2 = \sum_{k=1}^{r} p_{ik} p_{kj} \tag{2.1.3}$$

$$p_{34}^2 = \sum_{k=1}^{4} p_{3k} p_{k4}.$$

This means that, even if there is no historical evidence of being at states 3, 1, and 4 consecutively, there would have been some cases of moving *from* 3, and moving *to* state 4, separately, and we use those transitions for the second order probability calculations.

After generating the transition probabilities, we calculate the transition mean ($m_{ii'j}$) and volatility (($v_{ii'j}$) matrices using historical data. This helps us to determine the summary statistics of the variables through the transition between states. To sum up, $p_{143} = 0.30$, $m_{143} = 0.05$ and $v_{143} = 0.1$ means that, historically there is a 30 percent of change of moving to state 3 from states 1 and 4, respectively, and throughout these transitions, the mean of the variable was 0.05, and its volatility was 0.1.

```
1-load price series
2-convert price series to return series
3-adjust the series for outliers
4-define the states
5-detect the states in historical data
6-detect the transitions between t-2 and t-1
7-detect the transitions from t-2 and t-1, consecutively
    to t
8-detect the transitions from t-1 to t
9-calculate the first order transition matrix using 8
10-calculate the first order transition probability
   matrix using 9
11-construct the second order transition matrix using 6
   and 7
12-calculate the second order transition probability
   matrix using 11
13-if 12 is not available, calculate second order
   transition probabilities using 10
14-calculate the transition mean and volatility matrices
    using historical data.
```

Using the estimated parameters of the Markov Process described above, we run ordinary Monte Carlo simulations 10,000 times for the constructed Markov Chains, for each index. We simulate the chain monthly for the whole investment period of the participant, i.e. starting from the entry age until retirement. Throughout each chain, we generate a normal random variable for monthly returns of each index, with mean and standard deviation calculated as above. It is noteworthy to mention that we do not apply a Monte Carlo simulation on index returns, we apply the simulation on Markov Chains.

```
1-calculate the Markov Chain parameters for all of the 9
    financial instruments
2-run ordinary Monte Carlo simulation on indices
   modelled as Markov Process, using 1.
```

After simulating the benchmark index returns, we create 511 portfolios consisting of all equally weighted combinations of the 9 indices and simulate the accumulation amounts of a participant for each choice of portfolio using Equation (2.0.3). At this stage, we have 10,000 simulated accumulations for each 511 portfolio, of which we calculate the mean and related 95% confidence intervals. We group these portfolios according to instrument types to better analyze the effect of each instrument on investment performance. We assume a monthly contribution amount of TRY 100 for the first year.

```
1-set the initial contribution amount and portfolio
  management fees
2-create equally weighted portfolios consisting of all
  combinations of 9 financial instruments
3-assuming monthly contribution , evaluate Equation
  (2.0.3 using the previously simulated financial
  instrument returns , and the portfolios generated in
  2.
4-calculate the mean and 95% confidence intervals (CI)
  for all portfolio choice.
5-group the results according to instrument type.
```

Having an estimation for the accumulation amounts in TRY terms is useful for participants, especially in terms of figuring out the sufficiency of this accumulation at retirement. Nevertheless, calculating the annual internal rate of return (IRR) of the related pension investment is a better way to compare different investment strategies. For this purpose, we use Matlab's IRR function to calculate the investment period IRR of each portfolio and express the result in annual terms.

```
1-combine the contributions and accumulation amounts to
  create a cash-flow
2-using these cash-flows, calculate the IRR of all
  portfolio returns for the whole investment period
3-convert these full period IRRs to annual terms.
```

We run the stages discussed above for participants entering the system at ages 18, 26, 36, and 46, all of which retiring at age 56. We implement 3 scenarios in terms of contributions types, fees and state subsidies. In our first scenario, we assume fixed contribution amounts each year until retirement, no fees charged, and no state subsidies. In our second scenario, we assume increasing contribution amounts at the rate of previous years' annual repo return, portfolio management fees at industry averages, and again no state subsidies. In our final and most realistic scenario, we add state subsidies to our second scenario. We also group the portfolios according to exposures on different instruments, and define 5 groups. The first four groups present the portfolios with full exposure on a single instrument type namely FX, Gold, Bonds, and Equity, and the last group includes all portfolios. We present the results of these scenarios in Chapter 4. In all of these three scenarios, we assume that participants invest in the same portfolio until retirement.

The simulation steps described above mainly depends on nominal returns. For all scenarios we also repeat these simulations using ex-post real returns of instruments, and present the results in Chapter 4. We provide suggestions related to portfolio selection in Chapter 6.

Chapter 4

Results

In the previous Chapter, we have examined the details of the data we have used and the depth of the Turkish Capital Markets, and introduced the main assumptions and the building blocks of our model. We illustrated the outline of the Matlab algorithms we have generated, and presented ways to overcome the deficiency of historical data. In this Chapter, we present the main results discussed in Section 3.2 of Chapter 3.

4.1 Parameter Estimation

Table 4.1 shows the criteria for determining the state of each index through time, and Table 4.2 shows the corresponding state of each variable, between January 2011 and November 2016. It must be noted that, even if the methodology of determining the states is same for all instruments, their magnitude differs. For example, BIST Gross Repo Index have been at state 1 more than the remaining variables, and one might think that it has underperfomed historically. But the criteria for being at state 1 is having a return less than 0.50% for that index, where the same criteria is having a return less than -5.86% for BIST 100 Total Return equity index. While evaluating the state transitions, one must keep in mind this fact to prevent misjudgment.

Instrument	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM
Mean	0.67%	0.69%	0.63%	0.80%	0.59%
Volatility	0.16%	0.41%	1.30%	1.70%	2.88%
Mean - Stdev	0.50%	0.28%	-0.67%	-0.90%	-2.28%
Mean	0.67%	0.69%	0.63%	0.80%	0.59%
Mean + Stdev	0.83%	1.09%	1.93%	2.51%	3.47%
Instrument		KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN
Mean		1.46%	1.18%	0.87%	0.34%
Volatility		2.41%	2.45%	5.21%	6.20%
Mean - Stdev		-0.95%	-1.27%	-4.34%	-5.86%
Mean		1.46%	1.18%	0.87%	0.34%
Mean + Stdev		3.87%	3.64%	6.09%	6.54%

Table 4.1: State Criteria of the Benchmark Indexes in Numbers

For each transition between states, we calculate the transition occurrence numbers, transition probabilities, and the related mean and standard deviations for each variable, and present the results in Table 4.3 and Table 4.4. For example, for the Medium-Term Bond index, after being at states 3 and 2, resptectively, there is a 50% chance of passing to state 2, and the return of the variable will be a normal random variable with mean 0.25% and standard deviation 0.43%. For the equity index, there is a 71.4% probability for passing to state 4 from states 2 and 1, respectively. In this case, it's return will be a normal random variable with 10.50% mean and 2.03% standard deviation.

Instrument	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN
Jan-11	2	1	1	1	1	2	4	2	2
Feb-11	1	2	2	2	3	2	2	3	2
Mar-11	2	2	2	2	3	1	2	2	3
Apr-11	2	3	3	3	3	2	3	3	4
May-11	2	2	2	2	2	4	3	3	1
Jun-11	2	2	2	3	2	3	3	2	3
Jul-11	1	3	3	2	3	4	3	4	2
Aug-11	2	3	4	2	4	4	4	4	1
Sep-11	2	2	2	2	2	3	1	2	4
Oct-11	2	1	1	3	2	1	2	2	1
Nov-11	3	3	2	2	2	3	2	3	2
Dec-11	4	2	2	3	3	3	2	1	1
Jan-12	4	4	4	2	3	1	1	3	4
Feb-12	3	3	3	3	3	3	3	3	3
Mar-12	3	2	2	3	2	3	3	1	3
Apr-12	4	3	3	3	3	2	1	2	2
May-12	4	2	3	2	3	3	2	2	1
Jun-12	3	4	3	3	3	3	2	2	4
Jul-12	3	4	3	3	4	3	2	3	3
Aug-12	1	3	3	2	2	3	4	3	3
Sep-12	1	2	3	4	3	1	3	3	2
Oct-12	1	3	3	4	3	2	3	2	4
Nov-12	1	3	4	4	4	3	3	2	3
Dec-12	1	2	2	3	3	2	3	2	4
Jan-13	1	3	3	3	2	1	2	2	3

Instrument	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN
Feb-13	1	2	3	2	2	3	2	2	3
Mar-13	1	1	2	2	2	2	1	3	4
Apr-13	1	3	4	3	4	3	3	1	3
May-13	1	1	1	2	1	4	4	2	3
Jun-13	1	1	1	1	1	1	2	1	1
Jul-13	2	1	1	2	1	1	3	4	2
Aug-13	2	2	2	1	1	2	3	4	1
Sep-13	2	4	4	4	4	4	3	1	4
Oct-13	2	3	4	4	3	2	2	2	3
Nov-13	2	1	1	1	1	1	3	1	2
Dec-13	2	2	1	2	1	3	4	3	1
Jan-14	2	1	2	1	2	4	4	4	1
Feb-14	3	3	3	3	3	2	3	3	3
Mar-14	4	3	3	3	3	2	1	1	4
Apr-14	3	4	4	4	4	2	2	2	4
May-14	3	3	3	4	3	3	1	2	4
Jun-14	3	3	3	3	3	3	3	3	2
Jul-14	3	3	2	3	2	2	2	2	3
Aug-14	2	2	2	2	2	3	2	2	2
Sep-14	3	2	2	2	1	3	2	2	1
Oct-14	3	4	4	3	4	2	1	1	4
Nov-14	3	3	4	3	4	3	2	3	4
Dec-14	4	1	2	3	2	4	3	3	2
Jan-15	3	4	4	2	4	4	1	4	3
Feb-15	3	1	1	2	1	3	3	2	2

Instrument	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN
Mar-15	4	3	2	3	2	4	2	3	2
Apr-15	3	1	1	1	1	2	4	3	3
May-15	3	3	3	3	3	2	1	2	2
Jun-15	4	3	2	2	2	2	3	2	2
Jul-15	4	3	2	1	2	3	3	1	2
Aug-15	3	2	1	2	2	4	4	4	1
Sep-15	3	2	2	1	1	2	3	3	2
Oct-15	4	3	4	4	4	2	1	2	4
Nov-15	3	3	2	3	2	1	1	1	2
Dec-15	4	3	2	3	2	2	3	2	2
Jan-16	3	3	3	2	3	3	3	4	3
Feb-16	3	3	3	3	3	2	2	4	3
Mar-16	4	4	4	3	4	1	2	1	4
Apr-16	4	4	4	3	4	2	2	3	3
May-16	3	3	2	2	1	3	3	2	1
Jun-16	3	3	4	3	4	3	1	3	2
Jul-16	3	2	2	2	2	3	3	3	2
Aug-16	3	3	3	2	3	2	2	2	3
Sep-16	3	3	3	3	3	2	3	3	3
Oct-16	2	2	2	2	2	3	3	2	3
Nov-16	2	2	1	2	1	3	4	3	1

Table 4.2: Historical States of the Benchmark Indexes in Numbers.

Table 4.3: Second Order Transition Parameters of the Benchmark Indexes

KYD ON GROSS	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	9	1	-	-	90.0%	10.0%	-	-	0.41%	0.51%	-	-	0.04%	0.00%	-	-
s_{12}	-	3	-	-	-	100.0%	-	-	-	0.54%	-	-	-	0.02%	-	-
s_{13}	-	-	-	-	61.9%	34.0%	4.1%	-	0.49%	0.62%	0.74%	-	0.00%	0.01%	0.05%	-
s_{14}	-	-	-	-	61.9%	34.0%	4.1%	-	0.00%	0.00%	0.78%	-	0.00%	0.00%	0.03%	-
s_{21}	-	2	-	-	-	100.0%	-	-	-	0.53%	-	-	-	0.03%	-	-
s_{22}	1	8	2	-	9.1%	72.7%	18.2%	-	0.49%	0.56%	0.80%	-	0.00%	0.06%	0.01%	-
s_{23}	-	-	1	2	-	-	33.3%	66.7%	-	-	0.82%	0.91%	-	-	0.00%	0.01%
s_{24}	-	-	-	-	18.0%	53.8%	22.3%	5.9%	0.00%	0.00%	0.78%	0.87%	0.00%	0.00%	0.03%	0.04%
s_{31}	1	-	-	-	100.0%	-	-	-	0.38%	-	-	-	0.00%	-	-	-
s_{32}	-	1	1	-	-	50.0%	50.0%	-	-	0.64%	0.72%	-	-	0.00%	0.00%	-
s_{33}	1	2	6	6	6.7%	13.3%	40.0%	40.0%	0.49%	0.62%	0.70%	0.86%	0.00%	0.01%	0.03%	0.02%
s_{34}	-	-	5	4	-	-	55.6%	44.4%	-	-	0.80%	0.87%	-	-	0.01%	0.04%
s_{41}	-	-	-	-	2.6%	5.1%	59.8%	32.5%	0.41%	0.53%	0.00%	0.00%	0.04%	0.02%	0.00%	0.00%
s_{42}	-	-	-	-	2.6%	5.1%	59.8%	32.5%	0.47%	0.56%	0.77%	0.00%	0.03%	0.05%	0.04%	0.00%
s_{43}	-	-	8	1	-	-	88.9%	11.1%	-	-	0.76%	0.94%	-	-	0.05%	0.00%
s_{44}	-	-	4	-	-	-	100.0%	-	-	-	0.75%	-	-	-	0.03%	-

Table 4.3 Continued

KYD SHORT TERM	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	1	1	-	-	50.0%	50.0%	-	-	0.13%	0.46%	-	-	0.00%	0.00%	-	-
s_{12}	1	1	-	1	33.3%	33.3%	-	33.3%	0.25%	0.45%	-	1.22%	0.00%	0.00%	-	0.00%
s_{13}	2	1	2	-	40.0%	20.0%	40.0%	-	0.03%	0.48%	0.82%	-	0.25%	0.00%	0.10%	-
s_{14}	1	-	-	-	100.0%	-	-	-	-0.44%	-	-	-	0.00%	-	-	-
s_{21}	-	-	3	-	-	-	100.0%	-	-	-	0.85%	-	-	-	0.19%	-
s_{22}	-	-	3	1	-	-	75.0%	25.0%	-	-	0.85%	1.31%	-	-	0.16%	0.00%
s_{23}	-	3	4	-	-	42.9%	57.1%	-	-	0.53%	0.88%	-	-	0.02%	0.14%	-
s_{24}	-	-	3	1	-	-	75.0%	25.0%	-	-	1.00%	1.35%	-	-	0.07%	0.00%
s_{31}	1	1	1	1	25.0%	25.0%	25.0%	25.0%	-0.19%	0.39%	0.83%	1.29%	0.00%	0.00%	0.00%	0.00%
s_{32}	2	4	4	2	16.7%	33.3%	33.3%	16.7%	-0.09%	0.53%	0.82%	1.40%	0.25%	0.13%	0.08%	0.26%
s_{33}	-	6	5	2	-	46.2%	38.5%	15.4%	-	0.52%	0.82%	1.35%	-	0.11%	0.11%	0.19%
s_{34}	-	-	1	1	-	-	50.0%	50.0%	-	-	1.03%	1.19%	-	-	0.00%	0.00%
s_{41}	-	-	1	-	-	-	100.0%	-	-	-	0.74%	-	-	-	0.00%	-
s_{42}	-	-	-	-	13.1%	28.8%	47.8%	10.2%	0.02%	0.51%	0.83%	1.33%	0.26%	0.12%	0.11%	0.17%
s_{43}	2	2	2	-	33.3%	33.3%	33.3%	-	0.16%	0.54%	0.94%	-	0.05%	0.07%	0.15%	-
s_{44}	-	-	2	-	-	-	100.0%	-	-	-	0.82%	-	-	-	0.00%	-

Table 4.3 Continued

KYD MEDIUM TERM	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	1	2	-	-	33.3%	66.7%	-	-	-1.02%	-0.49%	-	-	0.00%	0.22%	-	-
s_{12}	1	2	1	2	16.7%	33.3%	16.7%	33.3%	-1.59%	0.31%	0.70%	2.99%	0.00%	0.07%	0.00%	0.17%
s_{13}	-	1	-	-	-	100.0%	-	-	-	0.62%	-	-	-	0.00%	-	-
s_{14}	-	-	-	-	18.6%	37.7%	25.0%	18.7%	-1.59%	0.05%	1.56%	2.06%	0.75%	0.20%	0.50%	0.06%
s_{21}	-	2	1	-	-	66.7%	33.3%	-	-	-0.26%	1.20%	-	-	0.11%	0.00%	-
s_{22}	1	1	3	2	14.3%	14.3%	42.9%	28.6%	-1.01%	-0.40%	0.96%	2.90%	0.00%	0.00%	0.24%	0.21%
s_{23}	-	1	5	1	-	14.3%	71.4%	14.3%	-	0.25%	1.00%	2.32%	-	0.00%	0.27%	0.00%
s_{24}	2	2	1	2	28.6%	28.6%	14.3%	28.6%	-1.76%	-0.08%	1.21%	2.02%	0.97%	0.25%	0.00%	0.00%
s_{31}	-	-	-	-	8.7%	31.1%	38.2%	22.1%	-1.29%	-0.19%	1.20%	0.00%	0.43%	0.35%	0.00%	0.00%
s_{32}	1	3	1	1	16.7%	50.0%	16.7%	16.7%	-1.19%	0.25%	0.72%	2.12%	0.00%	0.43%	0.00%	0.00%
s_{33}	-	3	5	3	-	27.3%	45.5%	27.3%	-	-0.14%	1.37%	2.65%	-	0.58%	0.49%	0.38%
s_{34}	-	2	1	1	-	50.0%	25.0%	25.0%	-	0.21%	1.92%	2.13%	-	0.02%	0.00%	0.00%
s_{41}	2	1	-	-	66.7%	33.3%	-	-	-1.42%	0.36%	-	-	0.51%	0.00%	-	-
s_{42}	1	1	2	2	16.7%	16.7%	33.3%	33.3%	-1.63%	0.14%	1.11%	2.37%	0.00%	0.00%	0.21%	0.26%
s_{43}	-	1	1	-	-	50.0%	50.0%	-	-	0.38%	1.04%	-	-	0.00%	0.00%	-
s_{44}	1	2	-	-	33.3%	66.7%	-	-	-1.24%	0.02%	-	-	0.00%	0.23%	-	-

Table 4.3 Continued

KYD CPI	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	-	-	-	-	13.6%	28.8%	42.3%	15.3%	0.00%	-0.13%	1.05%	4.08%	0.00%	0.61%	0.03%	0.00%
s_{12}	3	1	-	-	75.0%	25.0%	-	-	-1.67%	0.33%	-	-	0.68%	0.00%	-	-
s_{13}	-	1	1	-	-	50.0%	50.0%	-	-	0.42%	1.96%	-	-	0.00%	0.00%	-
s_{14}	-	-	1	1	-	-	50.0%	50.0%	-	-	1.93%	3.72%	-	-	0.00%	0.00%
s_{21}	-	2	1	2	-	40.0%	20.0%	40.0%	-	-0.36%	1.08%	4.08%	-	0.51%	0.00%	0.00%
s_{22}	-	1	6	-	-	14.3%	85.7%	-	-	-0.24%	1.30%	-	-	0.00%	0.50%	-
s_{23}	1	7	4	-	8.3%	58.3%	33.3%	-	-1.18%	0.19%	1.81%	-	0.00%	0.43%	0.46%	-
s_{24}	-	-	-	1	-	-	-	100.0%	-	-	-	3.19%	-	-	-	0.00%
s_{31}	-	-	1	-	-	-	100.0%	-	-	-	1.03%	-	-	-	0.00%	-
s_{32}	2	6	6	1	13.3%	40.0%	40.0%	6.7%	-3.85%	0.02%	1.62%	2.57%	3.91%	0.53%	0.44%	0.00%
s_{33}	-	7	3	1	-	63.6%	27.3%	9.1%	-	0.11%	1.30%	4.80%	-	0.61%	0.06%	0.00%
s_{34}	-	-	-	1	-	-	-	100.0%	-	-	-	3.80%	-	-	-	0.00%
s_{41}	-	1	-	-	-	100.0%	-	-	-	-0.46%	-	-	-	0.00%	-	-
s_{42}	-	-	-	-	7.6%	26.3%	36.6%	29.5%	-2.54%	0.03%	1.46%	2.57%	2.34%	0.47%	0.48%	0.00%
s_{43}	-	-	3	-	-	-	100.0%	-	-	-	1.42%	-	-	-	0.51%	-
s_{44}	1	-	2	1	25.0%	-	50.0%	25.0%	-0.93%	-	1.84%	3.10%	0.00%	-	0.77%	0.00%

Table 4.3 Continued

KYD LONG TERM	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	2	1	-	1	50.0%	25.0%	-	25.0%	-3.15%	0.05%	-	5.35%	0.10%	0.00%	-	0.00%
s_{12}	1	-	1	-	50.0%	-	50.0%	-	-3.69%	-	0.66%	-	0.00%	-	0.00%	-
s_{13}	-	1	1	-	-	50.0%	50.0%	-	-	0.03%	0.82%	-	-	0.00%	0.00%	-
s_{14}	-	2	1	1	-	50.0%	25.0%	25.0%	-	-1.23%	3.33%	4.35%	-	0.54%	0.00%	0.00%
s_{21}	-	-	1	2	-	-	33.3%	66.7%	-	-	1.60%	6.46%	-	-	0.00%	0.41%
s_{22}	2	3	3	1	22.2%	33.3%	33.3%	11.1%	-2.91%	-1.26%	0.78%	4.52%	0.10%	0.71%	0.22%	0.00%
s_{23}	-	-	6	1	-	-	85.7%	14.3%	-	-	1.70%	4.32%	-	-	0.58%	0.00%
s_{24}	2	-	-	-	100.0%	-	-	-	-3.97%	-	-	-	1.79%	-	-	-
s_{31}	1	-	-	-	100.0%	-	-	-	-3.74%	-	-	-	0.00%	-	-	-
s_{32}	1	4	1	-	16.7%	66.7%	16.7%	-	-3.44%	0.04%	1.84%	-	0.00%	0.50%	0.00%	-
s_{33}	-	4	3	4	-	36.4%	27.3%	36.4%	-	-0.21%	2.06%	4.77%	-	0.55%	0.61%	0.98%
s_{34}	-	2	2	1	-	40.0%	40.0%	20.0%	-	-0.68%	2.35%	3.81%	-	0.78%	0.73%	0.00%
s_{41}	1	1	-	1	33.3%	33.3%	-	33.3%	-7.00%	0.38%	-	4.17%	0.00%	0.00%	-	0.00%
s_{42}	-	2	2	1	-	40.0%	40.0%	20.0%	-	-1.32%	1.04%	4.70%	-	0.27%	0.25%	0.00%
s_{43}	1	1	1	-	33.3%	33.3%	33.3%	-	-2.64%	0.36%	1.74%	-	0.00%	0.00%	0.00%	-
s_{44}	1	1	-	-	50.0%	50.0%	-	-	-2.31%	-0.39%	-	-	0.00%	0.00%	-	-

Table 4.3 Continued

KYD EUROBOND USDTRY	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	-	1	-	-	-	100.0%	-	-	-	0.83%	-	-	-	0.00%	-	-
s_{12}	-	-	3	2	-	-	60.0%	40.0%	-	-	3.18%	4.77%	-	-	0.43%	0.82%
s_{13}	-	1	2	1	-	25.0%	50.0%	25.0%	-	-0.72%	2.48%	6.86%	-	0.00%	0.80%	0.00%
s_{14}	-	-	-	-	16.0%	30.4%	40.2%	13.4%	-5.50%	1.01%	2.53%	5.46%	0.00%	0.60%	0.91%	1.40%
s_{21}	-	3	2	-	-	60.0%	40.0%	-	-	0.53%	2.46%	-	-	0.29%	0.82%	-
s_{22}	2	2	3	-	28.6%	28.6%	42.9%	-	-1.23%	0.29%	2.35%	-	0.09%	1.55%	0.87%	-
s_{23}	-	2	5	3	-	20.0%	50.0%	30.0%	-	-0.38%	2.54%	4.27%	-	0.37%	0.80%	0.65%
s_{24}	-	1	1	-	-	50.0%	50.0%	-	-	0.12%	2.32%	-	-	0.00%	0.00%	-
s_{31}	-	1	2	-	-	33.3%	66.7%	-	-	1.12%	2.51%	-	-	0.00%	0.85%	-
s_{32}	2	1	4	-	28.6%	14.3%	57.1%	-	-2.23%	0.25%	2.61%	-	1.23%	0.00%	0.48%	-
s_{33}	2	4	3	-	22.2%	44.4%	33.3%	-	-4.09%	0.66%	2.70%	-	3.07%	0.56%	1.09%	-
s_{34}	1	3	-	2	16.7%	50.0%	-	33.3%	-5.50%	1.30%	-	5.46%	0.00%	0.12%	-	1.40%
s_{41}	1	-	-	-	100.0%	-	-	-	-1.05%	-	-	-	0.00%	-	-	-
s_{42}	1	3	-	-	25.0%	75.0%	-	-	-1.08%	0.09%	-	-	0.00%	0.84%	-	-
s_{43}	1	-	-	2	33.3%	-	-	66.7%	-2.65%	-	-	4.36%	0.00%	-	-	0.06%
s_{44}	-	-	2	-	-	-	100.0%	-	-	-	2.64%	-	-	-	1.26%	-

Table 4.3 Continued

KYD EUROBOND EURTRY	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	-	-	1	-	-	-	100.0%	-	-	-	3.31%	-	-	-	0.00%	-
s_{12}	1	2	1	-	25.0%	50.0%	25.0%	-	-1.54%	0.11%	2.65%	-	0.00%	1.22%	0.00%	-
s_{13}	-	3	3	1	-	42.9%	42.9%	14.3%	-	-0.56%	2.39%	4.49%	-	0.05%	0.56%	0.00%
s_{14}	-	-	-	-	17.2%	30.4%	39.0%	13.4%	-2.00%	-0.11%	1.95%	4.56%	0.09%	0.80%	0.52%	0.00%
s_{21}	-	1	3	-	-	25.0%	75.0%	-	-	1.02%	3.03%	-	-	0.00%	0.29%	-
s_{22}	3	4	2	1	30.0%	40.0%	20.0%	10.0%	-2.99%	-0.23%	3.09%	5.28%	1.16%	0.81%	0.62%	0.00%
s_{23}	2	-	3	1	33.3%	-	50.0%	16.7%	-1.66%	-	2.32%	6.08%	0.06%	-	1.05%	0.00%
s_{24}	1	-	1	-	50.0%	-	50.0%	-	-1.93%	-	1.84%	-	0.00%	-	0.00%	-
s_{31}	1	2	2	-	20.0%	40.0%	40.0%	-	-3.74%	-0.61%	2.82%	-	0.00%	0.53%	0.32%	-
s_{32}	-	3	2	1	-	50.0%	33.3%	16.7%	-	-0.03%	1.39%	5.42%	-	0.71%	0.12%	0.00%
s_{33}	1	3	5	3	8.3%	25.0%	41.7%	25.0%	-1.60%	0.38%	2.48%	5.82%	0.00%	0.60%	0.66%	0.57%
s_{34}	1	1	1	1	25.0%	25.0%	25.0%	25.0%	-2.06%	-0.68%	2.51%	4.56%	0.00%	0.00%	0.00%	0.00%
s_{41}	-	1	1	-	-	50.0%	50.0%	-	-	-0.20%	1.91%	-	-	0.00%	0.00%	-
s_{42}	-	1	1	-	-	50.0%	50.0%	-	-	-0.48%	1.35%	-	-	0.00%	0.00%	-
s_{43}	2	-	1	-	66.7%	-	33.3%	-	-2.59%	-	1.27%	-	1.57%	-	0.00%	-
s_{44}	-	-	1	-	-	-	100.0%	-	-	-	1.49%	-	-	-	0.00%	-

Table 4.3 Continued

KYD GOLD	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	-	-	-	-	18.8%	36.8%	31.8%	12.6%	0.00%	-0.91%	2.32%	9.29%	0.00%	1.50%	0.90%	0.29%
s_{12}	2	2	-	1	40.0%	40.0%	-	20.0%	-9.30%	-2.42%	-	6.13%	5.78%	2.28%	-	0.00%
s_{13}	-	1	2	1	-	25.0%	50.0%	25.0%	-	0.21%	3.55%	9.71%	-	0.00%	3.51%	0.00%
s_{14}	-	-	1	1	-	-	50.0%	50.0%	-	-	2.84%	10.95%	-	-	0.00%	0.00%
s_{21}	-	1	2	2	-	20.0%	40.0%	40.0%	-	0.61%	1.58%	9.29%	-	0.00%	0.16%	0.29%
s_{22}	2	5	4	-	18.2%	45.5%	36.4%	-	-5.51%	-1.96%	3.48%	-	1.55%	1.29%	2.26%	-
s_{23}	2	3	4	-	22.2%	33.3%	44.4%	-	-7.42%	-1.34%	4.36%	-	2.03%	0.86%	1.13%	-
s_{24}	-	-	-	2	-	-	-	100.0%	-	-	-	12.27%	-	-	-	3.08%
s_{31}	-	3	1	-	-	75.0%	25.0%	-	-	-0.92%	3.43%	-	-	1.48%	0.00%	-
s_{32}	1	3	4	1	11.1%	33.3%	44.4%	11.1%	-8.42%	0.25%	4.19%	10.21%	0.00%	0.45%	1.81%	0.00%
s_{33}	1	4	1	1	14.3%	57.1%	14.3%	14.3%	-4.88%	-1.99%	5.35%	9.07%	0.00%	1.81%	0.00%	0.00%
s_{34}	-	1	1	-	-	50.0%	50.0%	-	-	-0.56%	3.97%	-	-	0.00%	0.00%	-
s_{41}	-	1	1	-	-	50.0%	50.0%	-	-	-2.42%	2.66%	-	-	0.00%	0.00%	-
s_{42}	-	1	1	-	-	50.0%	50.0%	-	-	-0.29%	1.80%	-	-	0.00%	0.00%	-
s_{43}	1	1	-	-	50.0%	50.0%	-	-	-5.14%	-1.41%	-	-	0.00%	0.00%	-	-
s_{44}	2	1	-	-	66.7%	33.3%	-	-	-5.00%	-3.65%	-	-	0.29%	0.00%	-	-

Table 4.3 Continued

XU100 TOTAL RETURN	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_{11}	-	-	1	-	-	-	100.0%	-	-	-	1.12%	-	-	-	0.00%	-
s_{12}	2	1	-	1	50.0%	25.0%	-	25.0%	-8.07%	-1.85%	-	6.87%	2.72%	0.00%	-	0.00%
s_{13}	-	1	-	1	-	50.0%	-	50.0%	-	-1.55%	-	11.18%	-	0.00%	-	0.00%
s_{14}	1	-	3	1	20.0%	-	60.0%	20.0%	-6.24%	-	4.28%	6.72%	0.00%	-	1.66%	0.00%
s_{21}	1	1	-	5	14.3%	14.3%	-	71.4%	-9.17%	-1.35%	-	10.50%	0.00%	0.00%	-	2.03%
s_{22}	1	1	4	-	16.7%	16.7%	66.7%	-	-6.05%	-2.86%	3.37%	-	0.00%	0.00%	2.18%	-
s_{23}	-	3	2	1	-	50.0%	33.3%	16.7%	-	-2.72%	1.91%	8.13%	-	2.62%	1.72%	0.00%
s_{24}	-	1	1	-	-	50.0%	50.0%	-	-	-5.39%	0.73%	-	-	0.00%	0.00%	-
s_{31}	-	2	-	-	-	100.0%	-	-	-	-2.49%	-	-	-	1.99%	-	-
s_{32}	4	2	-	1	57.1%	28.6%	-	14.3%	-9.91%	-2.27%	-	8.87%	3.54%	2.00%	-	0.00%
s_{33}	2	2	1	2	28.6%	28.6%	14.3%	28.6%	-8.91%	-2.21%	2.64%	8.97%	4.29%	1.07%	0.00%	1.16%
s_{34}	1	-	3	1	20.0%	-	60.0%	20.0%	-8.60%	-	1.76%	6.61%	0.00%	-	1.53%	0.00%
s_{41}	-	1	1	-	-	50.0%	50.0%	-	-	-2.79%	0.35%	-	-	0.00%	0.00%	-
s_{42}	-	1	2	-	-	33.3%	66.7%	-	-	-4.74%	4.13%	-	-	0.00%	0.62%	-
s_{43}	1	1	4	1	14.3%	14.3%	57.1%	14.3%	-8.62%	-2.37%	2.21%	6.81%	0.00%	0.00%	1.96%	0.00%
s_{44}	-	2	-	1	-	66.7%	-	33.3%	-	-0.76%	-	7.61%	-	0.34%	-	0.00%

Table 4.4: First Order Transition Parameters of the Benchmark Indexes

KYD ON GROSS	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	10	3	-	-	76.9%	23.1%	-	-	0.41%	0.53%	-	-	0.04%	0.02%	-	-
s_2	2	12	3	-	11.8%	70.6%	17.6%	-	0.47%	0.56%	0.77%	-	0.03%	0.05%	0.04%	-
s_3	1	2	15	9	3.7%	7.4%	55.6%	33.3%	0.49%	0.62%	0.74%	0.88%	0.00%	0.01%	0.05%	0.04%
s_4	-	-	9	4	-	-	69.2%	30.8%	-	-	0.78%	0.87%	-	-	0.03%	0.04%
KYD SHORT TERM	**Transition Matrix**				**Transition Probabilities**				**Transition Mean Return**				**Transition Std. Dev. Return**			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	2	3	5	1	18.2%	27.3%	45.5%	9.1%	-0.03%	0.38%	0.82%	1.29%	0.23%	0.08%	0.15%	0.00%
s_2	3	5	7	4	15.8%	26.3%	36.8%	21.1%	0.02%	0.51%	0.83%	1.33%	0.26%	0.12%	0.11%	0.17%
s_3	4	12	13	2	12.9%	38.7%	41.9%	6.5%	0.10%	0.52%	0.86%	1.35%	0.17%	0.08%	0.12%	0.19%
s_4	1	-	6	2	11.1%	-	66.7%	22.2%	-0.44%	-	0.95%	1.27%	0.00%	-	0.11%	0.12%
KYD MEDIUM TERM	**Transition Matrix**				**Transition Probabilities**				**Transition Mean Return**				**Transition Std. Dev. Return**			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	3	6	1	-	30.0%	60.0%	10.0%	-	-1.29%	-0.19%	1.20%	-	0.43%	0.35%	0.00%	-
s_2	4	7	7	7	16.0%	28.0%	28.0%	28.0%	-1.35%	0.16%	0.93%	2.66%	0.30%	0.36%	0.23%	0.40%
s_3	-	6	11	4	-	28.6%	52.4%	19.0%	-	0.14%	1.17%	2.57%	-	0.49%	0.40%	0.35%
s_4	3	6	2	3	21.4%	42.9%	14.3%	21.4%	-1.59%	0.05%	1.56%	2.06%	0.75%	0.20%	0.50%	0.06%

Table 4.4 Continued

KYD CPI	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	-	4	2	2	-	50.0%	25.0%	25.0%	-	-0.13%	1.05%	4.08%	-	0.61%	0.03%	0.00%
s_2	5	8	12	1	19.2%	30.8%	46.2%	3.8%	-2.54%	0.03%	1.46%	2.57%	2.34%	0.47%	0.48%	0.00%
s_3	1	15	11	1	3.6%	53.6%	39.3%	3.6%	-1.18%	0.17%	1.58%	4.80%	0.00%	0.50%	0.43%	0.00%
s_4	1	-	3	4	12.5%	-	37.5%	50.0%	-0.93%	-	1.87%	3.45%	0.00%	-	0.55%	0.36%

KYD LONG TERM	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	4	2	2	4	33.3%	16.7%	16.7%	33.3%	-4.26%	0.22%	1.71%	5.61%	1.85%	0.23%	0.16%	1.12%
s_2	4	9	7	2	18.2%	40.9%	31.8%	9.1%	-3.24%	-0.70%	0.99%	4.61%	0.40%	0.84%	0.43%	0.13%
s_3	1	6	11	5	4.3%	26.1%	47.8%	21.7%	-2.64%	-0.08%	1.72%	4.68%	0.00%	0.49%	0.60%	0.87%
s_4	3	5	3	2	23.1%	38.5%	23.1%	15.4%	-3.42%	-0.84%	2.67%	4.08%	1.59%	0.61%	0.77%	0.38%

KYD EUROBOND USDTRY	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	1	5	4	-	10.0%	50.0%	40.0%	-	-1.05%	0.71%	2.48%	-	0.00%	0.33%	0.68%	-
s_2	5	7	10	2	20.8%	29.2%	41.7%	8.3%	-1.60%	0.07%	2.71%	4.77%	0.85%	0.86%	0.64%	0.82%
s_3	3	7	10	6	11.5%	26.9%	38.5%	23.1%	-3.61%	0.17%	2.58%	4.73%	2.33%	0.76%	0.79%	1.12%
s_4	1	4	3	2	10.0%	40.0%	30.0%	20.0%	-5.50%	1.01%	2.53%	5.46%	0.00%	0.60%	0.91%	1.40%

Table 4.4 Continued

KYD EUROBOND EURTRY	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	1	4	7	-	8.3%	33.3%	58.3%	-	-3.74%	-0.10%	2.85%	-	0.00%	0.83%	0.49%	-
s_2	4	10	6	2	18.2%	45.5%	27.3%	9.1%	-2.63%	-0.13%	2.16%	5.35%	1.19%	0.73%	0.92%	0.10%
s_3	5	6	12	5	17.9%	21.4%	42.9%	17.9%	-2.02%	-0.09%	2.32%	5.61%	0.94%	0.64%	0.72%	0.75%
s_4	2	2	3	1	25.0%	25.0%	37.5%	12.5%	-2.00%	-0.11%	1.95%	4.56%	0.09%	0.80%	0.52%	0.00%

KYD GOLD	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	-	5	4	2	-	45.5%	36.4%	18.2%	-	-0.91%	2.32%	9.29%	-	1.50%	0.90%	0.29%
s_2	5	11	10	2	17.9%	39.3%	35.7%	7.1%	-7.61%	-1.29%	3.81%	8.17%	3.57%	1.59%	1.92%	2.89%
s_3	4	9	7	2	18.2%	40.9%	31.8%	9.1%	-6.22%	-1.46%	4.27%	9.39%	1.82%	1.38%	1.75%	0.45%
s_4	2	2	2	3	22.2%	22.2%	22.2%	33.3%	-5.00%	-2.10%	3.41%	11.83%	0.29%	2.19%	0.80%	2.30%

XU100 TOTAL RETURN	Transition Matrix				Transition Probabilities				Transition Mean Return				Transition Std. Dev. Return			
States	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4	s_1	s_2	s_3	s_4
s_1	1	4	2	5	8.3%	33.3%	16.7%	41.7%	-9.17%	-2.28%	0.74%	10.50%	0.00%	1.32%	0.54%	2.03%
s_2	7	6	6	2	33.3%	28.6%	28.6%	9.5%	-8.83%	-2.86%	3.62%	7.87%	3.12%	1.37%	1.75%	1.41%
s_3	3	7	7	5	13.6%	31.8%	31.8%	22.7%	-8.81%	-2.36%	2.19%	8.81%	3.03%	1.63%	1.57%	1.69%
s_4	2	3	7	3	13.3%	20.0%	46.7%	20.0%	-7.42%	-2.30%	2.69%	6.98%	1.67%	2.68%	2.01%	0.55%

4.2 Ordinary Monte Carlo Simulation

As we have the parameters of the financial instruments modeled as Markov Chains, we run an Ordinary Monte Carlo Simulation to simulate the returns of the financial instruments until retirement, for any given entry age for the participant.

Figure 4.1 shows the simulation path of the each financial instrument for the longest possible investment period, assuming a minimum participation age of 18 and maximum retirement age of 56.

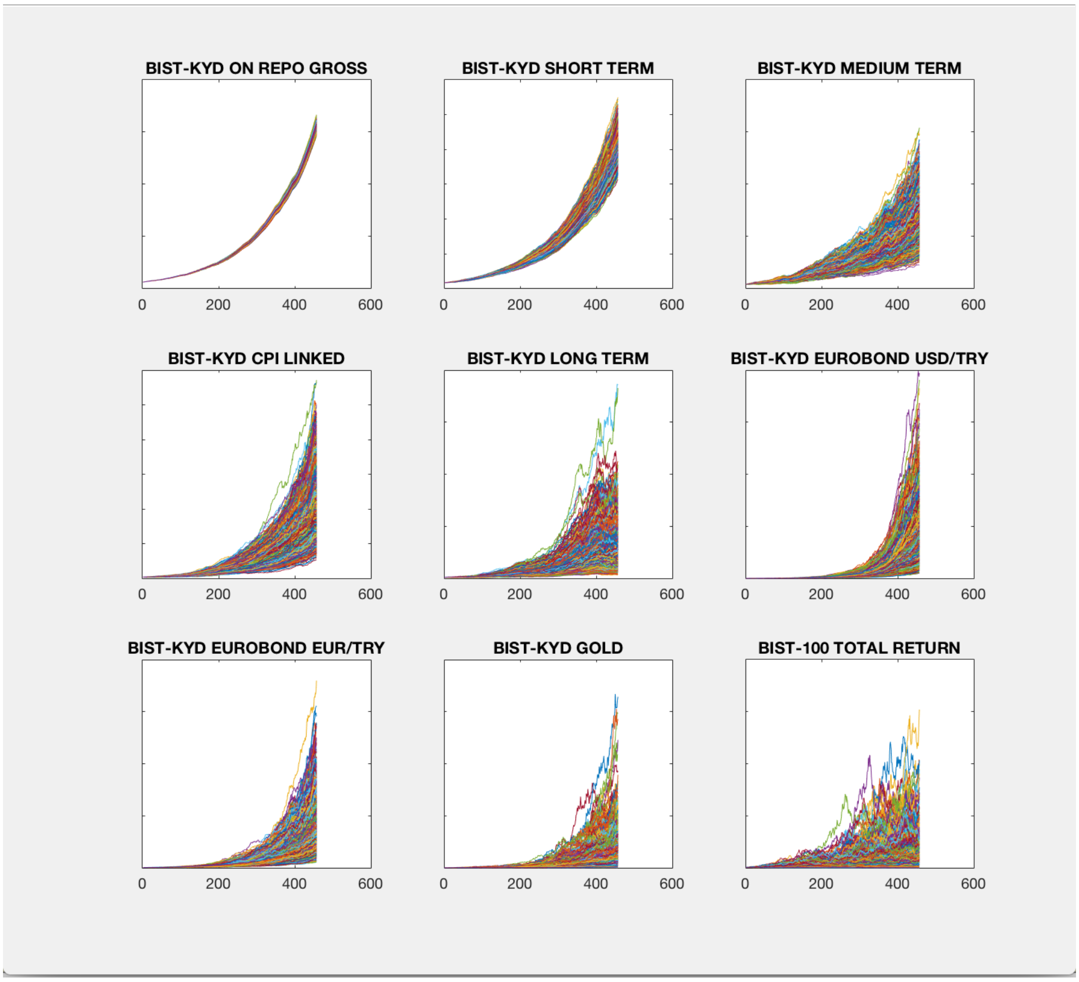


Figure 4.1: Simulation Paths of the Benchmark Indices for 38 years (Between Age 18 and 56)

4.3 Accumulation Phase Simulation

After simulating the financial instrument returns until a person retires, we create equally weighted portfolios consisting of all combinations of the 9 financial instruments, and using those portfolios with the returns, we run Equation (2.0.3) to successfully estimate a person's accumulation for each portfolio choice. We simulate three versions of accumulation amounts depending on the type of contributions and existance of portfolio management fees, and state subsidy funds: fixed contribution amounts without fees, increasing contribution amounts with fees and increasing contribution amounts with fees and state subsidies. The last scenario is obviously the most realistic scenario compared to the recent practice. To analyze the effects of each instrument on investment performance, we present our results by grouping the equally weighted portfolios by instrument types.

The weights of the instruments at each portfolio is presented in Table 7.2 of Appendix, at increasing order of weights from money market instruments to fx. i.e. the first portfolio fully invests in the repo index, while the last portfolio is invested fully in the Eurobond USDTRY index. The last two columns of this table also represent the mean and standard deviations of the related portfolios.

In Table 4.5, average accumulation amounts and average annual IRRs of all portfolio groups are presented in both nominal and real terms, under different scenarios and for participants entering the system at different ages. We express the findings of this chapter in a nutshell after the following graphical displays of our model's outcomes.

Nominal Returns	Entry Age	Average Accumulation Amount					Average IRR				
		FX	GOLD	BONDS	EQUITY	ALL PORTFOLIOS	FX	GOLD	BONDS	EQUITY	ALL PORTFOLIOS
Fixed Contribution with No Fees	18	3,007,545	716,284	318,172	162,127	494,620	16.19%	11.72%	8.48%	5.87%	9.90%
	26	1,261,878	344,038	164,260	82,119	247,721	18.29%	12.60%	8.81%	5.05%	10.52%
	36	213,351	159,755	66,369	43,309	87,313	18.66%	16.61%	9.32%	5.61%	11.40%
	46	33,424	24,182	19,735	16,241	21,820	19.78%	13.71%	9.85%	6.11%	11.66%
Increasing Contribution with Fees	18	3,532,222	1,269,034	689,999	459,760	914,203	14.32%	10.28%	6.80%	4.26%	8.20%
	26	1,555,992	594,934	339,623	212,842	448,077	16.49%	11.17%	7.16%	3.27%	8.88%
	36	291,591	233,628	114,797	84,854	142,200	16.86%	14.99%	7.55%	4.03%	9.69%
	46	41,890	31,620	26,506	22,392	28,880	18.02%	12.05%	8.21%	4.46%	10.00%
Increasing Contribution with Fees and State Subsidy	18	4,565,460	1,627,639	881,887	585,238	1,171,376	15.47%	11.53%	8.24%	5.87%	9.56%
	26	1,994,847	758,646	431,885	269,921	570,880	17.93%	12.75%	8.95%	5.34%	10.58%
	36	369,975	296,168	145,203	107,177	180,001	19.12%	17.28%	10.12%	6.79%	12.17%
	46	52,717	39,773	33,330	28,148	36,321	22.80%	16.93%	13.17%	9.53%	14.93%

Real Returns	Entry Age	Average Accumulation Amount					Average IRR				
		FX	GOLD	BONDS	EQUITY	ALL PORTFOLIOS	FX	GOLD	BONDS	EQUITY	ALL PORTFOLIOS
Fixed Contribution with No Fees	18	319,465	156,560	54,394	38,932	80,868	8.39%	5.72%	0.87%	-0.84%	2.54%
	26	202,372	68,568	40,452	27,852	55,082	9.62%	4.01%	0.76%	-1.75%	2.41%
	36	61,731	41,907	24,696	18,066	29,766	8.48%	5.31%	0.30%	-2.90%	1.96%
	46	18,297	14,255	12,139	10,982	13,138	8.31%	3.57%	0.39%	-1.62%	1.90%
Increasing Contribution with Fees	18	673,843	515,050	250,179	198,992	307,299	6.59%	5.04%	-0.75%	-3.09%	0.93%
	26	379,737	190,163	141,993	117,923	167,671	7.77%	2.21%	-0.82%	-2.99%	0.76%
	36	110,543	85,071	57,009	46,561	65,150	6.95%	4.06%	-1.21%	-4.18%	0.50%
	46	24,796	20,154	17,540	16,338	18,772	6.66%	2.07%	-1.16%	-2.84%	0.37%
Increasing Contribution with Fees and State Subsidy	18	861,432	654,990	316,783	251,642	389,876	8.04%	6.58%	1.37%	-0.66%	2.87%
	26	483,535	240,911	179,448	148,762	212,202	9.53%	4.37%	1.64%	-0.29%	3.06%
	36	139,760	107,404	71,867	58,626	82,177	9.55%	6.82%	1.92%	-0.79%	3.51%
	46	31,176	25,328	22,036	20,521	23,587	11.67%	7.21%	4.10%	2.48%	5.58%

Table 4.5: Summary Simulation Results of Portfolio Groups in Nominal and Real Terms. Total invested amounts for entry ages are 18, 26, 36, and 46 are TRY 45,600, TRY 36,000 ,TRY 24,000 and TRY 12,000, respectively, assuming fixed contribution amounts of TRY 100 monthly until retirement. Assuming increasing contribution amounts, total invested amounts become TRY 272,000, TRY 147,000, TRY 63,000 and TRY 19,000, respectively.

Participant Entry Age: 18 - Nominal Returns

Figure 4.2: Nominal Accumulation Amount and IRR Simulation: Participant Age 18

Participant Entry Age: 18 - Real Returns

Figure 4.3: Real Accumulation Amount and IRR Simulation: Participant Age 18

Participant Entry Age: 26 - Nominal Returns

Figure 4.4: Nominal Accumulation Amount and IRR Simulation: Participant Age 26

Participant Entry Age: 26 - Real Returns

Figure 4.5: Real Accumulation Amount and IRR Simulation: Participant Age 26

Participant Entry Age: 36 - Nominal Returns

Figure 4.6: Nominal Accumulation Amount and IRR Simulation: Participant Age 36

Participant Entry Age: 36 - Real Returns

Figure 4.7: Real Accumulation Amount and IRR Simulation: Participant Age 36

Participant Entry Age: 46 - Nominal Returns

Figure 4.8: Nominal Accumulation Amount and IRR Simulation: Participant Age 46

Participant Entry Age: 46 - Real Returns

Figure 4.9: Real Accumulation Amount and IRR Simulation: Participant Age 46

In a nutshell, in Section 4.1 of this section, we have shown the mean and standard deviation of the benchmark indices together with the related state transition criteria, historical states and detailed transition parameters. In Section 4.2, we have presented the Ordinary Monte Carlo simulation results for the return paths of benchmark indices for the longest investment period considered in this thesis. Finally, in this Section, we have presented the average accumulation amounts and investment period IRRs of participants entering the system at different ages, under different assumptions and portfolio allocations, in both nominal and real terms. We have showed that, although the introduction of fees decrease the investment performance of pension funds, state subsidies help individuals to have better accumulation amounts and IRRs at retirement. We have also showed that having FX exposure in portfolios increases the investment performance on all scenarios. Detailed interpretation of these findings will be presented in Chapter 5.

Chapter 5

Discussion

In Chapters 2 and 3, we have introduced the theory and assumptions underlying our model, and explained the data in detail, and constructed our model along with the related algorithms. In the previous chapter, we have presented the results of our model.

To construct the Markov Chains on financial benchmark indices, we first estimated the parameters of the related Markov Processes, including historical mean and standard deviation, state criteria, historical states, historical state transitions, transition probabilities, transition mean and standard deviations.

Second, applying Ordinary Monte Carlo Simulation on these chains we have generated return paths for the indices. Third, we have evaluated Equation (2.0.3), using these returns together with the equally weighted portfolios, with different contribution rate, fee and state subsidy assumptions. Finally, we have presented the expected retirement accumulation amounts of participants entering the private pension system at different ages for all scenarios.

In Section 3.2, we have mentioned that we choose not to remove outliers from the data series. In 1980, Hawkins (Hawkins, 1980) defined an outlier as *"an observation which deviates so much from other observations as to arouse suspicions that it was generated by a different mechanism"*. In time series data, outliers can arise because of errors in the process of collecting the data, misreporting, or sampling errors. But in finance, especially for the liquid financial instruments, the deviations from other observations should not necessarily be considered as outliers. These deviations may be the result of a significant regime shift, or a substantial stress on the economies. We believe that, in finance, these deviations should be considered as rare events having a huge impact on investment returns rather than being outliers.

In this chapter, we interpret the results presented in the previous chapter, and we make our conclusions in Chapter 6.

5.1 Modeling Results

Overall, assuming increasing contribution amounts, existence of fees and state subsidies, our model shows that a person entering the private pension system in Turkey at age 18 will have a total nominal accumulation amount of around TRY 914,000 at age 56, after investing a total amount of around TRY 272,000, and this accumulation amount leads to an average annual IRR of 8.2%. If we introduce the state subsidy to our model, his expected accumulation will be around TRY 1.2 Million, and this will yield to an average annual IRR of 9.6%. If he adds FX exposure to his portfolios, his total accumulation amount and investment performance will increase significantly. Figures 4.2 through 4.9 show the performance of all different portfolio groups in terms of accumulation amounts and IRRs, and in nominal and real terms.

Results show that, entry age of the participant makes a significant difference especially in terms of total accumulation amounts. The investment performance, measured by IRR is heavily effected by the fees, but the negative effect of fees is almost fully compensated by the introduction of state subsidies. Moreover, the marginal benefit of the state subsidies increase with decreasing investment period, because the total fees paid on state subsidies decreases. See Table 4.5 for details.

Our results lead to three inferences on pension fund investments:

Firstly, introduction of fees decreases the investment performance of any participant significantly, This shows that, historical decreasing trend of fees has served the system well, and it is consistent with our results and with the decreasing trend of interest rates since the inception of the system. However, although participants benefit from decreasing fees, the limit of the fees on the downside must be considered carefully according to the costs of the private pension firms and portfolio management companies, as portfolio management fees are shared out between private pension companies and portfolio management companies in practice. Any violation of synergy among the parties in the system, namely the participants, private pension firms and portfolio management companies would harm the future of the system, and would harm the savings ratio of the country as a whole, thus harming the participants itself, too.

Second, introduction of state subsidies into the system leads to better retirement oriented accumulations, and better investment internal rate of returns. Therefore, we suggest the state subsidies to be permanent, as it is a great incentive for individuals to join the private pension system. We also mentioned in Chapter 1 that, state subsidies are annually limited in the upside with the 25% of the annual gross minimum wage (w_{min}). So, any contribution amount more than the gross minimum wage will decrease the marginal benefit of state subsidies.

Final common inference of our results on pension fund investments is about portfolio allocations. On average, portfolios with FX exposure tend to outperform other portfolios significantly in all scenarios, both in nominal and real terms. Through Figures 4.2 and 4.9, portfolios with FX exposure have better accumulation amounts and IRRs compared to the average of all portfolios, and portfolios without any FX exposure underperform. Current asset allocations of Turkish Pension Funds show an increasing share of FX instruments, but a still a lower share compared to the results presented by our model.

We can also see the historical outperformance of FX instruments in Figure 7.3. This outperformance is the result of depreciation of Turkish Lira throughout the years. There are several economic explanations of currency depreciation in emerging countries like Turkey. Most important reason behind local currency depreciation is the high level of inflation in emerging countries. Also the current and expected monetary policy of a country, in both absolute and relative terms, is effective on its currency rate. Generally, easing in monetary policy leads to currency depreciation. Easing in monetary should not necessarily be effective in absolute terms to lead currency depreciation, but more relaxed monetary policy relative to peer countries can also lead to currency depreciation. Also the level structural reforms and general expectations on the future of a country's economy can lead to currency appreciation or depreciation.

Our results on the positive effect of fx allocation in pension funds is similar to the studies of Angelidis and Tessaromatis (Angelidis en Tessaromatis, 2010) and De Menil (De Menil, 2005). Similar to what they suggest in terms of exposure in international investments, exposure in FX instruments, including the BIST-KYD Gold Average Price Index, has a positive effect on fund performances in a similar way.

Chapter 6

Conclusion

Towards conclusion, in Chapter 1, we have explained the private pension business, the type of pension plans in practice, namely DB, DC, and Hybrid plans, and emphasized the recent shifts from DB plans to DC plans referring to related studies. We showed that the importance of the pension funds relative to the size of economies is very high, especially in developed markets, and it has been increasing rapidly in Turkey. We explained that effective private pension plan in Turkey is also DC type of plans, as in the most of OECD and non-OECD countries, in which the accumulation amounts of participants for the retirement depend heavily on pension fund performances. Considering the relatively low share of pension funds in the economy, and the scarcity of research in the area, we expressed the need for additional research about Turkish Private Pension System.

In Chapter 2, we have introduced an extensive retirement accumulation phase simulation model, based on Markov Chains and Monte Carlo simulations and focusing on the Turkish Private Pension System. Although we focus on the Turkish pension funds and Turkish financial instruments, the accumulation amount simulation model we have generated is applicable for any set of financial instruments. Unlike the previous studies on Turkish Private Pension System, focusing mostly on historical performances and operational structure, we have introduced a new and comprehensive framework focusing on accumulation projections.

The main purpose of this thesis is projecting the accumulation amounts of participants at retirement, rather than concentrating on their incomes at retirement. But the decumulation phase is also a challenging problem, and future research in this field would be beneficial.

We presented a pension fund management problem with state space modeling approach, and derived our main equation for retirement oriented accumulation amount calculation as follows:

$$Y_t = [Y_{t-1} + c_t(1-m)] \sum_{i=1}^{n} w_t^i e^{X_t^i - p} \tag{2.0.3}$$

Here, Y_t is the pension accumulation at time t where $Y_0 = 0$, c_t is the contribution amount at time t, n is the accumulation time in months, m is the administrative fee, p is the portfolio management fee, w_t^i is the weight of instrument i in the portfolio at time t, and X_t^i is the return of benchmark index i at time t, following a second order Markov Process.

We explained in detail the estimation of X_t^i for each financial instrument in Chapters 2 and 3, and presented the results in Chapter 4. We generated all possible equally weighted portfolios of the benchmark indices for w_t^i. We have analyzed 2 different scenarios for contribution amounts (c_t) and portfolio management fees (p), and 1 additional scenario including the state subsidy funds. We assumed no administrative fees (m) were charged in all scenarios. We have also run our scenarios with ex-post monthly inflation data, and presented the results with related real returns. Our scenarios included:

1. Constant contribution amounts until retirement with no fees,
2. Increasing contribution amount at the rate of past year's average annual repo rate, with fees at industry averages,
3. Increasing contribution amount at the rate of past year's average annual repo rate, with fees at industry averages, and a state subsidy of 25% which is subject to lower fees.

In Chapter 3, we elaborated on the data we have used, and revealed the algorithms for implementing our model, and outlined our solution for missing historical data in calculating the transition probabilities and related mean and standard deviations.

In Chapter 4, we presented the detailed results of our implementations, including the historical summary statistics and transition criteria of the benchmark indices,and historical states of those indices for calculating the related transition probabilities. We also presented the transition probabilities and transition mean and standard deviations of each index, and display the return paths of each financial instrument for a participant entering the system at age 18, and retiring at age 56.

The main results of our model is presented at Table 4.5 and Figures 4.2 through 4.9. We showed that, according to our model, assuming annually increasing contribution rates and industry average fees, and the existence of state subsidies, average annual nominal IRR of a participant throughout his investment period will be between 9.5% and 15%, depending on the entry age to the system. If there were no state subsidy for the participants, the average annual nominal IRR would fell to a value between 8% and 10%.

The average IRR of a participant is also between 10% and 12% assuming no fee charges and constant contribution amounts until retirement. This result proves that, in the existence of fees, increasing the contribution amounts helps the participants to achieve more accumulation amounts for retirement compared to fixed contribution and no fees scenario, but as the invested amount also increases through this period, the average IRR of a participant falls almost as the rate of fees. We showed that, the existence of state subsidy funds compensates most of the loss of participants causing from fees, and even increases the investment performance for older people, and ensure participants to get professional fund management services at lower costs.

Analyzing the portfolio groups of different instruments, we showed that FX exposure increases the average annual IRR of participants significantly for each scenario. The main reason behind the outperformance of FX securities over all securities is that, the currencies of countries with high inflationary environment tend to depreciate consistently. We explained that our findings of FX outperformance are consistent with the study of Angelidis and Tessaromatis (Angelidis en Tessaromatis, 2010) and De Menil (De Menil, 2005), in a way that investing in FX instruments can be considered as a hedge instrument for not investing internationally.

We have mentioned that not only individual participants, but also portfolio management companies and private pension companies can benefit from our framework. We believe that portfolio management companies may benefit from the Markov Chain technique we derived in Chapters 2 and 3 in their own analyzes on market behavior, and they may use our comparisons on portfolio allocations in their asset allocation strategies. For the private pension companies, our accumulation phase simulation framework can be useful on advising their customers about their retirements, and our scenarios on portfolio allocations can be beneficial while deciding the types of pension funds to be established. We believe that regulatory authorities may benefit from our framework in determining investment limitations, and fee structures on private pension system.

Finally, we list some open questions in terms of policy determination, and one can address those questions in further research. Between Figures 4.2 and 4.9, it is obvious that, in the existence of fees, the average annual IRRs are effected negatively. So, as a policy determination framework, one may consider to analyze an optimal model on fees, decreasing through time, without destructing the parties in the industry, including private pension firms and portfolio management companies. Private pension companies, portfolio management companies, individual participants and governments all benefit from the healthy development of the private pension system.

Private pension companies and portfolio management companies earn fees for the service they provide, individual participants get professional investment services and ensure a better income at their retirements, and governments benefit from the increasing savings rates in the economy. So, any alterations regarding the functioning of the system must be considered carefully to avoid any destruction of the synergy between these parties.

Another question to be considered is the level of FX exposure in pension fund investments. It is obvious that individuals should have an FX exposure more than the current allocations of funds, but the limitations on the regulations side should be considered carefully. Considering the current growth rates of pension funds together with it's further growth potential, in an environment of consistently depreciating local currency, the increasing allocation of pension funds on FX instruments could accelerate the currency depreciation. Rapid depreciation of the currency would lead to other economical problems like inflation and uncertainty, would again hurt all the parties related to private pension industry. So, considering these facts, one may consider to examine the optimum asset allocation rates of pension funds in FX instruments.

We mentioned that we are assuming equally weighted portfolios of different financial instruments, and do not change the portfolio allocations during the investment period. For a better optimized portfolio, one can also work on different portfolio allocations, like auto re-balancing the equal weights or increasing the share of short term fixed income assets while getting closer to retirement. We have argued that the risk-return trade off hypothesis in financial theory is not supported that much by the historical returns of the financial instruments presented in Table 3.4. While studying the optimal portfolio allocations of financial instruments through pension fund accumulation period, one can also bear in mind this controversy, and analyze the reasons behind it.

Current regulations allow participants to change their fund selection 6 times a year, so instead of investing in the same portfolio until retirement, one can also test the optimal number of portfolio re-allocations per year, until retirement.

Our final open question is related with the optimal amount of contributions. In Chapter 5, we have suggested a minimum annual contribution amount to maximize the benefits of state subsidies. In this thesis, we are focused on projecting accumulation amounts and suggesting policies regarding fees, portfolio allocations, and state subsidies. As a further research, one can expand our work on finding the optimal rate of contributions, as well as testing our suggestion on minimum annual contribution amounts.

Turkish Private Pension System have been developing rapidly since it's inception, and still has a substantial growth potential, comparing with the importance of private pension systems in global economies. Additionally, the auto enrollment system that will be effective gradually, starting from 2017, will also speed up the growth rates of the system, as well as the private savings. The new system will make it mandatory for all employers to join the private pension system gradually, with an option to leave the system in two months, and an additional state subsidy if they choose not to leave.

We believe that the results presented and the open questions listed in this thesis would be beneficial for all the counterparties in the current Turkish Private Pension System, and for preventing the auto-enrolled participants to leave the system, which is essential to achieve the aim of increasing private savings through auto-enrollments.

Chapter 7

Appendix

Test Name	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM
Jarque-Bera	0	0	0	1	0
Chi-square goodness-of-fit	1	0	0	1	0
Lilliefors	1	0	0	0	0

Test Name	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN
Jarque-Bera	1	0	0	0
Chi-square goodness-of-fit	0	0	0	0
Lilliefors	0	0	0	0

Table 7.1: Normality Tests for the Benchmark Indices. Testing the null hypothesis that the data series comes from a normal distribution. The test returns 0 if it fails to reject the null hypothesis.

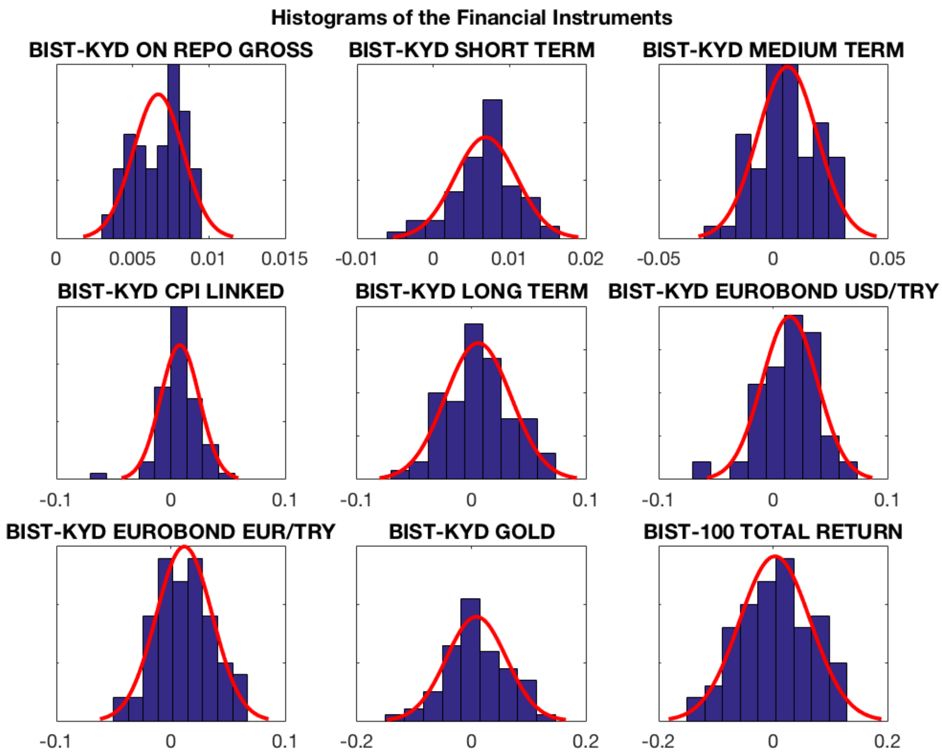


Figure 7.1: Histograms of the Financial Instruments

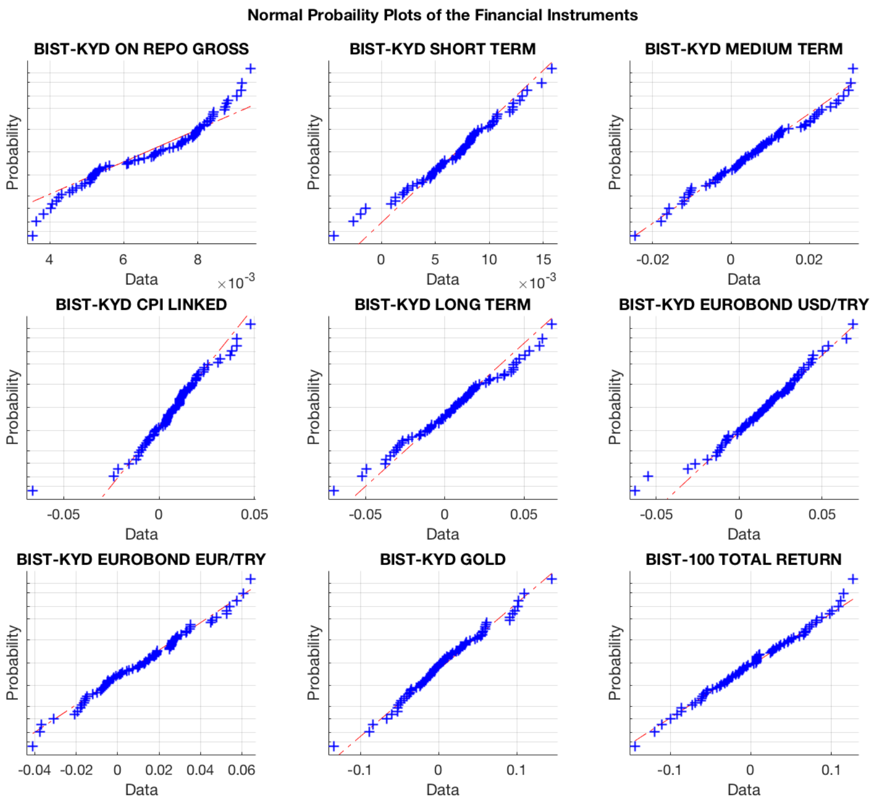


Figure 7.2: Normal Probability Plots of the Financial Instruments

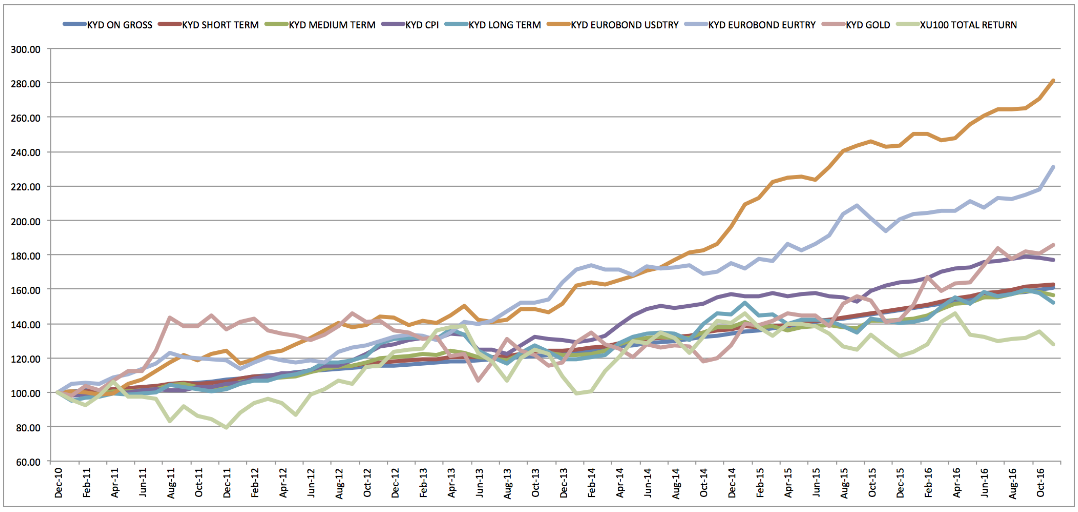


Figure 7.3: Historical Performances of the Financial Instruments

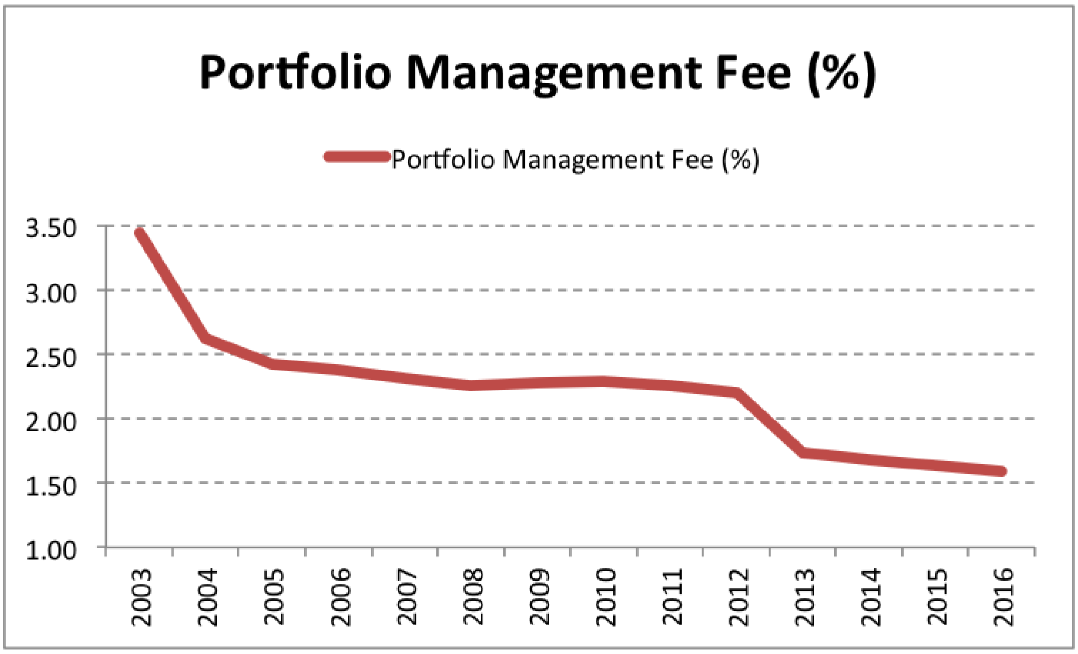


Figure 7.4: Portfolio Management Fees Between 2003 and 2016

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 1	100.0%	-	-	-	-	-	-	-	-	0.67%	0.16%
Portfolio 10	50.0%	50.0%	-	-	-	-	-	-	-	0.68%	0.25%
Portfolio 101	-	-	33.3%	-	33.3%	-	33.3%	-	-	0.80%	1.29%
Portfolio 102	-	-	33.3%	-	33.3%	-	-	33.3%	-	0.70%	2.18%
Portfolio 103	-	-	33.3%	-	33.3%	-	-	-	33.3%	0.52%	3.05%
Portfolio 107	-	-	33.3%	-	-	-	33.3%	33.3%	-	0.90%	2.13%
Portfolio 108	-	-	33.3%	-	-	-	33.3%	-	33.3%	0.72%	2.17%
Portfolio 109	-	-	33.3%	-	-	-	-	33.3%	33.3%	0.62%	2.55%
Portfolio 11	50.0%	-	50.0%	-	-	-	-	-	-	0.65%	0.67%
Portfolio 111	-	-	-	33.3%	33.3%	-	33.3%	-	-	0.86%	1.36%
Portfolio 112	-	-	-	33.3%	33.3%	-	-	33.3%	-	0.76%	2.18%
Portfolio 113	-	-	-	33.3%	33.3%	-	-	-	33.3%	0.58%	3.10%
Portfolio 117	-	-	-	33.3%	-	-	33.3%	33.3%	-	0.95%	2.13%
Portfolio 118	-	-	-	33.3%	-	-	33.3%	-	33.3%	0.78%	2.25%
Portfolio 119	-	-	-	33.3%	-	-	-	33.3%	33.3%	0.67%	2.59%
Portfolio 12	50.0%	-	-	50.0%	-	-	-	-	-	0.74%	0.87%
Portfolio 123	-	-	-	-	33.3%	-	33.3%	33.3%	-	0.88%	2.22%
Portfolio 124	-	-	-	-	33.3%	-	33.3%	-	33.3%	0.71%	2.49%
Portfolio 125	-	-	-	-	33.3%	-	-	33.3%	33.3%	0.60%	2.89%
Portfolio 129	-	-	-	-	-	-	33.3%	33.3%	33.3%	0.80%	2.44%
Portfolio 13	50.0%	-	-	-	50.0%	-	-	-	-	0.63%	1.45%
Portfolio 130	25.0%	25.0%	25.0%	25.0%	-	-	-	-	-	0.70%	0.78%
Portfolio 131	25.0%	25.0%	25.0%	-	25.0%	-	-	-	-	0.64%	1.12%
Portfolio 133	25.0%	25.0%	25.0%	-	-	-	25.0%	-	-	0.79%	0.59%
Portfolio 134	25.0%	25.0%	25.0%	-	-	-	-	25.0%	-	0.71%	1.36%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 135	25.0%	25.0%	25.0%	-	-	-	-	-	25.0%	0.58%	1.82%
Portfolio 136	25.0%	25.0%	-	25.0%	25.0%	-	-	-	-	0.69%	1.15%
Portfolio 138	25.0%	25.0%	-	25.0%	-	-	25.0%	-	-	0.84%	0.66%
Portfolio 139	25.0%	25.0%	-	25.0%	-	-	-	25.0%	-	0.76%	1.35%
Portfolio 140	25.0%	25.0%	-	25.0%	-	-	-	-	25.0%	0.63%	1.87%
Portfolio 142	25.0%	25.0%	-	-	25.0%	-	25.0%	-	-	0.78%	0.80%
Portfolio 143	25.0%	25.0%	-	-	25.0%	-	-	25.0%	-	0.71%	1.52%
Portfolio 144	25.0%	25.0%	-	-	25.0%	-	-	-	25.0%	0.57%	2.10%
Portfolio 148	25.0%	25.0%	-	-	-	-	25.0%	25.0%	-	0.85%	1.62%
Portfolio 149	25.0%	25.0%	-	-	-	-	25.0%	-	25.0%	0.72%	1.50%
Portfolio 15	50.0%	-	-	-	-	-	50.0%	-	-	0.92%	1.21%
Portfolio 150	25.0%	25.0%	-	-	-	-	-	25.0%	25.0%	0.64%	1.80%
Portfolio 151	25.0%	-	25.0%	25.0%	25.0%	-	-	-	-	0.67%	1.37%
Portfolio 153	25.0%	-	25.0%	25.0%	-	-	25.0%	-	-	0.82%	0.74%
Portfolio 154	25.0%	-	25.0%	25.0%	-	-	-	25.0%	-	0.74%	1.42%
Portfolio 155	25.0%	-	25.0%	25.0%	-	-	-	-	25.0%	0.61%	2.03%
Portfolio 157	25.0%	-	25.0%	-	25.0%	-	25.0%	-	-	0.77%	0.97%
Portfolio 158	25.0%	-	25.0%	-	25.0%	-	-	25.0%	-	0.69%	1.64%
Portfolio 159	25.0%	-	25.0%	-	25.0%	-	-	-	25.0%	0.56%	2.29%
Portfolio 16	50.0%	-	-	-	-	-	-	50.0%	-	0.77%	2.61%
Portfolio 163	25.0%	-	25.0%	-	-	-	25.0%	25.0%	-	0.84%	1.59%
Portfolio 164	25.0%	-	25.0%	-	-	-	25.0%	-	25.0%	0.71%	1.63%
Portfolio 165	25.0%	-	25.0%	-	-	-	-	25.0%	25.0%	0.63%	1.92%
Portfolio 167	25.0%	-	-	25.0%	25.0%	-	25.0%	-	-	0.81%	1.02%
Portfolio 168	25.0%	-	-	25.0%	25.0%	-	-	25.0%	-	0.74%	1.64%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 169	25.0%	-	-	25.0%	25.0%	-	-	-	25.0%	0.60%	2.33%
Portfolio 17	50.0%	-	-	-	-	-	-	-	50.0%	0.51%	3.11%
Portfolio 173	25.0%	-	-	25.0%	-	-	25.0%	25.0%	-	0.88%	1.59%
Portfolio 174	25.0%	-	-	25.0%	-	-	25.0%	-	25.0%	0.75%	1.69%
Portfolio 175	25.0%	-	-	25.0%	-	-	-	25.0%	25.0%	0.67%	1.95%
Portfolio 179	25.0%	-	-	-	25.0%	-	25.0%	25.0%	-	0.83%	1.67%
Portfolio 18	-	50.0%	50.0%	-	-	-	-	-	-	0.66%	0.84%
Portfolio 180	25.0%	-	-	-	25.0%	-	25.0%	-	25.0%	0.70%	1.87%
Portfolio 181	25.0%	-	-	-	25.0%	-	-	25.0%	25.0%	0.62%	2.18%
Portfolio 185	25.0%	-	-	-	-	-	25.0%	25.0%	25.0%	0.77%	1.83%
Portfolio 186	-	25.0%	25.0%	25.0%	25.0%	-	-	-	-	0.68%	1.45%
Portfolio 188	-	25.0%	25.0%	25.0%	-	-	25.0%	-	-	0.83%	0.79%
Portfolio 189	-	25.0%	25.0%	25.0%	-	-	-	25.0%	-	0.75%	1.46%
Portfolio 19	-	50.0%	-	50.0%	-	-	-	-	-	0.75%	0.98%
Portfolio 190	-	25.0%	25.0%	25.0%	-	-	-	-	25.0%	0.62%	2.09%
Portfolio 192	-	25.0%	25.0%	-	25.0%	-	25.0%	-	-	0.77%	1.04%
Portfolio 193	-	25.0%	25.0%	-	25.0%	-	-	25.0%	-	0.70%	1.69%
Portfolio 194	-	25.0%	25.0%	-	25.0%	-	-	-	25.0%	0.56%	2.36%
Portfolio 198	-	25.0%	25.0%	-	-	-	25.0%	25.0%	-	0.84%	1.61%
Portfolio 199	-	25.0%	25.0%	-	-	-	25.0%	-	25.0%	0.71%	1.68%
Portfolio 2	-	100.0%	-	-	-	-	-	-	-	0.69%	0.41%
Portfolio 20	-	50.0%	-	-	50.0%	-	-	-	-	0.64%	1.60%
Portfolio 200	-	25.0%	25.0%	-	-	-	-	25.0%	25.0%	0.63%	1.97%
Portfolio 202	-	25.0%	-	25.0%	25.0%	-	25.0%	-	-	0.82%	1.08%
Portfolio 203	-	25.0%	-	25.0%	25.0%	-	-	25.0%	-	0.74%	1.69%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EU-ROBOND USDTRY	KYD EU-ROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 204	-	25.0%	-	25.0%	25.0%	-	-	-	25.0%	0.61%	2.39%
Portfolio 208	-	25.0%	-	25.0%	-	-	25.0%	25.0%	-	0.89%	1.61%
Portfolio 209	-	25.0%	-	25.0%	-	-	25.0%	-	25.0%	0.75%	1.74%
Portfolio 210	-	25.0%	-	25.0%	-	-	-	25.0%	25.0%	0.68%	2.00%
Portfolio 214	-	25.0%	-	-	25.0%	-	25.0%	25.0%	-	0.83%	1.69%
Portfolio 215	-	25.0%	-	-	25.0%	-	25.0%	-	25.0%	0.70%	1.93%
Portfolio 216	-	25.0%	-	-	25.0%	-	-	25.0%	25.0%	0.63%	2.23%
Portfolio 22	-	50.0%	-	-	-	-	50.0%	-	-	0.93%	1.18%
Portfolio 220	-	25.0%	-	-	-	-	25.0%	25.0%	25.0%	0.77%	1.86%
Portfolio 222	-	-	25.0%	25.0%	25.0%	-	25.0%	-	-	0.80%	1.26%
Portfolio 223	-	-	25.0%	25.0%	25.0%	-	-	25.0%	-	0.73%	1.83%
Portfolio 224	-	-	25.0%	25.0%	25.0%	-	-	-	25.0%	0.59%	2.59%
Portfolio 228	-	-	25.0%	25.0%	-	-	25.0%	25.0%	-	0.87%	1.62%
Portfolio 229	-	-	25.0%	25.0%	-	-	25.0%	-	25.0%	0.74%	1.88%
Portfolio 23	-	50.0%	-	-	-	-	-	50.0%	-	0.78%	2.62%
Portfolio 230	-	-	25.0%	25.0%	-	-	-	25.0%	25.0%	0.66%	2.14%
Portfolio 234	-	-	25.0%	-	25.0%	-	25.0%	25.0%	-	0.82%	1.76%
Portfolio 235	-	-	25.0%	-	25.0%	-	25.0%	-	25.0%	0.69%	2.11%
Portfolio 236	-	-	25.0%	-	25.0%	-	-	25.0%	25.0%	0.61%	2.40%
Portfolio 24	-	50.0%	-	-	-	-	-	-	50.0%	0.52%	3.20%
Portfolio 240	-	-	25.0%	-	-	-	25.0%	25.0%	25.0%	0.76%	1.95%
Portfolio 244	-	-	-	25.0%	25.0%	-	25.0%	25.0%	-	0.86%	1.77%
Portfolio 245	-	-	-	25.0%	25.0%	-	25.0%	-	25.0%	0.73%	2.16%
Portfolio 246	-	-	-	25.0%	25.0%	-	-	25.0%	25.0%	0.65%	2.42%
Portfolio 25	-	-	50.0%	50.0%	-	-	-	-	-	0.72%	1.37%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 250	-	-	-	25.0%	-	-	25.0%	25.0%	25.0%	0.80%	1.98%
Portfolio 254	-	-	-	-	25.0%	-	25.0%	25.0%	25.0%	0.75%	2.16%
Portfolio 256	20.0%	20.0%	20.0%	20.0%	20.0%	-	-	-	-	0.68%	1.17%
Portfolio 258	20.0%	20.0%	20.0%	20.0%	-	-	20.0%	-	-	0.79%	0.63%
Portfolio 259	20.0%	20.0%	20.0%	20.0%	-	-	-	20.0%	-	0.73%	1.17%
Portfolio 26	-	-	50.0%	-	50.0%	-	-	-	-	0.61%	2.06%
Portfolio 260	20.0%	20.0%	20.0%	20.0%	-	-	-	-	20.0%	0.63%	1.68%
Portfolio 262	20.0%	20.0%	20.0%	-	20.0%	-	20.0%	-	-	0.75%	0.83%
Portfolio 263	20.0%	20.0%	20.0%	-	20.0%	-	-	20.0%	-	0.69%	1.36%
Portfolio 264	20.0%	20.0%	20.0%	-	20.0%	-	-	-	20.0%	0.58%	1.89%
Portfolio 268	20.0%	20.0%	20.0%	-	-	-	20.0%	20.0%	-	0.81%	1.29%
Portfolio 269	20.0%	20.0%	20.0%	-	-	-	20.0%	-	20.0%	0.70%	1.35%
Portfolio 270	20.0%	20.0%	20.0%	-	-	-	-	20.0%	20.0%	0.64%	1.58%
Portfolio 272	20.0%	20.0%	-	20.0%	20.0%	-	20.0%	-	-	0.79%	0.87%
Portfolio 273	20.0%	20.0%	-	20.0%	20.0%	-	-	20.0%	-	0.73%	1.35%
Portfolio 274	20.0%	20.0%	-	20.0%	20.0%	-	-	-	20.0%	0.62%	1.92%
Portfolio 278	20.0%	20.0%	-	20.0%	-	-	20.0%	20.0%	-	0.84%	1.28%
Portfolio 279	20.0%	20.0%	-	20.0%	-	-	20.0%	-	20.0%	0.74%	1.39%
Portfolio 28	-	-	50.0%	-	-	-	50.0%	-	-	0.91%	1.13%
Portfolio 280	20.0%	20.0%	-	20.0%	-	-	-	20.0%	20.0%	0.68%	1.60%
Portfolio 284	20.0%	20.0%	-	-	20.0%	-	20.0%	20.0%	-	0.80%	1.36%
Portfolio 285	20.0%	20.0%	-	-	20.0%	-	20.0%	-	20.0%	0.69%	1.55%
Portfolio 286	20.0%	20.0%	-	-	20.0%	-	-	20.0%	20.0%	0.63%	1.79%
Portfolio 29	-	-	50.0%	-	-	-	-	50.0%	-	0.75%	2.66%
Portfolio 290	20.0%	20.0%	-	-	-	-	20.0%	20.0%	20.0%	0.75%	1.49%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 292	20.0%	-	20.0%	20.0%	20.0%	-	20.0%	-	-	0.78%	1.01%
Portfolio 293	20.0%	-	20.0%	20.0%	20.0%	-	-	20.0%	-	0.71%	1.47%
Portfolio 294	20.0%	-	20.0%	20.0%	20.0%	-	-	-	20.0%	0.61%	2.08%
Portfolio 298	20.0%	-	20.0%	20.0%	-	-	20.0%	20.0%	-	0.83%	1.30%
Portfolio 299	20.0%	-	20.0%	20.0%	-	-	20.0%	-	20.0%	0.73%	1.51%
Portfolio 3	-	-	100.0%	-	-	-	-	-	-	0.63%	1.30%
Portfolio 30	-	-	50.0%	-	-	-	-	-	50.0%	0.49%	3.51%
Portfolio 300	20.0%	-	20.0%	20.0%	-	-	-	20.0%	20.0%	0.66%	1.72%
Portfolio 304	20.0%	-	20.0%	-	20.0%	-	20.0%	20.0%	-	0.79%	1.41%
Portfolio 305	20.0%	-	20.0%	-	20.0%	-	20.0%	-	20.0%	0.68%	1.69%
Portfolio 306	20.0%	-	20.0%	-	20.0%	-	-	20.0%	20.0%	0.62%	1.93%
Portfolio 31	-	-	-	50.0%	50.0%	-	-	-	-	0.70%	2.14%
Portfolio 310	20.0%	-	20.0%	-	-	-	20.0%	20.0%	20.0%	0.74%	1.56%
Portfolio 314	20.0%	-	-	20.0%	20.0%	-	20.0%	20.0%	-	0.82%	1.42%
Portfolio 315	20.0%	-	-	20.0%	20.0%	-	20.0%	-	20.0%	0.72%	1.73%
Portfolio 316	20.0%	-	-	20.0%	20.0%	-	-	20.0%	20.0%	0.66%	1.94%
Portfolio 320	20.0%	-	-	20.0%	-	-	20.0%	20.0%	20.0%	0.77%	1.58%
Portfolio 324	20.0%	-	-	-	20.0%	-	20.0%	20.0%	20.0%	0.73%	1.73%
Portfolio 327	-	20.0%	20.0%	20.0%	20.0%	-	20.0%	-	-	0.78%	1.07%
Portfolio 328	-	20.0%	20.0%	20.0%	20.0%	-	-	20.0%	-	0.72%	1.52%
Portfolio 329	-	20.0%	20.0%	20.0%	20.0%	-	-	-	20.0%	0.61%	2.13%
Portfolio 33	-	-	-	50.0%	-	-	50.0%	-	-	0.99%	1.29%
Portfolio 333	-	20.0%	20.0%	20.0%	-	-	20.0%	20.0%	-	0.84%	1.32%
Portfolio 334	-	20.0%	20.0%	20.0%	-	-	20.0%	-	20.0%	0.73%	1.55%
Portfolio 335	-	20.0%	20.0%	20.0%	-	-	-	20.0%	20.0%	0.67%	1.76%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 339	-	20.0%	20.0%	-	20.0%	-	20.0%	20.0%	-	0.79%	1.45%
Portfolio 34	-	-	-	50.0%	-	-	-	50.0%	-	0.84%	2.64%
Portfolio 340	-	20.0%	20.0%	-	20.0%	-	20.0%	-	20.0%	0.69%	1.74%
Portfolio 341	-	20.0%	20.0%	-	20.0%	-	-	20.0%	20.0%	0.63%	1.98%
Portfolio 345	-	20.0%	20.0%	-	-	-	20.0%	20.0%	20.0%	0.74%	1.60%
Portfolio 349	-	20.0%	-	20.0%	20.0%	-	20.0%	20.0%	-	0.83%	1.45%
Portfolio 35	-	-	-	50.0%	-	-	-	-	50.0%	0.57%	3.61%
Portfolio 350	-	20.0%	-	20.0%	20.0%	-	20.0%	-	20.0%	0.72%	1.78%
Portfolio 351	-	20.0%	-	20.0%	20.0%	-	-	20.0%	20.0%	0.66%	1.99%
Portfolio 355	-	20.0%	-	20.0%	-	-	20.0%	20.0%	20.0%	0.78%	1.62%
Portfolio 359	-	20.0%	-	-	20.0%	-	20.0%	20.0%	20.0%	0.74%	1.77%
Portfolio 364	-	-	20.0%	20.0%	20.0%	-	20.0%	20.0%	-	0.82%	1.53%
Portfolio 365	-	-	20.0%	20.0%	20.0%	-	20.0%	-	20.0%	0.71%	1.92%
Portfolio 366	-	-	20.0%	20.0%	20.0%	-	-	20.0%	20.0%	0.65%	2.14%
Portfolio 37	-	-	-	-	50.0%	-	50.0%	-	-	0.89%	1.48%
Portfolio 370	-	-	20.0%	20.0%	-	-	20.0%	20.0%	20.0%	0.77%	1.71%
Portfolio 374	-	-	20.0%	-	20.0%	-	20.0%	20.0%	20.0%	0.72%	1.89%
Portfolio 379	-	-	-	20.0%	20.0%	-	20.0%	20.0%	20.0%	0.76%	1.91%
Portfolio 38	-	-	-	-	50.0%	-	-	50.0%	-	0.73%	2.95%
Portfolio 383	16.7%	16.7%	16.7%	16.7%	16.7%	-	16.7%	-	-	0.76%	0.90%
Portfolio 384	16.7%	16.7%	16.7%	16.7%	16.7%	-	-	16.7%	-	0.71%	1.27%
Portfolio 385	16.7%	16.7%	16.7%	16.7%	16.7%	-	-	-	16.7%	0.62%	1.78%
Portfolio 389	16.7%	16.7%	16.7%	16.7%	-	-	16.7%	16.7%	-	0.81%	1.10%
Portfolio 39	-	-	-	-	50.0%	-	-	-	50.0%	0.47%	4.05%
Portfolio 390	16.7%	16.7%	16.7%	16.7%	-	-	16.7%	-	16.7%	0.72%	1.30%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 391	16.7%	16.7%	16.7%	16.7%	-	-	-	16.7%	16.7%	0.67%	1.47%
Portfolio 395	16.7%	16.7%	16.7%	-	16.7%	-	16.7%	16.7%	-	0.77%	1.21%
Portfolio 396	16.7%	16.7%	16.7%	-	16.7%	-	16.7%	-	16.7%	0.68%	1.45%
Portfolio 397	16.7%	16.7%	16.7%	-	16.7%	-	-	16.7%	16.7%	0.63%	1.65%
Portfolio 4	-	-	-	100.0%	-	-	-	-	-	0.80%	1.70%
Portfolio 401	16.7%	16.7%	16.7%	-	-	-	16.7%	16.7%	16.7%	0.73%	1.33%
Portfolio 405	16.7%	16.7%	-	16.7%	16.7%	-	16.7%	16.7%	-	0.80%	1.21%
Portfolio 406	16.7%	16.7%	-	16.7%	16.7%	-	16.7%	-	16.7%	0.71%	1.48%
Portfolio 407	16.7%	16.7%	-	16.7%	16.7%	-	-	16.7%	16.7%	0.66%	1.66%
Portfolio 411	16.7%	16.7%	-	16.7%	-	-	16.7%	16.7%	16.7%	0.76%	1.35%
Portfolio 415	16.7%	16.7%	-	-	16.7%	-	16.7%	16.7%	16.7%	0.72%	1.48%
Portfolio 420	16.7%	-	16.7%	16.7%	16.7%	-	16.7%	16.7%	-	0.79%	1.27%
Portfolio 421	16.7%	-	16.7%	16.7%	16.7%	-	16.7%	-	16.7%	0.70%	1.61%
Portfolio 422	16.7%	-	16.7%	16.7%	16.7%	-	-	16.7%	16.7%	0.65%	1.78%
Portfolio 426	16.7%	-	16.7%	16.7%	-	-	16.7%	16.7%	16.7%	0.75%	1.43%
Portfolio 43	-	-	-	-	-	-	50.0%	50.0%	-	1.03%	3.25%
Portfolio 430	16.7%	-	16.7%	-	16.7%	-	16.7%	16.7%	16.7%	0.72%	1.57%
Portfolio 435	16.7%	-	-	16.7%	16.7%	-	16.7%	16.7%	16.7%	0.74%	1.59%
Portfolio 44	-	-	-	-	-	-	50.0%	-	50.0%	0.76%	2.92%
Portfolio 441	-	16.7%	16.7%	16.7%	16.7%	-	16.7%	16.7%	-	0.80%	1.31%
Portfolio 442	-	16.7%	16.7%	16.7%	16.7%	-	16.7%	-	16.7%	0.71%	1.65%
Portfolio 443	-	16.7%	16.7%	16.7%	16.7%	-	-	16.7%	16.7%	0.66%	1.83%
Portfolio 447	-	16.7%	16.7%	16.7%	-	-	16.7%	16.7%	16.7%	0.75%	1.46%
Portfolio 45	-	-	-	-	-	-	-	50.0%	50.0%	0.61%	3.49%
Portfolio 451	-	16.7%	16.7%	-	16.7%	-	16.7%	16.7%	16.7%	0.72%	1.61%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 456	-	16.7%	-	16.7%	16.7%	-	16.7%	16.7%	16.7%	0.75%	1.63%
Portfolio 46	33.3%	33.3%	33.3%	-	-	-	-	-	-	0.66%	0.57%
Portfolio 462	-	-	16.7%	16.7%	16.7%	-	16.7%	16.7%	16.7%	0.74%	1.73%
Portfolio 469	14.3%	14.3%	14.3%	14.3%	14.3%	-	14.3%	14.3%	-	0.78%	1.12%
Portfolio 47	33.3%	33.3%	-	33.3%	-	-	-	-	-	0.72%	0.66%
Portfolio 470	14.3%	14.3%	14.3%	14.3%	14.3%	-	14.3%	-	14.3%	0.70%	1.42%
Portfolio 471	14.3%	14.3%	14.3%	14.3%	14.3%	-	-	14.3%	14.3%	0.66%	1.57%
Portfolio 475	14.3%	14.3%	14.3%	14.3%	-	-	14.3%	14.3%	14.3%	0.74%	1.25%
Portfolio 479	14.3%	14.3%	14.3%	-	14.3%	-	14.3%	14.3%	14.3%	0.71%	1.39%
Portfolio 48	33.3%	33.3%	-	-	33.3%	-	-	-	-	0.65%	1.08%
Portfolio 484	14.3%	14.3%	-	14.3%	14.3%	-	14.3%	14.3%	14.3%	0.74%	1.40%
Portfolio 490	14.3%	-	14.3%	14.3%	14.3%	-	14.3%	14.3%	14.3%	0.73%	1.49%
Portfolio 497	-	14.3%	14.3%	14.3%	14.3%	-	14.3%	14.3%	14.3%	0.73%	1.52%
Portfolio 5	-	-	-	-	100.0%	-	-	-	-	0.59%	2.88%
Portfolio 50	33.3%	33.3%	-	-	-	-	33.3%	-	-	0.85%	0.78%
Portfolio 505	12.5%	12.5%	12.5%	12.5%	12.5%	-	12.5%	12.5%	12.5%	0.72%	1.34%
Portfolio 51	33.3%	33.3%	-	-	-	-	-	33.3%	-	0.74%	1.75%
Portfolio 52	33.3%	33.3%	-	-	-	-	-	-	33.3%	0.57%	2.14%
Portfolio 53	33.3%	-	33.3%	33.3%	-	-	-	-	-	0.70%	0.93%
Portfolio 54	33.3%	-	33.3%	-	33.3%	-	-	-	-	0.63%	1.38%
Portfolio 56	33.3%	-	33.3%	-	-	-	33.3%	-	-	0.83%	0.75%
Portfolio 57	33.3%	-	33.3%	-	-	-	-	33.3%	-	0.72%	1.77%
Portfolio 58	33.3%	-	33.3%	-	-	-	-	-	33.3%	0.55%	2.34%
Portfolio 59	33.3%	-	-	33.3%	33.3%	-	-	-	-	0.69%	1.44%
Portfolio 61	33.3%	-	-	33.3%	-	-	33.3%	-	-	0.88%	0.85%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 62	33.3%	-	-	33.3%	-	-	-	33.3%	-	0.78%	1.77%
Portfolio 63	33.3%	-	-	33.3%	-	-	-	-	33.3%	0.61%	2.41%
Portfolio 65	33.3%	-	-	-	33.3%	-	33.3%	-	-	0.81%	0.99%
Portfolio 66	33.3%	-	-	-	33.3%	-	-	33.3%	-	0.71%	1.97%
Portfolio 67	33.3%	-	-	-	33.3%	-	-	-	33.3%	0.54%	2.71%
Portfolio 7	-	-	-	-	-	-	100.0%	-	-	1.18%	2.45%
Portfolio 71	33.3%	-	-	-	-	-	33.3%	33.3%	-	0.91%	2.16%
Portfolio 72	33.3%	-	-	-	-	-	33.3%	-	33.3%	0.73%	1.94%
Portfolio 73	33.3%	-	-	-	-	-	-	33.3%	33.3%	0.63%	2.33%
Portfolio 74	-	33.3%	33.3%	33.3%	-	-	-	-	-	0.71%	1.02%
Portfolio 75	-	33.3%	33.3%	-	33.3%	-	-	-	-	0.64%	1.49%
Portfolio 77	-	33.3%	33.3%	-	-	-	33.3%	-	-	0.83%	0.79%
Portfolio 78	-	33.3%	33.3%	-	-	-	-	33.3%	-	0.73%	1.81%
Portfolio 79	-	33.3%	33.3%	-	-	-	-	-	33.3%	0.55%	2.42%
Portfolio 8	-	-	-	-	-	-	-	100.0%	-	0.87%	5.21%
Portfolio 80	-	33.3%	-	33.3%	33.3%	-	-	-	-	0.70%	1.53%
Portfolio 82	-	33.3%	-	33.3%	-	-	33.3%	-	-	0.89%	0.88%
Portfolio 83	-	33.3%	-	33.3%	-	-	-	33.3%	-	0.79%	1.80%
Portfolio 84	-	33.3%	-	33.3%	-	-	-	-	33.3%	0.61%	2.48%
Portfolio 86	-	33.3%	-	-	33.3%	-	33.3%	-	-	0.82%	1.06%
Portfolio 87	-	33.3%	-	-	33.3%	-	-	33.3%	-	0.72%	2.03%
Portfolio 88	-	33.3%	-	-	33.3%	-	-	-	33.3%	0.54%	2.79%
Portfolio 9	-	-	-	-	-	-	-	-	100.0%	0.34%	6.20%
Portfolio 92	-	33.3%	-	-	-	-	33.3%	33.3%	-	0.91%	2.16%
Portfolio 93	-	33.3%	-	-	-	-	33.3%	-	33.3%	0.74%	2.00%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 94	-	33.3%	-	-	-	-	-	33.3%	33.3%	0.64%	2.39%
Portfolio 95	-	-	33.3%	33.3%	33.3%	-	-	-	-	0.68%	1.82%
Portfolio 97	-	-	33.3%	33.3%	-	-	33.3%	-	-	0.87%	0.98%
Portfolio 98	-	-	33.3%	33.3%	-	-	-	33.3%	-	0.77%	1.88%
Portfolio 99	-	-	33.3%	33.3%	-	-	-	-	33.3%	0.59%	2.70%
Portfolio 511	11.1%	11.1%	11.1%	11.1%	11.1%	11.1%	11.1%	11.1%	11.1%	0.80%	1.27%
Portfolio 502	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	-	0.86%	1.14%
Portfolio 503	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	-	12.5%	0.80%	1.29%
Portfolio 504	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	-	12.5%	12.5%	0.76%	1.44%
Portfolio 506	12.5%	12.5%	12.5%	12.5%	-	12.5%	12.5%	12.5%	12.5%	0.83%	1.20%
Portfolio 507	12.5%	12.5%	12.5%	-	12.5%	12.5%	12.5%	12.5%	12.5%	0.80%	1.31%
Portfolio 508	12.5%	12.5%	-	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	0.83%	1.32%
Portfolio 509	12.5%	-	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	0.82%	1.40%
Portfolio 510	-	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	0.82%	1.43%
Portfolio 466	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	-	-	0.86%	0.92%
Portfolio 467	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	-	14.3%	-	0.82%	1.23%
Portfolio 468	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	-	-	14.3%	0.74%	1.55%
Portfolio 472	14.3%	14.3%	14.3%	14.3%	-	14.3%	14.3%	14.3%	-	0.90%	1.14%
Portfolio 473	14.3%	14.3%	14.3%	14.3%	-	14.3%	14.3%	-	14.3%	0.82%	1.17%
Portfolio 474	14.3%	14.3%	14.3%	14.3%	-	14.3%	-	14.3%	14.3%	0.78%	1.34%
Portfolio 476	14.3%	14.3%	14.3%	-	14.3%	14.3%	14.3%	14.3%	-	0.87%	1.22%
Portfolio 477	14.3%	14.3%	14.3%	-	14.3%	14.3%	14.3%	-	14.3%	0.79%	1.31%
Portfolio 478	14.3%	14.3%	14.3%	-	14.3%	14.3%	-	14.3%	14.3%	0.75%	1.50%
Portfolio 480	14.3%	14.3%	14.3%	-	-	14.3%	14.3%	14.3%	14.3%	0.83%	1.27%
Portfolio 481	14.3%	14.3%	-	14.3%	14.3%	14.3%	14.3%	14.3%	-	0.90%	1.23%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EU-ROBOND USDTRY	KYD EU-ROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 482	14.3%	14.3%	-	14.3%	14.3%	14.3%	14.3%	-	14.3%	0.82%	1.33%
Portfolio 483	14.3%	14.3%	-	14.3%	14.3%	14.3%	-	14.3%	14.3%	0.78%	1.51%
Portfolio 485	14.3%	14.3%	-	14.3%	-	14.3%	14.3%	14.3%	14.3%	0.86%	1.28%
Portfolio 486	14.3%	14.3%	-	-	14.3%	14.3%	14.3%	14.3%	14.3%	0.83%	1.39%
Portfolio 487	14.3%	-	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	-	0.89%	1.28%
Portfolio 488	14.3%	-	14.3%	14.3%	14.3%	14.3%	14.3%	-	14.3%	0.81%	1.43%
Portfolio 489	14.3%	-	14.3%	14.3%	14.3%	14.3%	-	14.3%	14.3%	0.77%	1.60%
Portfolio 491	14.3%	-	14.3%	14.3%	-	14.3%	14.3%	14.3%	14.3%	0.85%	1.34%
Portfolio 492	14.3%	-	14.3%	-	14.3%	14.3%	14.3%	14.3%	14.3%	0.82%	1.47%
Portfolio 493	14.3%	-	-	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	0.85%	1.48%
Portfolio 494	-	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	-	0.89%	1.30%
Portfolio 495	-	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	-	14.3%	0.81%	1.47%
Portfolio 496	-	14.3%	14.3%	14.3%	14.3%	14.3%	-	14.3%	14.3%	0.77%	1.64%
Portfolio 498	-	14.3%	14.3%	14.3%	-	14.3%	14.3%	14.3%	14.3%	0.85%	1.37%
Portfolio 499	-	14.3%	14.3%	-	14.3%	14.3%	14.3%	14.3%	14.3%	0.82%	1.50%
Portfolio 500	-	14.3%	-	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	0.85%	1.51%
Portfolio 501	-	-	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	0.84%	1.60%
Portfolio 382	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	-	-	-	0.81%	1.08%
Portfolio 386	16.7%	16.7%	16.7%	16.7%	-	16.7%	16.7%	-	-	0.90%	0.77%
Portfolio 387	16.7%	16.7%	16.7%	16.7%	-	16.7%	-	16.7%	-	0.85%	1.17%
Portfolio 388	16.7%	16.7%	16.7%	16.7%	-	16.7%	-	-	16.7%	0.77%	1.42%
Portfolio 392	16.7%	16.7%	16.7%	-	16.7%	16.7%	16.7%	-	-	0.87%	0.91%
Portfolio 393	16.7%	16.7%	16.7%	-	16.7%	16.7%	-	16.7%	-	0.82%	1.32%
Portfolio 394	16.7%	16.7%	16.7%	-	16.7%	16.7%	-	-	16.7%	0.73%	1.60%
Portfolio 398	16.7%	16.7%	16.7%	-	-	16.7%	16.7%	16.7%	-	0.92%	1.30%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 399	16.7%	16.7%	16.7%	-	-	16.7%	16.7%	-	16.7%	0.83%	1.19%
Portfolio 400	16.7%	16.7%	16.7%	-	-	16.7%	-	16.7%	16.7%	0.78%	1.42%
Portfolio 402	16.7%	16.7%	-	16.7%	16.7%	16.7%	16.7%	-	-	0.90%	0.93%
Portfolio 403	16.7%	16.7%	-	16.7%	16.7%	16.7%	-	16.7%	-	0.85%	1.32%
Portfolio 404	16.7%	16.7%	-	16.7%	16.7%	16.7%	-	-	16.7%	0.76%	1.63%
Portfolio 408	16.7%	16.7%	-	16.7%	-	16.7%	16.7%	16.7%	-	0.95%	1.30%
Portfolio 409	16.7%	16.7%	-	16.7%	-	16.7%	16.7%	-	16.7%	0.86%	1.23%
Portfolio 410	16.7%	16.7%	-	16.7%	-	16.7%	-	16.7%	16.7%	0.81%	1.43%
Portfolio 412	16.7%	16.7%	-	-	16.7%	16.7%	16.7%	16.7%	-	0.91%	1.36%
Portfolio 413	16.7%	16.7%	-	-	16.7%	16.7%	16.7%	-	16.7%	0.82%	1.37%
Portfolio 414	16.7%	16.7%	-	-	16.7%	16.7%	-	16.7%	16.7%	0.77%	1.59%
Portfolio 416	16.7%	16.7%	-	-	-	16.7%	16.7%	16.7%	16.7%	0.87%	1.39%
Portfolio 417	16.7%	-	16.7%	16.7%	16.7%	16.7%	16.7%	-	-	0.89%	1.03%
Portfolio 418	16.7%	-	16.7%	16.7%	16.7%	16.7%	-	16.7%	-	0.84%	1.40%
Portfolio 419	16.7%	-	16.7%	16.7%	16.7%	16.7%	-	-	16.7%	0.75%	1.75%
Portfolio 423	16.7%	-	16.7%	16.7%	-	16.7%	16.7%	16.7%	-	0.94%	1.31%
Portfolio 424	16.7%	-	16.7%	16.7%	-	16.7%	16.7%	-	16.7%	0.85%	1.32%
Portfolio 425	16.7%	-	16.7%	16.7%	-	16.7%	-	16.7%	16.7%	0.80%	1.53%
Portfolio 427	16.7%	-	16.7%	-	16.7%	16.7%	16.7%	16.7%	-	0.90%	1.40%
Portfolio 428	16.7%	-	16.7%	-	16.7%	16.7%	16.7%	-	16.7%	0.81%	1.48%
Portfolio 429	16.7%	-	16.7%	-	16.7%	16.7%	-	16.7%	16.7%	0.76%	1.70%
Portfolio 431	16.7%	-	16.7%	-	-	16.7%	16.7%	16.7%	16.7%	0.86%	1.45%
Portfolio 432	16.7%	-	-	16.7%	16.7%	16.7%	16.7%	16.7%	-	0.93%	1.41%
Portfolio 433	16.7%	-	-	16.7%	16.7%	16.7%	16.7%	-	16.7%	0.84%	1.51%
Portfolio 434	16.7%	-	-	16.7%	16.7%	16.7%	-	16.7%	16.7%	0.79%	1.72%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 436	16.7%	-	-	16.7%	-	16.7%	16.7%	16.7%	16.7%	0.89%	1.47%
Portfolio 437	16.7%	-	-	-	16.7%	16.7%	16.7%	16.7%	16.7%	0.85%	1.59%
Portfolio 438	-	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	-	-	0.89%	1.07%
Portfolio 439	-	16.7%	16.7%	16.7%	16.7%	16.7%	-	16.7%	-	0.84%	1.43%
Portfolio 440	-	16.7%	16.7%	16.7%	16.7%	16.7%	-	-	16.7%	0.75%	1.80%
Portfolio 444	-	16.7%	16.7%	16.7%	-	16.7%	16.7%	16.7%	-	0.94%	1.33%
Portfolio 445	-	16.7%	16.7%	16.7%	-	16.7%	16.7%	-	16.7%	0.85%	1.36%
Portfolio 446	-	16.7%	16.7%	16.7%	-	16.7%	-	16.7%	16.7%	0.80%	1.56%
Portfolio 448	-	16.7%	16.7%	-	16.7%	16.7%	16.7%	16.7%	-	0.90%	1.43%
Portfolio 449	-	16.7%	16.7%	-	16.7%	16.7%	16.7%	-	16.7%	0.82%	1.52%
Portfolio 450	-	16.7%	16.7%	-	16.7%	16.7%	-	16.7%	16.7%	0.76%	1.74%
Portfolio 452	-	16.7%	16.7%	-	-	16.7%	16.7%	16.7%	16.7%	0.86%	1.48%
Portfolio 453	-	16.7%	-	16.7%	16.7%	16.7%	16.7%	16.7%	-	0.93%	1.43%
Portfolio 454	-	16.7%	-	16.7%	16.7%	16.7%	16.7%	-	16.7%	0.84%	1.55%
Portfolio 455	-	16.7%	-	16.7%	16.7%	16.7%	-	16.7%	16.7%	0.79%	1.75%
Portfolio 457	-	16.7%	-	16.7%	-	16.7%	16.7%	16.7%	16.7%	0.89%	1.49%
Portfolio 458	-	16.7%	-	-	16.7%	16.7%	16.7%	16.7%	16.7%	0.86%	1.62%
Portfolio 459	-	-	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	-	0.92%	1.49%
Portfolio 460	-	-	16.7%	16.7%	16.7%	16.7%	16.7%	-	16.7%	0.84%	1.67%
Portfolio 461	-	-	16.7%	16.7%	16.7%	16.7%	-	16.7%	16.7%	0.78%	1.87%
Portfolio 463	-	-	16.7%	16.7%	-	16.7%	16.7%	16.7%	16.7%	0.88%	1.56%
Portfolio 464	-	-	16.7%	-	16.7%	16.7%	16.7%	16.7%	16.7%	0.85%	1.71%
Portfolio 465	-	-	-	16.7%	16.7%	16.7%	16.7%	16.7%	16.7%	0.88%	1.72%
Portfolio 257	20.0%	20.0%	20.0%	20.0%	-	20.0%	-	-	-	0.85%	0.81%
Portfolio 261	20.0%	20.0%	20.0%	-	20.0%	20.0%	-	-	-	0.81%	1.06%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 265	20.0%	20.0%	20.0%	-	-	20.0%	20.0%	-	-	0.92%	0.81%
Portfolio 266	20.0%	20.0%	20.0%	-	-	20.0%	-	20.0%	-	0.86%	1.33%
Portfolio 267	20.0%	20.0%	20.0%	-	-	20.0%	-	-	20.0%	0.76%	1.47%
Portfolio 271	20.0%	20.0%	-	20.0%	20.0%	20.0%	-	-	-	0.84%	1.08%
Portfolio 275	20.0%	20.0%	-	20.0%	-	20.0%	20.0%	-	-	0.96%	0.85%
Portfolio 276	20.0%	20.0%	-	20.0%	-	20.0%	-	20.0%	-	0.90%	1.33%
Portfolio 277	20.0%	20.0%	-	20.0%	-	20.0%	-	-	20.0%	0.79%	1.51%
Portfolio 281	20.0%	20.0%	-	-	20.0%	20.0%	20.0%	-	-	0.92%	0.95%
Portfolio 282	20.0%	20.0%	-	-	20.0%	20.0%	-	20.0%	-	0.86%	1.46%
Portfolio 283	20.0%	20.0%	-	-	20.0%	20.0%	-	-	20.0%	0.75%	1.71%
Portfolio 287	20.0%	20.0%	-	-	-	20.0%	20.0%	20.0%	-	0.97%	1.56%
Portfolio 288	20.0%	20.0%	-	-	-	20.0%	20.0%	-	20.0%	0.87%	1.29%
Portfolio 289	20.0%	20.0%	-	-	-	20.0%	-	20.0%	20.0%	0.81%	1.57%
Portfolio 291	20.0%	-	20.0%	20.0%	20.0%	20.0%	-	-	-	0.83%	1.24%
Portfolio 295	20.0%	-	20.0%	20.0%	-	20.0%	20.0%	-	-	0.95%	0.89%
Portfolio 296	20.0%	-	20.0%	20.0%	-	20.0%	-	20.0%	-	0.89%	1.37%
Portfolio 297	20.0%	-	20.0%	20.0%	-	20.0%	-	-	20.0%	0.78%	1.65%
Portfolio 301	20.0%	-	20.0%	-	20.0%	20.0%	20.0%	-	-	0.91%	1.04%
Portfolio 302	20.0%	-	20.0%	-	20.0%	20.0%	-	20.0%	-	0.84%	1.54%
Portfolio 303	20.0%	-	20.0%	-	20.0%	20.0%	-	-	20.0%	0.74%	1.86%
Portfolio 307	20.0%	-	20.0%	-	-	20.0%	20.0%	20.0%	-	0.96%	1.55%
Portfolio 308	20.0%	-	20.0%	-	-	20.0%	20.0%	-	20.0%	0.86%	1.39%
Portfolio 309	20.0%	-	20.0%	-	-	20.0%	-	20.0%	20.0%	0.79%	1.66%
Portfolio 311	20.0%	-	-	20.0%	20.0%	20.0%	20.0%	-	-	0.94%	1.08%
Portfolio 312	20.0%	-	-	20.0%	20.0%	20.0%	-	20.0%	-	0.88%	1.54%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 313	20.0%	-	-	20.0%	20.0%	20.0%	-	-	20.0%	0.77%	1.90%
Portfolio 317	20.0%	-	-	20.0%	-	20.0%	20.0%	20.0%	-	1.00%	1.55%
Portfolio 318	20.0%	-	-	20.0%	-	20.0%	20.0%	-	20.0%	0.89%	1.44%
Portfolio 319	20.0%	-	-	20.0%	-	20.0%	-	20.0%	20.0%	0.83%	1.68%
Portfolio 321	20.0%	-	-	-	20.0%	20.0%	20.0%	20.0%	-	0.95%	1.61%
Portfolio 322	20.0%	-	-	-	20.0%	20.0%	20.0%	-	20.0%	0.85%	1.59%
Portfolio 323	20.0%	-	-	-	20.0%	20.0%	-	20.0%	20.0%	0.79%	1.86%
Portfolio 325	20.0%	-	-	-	-	20.0%	20.0%	20.0%	20.0%	0.90%	1.64%
Portfolio 326	-	20.0%	20.0%	20.0%	20.0%	20.0%	-	-	-	0.83%	1.29%
Portfolio 330	-	20.0%	20.0%	20.0%	-	20.0%	20.0%	-	-	0.95%	0.92%
Portfolio 331	-	20.0%	20.0%	20.0%	-	20.0%	-	20.0%	-	0.89%	1.40%
Portfolio 332	-	20.0%	20.0%	20.0%	-	20.0%	-	-	20.0%	0.78%	1.69%
Portfolio 336	-	20.0%	20.0%	-	20.0%	20.0%	20.0%	-	-	0.91%	1.09%
Portfolio 337	-	20.0%	20.0%	-	20.0%	20.0%	-	20.0%	-	0.85%	1.58%
Portfolio 338	-	20.0%	20.0%	-	20.0%	20.0%	-	-	20.0%	0.74%	1.91%
Portfolio 342	-	20.0%	20.0%	-	-	20.0%	20.0%	20.0%	-	0.97%	1.56%
Portfolio 343	-	20.0%	20.0%	-	-	20.0%	20.0%	-	20.0%	0.86%	1.43%
Portfolio 344	-	20.0%	20.0%	-	-	20.0%	-	20.0%	20.0%	0.80%	1.70%
Portfolio 346	-	20.0%	-	20.0%	20.0%	20.0%	20.0%	-	-	0.94%	1.12%
Portfolio 347	-	20.0%	-	20.0%	20.0%	20.0%	-	20.0%	-	0.88%	1.58%
Portfolio 348	-	20.0%	-	20.0%	20.0%	20.0%	-	-	20.0%	0.78%	1.95%
Portfolio 352	-	20.0%	-	20.0%	-	20.0%	20.0%	20.0%	-	1.00%	1.56%
Portfolio 353	-	20.0%	-	20.0%	-	20.0%	20.0%	-	20.0%	0.89%	1.47%
Portfolio 354	-	20.0%	-	20.0%	-	20.0%	-	20.0%	20.0%	0.83%	1.72%
Portfolio 356	-	20.0%	-	-	20.0%	20.0%	20.0%	20.0%	-	0.96%	1.63%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 357	-	20.0%	-	-	20.0%	20.0%	20.0%	-	20.0%	0.85%	1.64%
Portfolio 358	-	20.0%	-	-	20.0%	20.0%	-	20.0%	20.0%	0.79%	1.91%
Portfolio 360	-	20.0%	-	-	-	20.0%	20.0%	20.0%	20.0%	0.91%	1.67%
Portfolio 361	-	-	20.0%	20.0%	20.0%	20.0%	20.0%	-	-	0.93%	1.24%
Portfolio 362	-	-	20.0%	20.0%	20.0%	20.0%	-	20.0%	-	0.87%	1.68%
Portfolio 363	-	-	20.0%	20.0%	20.0%	20.0%	-	-	20.0%	0.77%	2.10%
Portfolio 367	-	-	20.0%	20.0%	-	20.0%	20.0%	20.0%	-	0.99%	1.57%
Portfolio 368	-	-	20.0%	20.0%	-	20.0%	20.0%	-	20.0%	0.88%	1.58%
Portfolio 369	-	-	20.0%	20.0%	-	20.0%	-	20.0%	20.0%	0.82%	1.83%
Portfolio 371	-	-	20.0%	-	20.0%	20.0%	20.0%	20.0%	-	0.95%	1.68%
Portfolio 372	-	-	20.0%	-	20.0%	20.0%	20.0%	-	20.0%	0.84%	1.77%
Portfolio 373	-	-	20.0%	-	20.0%	20.0%	-	20.0%	20.0%	0.78%	2.04%
Portfolio 375	-	-	20.0%	-	-	20.0%	20.0%	20.0%	20.0%	0.90%	1.74%
Portfolio 376	-	-	-	20.0%	20.0%	20.0%	20.0%	20.0%	-	0.98%	1.69%
Portfolio 377	-	-	-	20.0%	20.0%	20.0%	20.0%	-	20.0%	0.88%	1.81%
Portfolio 378	-	-	-	20.0%	20.0%	20.0%	-	20.0%	20.0%	0.81%	2.05%
Portfolio 380	-	-	-	20.0%	-	20.0%	20.0%	20.0%	20.0%	0.93%	1.76%
Portfolio 381	-	-	-	-	20.0%	20.0%	20.0%	20.0%	20.0%	0.89%	1.90%
Portfolio 132	25.0%	25.0%	25.0%	-	-	25.0%	-	-	-	0.86%	0.76%
Portfolio 137	25.0%	25.0%	-	25.0%	-	25.0%	-	-	-	0.90%	0.80%
Portfolio 141	25.0%	25.0%	-	-	25.0%	25.0%	-	-	-	0.85%	1.06%
Portfolio 145	25.0%	25.0%	-	-	-	25.0%	25.0%	-	-	1.00%	1.00%
Portfolio 146	25.0%	25.0%	-	-	-	25.0%	-	25.0%	-	0.92%	1.62%
Portfolio 147	25.0%	25.0%	-	-	-	25.0%	-	-	25.0%	0.79%	1.63%
Portfolio 152	25.0%	-	25.0%	25.0%	-	25.0%	-	-	-	0.89%	0.94%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 156	25.0%	-	25.0%	-	25.0%	25.0%	-	-	-	0.84%	1.25%
Portfolio 160	25.0%	-	25.0%	-	-	25.0%	25.0%	-	-	0.98%	0.99%
Portfolio 161	25.0%	-	25.0%	-	-	25.0%	-	25.0%	-	0.91%	1.64%
Portfolio 162	25.0%	-	25.0%	-	-	25.0%	-	-	25.0%	0.77%	1.78%
Portfolio 166	25.0%	-	-	25.0%	25.0%	25.0%	-	-	-	0.88%	1.28%
Portfolio 170	25.0%	-	-	25.0%	-	25.0%	25.0%	-	-	1.03%	1.04%
Portfolio 171	25.0%	-	-	25.0%	-	25.0%	-	25.0%	-	0.95%	1.64%
Portfolio 172	25.0%	-	-	25.0%	-	25.0%	-	-	25.0%	0.82%	1.83%
Portfolio 176	25.0%	-	-	-	25.0%	25.0%	25.0%	-	-	0.98%	1.14%
Portfolio 177	25.0%	-	-	-	25.0%	25.0%	-	25.0%	-	0.90%	1.79%
Portfolio 178	25.0%	-	-	-	25.0%	25.0%	-	-	25.0%	0.77%	2.07%
Portfolio 182	25.0%	-	-	-	-	25.0%	25.0%	25.0%	-	1.05%	1.96%
Portfolio 183	25.0%	-	-	-	-	25.0%	25.0%	-	25.0%	0.91%	1.57%
Portfolio 184	25.0%	-	-	-	-	25.0%	-	25.0%	25.0%	0.84%	1.91%
Portfolio 187	-	25.0%	25.0%	25.0%	-	25.0%	-	-	-	0.89%	1.00%
Portfolio 191	-	25.0%	25.0%	-	25.0%	25.0%	-	-	-	0.84%	1.31%
Portfolio 195	-	25.0%	25.0%	-	-	25.0%	25.0%	-	-	0.99%	1.02%
Portfolio 196	-	25.0%	25.0%	-	-	25.0%	-	25.0%	-	0.91%	1.66%
Portfolio 197	-	25.0%	25.0%	-	-	25.0%	-	-	25.0%	0.78%	1.84%
Portfolio 201	-	25.0%	-	25.0%	25.0%	25.0%	-	-	-	0.89%	1.34%
Portfolio 205	-	25.0%	-	25.0%	-	25.0%	25.0%	-	-	1.03%	1.06%
Portfolio 206	-	25.0%	-	25.0%	-	25.0%	-	25.0%	-	0.96%	1.66%
Portfolio 207	-	25.0%	-	25.0%	-	25.0%	-	-	25.0%	0.82%	1.89%
Portfolio 211	-	25.0%	-	-	25.0%	25.0%	25.0%	-	-	0.98%	1.18%
Portfolio 212	-	25.0%	-	-	25.0%	25.0%	-	25.0%	-	0.90%	1.82%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EU-ROBOND USDTRY	KYD EU-ROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 213	-	25.0%	-	-	25.0%	25.0%	-	-	25.0%	0.77%	2.13%
Portfolio 217	-	25.0%	-	-	-	25.0%	25.0%	25.0%	-	1.05%	1.96%
Portfolio 218	-	25.0%	-	-	-	25.0%	25.0%	-	25.0%	0.92%	1.62%
Portfolio 219	-	25.0%	-	-	-	25.0%	-	25.0%	25.0%	0.84%	1.95%
Portfolio 221	-	-	25.0%	25.0%	25.0%	25.0%	-	-	-	0.87%	1.54%
Portfolio 225	-	-	25.0%	25.0%	-	25.0%	25.0%	-	-	1.02%	1.11%
Portfolio 226	-	-	25.0%	25.0%	-	25.0%	-	25.0%	-	0.94%	1.71%
Portfolio 227	-	-	25.0%	25.0%	-	25.0%	-	-	25.0%	0.81%	2.05%
Portfolio 231	-	-	25.0%	-	25.0%	25.0%	25.0%	-	-	0.97%	1.30%
Portfolio 232	-	-	25.0%	-	25.0%	25.0%	-	25.0%	-	0.89%	1.92%
Portfolio 233	-	-	25.0%	-	25.0%	25.0%	-	-	25.0%	0.76%	2.32%
Portfolio 237	-	-	25.0%	-	-	25.0%	25.0%	25.0%	-	1.04%	1.94%
Portfolio 238	-	-	25.0%	-	-	25.0%	25.0%	-	25.0%	0.90%	1.73%
Portfolio 239	-	-	25.0%	-	-	25.0%	-	25.0%	25.0%	0.83%	2.07%
Portfolio 241	-	-	-	25.0%	25.0%	25.0%	25.0%	-	-	1.01%	1.35%
Portfolio 242	-	-	-	25.0%	25.0%	25.0%	-	25.0%	-	0.93%	1.92%
Portfolio 243	-	-	-	25.0%	25.0%	25.0%	-	-	25.0%	0.80%	2.36%
Portfolio 247	-	-	-	25.0%	-	25.0%	25.0%	25.0%	-	1.08%	1.94%
Portfolio 248	-	-	-	25.0%	-	25.0%	25.0%	-	25.0%	0.95%	1.79%
Portfolio 249	-	-	-	25.0%	-	25.0%	-	25.0%	25.0%	0.87%	2.09%
Portfolio 251	-	-	-	-	25.0%	25.0%	25.0%	25.0%	-	1.03%	2.02%
Portfolio 252	-	-	-	-	25.0%	25.0%	25.0%	-	25.0%	0.89%	1.98%
Portfolio 253	-	-	-	-	25.0%	25.0%	-	25.0%	25.0%	0.82%	2.32%
Portfolio 255	-	-	-	-	-	25.0%	25.0%	25.0%	25.0%	0.96%	2.06%
Portfolio 100	-	-	33.3%	-	33.3%	33.3%	-	-	-	0.89%	1.65%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 104	-	-	33.3%	-	-	33.3%	33.3%	-	-	1.09%	1.33%
Portfolio 105	-	-	33.3%	-	-	33.3%	-	33.3%	-	0.99%	2.18%
Portfolio 106	-	-	33.3%	-	-	33.3%	-	-	33.3%	0.81%	2.36%
Portfolio 110	-	-	-	33.3%	33.3%	33.3%	-	-	-	0.95%	1.70%
Portfolio 114	-	-	-	33.3%	-	33.3%	33.3%	-	-	1.15%	1.40%
Portfolio 115	-	-	-	33.3%	-	33.3%	-	33.3%	-	1.05%	2.18%
Portfolio 116	-	-	-	33.3%	-	33.3%	-	-	33.3%	0.87%	2.44%
Portfolio 120	-	-	-	-	33.3%	33.3%	33.3%	-	-	1.08%	1.52%
Portfolio 121	-	-	-	-	33.3%	33.3%	-	33.3%	-	0.98%	2.38%
Portfolio 122	-	-	-	-	33.3%	33.3%	-	-	33.3%	0.80%	2.75%
Portfolio 126	-	-	-	-	-	33.3%	33.3%	33.3%	-	1.17%	2.61%
Portfolio 127	-	-	-	-	-	33.3%	33.3%	-	33.3%	0.99%	2.10%
Portfolio 128	-	-	-	-	-	33.3%	-	33.3%	33.3%	0.89%	2.54%
Portfolio 49	33.3%	33.3%	-	-	-	33.3%	-	-	-	0.94%	0.83%
Portfolio 55	33.3%	-	33.3%	-	-	33.3%	-	-	-	0.92%	0.94%
Portfolio 60	33.3%	-	-	33.3%	-	33.3%	-	-	-	0.98%	1.01%
Portfolio 64	33.3%	-	-	-	33.3%	33.3%	-	-	-	0.91%	1.33%
Portfolio 68	33.3%	-	-	-	-	33.3%	33.3%	-	-	1.10%	1.35%
Portfolio 69	33.3%	-	-	-	-	33.3%	-	33.3%	-	1.00%	2.15%
Portfolio 70	33.3%	-	-	-	-	33.3%	-	-	33.3%	0.82%	2.10%
Portfolio 76	-	33.3%	33.3%	-	-	33.3%	-	-	-	0.92%	1.00%
Portfolio 81	-	33.3%	-	33.3%	-	33.3%	-	-	-	0.98%	1.06%
Portfolio 85	-	33.3%	-	-	33.3%	33.3%	-	-	-	0.91%	1.41%
Portfolio 89	-	33.3%	-	-	-	33.3%	33.3%	-	-	1.11%	1.34%
Portfolio 90	-	33.3%	-	-	-	33.3%	-	33.3%	-	1.01%	2.16%

Portfolio	KYD ON GROSS	KYD SHORT TERM	KYD MEDIUM TERM	KYD CPI	KYD LONG TERM	KYD EUROBOND USDTRY	KYD EUROBOND EURTRY	KYD GOLD	XU100 TOTAL RETURN	Expected Return	Expected Std. Dev.
Portfolio 91	-	33.3%	-	-	-	33.3%	-	-	33.3%	0.83%	2.16%
Portfolio 96	-	-	33.3%	33.3%	-	33.3%	-	-	-	0.96%	1.24%
Portfolio 14	50.0%	-	-	-	-	50.0%	-	-	-	1.06%	1.21%
Portfolio 21	-	50.0%	-	-	-	50.0%	-	-	-	1.07%	1.24%
Portfolio 27	-	-	50.0%	-	-	50.0%	-	-	-	1.04%	1.39%
Portfolio 32	-	-	-	50.0%	-	50.0%	-	-	-	1.13%	1.51%
Portfolio 36	-	-	-	-	50.0%	50.0%	-	-	-	1.03%	1.98%
Portfolio 40	-	-	-	-	-	50.0%	50.0%	-	-	1.32%	2.03%
Portfolio 41	-	-	-	-	-	50.0%	-	50.0%	-	1.17%	3.23%
Portfolio 42	-	-	-	-	-	50.0%	-	-	50.0%	0.90%	3.14%
Portfolio 6	-	-	-	-	-	100.0%	-	-	-	1.46%	2.41%

Table 7.2: Benchmark Index Weights on Each Equally Weighted Portfolio

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