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The Risk Appetite of Pension Funds

The Case of Greece

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Preface and Acknowledgements

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Abstract

The purpose of this thesis project is to concentrate on a unique country and investigate the effect of pension funds' characteristics on their risk appetite by observing their different investment strategies. The country we focus on is Greece. To develop our research we apply a panel data analysis using both fixed and random effects on 81 pension funds for the time period 2005-2009. We conjectue a negative relationship between age and equity in according with the life-cycle investment theory as well as a positive size-equity relationship. Additionally, we test the economic sector-stock relationship for 17 sectors by assuming a positive sector-equity relationship for industries with the appropriate "know-how" when investing. We find that younger pension funds as well as the wealthier ones tend to take more risk on average by indeed indicating the negative age-equity and the positive size-equity relationships respectively as we conjectured. Moreover, we find that the majority of the economic sectors in which pension funds belong to, do not significantly affect their funds' risk taking behavior while only the Banking sector significantly positively affects its pension funds' risk appetite.

Keywords:
Pension funds, risk appetite, characteristics, panel data analysis, Greece

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Chapter 1: Introduction

Nowadays, pension funds around the world possess a substantial role in people's lives since they are responsible to provide them with pension income as well as, occasionally, with health insurance. The pension market is one the largest and most liquid market worldwide holding the largest amount of assets surpassing the US$ 20 trillion for 2011 according to the OECD. Pension funds can either be public or privatized. The pension systems of Netherlands, UK, and USA are examples of privatized schemes while in Sweden pension funds are both public and private. The ''Global Pension Assets Study 2012'' conducted by Towers Watson presents the countries with the biggest and best designed pension systems among the OECD. Illustrative, the pension markets of Australia, Canada, Japan, Netherlands, Switzerland, UK, and USA hold US$ 26,180 billion in total assets. In 2011, the average asset allocation of these countries was 37.7% equities, 40.1% bonds, 3.7% capital reserves, and 18.5% other assets including real estate. Among these countries, Australia, USA, and UK seem to prefer more liberal investment strategies since they allocate their assets mostly in equities. Compared to 2010, pension funds reduced their portion of stocks while they increased their bond allocation. That change in their risk appetite can be attributed to a variety of factors, such as the crisis or individual characteristics of each pension fund like demographics.

Consistent with this, the purpose of this research project is to focus on the differences of pension funds' investment strategies in a unique country by investigating the impact of the funds' individual characteristics on their risk-taking behavior. This will happen by testing the effect of these characteristics on the portion of pension funds' total assets invested in stocks. Such characteristics can be their size, the average ages of their participants, the wealth of the plan sponsor, the industry etc. The country that this project will concentrate on is Greece. Due to the limited availability of data on pension funds' characteristics we were only able to investigate the effect of their size, age and the economic sector they belong to. The choice of Greece lies in the fact that its pension system is highly complex and weak, governed by very conservative regulations while facing major problems through time such as large deficits, economic frauds, the recent debt crisis, etc. Thus, it would be actually interesting to explore the changes in the risk appetite of such a country's pension funds, since it belongs in the Eurozone and more widely in the European Union, co-existing among wealthier countries with better well-designed pension systems.

This project is highly connected with the existing literature on the impact of pension funds' characteristics on their risk appetite which will be further discussed in the next chapter. Illustrative, Bikkers et al. (2011), Alestalo and Puttonen (2006), and Gerber and Weber (2007) found that there is a negative relationship

between age and stocks, indicating that younger workers take more risks, thus confirming the life-cycle investment theory, while Lucas and Zeldes (2009) were not able to detect the same significant results. Furthermore, Bikkers et al. (2011) state that younger pension funds take more risk on average as well as bigger in size pension funds follow the same path. Those last results are consistent to the findings of our research.

The contribution of this research project is that, firslty, it adds value in the existing literature, since it is the first one that attempts to explore the effect of Greek pension funds' characteristics on their risk-taking behavior. Secondly, alongside with the aforementioned academic papers that respectively refer to the effect of Dutch, Finnish, Swiss, and U.S pension funds' characteristics on their risk-taking behavior, the added value of our research is that it contributes to the collection of that kind of research papers that each one concentrates on a specific country's asset allocation attempting to investigate their investment strategies. The rationale behind this perspective is to create room for a research which aims to use such papers in order to make a comparison between countries that will help to extract significant conclusions on the countries' investment strategies and risk appetite changes that concern the general pension market. Lastly, this thesis' major contribution is, that it can be used by the Ministry of Labor and Social Security under whose supervision Greek pension funds operate or the economic sector in which the funds' belong to, in order to improve their asset management and hence their funds' asset allocation as well as to better control the changes in their risk-taking behavior according to the effect of their different characteristics.

However, our research is governed by an important limitation that restricts our range of research in the context of the effect of pension funds' characteristics on their risk-taking behavior. The lack of data on other characteristics of the funds, like the wealth of pension plans, the funding ratio, their demographics like the number of their male and female participants, etc, limits our potential to completely study the total effect of all the characteristics of pension funds on their risk appetite as well as to broaden our research in studying every fund individually and observe how it operates. Moreover, the absence of data on pension funds' characteristics compels us not to include robustness checks to generate robust results due to the uncertainty of the reliability of the robustness checks' estimations, since having only two control variables to test.

Regarding the available data and the existing literature, the research questions that are addressed are the following:

- **Hypothesis 1:** *The age of pension funds' participants has a negative relationship with funds' portion of stocks.*

- **Hypothesis 2:** *The size of pension funds has a positive relationship with funds' portion of stocks.*

- **Hypothesis 3:** *The Banking sector has on average the highest positively relationship with its pension funds' portion of stocks due to the industry's better "know-how" and expertise. We test the effect of the economic sectors in which pension funds belong to, on their funds' portion of stocks.*

The first hypothesis attempts to investigate whether there is a negative age-equity relationship and the effect of pension funds' maturity on their risk-taking behavior. The second hypothesis addresses the issue whether there is a positive size-equity relationship and the effect of funds' size on their risk appetite. The last hypothesis is trying to explore the effect of the economic sector, in which pension funds belong to, on their risk appetite. Regarding the first hypothesis our findings indicate a significantly negatively age-stocks relationship confirming the life-cycle investment theory that the younger funds take more risk on average. Accordingly, concerning the second hypothesis, the findings display a significantly positively size-equity relationship declaring that the wealthier funds take more risk on average. Lastly, the last hypothesis indicate that the majority of the industries do not have a significant effect on pension funds risk-appetite while only the Banking sector significantly positively affects its pension funds' risk taking behavior.

The methodology that is applied is panel data analysis using both the fixed and random effects models. The application of panel data analysis is crucial since it allows controlling for variables that it is not possible to otherwise observe or measure like the differences in the risk-taking behavior of pension funds which account for individual heterogeneity. Moreover, the choice of random effects model, was considered because of its ability to capture the impact of time-invariant characteristics on pension funds' risk appetite like the economic sector while fixed effects are able to examine the causes of changes within the pension funds like their size and age.

Concluding, the remainder of this project is organized as follows: Chapter 2 presents the existing literature review including a description of the Greek Social Security System. Moreover a comparison of Greece to other countries is taking place as well as the relevant literature on the effect of pension funds' characteristics on their risk appetite. Next, Chapter 3 offers a descriptive statistics of our data. In Chapter 4, the applied methodology and the hypotheses tested are being discussed while Chapter 5 analyzes the results of our research. Finally, Chapter 6 presents our conclusions.

Chapter 2: Literature Review

In this chapter, a description of the Greek social security system will take place. Then, an analysis of the regulation and asset allocation of the pension funds will follow. Finally, we conclude with a comparison of countries.

2.1. The Greek Social Security System

The Greek social security system was founded in 1950 as the main scheme to provide health insurance and pension wealth to Greek people. The pension system is public and pension funds are being run by the Greek government. Basically, the pension system is divided in three pillars and operates on a pay-as-you-go (PAYGO) basis: the first pillar contains the main and auxiliary mandatory insurance; the second pillar includes the occupational supplementary system and the third pillar the private insurance (Ministry of Labor, 2005). Furthermore, it can be categorized into five primary pension groups depending on the employment type of every person: public servants, farmers, private sector employees, freelance professionals, and employees in state-owned banks (Nektarios, 2000). Each group is served by an independent pension fund and each fund functions under different regulation. Additionally, the Greek social security system includes a number of smaller in size pension funds that operate providing services to bank employees and to other professional classes like lawyers, doctors, engineers etc. (Milonas et al, 2009).

According to the social budget of 2008, the Greek social security institutions were 131 operating under the supervision of 6 Ministries. In 2008, the implementation of the Law 3655/2008 allowed the merger of the funds, constraining them to 21. This large number of the pension funds indicates a highly segmented and complex public social security system. The 21 funds that are currently active contain: 5 institutions of primary pension, 8 of auxiliary pension, 5 of welfare assistance and 3 institutions of health/mutual assistance (Milonas et al, 2009). These pension funds manage their assets and funds themselves, including their investment strategies, under a management team that is appointed by the government. It is worth mentioning that despite the 21 pension funds, the 90% of the insured and retirees are covered by the 3 biggest in size funds, i.e. IKA (Social Insurance Institute) 46.3%, OAEE (Self-Employed Insurance Organization) 14.1% and OGA (Agricultural Insurance Fund) 29.5%. The insurance of the rest 10% of the Greek population is covered by the 18 remaining funds. The property of the 21 social security funds corresponds to the 12% of the national GDP. This rate is the higher in the EU regarding the countries that have implemented the PAYGO system. At the end of 2009 this rate was equivalent to €31 billion.

Specifically, 53% of this amount was deposited in the Central Bank of Greece as capital reserve, 30% was invested in Greek Government bonds, and 8% in stocks traded in the Athens Stock Exchange index, 4% in mutual funds and 5% in real estate.

A major problem of the Greek pension system is that it is generally unfunded. Many pension funds hold several kinds of assets but they are negligible when compared to the level of pension amounts of every worker. Therefore, the state is required to finance any gap between the pension fund's revenues earned from the money paid by the active workers and the pensions paid to the retirees. However the financing of Greek pension funds compared to other countries of Europe is very poor (Milonas et al, 2009). The state, in order to be able to finance a pay-as-you-go system in the future, has to take into account the country's demographic changes (ratio of active workers to retirees) and the average pension relative to the average earnings. In accordance with the Greek Social Budget of 2006, the total spending of pension funds was 12% of GDP as aforementioned and it is expected to rise almost to 25% by 2050 (Angelidis & Tessaromatis, 2010). The actual cause of the poor funding of the social security system is the early retirement of the Greek workers from the labor market. Illustrative, the average pension age of Greek workers is 56 for women and 61 for men (Milonas et al, 2009).

Additionally, a common problem of all social security organizations is the lack of professional asset management. As mentioned above, the investment strategies and decisions about the asset allocation is taken by the Board of Directors of each pension fund which is mainly composed by state officials that are being appointed by each government, the majority of whom are not acquainted with asset markets. Therefore, the absence of a strong and well qualified management team has led pension funds earn low returns.

2.2. Regulation and Asset Allocation of Greek Pension Funds

The regulation concerning the management and the investment policy of Greek pension funds' capital reserves is the most restrictive in the European Union. The most interesting feature until lately was the low rate of investing in highly risky investment products and the restriction investing in securities outside the Greek Market. That changed after the implementation of the Law 3586/2007 which permitted pension funds to invest in securities of the European Union countries only if the management team considers the investment opportunity viable. The above facts in combination with the absence of investment infrastructure in the funds had as a result the lack of significant investment strategies.

The years after World War II and until 1994 the investment and allocation of pension funds' assets was governed by the Law 1611/1950 according to which pension funds were obliged to deposit the whole amount of their reserves in the Central Bank of Greece receiving a 'specific interest rate' as a return. Furthermore, the short term deposits of the funds did not receive any returns at all. The absence of sufficient investment strategies alongside with the negative yields of their reserves created a limited

amount of capital reserve. This amount was the lowest in Europe in the after war period ranging from 3% to 10%. More specifically, during the years 1975-1985, the capital reserves were the main investment of pension funds' assets which increased from 58% in 1975 to 85% in 1984 while securities decreased from 41% in 1975 to 15% in 1984. This situation was reversed in the '90's. Though, according to Nektarios (2007), it is obvious that pension funds faced large income losses that led to large deficits in the period 1972-1990.

The negative progress of the reserves' management is due to the establishment of the Law 1611/1950 which was implemented without any serious amendment until 1994 when it was abolished. In 1975 the Monetary Committee allowed pension funds to invest up to 20% of their capital reserves deposited in the Central Bank in Treasury Bills. Subsequently, in 1979 pension funds were allowed to invest up to 1.5 billion Drachmas in stocks traded in the Athens Stock Exchange index. The first sufficient adjustments were performed after the implementation of the Laws 1902/1990, 2076/1992, and 2042/1992 which permitted the abolishment of Central Bank's 'specific interest rate' and the capital reserves started receiving the current market interest rate. Also, AEDAK of pension funds was founded which took over the investment management of pension funds' mutual funds. After that, the pension funds could invest 20% of their capital reserves per year: up to 8% in real estate and up to 12% in stocks traded in Athens Stock Exchange. Finally, Nektarios (2007) mentions that the abolishment of Law 1611/1950 and the establishment of Law 2216/1994 permitted to the social security institutions to invest in Greek Government Bonds.

Central Bank's 'specific interest rate' played an extremely negative role regarding pension fund's reserves. For the time period 1955-1973, the Monetary Committee set the 'specific interest rate' at 4% while the market interest rates fluctuated between 5%-9.5%. During that time, pension funds' losses were very low due to the low inflation but during 1974-1994 when inflation was raised to 20%, pension funds' losses increased (Nektarios, 2007).

Apart from the negative yields of pension funds' reserves, the lack of a serious investment strategy in conjunction with the low interest rates led the average annual return below the inflation rate for the time period 1975-1993. The first positive yield appears in 1994 alongside the withdrawal of the obligatory deposits within the Central Bank and their investment in different instruments. After that year, the yields become more positive especially in 1997 due to the high performance of the stocks traded in the Athens Stock Exchange index.

During the period 1997-2009, the average annual return of pension funds' total portfolio was 6.5%. At the same time the average annual return of their capital reserves was 5.7% and 6.9% for Government Bonds. If the assets were invested in the pension funds' stock portfolio, the average annual return would be 12.5% despite the significant decrease of the stocks' value in the period 2000-2002 and in 2008 when the crisis started. Behind this, Milonas et al. (2003) in their paper 'Balancing Greek Social Security via Equity Investment' try to shed light whether it would be better to invest in stocks. Their goal is to model

the impact of equity investment on Greek pensions' wealth. They collected data on pensions wealth from 1950 to 2003 (year that the research was conducted) and stock returns. They found that without allocating their assets in stocks, pension funds could not have gained high returns. Also, they state that if pension funds had already invested in stocks keeping risks in permissible levels they would have gained significantly high yields on past pension surpluses. Additionally, Munnell and Balduzzi (1998) proposed that financial gaps in pension funds can close by investing in equities receiving the higher expected return than implementing austerity measures. On the other hand, Bader and Gold (2007) stood against stocks after finding that using government bonds instead of equities creates more value as well as limits the risks.

During the same time period the average inflation rate was 3.6% and therefore the actual average annual yield was 2.9%. Although this percentage is significantly higher than the negative yields of the previous decades, it is still significantly lower than the average annual yields of countries with higher experience and professionalism in the management of their pension funds' portfolios like USA (4.7%) and UK (5.4%).

The issues regarding the investment policy and hence the funds' asset allocation can be encountered by the principles of portfolio theory and risk-return relationship. Milonas et al. (2009) in their paper about the fund management in Greek pension system examine whether a less conservative but more liberal investments policies could provide more earnings to the pension funds. In order to conduct their study they used three different time series covering a time space from 1950-2000, 1962-2000, and 1990-2007 (the year that this research was in progress), using data on pension reserves, pension revenues and expenses, and pension reserves including equity respectively. The results showed that an efficient fund management can lead to substantial revenues when using more risky investment strategies in reasonable risk levels.

Additionally, part of the regulation on Greek pension funds is the restrictions and the limitations they have on the amount of the capital reserve they are allowed to invest as well as the securitization of their reserves by investing their assets in low risk instruments like bank deposits, government bonds, mutual funds and less in stocks and equities. The Greek funds are allowed to invest only the 23% of their capital reserve each year while the rest 77% is deposited in the Central Bank of Greece gaining the current deposit interest rate.

Adhering to the regulations governing the Greek pension funds on their investment strategies, Angelidis and Tessaromatis (2010) analyzed the impact and costs of the constraints on the management of the Greek portfolios by quantifying the losses that portfolios face due to under-diversification and poor asset allocation by providing empirical evidence. In order to pursuit their research they used a dataset of 82 funds including equity, bonds, mutual funds and cash holdings of the year 2005 for each of these funds. They find that the high concentration of Greek equity portfolios implies significant returns and utility loss which is increased when there is absence of international diversification. Binsbergen and Brandt (2007)

focus on the effects that the regulations and constraints might have on pension funds' decisions. The results showed that constraints such as constraints regarding the risk level, short sale constraints and limitations on the maximum holdings lowers the gains even from strong investment strategies. On the other hand, Davis (1996) shows that pension funds functioning in countries with lax regulation regarding their investment policy and strategy attain higher returns than pension funds in countries with stricter portfolio restrictions. In the same wavelength, Milonas et al. (2010) in their research study the potential losses of the Greek pension system due to the restrictive regulation on the investment of their assets. Also, they study whether looser investment constraints on the amount of capital reserve to invest and the associated risk could have a positive/negative effect, considering that the funds had also the ability to invest in equities and foreign bonds. Their findings confirm that more diversified investments lead to lower levels of risk associated with the reserves and is more beneficial. The same happens when the reserves are allocated to foreign bonds. They conclude that the Greek state should implement more flexible investment constraints that permit more liberal strategies that take advantage of the diversification benefits by earning higher returns.

Considering the above we can estimate that investors being restricted to invest only in domestic products can lead to inferior returns and higher risk portfolios compared to internationally well diversified portfolios.

2.3. A Comparison of Greece to Other Countries

In this section there will be a comparison between the pension funds of Greece and other European and rest of the world countries, in order to present the weakness of the Greek restrictive social security system when allocating its assets. These are countries with stronger pension systems including Germany, France, Netherlands, Switzerland, UK, USA and Japan. Illustrative, USA, UK, and Japan constitute the 3 largest pension markets holding more than the 90% of the total assets of the world pension market corresponding to 75%, 11%, and 8% respectively (Chan-Lau, 2005).

According to the Social Budget of 2010, in 2009 the total assets of Greek pension funds' corresponded to the 12% of total GDP which was equivalent to €31billion. More specifically, 53% was capital reserve, 30% was invested in Greek Government bonds, and 8% in stocks traded in the Athens Stock Exchange index, 4% in mutual funds and 5% in real estate. On the other hand, in accordance with Table 1, for the same year, the Dutch pension funds' total assets corresponded to 120% of the national GDP which was equal to $990 billion possessing the highest percentage in Europe. Similar to Netherlands, Swiss pension funds' total assets stood for the 113% of the national GDP that was equivalent to $583 billion. Considering this, Gerber and Weber (2007) state that Switzerland is well prepared for any demographic challenge to come in all the industrialized countries. Next, UK pension funds' total spending is equal to 80% of the national GDP which is translated almost to $1.8 trillion. Lastly, German and French pension

funds' total assets were $411 and $178 billion which corresponded to 12% and 6% respectively. Outside Europe, Japan is the second largest pension market in the world with total assets $3 trillion which correspond to 80% of the total GDP. Of course, the world's biggest pension market is the US market with total spending equal to 70% of the national GDP that is equivalent to $13 trillion. Checking the numbers, anyone can understand that countries with more lax investment constraints and more liberal investment strategies could achieve higher returns and thus create a more vital and healthy pension system. Furthermore, regarding the restrictions that Greek pension funds face investing in foreign markets, Roldos (2003) proposed that investing in foreign securities can be reached through global well diversified fixed income and equity mutual funds. Some Greek pension funds have started holding foreign mutual fund portfolios since 2007 when the permission was given by the Law 3586/2007 following Roldos' (2003) statement. Greek pension funds hold three different foreign mutual fund portfolios: Bond Fund Foreign, Equity Fund Foreign, and Balanced Fund Foreign (combination of stocks and bonds).

Countries	Assets 2009 in billion USD ($)	%GDP in Local Currency
France	178	6
Germany	411	12
Japan	3,152	61
Netherands	990	120
Switzerland	583	113
UK	1,791	801
US	13,196	93
Total	20,301	61

Table 1: Pension funds' assets by country, expressed in USD $ and in %GDP; Source: Towers Watson; Global pension assets study 2010

Regarding the asset allocation, observing Table 2, anyone can notice that none of the countries mentioned above heavily invest in capital reserves. The maximum percent that is invested in capital reserves belongs to France and corresponds to 10% unlike Greece where pension funds' deposits surpass the 50% of their total assets due to the Greek restricted conservative regulations. France and Germany invest just a little more than 30% of their total assets in stocks while Netherlands and Switzerland seem to be the least risky countries investing just less than 30%. Regarding Netherlands' position, Kakes (2006) investigated the financial behavior of 77 Dutch pension funds collecting data from 2002-2005. His findings showed that larger organizations invest mostly in equities as well as foreign securities presenting a more rebalancing behavior unlike smaller and company-affiliated pension funds which have as first priority to ensure the payment of pensions by increasing the pension contributions. Furthermore, Kemna, Ponds, and Steenbeek

(2011) report that Dutch pension funds better choose to hold internationally well-diversified portfolios investing only the 10% of their assets domestically.

Countries	Asset Alocation 2009 (%)			
	Equity	Bonds	Other	Cash
France	33	46	12	10
Germany	32	62	4	2
Japan	36	55	7	2
Netherlands	28	48	24	1
Switzerland	27	36	29	8
UK	60	31	6	3
US	61	19	20	0

Table 2: Asset allocation of pension funds by country; Source: Towers Watson; Global pension assets study 2010

Finally, USA and UK follow riskier strategies investing 60% of their assets in stocks. Concerning the bond portfolios, Germany has the largest one investing more than 60% in bonds while the rest of the countries fluctuate between 19%-55% with USA investing the least amount. Greece invests 30% of its assets in bonds following safer strategies like the majority of the countries.

2.4. Characteristics that Drive the Risk-taking Behavior of Pension Funds

The risk appetite of pension funds can be affected by several aspects. Pension funds possess several characteristics that can influence their risk-taking behavior. Such characteristics may be considered the effect of the age of participants on the equity share of pension funds, the effect of the funds' size, the effect of the industry in which the pension fund belongs to, the regulation that governs the pension fund, the pension plans, etcetera. Moreover, in this section there will be a presentation of the most significant existing literature on the characteristics that drive pension funds' behavior as well as the presentation of our Hypotheses tested motivated by the existing literature.

2.4.1. Average Age of Pension Funds' Participants

Bikker, Broeders, Hollanders, and Ponds (2011) address the issue whether the investment strategies of Dutch pension funds depend on the age of their participants. Also, they extend their research by investigating whether the older pension funds follow less risky investment strategies than the younger ones which are when the equity held is less than bonds. The authors achieved that by utilizing the life-

cycle saving and investing model. The dataset used covers information on the asset allocation and other characteristics of 569 Dutch pension funds for the year 2007. Regarding the asset allocation, Bikker et al. (2011) find that equity exposure of pension funds diminishes when there is an increase on the average age of participants. Furthermore, they find that active members have a stronger significant age-equity relationship than the retired and deferred members. That means that for 2007 an increase of the average age of active members by 1 year decreases the equity investment by 0.5 percentage point. This negative relationship is justified by the life-cycle theory which mentions that the equity held by the retired people should be constant since they do not own any human capital.

However, this significantly negative age-equity relationship is found in several other studies. Indicative, Alestalo and Puttonen (2006) in their research about the asset allocation of Finnish pension funds examine whether the young members of pension funds follow riskier investment strategies by having longer investment horizons compared to pension funds with older participants. The authors manage to address this issue by examining the aspects that influence the asset allocation of pension funds and also, whether pension funds with different liabilities follow different investment strategies. They report that an increase of the average age of active members by 1 year decreases the equity investment by 1.7 percentage point after analyzing data for 42 pension funds for the year 2002. Beside the negative equity-age relationship, the authors also find that Finnish pension funds have dispersed asset allocation meaning that other funds may hold portfolios that only consist of fixed income securities while other funds may hold a very small amount of fixed income securities or none. Also, they observe that equity investments have quite high variation, fluctuating from 0-70%.

Subsequently, Gerber and Weber (2007) in their survey about Swiss pension funds moved in the same context. They collect data on the asset allocation of Swiss pension funds for the years 2000-2002 and concentrate on the relationship between the balance sheet liabilities, the investment behavior and the cost of these funds. They indicate that an increase of the average age of active members by 1 year decreases the equity investment by 0.18 percentage point.

On the other hand, unlike the previous authors, Lucas and Zeldes (2009) were not able to detect a significantly negative relationship between equity exposure and average age of active participants after analyzing data on 109 state and 87 local pension plans containing liabilities and asset allocation of US pension funds.

The above literature alongside with the available data helped us to address our first hypothesis to test. Regarding the first hypothesis, since we could not find data on the average age of pension funds' participants like Bikker et al. (2011), we followed Lucas and Zeldes (2009) who tested the relationship between pension funds' portion of stocks and their share of active members which was used as an age pattern. Similarly, we used the funds' ratio of retired to active members as an age proxy indicating that the higher is the ratio, the older is the pension fund. Both articles found a negative relationship between

age and stocks confirming the life-cycle investment theory, that is why we conjecture the same relationship. More specifically:

- **Hypothesis 1:** *The age of pension funds' participants has a negative relationship with funds' portion of stocks.*

The next section continues with the presentation of Hypothesis 2 and the existing literature in which we were based to address it.

2.4.2. Pension Funds' Size

Bikker, Broeders, Hollanders, and Ponds (2011) address the issue whether the investment strategies of Dutch pension funds depend on their size. As size, they use the number of funds' participants and test their effect on the portion of stocks held by the funds. They found that an increase of pension funds' members from 10,000 to 100,000 leads to an increase of their equity exposure by 2.5 percentage units, indicating that pension funds prefer to follow more liberal investment strategies when growing in size. The authors attribute the risky behavior of the large pension funds to their size which allows them to better manage highly risky situations giving them the opportunity to pursuit more liberal investments strategies. Moreover, they believe that major problems that concern large pension funds cannot be neglected by the government since the funds might hold thousands of pension plans and hence putting at risk many people's pensions. So, they cannot let them default.

By following Bikker et al (2011), we were able to form our second hypothesis. Unlike them, who used the total number of pension funds' participants as the size, we prefer to be involved with money and define pension funds' size as their total wealth by summing up their total assets. Regarding that, our second hypothesis is as follows:

- **Hypothesis 2:** *The size of pension funds has a positive relationship with funds' portion of stocks.*

The next section contains the existing literature on other characteristics of pension funds as well as the presentation of Hypothesis 3 as it derives from the existing literature.

2.4.3. Pension Funds' Other Characteristics

Further up, Amir, Guan, and Oswald (2009) study the impact of pension accounting on asset allocation of pension funds. They investigate the effect of the accounting standards and more specifically the effect of the SFAS 158 pension disclosures and pension recognition for the US and FRS 17 and IAS 19 for the UK. Regarding UK, the dataset used consists of 250 FTSE enterprises that promote defined benefit pension plans for the years 2000-2007. Respectively, the US dataset contains 300 pension funds for the

same period. The findings testify that UK companies decreased their equity share and increased their debt securities share while the FRS 17 disclosure took place. Similar results were observed during the adoption of FRS 17 and IAS 19 pension recognition period. During the SFAS 158 US companies follow the same investment strategy by reducing their exposure to equities.

Close to this research, Mohan and Zhang (2011) attempt to explore the determinants and characteristics of public pension plan risk appetite using data on public pension plans invested in equities for the period 2001-2009 and interpreting them as the measure of risk taking. Also, they use the pension plan asset beta as a risk measure. Furthermore, the authors after considering determinants like political pressure, workforce features, fiscal constraints and state government incentives, came to the conclusion that the risk appetite is heavily affected by the government accounting standards. Highly risk-taking behavior of the fund managers is also observed from the public pension plans' results when pension plans are underfunded and gain very low returns.

Remaining to pension plans as characteristic that influence the risk-taking behavior Choy, Lin, and Officer (2012) investigate the size of the effect of a Defined Benefit (DB) pension plan freeze on the risk appetite of a pension funds and its risk. The dataset refers to the period 2002-2007 and includes enterprises with frozen DB pension plans. The results showed an increase in a company's risk due to its high idiosyncratic risk. In addition, the authors did not constrain their research only to the freeze period of 2002-2007 but extended their investigation exploring the pre- and post- freeze periods. The results indicate that companies change investment policies by following high risk R&D strategies for both pre- and post- freeze periods. Also, firms tend to increase their leverage mostly in the pre-freeze period and are willing to take more risks.

Regarding the above literature we were not able to form a research question regarding the aforementioned characteristics due to the absence of the relevant data. Although, we were able to come up with a hypothesis based on the existing data. The idea behind the third hypothesis is based on the aggregation of pension funds into economic sectors, thus creating the only time-invariant variable whose effect could be tested on pension funds' risk-taking behavior. Specifically, by creating dummy sectors variables we will capture the industry's effect on pension funds' risk-taking behavior which is expressed by the percentage of pension funds' total assets invested in stocks as well as to capture the differences in sectors' investment strategies. Therefore, our last hypothesis is the following:

- **Hypothesis 3:** *The Banking sector has on average the highest positively relationship with its pension funds' portion of stocks due to the industry's better "know-how" and expertise. We test the effect of the economic sectors, in which pension funds belong to, on their funds' portion of stocks.*

Chapter 3: Data

In this chapter, the data used for this research will be presented as well as a descriptive statistics will take place in order to further analyze and understand them.

3.1. Data Collection

To begin with, the data used for this study can be divided in two broad categories: financial and non-financial data, forming a dataset of 405 observations. The first category contains information about the strategic asset allocation of 81 Greek pension funds for the years 2005, 2006, 2007, 2008, and 2009 provided by the Greek Ministry of Labor and Social Security. According to the data, the Greek pension funds allocate their assets mostly to government bonds, stocks, deposits, and real estate and much less in mutual funds, treasury bills and commercial bonds. Also, some funds hold negligible amounts in debentures and loans. It worth noting that the dataset refers only to domestic securities due to the strict regulation on pension funds' asset allocation except from some pension funds which hold mutual fund portfolios with foreign bonds and stocks[1]. However, a clarification that has to be mentioned is that the pension funds were merged to 21 in 2008 after the implementation of the Law 3655/2008. Therefore, the data for 2008 and 2009 refer only to the 21 new pesnion funds. Because of that preventing the smoothly conduct of this study, it seemed wiser to disaggregate the pension funds and their asset allocation like in the previous years. In order to accomplish that, information from the Social Budgets of 2008 and 2009 was gathered that analytically include the merging of the pension funds. Regarding this project, the financial data helped us to create a variable referring to the size of the funds taking advantage of the data on their asset allocation and investigate the effect of funds' size on their portion of stocks. This relationship will answer wether pension funds take more rik dependently on their size.

On the other hand, the non-financial dataset includes information about the active members and retirees of the 81 pension funds for the same time interval. Unfortunately, other non-financial characteristics of the funds were not available at that time and therefore only one relationship could be tested concerning that kind of data, that is, how much more or less units, pension funds invest in stocks in relation to the ratio of retirees to active members. The ratio indicates the age proxy of the funds and will answer whether pension funds take more risk dependently on their figures on active members and retirees and hence the age of their participants. The data were derived from the Social Budgets of 2005, 2006, 2007, 2008, and 2009 which were published by the Ministry of Labor and Social Security. Because of the funds' merging,

[1]Information about Greek regulation on pension funds' asset allocation exists in section 2.2.

the same disaggregation process had to be performed for the years 2008 and 2009 in order the project to be normally proceeded.

3.2. Descriptive Statistics of the Data

In this part a descriptive statistics will take place in order to explore and understand the data and check what conclusions can be derived that may help the research and understand the possible relationships that will be tested later.

The following figure presents the course of pension funds' asset allocation in percentage terms for the years 2005-2009. In Figure 1 anyone can observe the variable 'Others'. This variable contains the amounts invested in mutual funds, treasury bills, commercial bonds, debentures, and loans by the pension funds. It was created for simplification reasons due to the fact that the Greek pension funds invest very little in those securities in total compared to stocks, government bonds, real estate, and deposits.

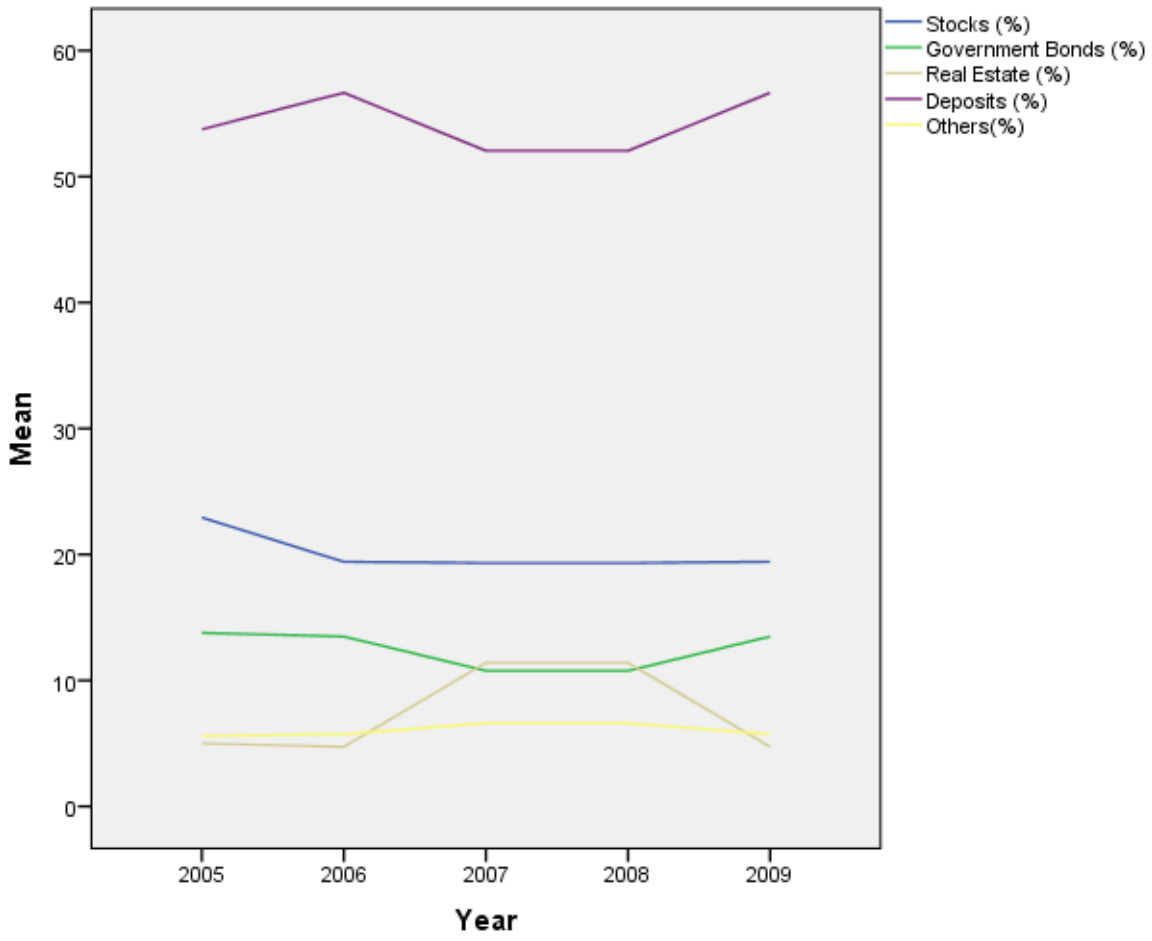

Figure 1: Asset allocation of pension funds in percentage terms over the 5-year time interval

According to Figure 1, pension funds seem to have followed more conservative investment strategies on average through the time interval of 2005-2009. This is obvious since the high percentage invested in capital reserves predominates. Pension funds allocate on average 54% of their assets in capital reserves in order to ensure their liquidity position, thus, introducing some fluctuations between 2005 and 2009 despite the fact that deposits consistently remain above 50%. Specifically, in 2006 deposits increased to almost 57% of pension funds' total assets. Approaching 2007, deposits declined reaching 50% and stabilized to the same percentage until 2008 when they increased again. The graph continues by showing that stocks come second in preference since the funds invest on average 20% of their assets in stocks. In 2005, pension funds invested around 23% of their total assets in stocks facing a decline to 20% in 2006 and keeping this percentage constant for the years remaining.

The second in preferance secuirties are government bonds in which pension funds decided to invest on average 12.5% through the years 2005-2009. The graph shows that bonds are fixed to 12% for 2005 remaining almost steady until 2006 when they drop to 10% and staying put in 2007 and 2008 when they start to increase. Next, the yellow line which represents the percentage of assets invested in other securities remains almost constant through the years and it is fixed at 6% on average. Last but not least, real estate investments hold the 7.5% of pension funds' asset allocation. Their course begin from 5% for 2005 and 2006 when they start to experience a large increase that reaches just above 10% of the total assets invested and remaining in the same position until 2008 when it starts decreasing again. This increase can be justified by the negative correlation between real estate and deposits which is statistically significant as the correlations matrix indicates in Table 6. The same conclusions can be derived from Table 10 (Appendix I) in the which presents the overall descriptive statistics of the data for the concerned time interval.

However, according to Figure 1, each pension fund seems to follow different strategies than the average strategy of all funds due to the high variation in their asset allocation. Looking at the maximum range, there are pension funds that choose to invest not only the majority but their total assets in stocks and hence to follow a highly risky strategy while other funds are committed to safer policies investing the highest percentage of their assets in government bonds. On the other hand, there are funds that choose not to risk at all investing their total assets only in deposits or real estate indicating their conservative attitude. Regarding the non-financial data for the same time horizon, the mean for active members is 90,190 while the mean of retirees is 38,738 (Figure 4, Appendix IV).

The next table (Table 3) presents the descriptive statistics for each year individually. Noticing the table, anyone can confirm the findings extracted from Figure 1 above.

95% Confidence Level	Year	Minimum (%)	Maximum (%)	Mean (%)	Std. Deviation (%)
Stocks (%)	2005	0	90	22.9	23.8
	2006	0	77	19.4	19.1
	2007	0	99	19.2	21.6
	2008	0	99	19.2	21.6
	2009	0	77	19.4	19.1
Government Bonds (%)	2005	0	72	13.7	19.6
	2006	0	77	13.4	19.1
	2007	0	73	10.7	16.3
	2008	0	73	10.7	16.3
	2009	0	77	13.4	19.1
Real Estate (%)	2005	0	100	5.01	12.1
	2006	0	40	4.7	6.5
	2007	0	100	11.4	24.1
	2008	0	100	11.4	24.1
	2009	0	40	4.7	6.6
Deposits (%)	2005	0	100	53.7	29.6
	2006	0	100	56.6	27.1
	2007	0	100	52.1	30.6
	2008	0	100	52.1	30.6
	2009	0	100	56.6	27.1
Others (%)	2005	0	47	5.5	9.7
	2006	0	54	5.7	10.6
	2007	0	76	6.6	13.3
	2008	0	76	6.6	13.3
	2009	0	54	5.7	10.6
Active	2005	0	1979000	89622.2	298830.7
	2006	0	1991000	89991.3	300052.4
	2007	0	1991000	90346.6	300255.1
	2008	0	2016000	90975.9	302565.1
	2009	0	2198000	90011.7	319989.8
Retired	2005	0	918000	37346.3	149391.01
	2006	0	918600	37622.4	150392.4
	2007	0	940600	38861.6	153922.1
	2008	0	982216	39738.9	157215.5
	2009	0	1127000	40118.3	169012.4

Table 3: Descriptive statistic of pension funds' asset allocation per year

Firstly, deposits, which hold the biggest percentage, begin their course with almost 54% invested on average in 2005. Next year the average deposits increased to 56% and before reaching 2007 they started falling to 52% which also remained the same for 2008 in order to start increasing again to 56% in 2009. However, stocks which represented almost the 23% on average in 2005 begin to decline arriving at 19% in 2006 which remained the same until 2009. Moreover, government bonds present little fluctuations starting almost from 14% invested on average in 2005 and 13.5% in 2006 in order to start declining, reaching 11% in 2007 and 2008 and increasing again to 13% in 2009. On the other hand, real estate presents high fluctuations. Pension funds invested the lowest amount in real estate in 2005 representing almost the 5% on average. In 2006 it faced a minor decline just getting a little bit lower than 5% to start heavily increasing to 11.5% in 2007 which stayed the same until 2008. In 2009 real estate decreased its percentage again to 5%. Lastly, the rest securities held by the funds constantly represent the 6% of their total portfolio on average for the whole time horizon.

The following table presents a descriptive statistics of the variables that we are going to use to run our models. The variables used are pension funds' percentage of total assets invested in stocks which stands for our dependent variable, also representing our risk measure, and the two control variables which are the ratio of retired to active members of pension funds as the age proxy, and funds' size which represents their total wealth. The table shows that the average percentage of stocks held by the pension funds is 20% for the years 2005-2009 in a stock range between 0-99%. Next, the average ratio of pension funds is 0.378 varying between a range of 0-2.75. Lastly, the average funds' size is 0.369 millions which is too small regarding the highest wealth which is 5.5 billion.

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Stocks (%)	405	0	99	20.07	21.098
Age (Ratio)	405	0	2.75	0.378	0.483
Size	405	0.001	5.5	0.369	0.721

Table 4: Descriptive statistics of dependent and independent variables

Remaining to the the descriptive statistics part, the following table presents the descriptives of the economic sectors' asset allocation. Since, the economic sector will be used as a dummy variable to check its effect on pension funds' portion of stocks, it would be wiser to check the allocation of their assets. We observe that deposits hold the highest avergae percentage that is 50% while the second in preference assets are stocks which stand for almost the 20% of sectors' allocation. Next, in line come the government bonds which hold almost the 15% of sectors' asset allocation while the real estate and other securities come last with 9% and 6% respectively.

	Observations (N)	Minimum (%)	Maximum (%)	Mean (%)	Std. Deviation (%)
Stocks (%)	85	4	45	19.8	9.9
Government Bonds (%)	85	0	61	14.9	13.3
Real Estate (%)	85	0	69	9	12.7
Deposits (%)	85	1	84	50.3	20.5
Others (%)	85	0	28	6.2	5.6

Table 5: Overall descriptive statistics of economic sectors' asset allocation for the time period 2005-2009

The next table presents the correlations matrix. Table 6 shows that both stocks and deposits are statistically significantly negatively correlated with each other as well as with the rest securities. Bonds and real estate are also significantly negatively correlated with each other and the remainder of the securities, apart from 'other' securities that the relationships are not significant. On the other hand active members and retirees are statistically significantly positively correlated with each other following normal stable route through the years as Figure 2 indicates.

95% Confidence Level[2]	Stocks (%)	Government Bonds (%)	Real Estate (%)	Deposits (%)	Others (%)	Active	Retired	Ratio	Size
Stocks (%)	1	-0.106*	-0.109*	-0.528**	-0.113*	0.058	0.019	0.146**	0.79
Government Bonds (%)	-0.106*	1	-0.149**	-0.456**	-0.021	0.296**	0.407**	0.89	0.443**
Real Estate (%)	-0.109*	-0.149**	1	-0.379**	-0.089	-0.011	-0.024	0.013	-0.118*
Deposits (%)	-0.528**	-0.456**	-0.379**	1	-0.254**	-0.308**	-0.311**	-0.124*	-0.160**
Others (%)	-0.113*	-0.21	-0.089	-0.254**	1	0.211**	0.135**	-0.062	0.009
Active	0.58*	0.296**	-0.011	-0.308**	0.211**	1	0.903**	0.031	0.660**
Retired	0.19*	0.407**	-0.024	-0.311**	0.135**	0.903**	1	0.145**	0.703**
Ratio (Age Proxy)	0.146**	0.89	-0.13	-0.124*	-0.062	0.031	0.145**	1	0.69
Size	0.79	0.443**	-0.118*	-0.160*	0.009	0.660**	0.703**	0.60	1

Table 6: Correlation Matrix

Concluding, the next chapter presents and discusses the relevant methodology that we used in order to pursuit our estimated results as well as a description of the hypotheses that were tested.

[2] * stands for a 5% significance level and ** stands for 1% significance level.

Chapter 4: Methodology

As discussed in the earlier chapters, the aim of this project is to investigate what characteristics of pension funds have an effect on their risk-taking behavior. In this part, the hypotheses tested and the methodology used will be presented and analyzed.

4.1. Panel Data Analysis

The dataset used includes both cross-sectional and time series data in which the behavior of pension funds is observed across time, creating a panel data set. That is why a panel data analysis will be performed. Moreover, the dataset is strongly balanced since none of the units of each observation are missing across time. The reason why panel data analysis is important in this kind of research is because it allows controlling for variables that you cannot otherwise observe and/or measure, like characteristics of pension funds as risk-taking factors or differences in pension funds' investment strategies which are this project's cases. Furthermore, someone can observe variables that change over time but not across the institutions, e.g. regulations. All these account for individual heterogeneity. Additionally, someone can achieve multilevel or hierarchical modeling by including variables at different levels of the analysis (Dougherty 2006, Wooldridge 2002).

There are two techniques in order to analyze panel data: the fixed effects (FE) and the random effects (RE). The first model is used when someone needs to analyze the effect of some variables that vary over time. They investigate the relationship between the predictor, which is the independent variable, and the outcome, which is the dependent one, within an entity which in this case are pension funds. For example, Hypotheses 1 and 2, which investigate whether the maturity and the size of the funds respectively influence their risk appetite. Furthermore, each pension fund is distinguished by its own characteristics that may or may not have an impact on the control variables. In order to use fixed effects, there are a couple of assumptions that should be considered. The first is that there might be something in the pension fund or entity that may influence both the explanatory and response variables. So, there is need in controlling this. In other words, the time-invariant differences between the funds are controlled by the fixed effects model in order to prevent an inconsistency or biasness of the estimated coefficients that may be caused by the omitted time-invariant characteristics. This is the intuition behind the assumption of the correlation between the institution's error term and independent variables. Hence, fixed effects' job is to detach the effect of those time-invariant characteristics from the controlled variables in order to estimate their net effect. The second assumption lies in the fact that time-invariant characteristics are unique for

each entity or pension fund and should be uncorrelated with other characteristics within the entity. Also, since each pension fund is different from the other, an entity's error term and constant[3], that captures the heterogeneity of firms (Greene, 2003), should be uncorrelated with the others otherwise fixed effects model does not fit to test that relationship. Of course, there are also some disadvantages when using the fixed effects method such as losing degrees of freedom (model losses its efficiency) and cannot investigate the pension fund's time-invariant[4] characteristics. According to Kohler Ulrich, and Kreuter (2009), this is because this model is created to study the reasons of changes within an entity and while time-invariant characteristics are absorbed by the intercept (constant for each entity), they cannot consider such changes. There are three different versions of fixed effects: the within-group fixed effects, the first differences fixed effects, and the least squares dummy variable fixed effects. In this project we will apply the LSDV regression model.

On the other hand, the intuition behind random effects model which is the opposite of fixed effects, is that the model assumes that there is a random variation across the pension funds which is uncorrelated with the independent variables. Contrary to fixed effects, random effects can explore the time-invariant characteristics of an entity which is also the case here, e.g. Hypothesis 3 which investigates the effect of the economic sector on pension funds' risk-taking behavior. Moreover, random effects model permits to time-invariant characteristics to act like explanatory variables by assuming that the pension fund's error term[5] is uncorrelated with the independent variables. Furthermore, random effects are governed by two preconditions. The first condition states that the observations should be randomly chosen by a given sample or population while the second declares that the unobserved explanatory variables are distributed independently from the observed ones.

The simplest form of a panel data equation is described by

$$Y_{i,t} = \beta_0 + \sum_j^n \beta_j X_{i,t} + \varepsilon_{i,t} \tag{4.1}$$

where $Y_{i,t}$ represents the dependent variable, β_0 the unknown intercept for each entity, $X_{i,t}$ the independent variable, β_i the coefficient of the explanatory variable and $\varepsilon_{i,t}$ the error term. The index i refer to the individual or entity and t refers to the time period covered. Furthermore, the equation can be extended when entity effects are added in order to control for changes across the entities that cannot be observed. They take the form of unobserved explanatory variables. Hence, the new equation will be

$$Y_{i,t} = \beta_0 + \sum_j^n \beta_j X_{j,i,t} + \sum_p^k \gamma_p D_{p,i} + \varepsilon_{i,t} \tag{4.2}$$

where $Y_{i,t}$ again stands for the dependent variable, X_j represent the observed explanatory variables and D_p are the unobserved explanatory variables. The constant β_0 is the intercept for each individual, β_j and $\varepsilon_{i,t}$ is the error term. The letters i and t have the same explanation as in the equation (4.1) while j and p are

[3] The constant term captures the entity's individual characteristics.
[4] They are perfect collinear with the pension fund dummies.
[5] The error term captures other factors that could influence the dependent variable.

used in order to distinguish between observed and unobserved explanatory variables. Moreover, this equation can be expanded more when time effects are added in the formula, in order to control for changes across time. They take the form of dummy variables excluding the first time period as the reference period.

Since the observed explanatory variables are of higher interest when using panel data, the unobserved variables which are bounded to unobserved heterogeneity, could be replaced by the unobserved effect α_i after assuming that unobserved heterogeneity is not changing through the entities. Therefore, equation (4.2) can be rewritten as

$$Y_{i,t} = \beta_0 + \sum_j^n \beta_j X_{j,i,t} + \alpha_i + \varepsilon_{i,t} \quad (4.3)$$

where

$$\alpha_i = \sum_p^k \gamma_p D_{p,i} \quad (4.4)$$

with $\alpha_i$being the unobserved effect which represents the implications on the dependent variable $Y_{i,t}$.

Now, the most important issue is to decide whether to use the fixed effects or the random effects model. In order to accomplish that, the preconditions of using panel data will be checked as well as a Durbin–Wu–Hausman test will be conducted in order to verify our choice. More about this approach will be analyzed in the next section.

4.2. Fixed or Random Effects?

As mentioned above, before proceeding to the analysis of the Hypotheses tested, the decision whether to use the fixed effects or the random effects model has to be taken. In order to choose the correct model, the preconditions of using panel data will be considered as well as a Durbin–Wu–Hausman test will be conducted to confirm our choice.

In this project, in order to choose the best technique we will follow Dougherty's desicion map (Dougherty, 2006). As mentioned before, in order to use a random effects model, we should meet some preconditions. The first precondtion states that our observations should be randomely chosen from a given sample which is not the case with our dataset. Since this precondition is violated, Dougherty (2006) suggests to use only the fixed effects model. To verify Dougherty's suggestion we will also perform a Durbin–Wu–Hausman test between the two panel data methods.

The Durbin–Wu–Hausman test examines whether the coefficients of the observed explanatory variables for both fixed and random effects, which in this thesis project are the ratio of retired to active members of the pension funds and the funds' size, are statistically different in the two models. The null hypothesis states that the preferred model is the random effects model. Basically, it tests whether the unique error

terms $u_{i,t}$ are correlated with the predictors which is the opposite than the null hypothesis predicts. The DWH test that is performed below counts for all the three Hypotheses tested, since the same figures of stocks, active and retired members and size of pension funds are used to run the relative regression models.

The DWH test is described by the formula

$$H = (\beta_{fe} - \beta_{re})' \, [Var(fe) - Var(re)]^{-1} \, (\beta_{fe} - \beta_{re}) \tag{4.5}$$

which it is well-approximated by the chi-squared distribution, with $Var(\beta_{fe}) - Var(\beta_{re})$ indicating the number of degrees of freedom. If the $Prob > Chi^2$, which stands for the *p-value*, is lower than the *critical value* of 0.05, then fixed effects is the appropriate model, otherwise the best choice is random effects. The next table presents the DWH test results.

	Coefficients[6]		(b – B) Difference	Sqrt[diag (V_b – V_B)] S.E.	Chi^2	$Prob > Chi^2$
	(b) FE	(B) RE				
Ratio (Age Proxy)	-0.1712301	2.593827	-2.765057	2.066311	6.54	0.0380
Size	17.8128	-0.4121819	18.22498	8.153144		

Table 7: Durbin–Wu–Hausman test

The results clearly mention that the most suitable technique to use in this research is the fixed effects model as the $Prob > Chi^2$ is 0.0380 which is lower than 0.05, thus rejecting the null hypothesis which indicates that there is no correlation between the ratio, size and pension funds' error term $u_{i,t}$ (Park, 2005). Therefore, the DWH test confirms Dougherty's decison map and our choice to follow it by using fixed effects. However, we are going to apply fixed effects only in Hypotheses 1 and 2 using the LSDV regression model. In Hypothesis 3, we considered wiser to use random effects model since we intend to capture the impact of the economic sectors on pension funds' risk-taking behavior as the economic sectors are being time invariant variables and can only be captured by random effects.

4.3. The Hypotheses Tested Using Fixed & Random Effects Regression Models

To begin with, in this section equation (4.3) will be transformed in order to apply for fixed and random effects. Moreover, the Hypotheses that will be tested will be further analyzed. We remind that in

[6] The coefficients b and B in Table 6 refer to coefficients β_{fe} and β_{re} respectively.

Hypotheses 1 and 2 the method of fixed effects will be applied while for Hypothesis 3 the random effects model will be used. The choice of the above hypotheses were bazed on the existing literature as presented in section 2.4 and the available data we got at that time. Regarding that, we were able to obtain data only for the asset allocation, the size and the figures of retired and active members, thus, restricting our range of research. Moreover, those data seemed to be enough for conducting a valid research since relative relationships with similar variables have already been used in the existing literature thus giving us the opportunity to also apply them by confirming or contradicting the existing findings.

Before proceeding to the analysis of the Hypotheses tested, we are going to present them for once more:

- ***Hypothesis 1*****:** *The age of pension funds' participants has a negative relationship with funds' portion of stocks.*

- ***Hypothesis 2*****:**. *The size of pension funds has a positive relationship with funds' portion of stocks.*

- ***Hypothesis 3*****:** *The Banking sector has on average the highest positively relationship with its pension funds' portion of stocks due to the industry's better "know-how" and expertise. We test the effect of the economic sectors, in which pension funds belong to, on their funds' portion of stocks.*

4.3.1. Fixed Effects using Least Squares Dummy Variable regressions model

In this section equation (4.3) will be transformed in order to apply for fixed effects using LSDV regressions model, since the Durbin–Wu–Hausman confirmed its implementation. In this method the unobserved effect takes action playing the role of pension funds' intercept. The model is constructed by adding a set of binary variables, Z_i, for every pension fund/individual each one corresponding to a specific pension fund and taking the value of 1, otherwise 0. Since we did that and in order to avoid multicolinearity, the intercept β_1 is being dropped while its properties are taken by the term $\alpha_i Z_i$ creating a fixed effect on $Y_{i,t}$, where α_i is now implemented as the coefficient of the pension fund dummy variables. Now, the model is equivalent to a pooled OLS with dummy variables.

Provided that, equation (4.3) can be rewritten in its final form

$$Y_{i,t} = \sum_j^n \beta_j X_{i,j,t} + \sum_i^n \alpha_i Z_i + \varepsilon_{i,t} \quad (4.6)$$

Because of the large number of pension funds and hence the large number of the dummy variables, we do not only estimate OLS in the normal way but also using the "areg" command in STATA for simplification reasons. This function facilitates us since it suppresses the large set of dummy variables making the model more presentable by avoiding their inclusion. In the next chapter there will be a

presentation of the results by using the simple fixed effects model and the LSDV using both the normal way and the STATA "trick", thus, indicating the same results.

Before proceeding to the analysis of Hypotheses 1 and 2, we are going to match the variables of our two hypotheses into equations (4.3) and (4.6) respectively in order to see how the models are being formed. More specifically, equation (4.3) is being transformed to:

$$Stocks_{i,t} = \beta_0 + \beta_1 Age_{i,t} + \beta_2 Size_{i,t} + \alpha_i + \varepsilon_{i,t} \quad (4.7)$$

while equation (4.6) is

$$Stocks_{i,t} = \beta_1 Age_{i,t} + \beta_2 Size_{i,t} + \sum_i^n \alpha_i Funds_i + \varepsilon_{i,t} \quad (4.8)$$

which can be further simplified in the form

$$Stocks_{i,t} = \lambda_0 + \beta_1 Age_{i,t} + \beta_2 Size_{i,t} + \varepsilon_{i,t} \quad (4.9)$$

where

$$\lambda_0 = \sum_i^n \alpha_i Funds_i \quad (4.10)$$

where $Stocks_{i,t}$ is the dependent variable, $Age_{i,t}$ and $Size_{i,t}$ are the predictors, α_i the unobserved effect, $\sum_i^n Funds_i$ the pension fund dummy variables, and λ_0 is funds' intercept.

As mentioned in the previous sections, the LSDV (4.8) equation will include a set of 81 dummy variables, as much as the pension funds, $\sum_i^n Funds_i$, each one corresponding to a specific fund taking the value of 1, otherwise 0. Furthermore, the unobserved effect α_i is now being treated as the coefficient of each pension fund dummy variable, thus, taking the place of the intercept β_0 which is dropped from the model. Finally both the unobserved effect and the set of dummy variables form the term $\sum_i^n \alpha_i Funds_i$ which creates a fixed effect on $Stocks_{i,t}$. Since a fixed effects model is used, it is important to recall that we use that kind of methodology because we assume that there is something in the pension funds that may affect the explanatory variables. Therefore there is need in controlling this and this is where fixed effects help to remove the impact of those time-invariant characteristics from the predictors in order to be able to estimate the predictors' net effect. The above variables will be analyzed in the next sections.

4.3.2. Hypothesis 1: Do Younger Pension Funds Take More Risk Than The Older Funds?

Regarding answering Hypothesis 1, we will test the relationship between the percentage of pension funds' total assets invested in stocks and each pension fund's ratio of retirees to active members. Specifically, the intuition behind Hypothesis 1 is to investigate the effect that an increase of the ratio of retired to

active members will have on the portion of stocks invested by the funds, that is, a change in their risk appetite. This will happen by taking into account the predictors' coefficients which indicate the changes in the portion of stocks invested by the pension funds when the ratio of retirees to active members increases by one unit. Therefore, the percentage of stocks invested by the pension funds will be the dependent variable of the regression representing the risk measure of this model while the ratio will be the predictor which will be responsible for the changes in stocks and treated as an age proxy measure. The stocks, which are expressed in percentages, were chosen to represent the risk measure of the model due to the fact that they are the riskiest among the securities invested by the funds since they earn higher returns and hence explaining better their risk-taking behavior. Indeed, Milonas et al. (2003) confirm that Greek pension funds would not have gained higher returns unless more risk was taken in permissible levels by allocating their assets in stocks. On the other hand, the ratio of retired to active members will be applied as an age proxy indicating the maturity of pension funds meaning that the higher is the ratio, the older is the pension fund. It was the only available non-financial characteristic at that moment, thus, serving the purpose of this research that is to investigate the impact of pension funds' characteristics on their risk appetite. The figures of the retired and active members are expressed in thousands.

4.3.3. Hypothesis 2: Do the Wealthier Pension Funds Take More Risk Than the Poorer funds?

Regarding answering Hypothesis 2, we will test the relationship between the percentages of stocks invested by the pension funds and their total wealth. Basically, we will investigate the effect that an increase in pension funds' wealth, and hence a change in their size, will have on the portion of stocks invested by them, that is, a change in their risk-taking behavior. This will happen by taking into account the predictors' coefficients, which indicate the changes in the portion of stocks invested by the pension funds, when the wealth of the funds increases by one unit. Therefore, the percentage of stocks invested by the pension funds will be the dependent variable of the regression representing the risk measure of the model like in the previous hypothesis, while the wealth will be the predictor which will be responsible for the changes in stocks and treated as a measure of size. The stocks, which are expressed in percentages, were chosen to represent the risk measure of the model since they are the riskiest among the securities invested by the funds while earning higher returns and hence explaining better their risk-taking behavior. On the other hand, pension funds' wealth indicates the size of funds meaning that the wealthier a pension fund is, the bigger in size is the fund. The size of the funds is measures in units of billions[7].

[7] For example 1 corresponds for one billion, 0.1 for a hundrend millions etc.

4.3.4. Hypothesis 3: Does the Economic Sectors, in Which Pension Funds Belong to, Influence their Risk-taking Behavior?

The idea behind Hypothesis 3 is to check whether the economic sectors in which pension funds belong to, have an effect on their risk-taking behavior. In order to answer this question, random effects regressions model should be applied. As mentioned in a previous section, the economic sector belongs to the time-invariant characteristics of pension funds, and only a random effects regressions model is able to capture and explain variables like these. Therefore, to answer this question the most suitable method to use is random effects, despite the suggestions of Dougherty's (2006) desicion map and DWH's test results. The risk measure of the model will remain the percentage of total assets invested in stocks representing the dependent variable while the ratio of the retired to active members and the wealth will be the predictors representing pension funds' maturity and size respectively. The variables of stocks, the figures of retired and active members, and the size are expressed in the same units of measure like in the previous hypotheses. In this problem statement, pension funds were ''aggregated'' in 17 sectors each one corresponding to an economic sector dummy variable, in order to capture the impact that the differences across the sectors might have in the risk-taking behavior of the funds. The funds were divided in sectors according to their status. The dummy sectors refer to: private, public, communications, transportation, medicals, law, media, agriculture, and insurance, freelance professions, security forces, services, tourism, chemicals, and engineers, leaving the bank sector out as the reference level in order to avoid perfect multicolinearity. The Bank sector was chosen as the reference level due to the fact that is one of the largest sectors, investing on average 34% of their total assets in stocks and thus could be a representative sector to compare. Each binary variable will take the value of 1 if it refers to a pension fund that belongs to the relative industry, 0 otherwise. Therefore, the economic sector time-invariant variables will behave as explanatory since the random effects model assumes that the pension funds' error term is uncorrelated with the age and size predictors.

To normally proceed, equation (4.3) has to be reconstructed. Provided that, it can be rewritten in the form

$$Y_{i,t} = \beta_0 + \sum_j^n \beta_j X_{j,i,t} + \sum_i^n Z_{\text{i-1}} + u_{i,t} \tag{4.11}$$

where

$$u_{i,t} = \alpha_i + \varepsilon_{i,t} \tag{4.12}$$

where the unobserved effect is randomely distributed and incorporated into the error term. Regression model's (4.9) form is partly the same with the one described by the equation (4.3). The dependent and independent time-variant variables remain the same. Moreover, we add the term $\sum_i^n Z_{\text{i-1}}$ which represents the set of 16 dummy sector variables. The term $u_{i,t}$ represents the new error term containing the unobserved effect. Lastly, the constant β_0 implies the reference sector.

Next, we will match the variables of Hypothesis 3 into equation (4.9) in order to understand how the model is being formed. So, the new equation is

$$Stocks_{i,t} = \beta_0 + \beta_1 Age_{i,t} + \beta_2 Size_{i,t} + \sum_i^n \alpha_i Sectors_{i-1} + u_{i,t} \quad (4.13)$$

In order to verify the application of random effects technique, it was considered beneficial to run a Breusch-Pagan Lagrange multiplier (LM) test, which tests for random effects and helps someone to choose between a simple OLS regression and random effects. The null hypothesis tests that the variances across the pension funds is 0 [Var(u) = 0] that is insignificant differences across units. The LM test has confirmed the findings of the DWH test since the *Prob* > Chi^2 which is 0, is lower than 0.05, thus rejecting the null hypothesis indicating that there is evidence of significant differences across the pension funds and therefore random effects model should be applied (Appendix VIII, Table 9).

Chapter 5: Results

The aim of this chapter is to present and interpret the results of the hypotheses tested as described in the previous chapter as well as to explain other possible conclusions that could arise by the analysis of the coefficients.

5.1. Analysis of Hypotheses 1 & 2

Below, Table 8 presents the estimation results arising from equations (4.7) and (4.9) that concern Hypotheses 1 & 2 by using the simple fixed effects regression nomdel, the LSDV and the "areg" simplification command for LSDV in order to avoid all the unnecessary dummy variables. Observing the results, anyone can realize that all the three models present the same results as they should do. Before analyzing the coefficients, the model fit should be considered by looking at the model's R^2 and the *F-test.* The higher the R^2, the better the regressors predict the outcome variable. In this case, the R^2 is equal to 0.8321 that is a decent performance value, indicating that this model and hence the explanatory variables (ratio of retired to active, size) are able to explain the 83.21% of the variation of stocks. Next, the *F-test* evaluates whether the model is adequate by examining whether all the coefficients in the model are different than zero. In order to be valid the *Prob > Chi*^{2} has to be lower than 0.05. The results show that the p-value is zero indicating that the model is not useless.

Proceeding to the results, Table 6 shows that the constant, which captures the individual characteristics of pension funds, is statistically significant in the 95% confidence level indicating that when the funds' ratio of retired to active members, that is the age proxy, and size are zero, pension funds seem to invest on average 13.556 percentage units of their assets in stocks which is less than the average percentage invested by them for the time period 2005-2009 as presented by *Figure 1*.

Next, the ratio of retired to active members indicates the maturity of the funds and it is used as an age proxy, meaning that the higher the ratio is, the older is the fund, and hence, the higher the average age of their participants. In this hypothesis we conjecture a negative age-stocks relationship as the life-cycle theory predicts. The results show that there is evidence in the data that in a 5% significance level, pension funds slightly reduce their portion of stocks by 0.171 percentage units when the ratio increases by one unit. That means that the older pension funds prefer to take less risk than the younger funds. The ratio rises when the number of retired people increases and the number of active members decreases. So, for each additional person that is retiring, participants' average age increases, leading the older pension funds to slightly decrease their risk-taking behavior by investing less in stocks, thus, pursuing more

conservative investment strategies than younger funds do. Fuerthermore, our results confirm the life-cycle investment theory which exactly indicates a negative stocks-age relationship. The equity exposure of the active participants should decrease with their age and remain constant after retirement (Bikker et al, 2011). Since the coefficient of the ratio, which represents pension funds' maturity, appears to be negative, that leads to the conclusion that the younger funds take more risk than the older funds. In association to our research, there are many academic papers that investigated the impact that the average age of the funds' members has on their risk-taking behavior. Bikker et al. (2011), Alestalo and Puttonen (2006), and Gerber and Weber (2007) confirmed the life-cycle investment theory by finding that when there is an increase in the average age of their participants, the amount invested in equity decreases significantly indicating a negative relationship between stocks and age. A possible explanation about the negative effect of participants' average age on Greek pension funds' risk-taking behavior could be the fact that until recently workers had the opportunity to retire early, in young age if they met specific requirements according to the Greek Law. Since, a lot of workers could meet that early retirement requirements, they took advantage of it, thus keeping the average age of active in low levels and, hence, a younger labor force. Therefore, the younger the workers in a pension fund, the more risk they take as the life-cycle theory states.

Model Outcome Variable: Stocks (%)	Fixed effects		"areg"		LSDV[8]	
	Coefficients	t-values	Coefficients	t-values	Coefficients	t-values
Constant	13.556***	3.95	13.556***	3.95	4.126**	1.97
Ratio (Age Proxy)	-0.171**	-1.99	-0.171**	`-1.99	-0.171**	-1.99
Size (Wealth)	17.812**	2.11	17.812**	2.11	17.812**	2.11
R^2	0.8321					
F-test: *Prob > F*	0.0000					
95% Confidence Level[9]						

Table 8: Effect of pension funds'maturity and size on their risk appetite. It includes the outcome variable, the constant, the predicotrs, their coefficients and t-values.

The next hypothesis conjectures a positive relationship between pension funds' size and risk. We are going to investigate the effect of funds' size on their portion of stocks. We remind that the size variable represents pension funds' total wealth. We argue that indeed the bigger in size pension funds would place more money in risky securities since they have the convenience to better allocate their assets among a big variety of securities by creating well-diversified portfolios and managing better risky situations. Clearly, according to the results of Table 8, there is evidence in the data that in a 5% significance level, pension funds' increase their portion of stocks by 17.812 percentage points on average when their total wealth rises by one unit of billions. This positive relationship between size and risk indicate that the bigger in

[8] See Appendix tade for the complete table including the dummy variables.
[9] * stands for a 10% significance level, ** stands for a 5% significance level, and *** stands for 1% significance level.

size pension funds pursuit more liberal investment strategies, thus, increasing their risk-taking behavior by investing more in stocks. The reasoning that the wealthier pension funds' take more risk is also being supported by the exististin literature.

Similar results were obtained by Bikker et al (2011). They attribute the risky behavior of the large pension funds to their size which allows them to better manage highly risky situations giving them the opportunity to pursuit more liberal investments. Moreover, they believe that major problems that concern large pension funds cannot be neglected by the government since the funds might hold thousands of pension plans and hence jeopardizing many people's pensions. So, they cannot let them go bankrupt. Such a problem for Greek pension funds could be the liquidity drain caused by the recent crisis. The huge deficits can also be considered as a major problem that may be caused by the poor management of their capital reserves or their bad investment choices. Thus, governments are forced to finance the state funds, which money, pension funds allocate in risky assets in order to rebound, by mostly increasing their portion in equities. This takes the form of a vicious cycle that could be repeated over and over again. Moreover, Smetters (2000) confirms this situation, stating that when investing a part of pension funds' trust funds in stocks will decrease pension system's deficit and solvency problems. All these cases are embraced for this research since they describe the Greek reality today. Furthermore, large pension funds that register a big number of the labor force may also receive higher pension contributions from people's salaries by giving them the chance to invest more confidently in equities satisfying their risk-taking behavior.

Regarding the set of dummy variables, as we mentioned in section 4.3.1, they, along with the unobserved effect will behave as the pension funds' intercept, since that was the reason for dropping the β_0 intercept from equation (4.6) in the first place. So, there is no need in further analyzing those variables independently and deal with unnecessary information[10]. Thus, that was the intuition behind the usage of STATA command "areg", as we explained in the previous chapter.

Beside pension funds' size and age, there are other characteristics that could influence the funds' risk-taking behavior such as the wealth of pension plan sponsor and the economic sector or industry in which each pension fund operates. Regarding pension plans, Choy, Lin, and Officer (2012) studied the effect that a defined benefit (DB) pension plan freeze might have on the investment strategies of pension funds. They observed that in the period following a DB plan freeze, pension funds seem to choose riskier investment policies due to an increase in their idiosyncratic risk. The effect of the economic sector will be analyzed in the next section.

[10] See Appendix IX.

5.2. Analysis of Hypothesis 3

The following table exhibits the estimation results arising from the adjusted equation (4.13) which refers to Hypothesis 3. Checking the model fit, the R^2 in this regression model is relatively small, fixed to 0.182 indicating that the predictor variables, which is the ratio of retired to active members and size, are able to explain only the 18.2% of stocks' variation (outcome variable). On the other hand, the *F-test* shows that the *Prob* > Chi^2, which stands for the *p-value*, is 0 that is lower than 0.05, denoting that all the coefficients in the model are different than zero and hence the model is accepted.

Proceeding to the estimated results, we observe that when using random effects our predictors change compared to fixed effects. Table 9 indicates that the negative age-equity relationship that life-cycle theory states, does exist but it is not significant. The results show that when there is an increase in the ratio of retired to active members, pension funds decrease their portion of stocks by -0.951 percentage units on average declaring a positive age-equity relationship which means that the older pension funds take more risk than the younger funds. Remember that, since we use the ratio as an age proxy that means that the higher is the ratio, the older is the pension fund. However, the results were the opposite from what we predicted in the previous hypothesis but, since the coefficient of our age proxy variable is not significant and we can attribute this change to chance.

On the other hand, pension funds' wealth/size still seems to play a major role on the funds' risk-taking behavior even when we use random effects. Like in the previous hypothesis, the results indicate that in 5% significance level, there is evidence in the data that when pension funds' size increases by one unit of billions, they raise their equity holdings by 2.512 percentage units on average thus confirming that the wealthier and hence bigger in size funds take more risk than the smaller funds.

Further on, the economic sector dummy variables are incorporated into the regression model as time-invariant factors in order to detect the differences in the economic sectors' investment startegies and their effect on the portion of stocks invested by the pension funds. Since it is assumed that there is no correlation between the pension funds' error term and the predictor when using the random effects model, the time-invariant variables will behave as explanatory. To begin with, the constant captures the individual characteristics of the reference level in which case is the Bank sector. The results indicate that in a 5% significance level, the banking sector significantly positively affects its pension funds risk appetite by investing on average 28.264 percentage units in equities expressing a highly risky profile. The big size of the industry may influence its funds' increasing risk-taking behavior.

Next, the Private and Law sectors seem to follow less risky investments strategies than the reference industry since they have a negative effect on their pension funds' risk appetie. Their funds invest on average 3.504 and 1.014 less percentage units in stocks. Though, the results show that the differences in the investment policies across the sectors are insignificant and the fluctuations in their risk-taking behavior could be due to chance. On the other hand, there is evidence in the data that in a 5% significance

level, Media and Agriculture sectors seem to follow very conservative investment policies compared to the Bank sector, since these sectors have a significantly negative effect on their funds' equity exposure which has respectively been reduced by 23.974 and 21.301 percentage units. The results show that the different investment strategies between the economic sectors are indeed statistically significant thus affecting their pension funds' risk-taking behavior the most. Contrary, Insurance, Communications and Public sectors tend to invest half the percentage points than the reference sector, indicating safer solutions when allocating their assets. Specifically, the three sectors have a negative effect on their pension funds' risk-taking behavior by decreasing their funds' equity exposure by 10.891, 11.239, and 7.831 less percentage units than the Banking sector. However, the results indicate that the differences in the investment strategies across the sectors are insignificant and the risk-appetite changes could be attributed to chance. In the same pattern, the Transportation sector seems to have highly affected pension funds' risk-taking behavior. In a 5% significance level, the Transportation industry prefers to invest in safer securities such as bonds since it negatively affects its funds' risk appetite by decreasing their portion of stocks by 22.26 percentage units on average compared to Bank sector.

On the other hand, Freelancers seem to follow more liberal investment strategies than the reference industry. The results show that the Freelancers sector positively affects its funds' risk-taking behavior by increasing their stocks holdings on average by 6.441 percentage units, thus following riskier investment strategies. However, the results indicate that the different investment strategies between the two sectors are insignificant and the changes in the risk-appetite of pension funds' could be due to chance.

Furthermore, in a 5% significance level, the industry of Security Forces which involves pension funds that are affiliated to professions such as the police forces or the fire brigade, significantly negatively affects its pension funds' portion of stocks reducing it by 16.636 percentage units and indicating their preference to allocate their assets in safer products. The results declare that the differences between the two sectors are statistically significant. Further up, there is evidence in the data that the next group of industries slightly show a low risk profile. More specifically, the economic sectors of Legal Services, Medicals, Engineers, Industrial, and Tourism negatively affect their pension funds' risk-taking behavior by decreasing their equity possessions by 10.778, 6.769, 7.272, 3.094, and 1.152 percentage units respectively compared to Bank industry. Though, the results show that this conservative behavior when investing could be due to chance, since the different strategies across the industries are insignificant. Lastly, the Port industry seems to prefer keeping its risk appetite in low levels. The results indicate that the sector significantly negativley affects its pension funds' equity holdings since they reduce its portion of stocks by 16.671 percentage units compared to the reference industry. The coefficient of the unobserved explanatory variable is significant declaring that the differences among the sectors have an important effect on pension funds' risk-taking behavior.

Model Outcome Variable: Stocks (%)	Coefficients	t-values
Constant (Bank Sector)	28.264***	4.71
Ratio: Retired / Active (Age Proxy)	-0.951	-1.39
Size (Funds' Wealth)	2.512**	2.02
Economic Sector Dummy Variables:		
Private Sector	-3.504	-0.33
Law Sector	-0.1014	-0.11
Media Sector	-23.974***	-4.03
Agriculture Sector	-21.301***	-3.28
Insurance Sector	-10.891	-1.26
Public sector	-7.831	-0.77
Communications Sector	-11.239	-1.21
Transportation Sector	-22.488***	-2.75
Freelancers Sector	6.349	1.01
Security Forces Sector	-16.796**	-2.04
Legal Services Sector	-10.791	-1.15
Medical Sector	-6.281	-0.67
Engineers Sector	-6.599	-0.97
Industrial (Chemicals) Sector	-3.262	-0.29
Tourism Sector	-1.251	-0.06
Port Sector	-17.921***	-2.43
Model Fit:		
R^2	0.182	
F-Test: *Prob > Chi*^{2}	0.0000	
95% Confidence Level[11]		

Table 9: Effect of economic sectors on pension funds' risk appetite. It includes the outcome variable, the constant, the observed and unobserved explanatory variables, their coefficients and their t-value

Summing up, the Private, Law, Insurance, Public, Communications, Freelancers, Legal Servics, Medicals, Engineers, Industrial, and Tourism sectors have insiginificant effects on their funds' portion of stocks indicating that the differences in the investment strategies between the sectors as well as the changes in their pension funds' risk appetite can be attributed to chance. On the other hand, the different investment strategies of only six out of the seventeen sectors significantly affected pension funds' risk-taking behavior. Specifically, observing Table 9, anyone can see that the reference industry is the only sector that significantly positively affects its funds' equity exposure, indicating the riskiest behavior. The rest of the sectors, like the Media, Agriculture, Transportation, Security Forces, and Port have a significantly negative effect on their funds' portion of stocks and hence on their risk appetite. That makes Bank sector, the industry with the riskiest profile when investing. We argue that the size of the economic sectors could be a sufficient reason which can have a significant effect on pension funds' risk-taking behavior. The bigger the sector, the larger its effect on funds' risk appetite. We claim that the Bank sector significantly positively affects pension funds' risk appetite due to its big size, and since it oprates in the banking industry and being involved in the financial markets, it has the "know how" when investing and it is able to deal with higly risky situations, thus positively affecting pension funds' risk-taking behavior by

[11] * stands for a 10% significance level, ** stands for a 5% significance level, and *** stands for 1% significance level.

investing more in equities. Moreover, because of Greece's current situation, large amounts of money that were borrowed from the ECB[12], IMF[13] and Eurozone's countries were exploited by stimulating the banking industry due to the major finace problems it faced at that time which money were invested in such a way that will help them to financially rebound. Compared to Bank sector, we argue that the rest sectors with significant results, were too small in size and their grants to low to allow industries to allocate them in such a way to recover and in conjuction with the worst expertise, they preferred to follow more conservative investment strategies.

[12] European Central Bank.
[13] International Monetary Fund.

Chapter 6: Conclusion

The Greek Social Security System has experienced major problems through the years such as large deficits, poor state-funding, economic frauds, and the recent debt crisis of Greece, thus creating a weak pension system that is characterized by high complexity. Furthermore, the above problems, the strict regulation, and pension funds' poor asset management has influenced their risk appetite by allocating their assets in safer securities. Despite these factors, we believe that other aspects such as pension funds' unique individual characteristics might be responsible for the changes in their risk-taking behavior. Regarding the above, combined with the current situation of Greece, due to the debt crisis and now the recession, makes Greece's case interestimg in the framework of their investment strategies and appetite for risk.

This research report centralizes exactly around the investigation of Greek pension funds' characteristics, such as the age, size and economic sector, and the effect that they might have on funds' risk appetite. The choice of Greece lies in the fact that it is governed by a weak and highly complex pension system which faces major problems that co-exists among European Union countries' wealthiest pension schemes, thus, making it interesting The hypotheses that were addressed based on the existing literature and data are the following:

- ***Hypothesis 1*****:** *The age of pension funds' participants has a negative relationship with funds' portion of stocks.*

- ***Hypothesis 2*****:**. *The size of pension funds has a positive relationship with funds' portion of stocks.*

- ***Hypothesis 3*****:** *The Banking sector has on average the highest positively relationship with its pension funds' portion of stocks due to the industry's better "know-how" and expertise. We test the effect of the economic sectors, in which pension funds belong to, on their funds' portion of stocks.*

To answer these questions we tested the relationships between age and equity, size and equity, and economic sectors and equity. In order to conduct this research, we used panel data analysis on yearly data for the time period 2005-2009 on 81 Greek pension funds. The results, which are consistent with Lucas and Zeldes (2009), and Bikker et al. (2011) findings, indicate that there is a negative age-equity relationship declaring that the younger pension funds take more risk on average while there is a positive size-equity relationship dipslaying that the wealthier funds choose to follow more liberal investment

strategies. Accordingly, concerning the economic sectors, the results showed that only the Banking sector significantly positvely affects its pension funds' risk appetite while the majority of the sectors do not seem to have significant effect on their funds as well as insignificant differences in their investment strategies.

We strongly believe that the contribution of our thesis project is very important since it is the first research on the effect of Greek pension funds'characteristics on their risk-taking behavior, by expanding the range of the existing literature on that kind of studies. Moreover, our thesis contributes to the collection of similar projects that concentrate on a specific country's asset allocation attempting to investigate their investment strategies and risk behavior, thus, creating room for a further possible research between countries that will help to extract important conclusions for the pension markets. However, the major contribution of our research lies in the fact that the Greek Government and specially the Ministry of Labor and Social Security under which the Greek pension funds operate study, can utilize this project in order to improve pension funds asset management and operation. Furthermore, important conclusions were derived regarding the Greek Social Security System and the Greek pension funds and their appetite for risk. Problems, such as the strict regulations, early retirement, iliquidity drains, deficits, the debt crisis and now the recession period might be considered crucial factors that lead Greek funds to change their risk-taking behavior.

However, there is an important limitation that restricts the range of our research. The lack of data on other characteristics of the funds, limits our research to fully study the total effect of pension funds' characteristics on their risk-taking behavior that would give us the opportunity to better understand their behavior and the aspects that influence it, while also to study each pension fund individually. Moreover, this absence of data compels us not to include robustness checks to generate robust results due to the uncertainty of the reliability of the robustness checks' estimations, since having only two control variables to test.

On the other hand, a better possible collection and distribution of data on funds' characteristics by the Ministry of Labor and Social Security or the funds themselves would give us the chance to complete our research on the risk appetite of pension funds. Furthermore, we could possibly further expand our future research in the context of pension funds' risk appetite by studying how, a possible liberation of pension funds' strict regulations as well as a possible privatization, would positivley or negativley influence their risk-taking behavior.

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Appendix

Appendix I: Overall Descriptive Statistics

	Observations (N)	Minimum (%)	Maximum (%)	Mean (%)	Std. Deviation (%)
Stocks (%)	405	0	99	20.1	21.1
Government Bonds (%)	405	0	77	12.4	18.1
Real Estate (%)	405	0	100	7.4	16.9
Deposits (%)	405	0	100	54.2	29.1
Others (%)	405	0	76	6.1	11.6
Active Members	405	0	2198000	90189.5	302931.1
Retired	405	0	1127000	38737.5	155376.9

Table 10: Overall descriptive statistics of pension funds' asset allocation for the time period 2005-2009

Appendix II: Pension Funds' Asset Allocation in Real Money

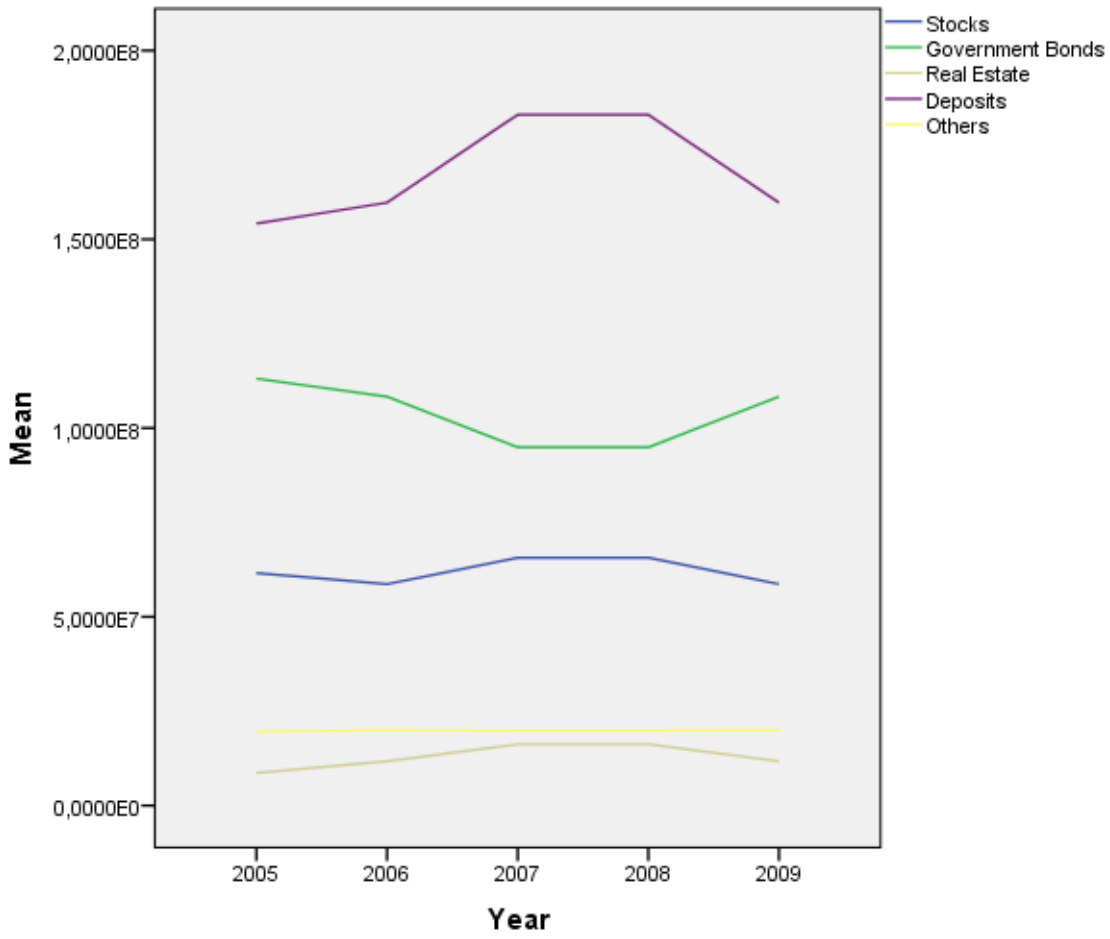

Figure 2: Asset allocation of pension funds in real money over the 5-year time interval

Appendix III: Economic Sectors' Asset Allocation

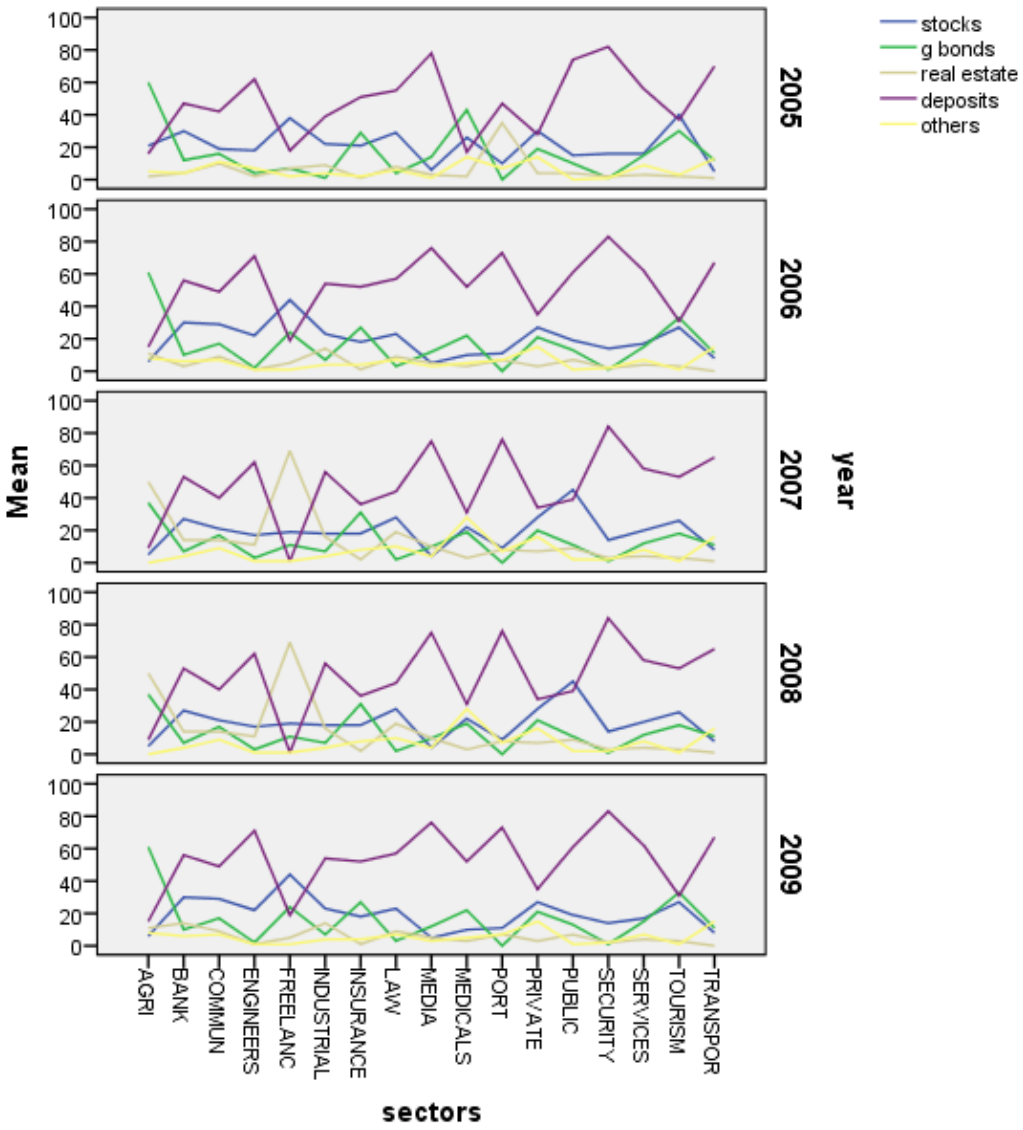

Figure 3: Asset allocation of economic sectors

Appendix IV: The Trend in Active and Retired people

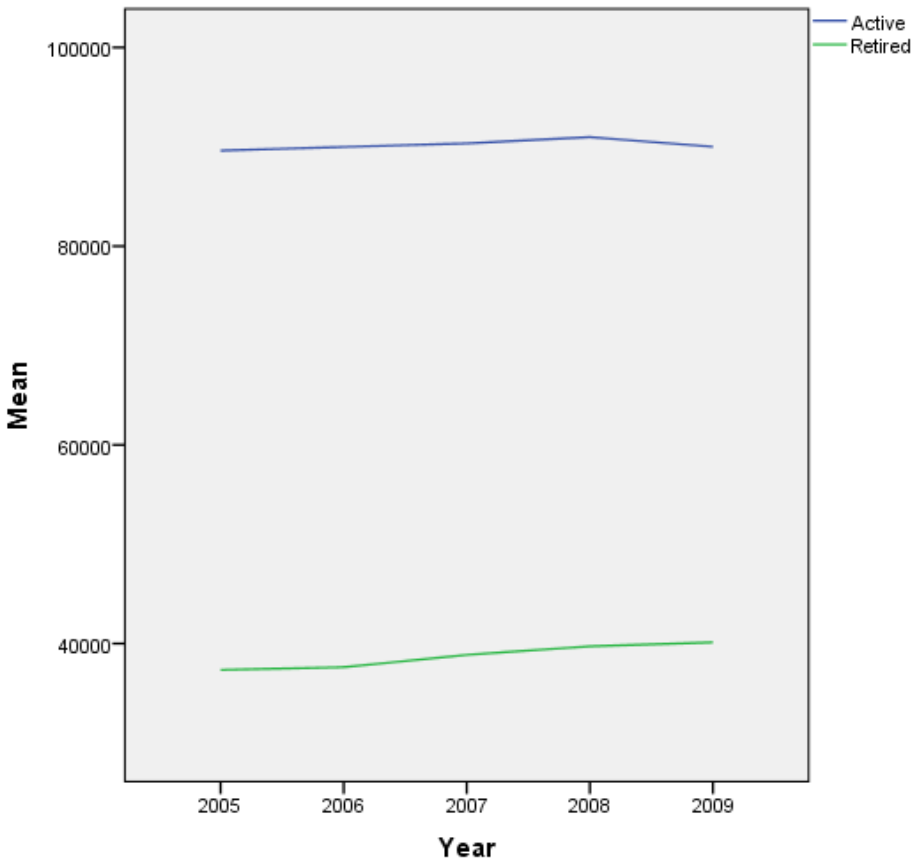

Figure 4: It shows the course of active and retired people through the time period 2005-2009.

Appendix V: Asset Allocation of Greek Pension Funds

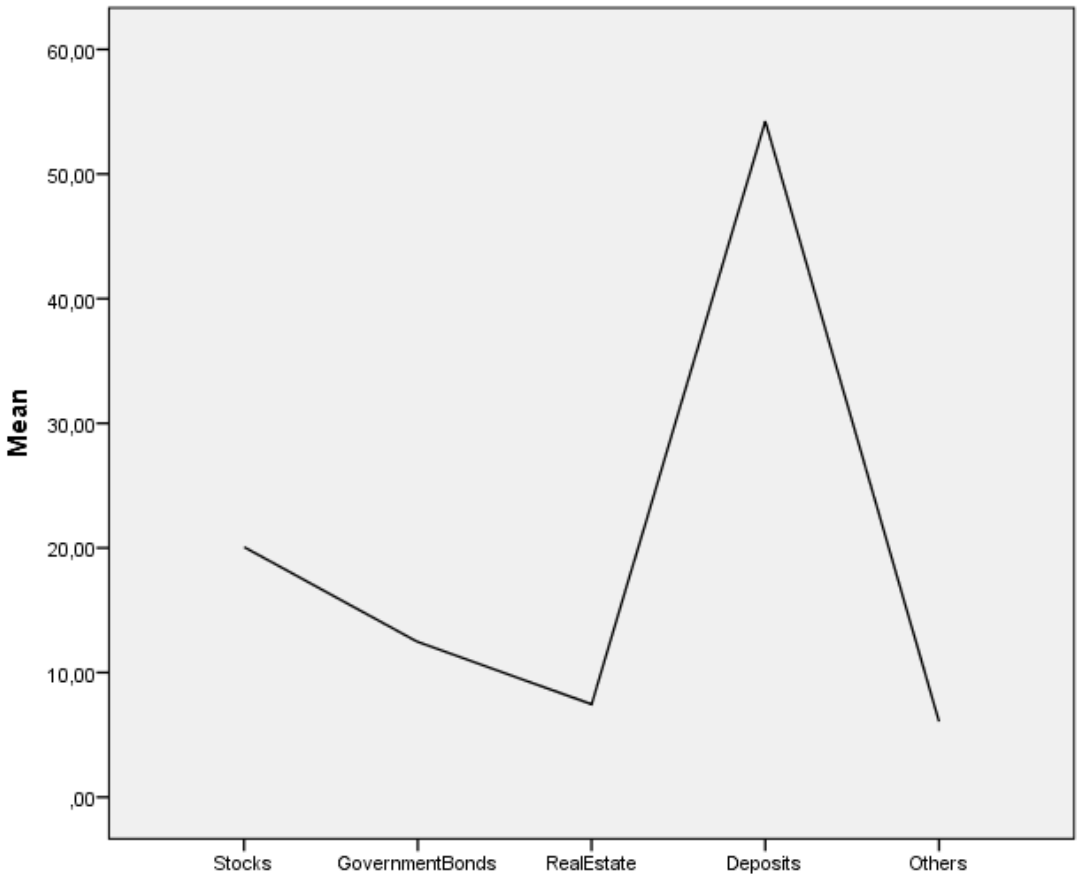

Figure 5: It shows the asset allocation of Greek pension funds during the time period 2005-2009.

Appendix VI: Breusch-Pagan Lagrange Multiplier (LM) test

$$Stocks[id, t] = xb + u[id] + e[id, t]$$

	Var	Sd = sqrt(Var)
Stocks	445.1236	21.09795
e	93.77316	9.683654
u	349.1609	18.68585

Table 11: Breusch-Pagan Lagrange multiplier (LM) test

$Chi^2(1)$	489.86
Prob > Chi^2	0.0000

Table 11: Breusch-Pagan Lagrange multiplier (LM) test cont.

Appendix VII: LSDV Results of Hypotheses 1 & 2

Model Outcome variable: Stocks (%)	Coefficients	t-values	Economic Sectors
Constant (EDOEAP)	4.126**	1.97	*Media*
Ratio: Retired / Active (Age Proxy)	-0.171**	-1.99	
Size (Funds' Wealth)	17.812**	2.11	
Pension Fund Dummy Variables:			
TAP-TE	46.715434***	18.72	*Bank*
ETEAM	42.78663***	9.07	*Private*
ETEX	-1.6887886	-0.80	*Security Forces*
ETYAP	-5.084481***	-2.77	*Security Forces*
ETYPS	-86.664544**	-2.41	*Security Forces*
IKA-ETAM	-1.7215966	-0.84	*Private*
KYYAP	8.858543**	2.07	*Security Forces*
MTY-TE	23.398782**	2.02	*Bank*
OAEE-TAE	28.801672***	3.94	*Freelancers*
OAEE-TEBE	31.836998**	2.10	*Freelancers*
OAEE-TSA	50.160734***	13.38	*Freelancers*
OAP-DEH	-34.137962**	-2.15	*Legal Services*
OGA	9.7703526***	3.31	*Agriculture*
TAAPTPGAE	14.802253***	7.92	*Bank*
TAAS	-14.211038***	-4.23	*Security Forces*
TADKY	-8.9398007***	-3.43	*Public*
TAISYT	-6.5767057***	-2.67	*Media*
TAKSY	-6.6446157***	-4.37	*Tourism*
TANPY	35.13233***	3.17	*Tourism*
TAP-ET	29.951085***	6.06	*Bank*
TAP-ETBA	39.206475***	16.17	*Bank*
TAP-HLPAP	20.299779***	7.16	*Transportation*
TAP-HSAP	-4.3363435**	-2.13	*Transportation*
TAP-OTE	-1.4023309	-0.42	*Communications*
TAP-ETE	12.52487***	5.47	*Bank*
TAPAEE	26.784711***	7.30	*Insurance*
TAPEAPI	52.21933***	22.53	*Private*
TAPEM	-8.9035446***	-5.39	*Chemicals*
TAPEPA	-4.228683**	-2.05	*Port*
TAPET	-4.1938412**	-2.02	*Media*
TAPILT	2.4801418	1.36	*Bank*
TAPPTEBEBEK	41.326159	1.88	*Public*
TAPPEL	35.031279***	11.27	*Chemicals*
TARP-OTE	12.784141***	2.66	*Communications*
TAS	18.766117***	8.91	*Law*
TATTA	-6.8941426***	-4.43	*Legal Services*
TAYAP	-2.4569754	-1.08	*Security Forces*
TAYPS	-5.3774532***	-2.93	*Security Forces*
TEAA	30.881554***	14.61	*Private*
TEAAPAE	-3.8401364	-0.86	*Insurance*
TEADY	-24.382727	-1.79	*Public*
TEAEIGE	4.9840518***	3.11	*Private*
TEAHE	24.753082***	6.03	*Engineers*

TEAKDPYK	3.1244703**	2.00	*Legal Services*
TEAP-EYDAP	13.800723***	4.89	*Legal Services*
TEAPAEL	9.8798236***	5.04	*Port*
TEAPEP	45.098735***	6.61	*Chemicals*
TEAPET	9.8868648***	3.24	*Chemicals*
TEAPOKA	-7.2613656	-1.92	*Insurance*
TEAPOZO	-6.6379059***	-4.22	*Private*
TEAPPERTT	-1.637854	-0.87	*Media*
TEAPTN	25.378056	1.61	*Law*
TEAX	15.687882***	7.85	*Engineers*
TEAYEK	-11.071986	-1.60	*Legal Services*
TEAYET	-2.8309283	-1.73	*Private*
TEAYFE	3.3437362	1.33	*Medicals*
TN	-7.1647059	-0.88	*Law*
TPDA	36.535319***	20.00	*Law*
TPDE	36.774592***	17.16	*Law*
TPDP	58.0789***	25.60	*Law*
TPDTH	-4.2508421**	-2.06	*Law*
TPDY	1.6765701	0.68	*Public*
TPEDE	19.40317***	12.30	*Legal Services*
TPOEKE	41.919082***	7.56	*Public*
TPP-OLTH	12.388843***	5.27	*Port*
TPP-OSE	-5.3583872***	-3.46	*Transportation*
TPP-OYTH	-4.1902786**	-2.02	*Legal Services*
TPX	72.55888***	32.31	*Tourism*
TSAY	3.3934903	0.38	*Medicals*
TSEAP-GSO	1.0725687	0.19	*Agriculture*
TSEYP	3.6635271	1.97	*Media*
TSEYPTH	.65589354	0.30	*Media*
TSMEDE	-41.515888	-1.96	*Engineers*
TSP-ATE	-3.675082	-1.73	*Bank*
TSP-ETE	44.295178***	11.42	*Bank*
TSP-HSAP	-3.9116279	-1.17	*Transportation*
TSP-TE	23.682681***	3.27	*Bank*
TSPEATH	-13.837817***	-3.95	*Media*
TYDE	-4.1938412**	-2.02	*Law*
TYDKY	-13.500908***	-3.49	*Public*
Model Fit			
R^2	0.8321		
F-Test: *Prob > Chi*^{2}	0.0000		
95% Confidence Level[14]			

Table 12: Impact of pension funds' size on their portion of stocks. The table includes the outcome variable, the constant, the observed and unobserved explanatory variables, their coefficients, their t-values and the economic sector in which pension funds belong to.

[14] * stands for a 10% significance level, ** stands for a 5% significance level, and *** stands for 1% significance level.