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## **RISK MANAGEMENT IN PENSION FUNDS: A EUROPEAN PERSPECTIVE**

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## **ABSTRACT**

The thesis is mainly focused on European pension funds and their evolution in measuring and managing risks. The decision to analyse private pensions arises from the present Italian situation, characterised by the welfare state's crisis and by continuous cuts in public pensions. Most of the population does not have a clear knowledge of the topic, and does not comprehend the necessity to change the current retirement system, that is unsustainable in the long term, and it is creating huge inequality between old and young people. The main objective, therefore, is to clarify the situation about pension funds in Europe, and try to understand how they will evolve in the next years. In the first part, some general concepts about retirement systems are introduced, as well as the peculiar features and actors of pension funds. Then the most important risks faced by collective plans are explained, among which credit, market and longevity risks. The literature review ends with an overview of some tools used by fund managers in order to hedge against risks, for example financial derivatives or stress-tests. The second part of the thesis starts with a framework about the most relevant risks that hit European pension schemes in the last years, such as low interest rates or equity risk, and the most recent trends in the sector, like the gradual shift from DB to DC plans, or the increasing equity investments because of the search of "high-yield" investments. For the empirical analysis, the Norwegian Government Pension Fund-Global and the Italian Unicredit Group's pension fund have been chosen because of the information freely accessible from their websites. However, as explained, the two funds present different sizes, characteristics, histories and investment strategies. The comparison between the two funds focuses on the period between 2006 and 2009, i.e. during the global financial crisis, and 2016. A general situation of financial markets is explained for each year, and after that, the research explains the returns obtained by each fund on the basis of the risks faced. The Norwegian pension plan has resulted to have more awareness in measuring and managing risks since 2006, not only because of the huge size, but also due to the strict limits imposed by the ministry of finance. The plan was hardly hit in 2008, but it succeeded in recovering very successfully in the following year thanks to the important reforms undertaken. On the opposite Unicredit's pension fund was less exposed to the crisis, even if it recovered less successfully due to weak reforms and low

experience in adopting risk management techniques. The gap greatly reduces in 2016, but there is still a little harmonisation in the procedures adopted. In conclusion, as recently suggested by EIOPA, a standardisation of risk management techniques and more transparency are required for all European occupational schemes.

# 1. INTRODUCTION

The debate about private pensions regards closely each worker that can accumulate and invest part of his/her savings for the retirement. However, lots of people do not have a clear knowledge of the sector and there is still a common lack of information among Italians. In July 2016 IPR Marketing, in collaboration with "Il Sole 24 Ore", conducts a research on pension funds among Italians. Considering a panel of 1000 citizens, disaggregated for age, sex and geographical area, the results point out a weak knowledge about pensions, with 60% of interviewees saying that they do not know what complementary pensions are. Moreover 59% is completely unaware of the difference between pension funds and PIP (piani di investimento pensionistici), and 27% prefer not to answer (IPR Marketing, 2016).

Many Italian people have not understood that the "retirement problem" is becoming bigger and bigger, and it can have serious consequences for future generations, that will not have, even a minimum, public pension. A lot of workers near the retirement do not comprehend that the current system is not sustainable in the future, they are ignorant about the stability of public pensions and they claim their acquired rights. However, also many young workers believe that it is too early to enrol into pension funds from the first working years. The government will inevitably continue to cut public pensions, since the present system is no more in equilibrium, and the contributions of active workers are not enough to pay public pensions for the same period. The main reasons are the increasing life expectancy, that brings to a gradually aging of the population, and the reduced fertility rate, that means less active workers in the future.

As Colombo (2017) states, young people are exposed to two risks: too low future pensions, especially in case of discontinuous careers and fragmented contributions, and too distant pensions, with a high probability to remain unemployed in the last working years. For these reasons the Italian government is discussing about the introduction of a guaranteed pension for young people and for those that started to work after the 1st January 1996, after the introduction of the less generous "sistema contributivo". Stefano Patriarca, economic counsellor for the Presidency of the Council of Ministers, explains that the objective is to introduce, as in the previous system ("retributivo"), a "minimum public pension of 650 euro for who has at least 20 years of contribution, that can



increase of 30 euro per month for each year up to a maximum of 1000 euro" (Il Sole 24 Ore, 2017).

The welfare state and public pensions have been very generous up to now for their beneficiaries, among which those people that received minimum pensions, even though they did not have the required years of contributions. Nevertheless, the global financial crisis changed the distribution of resources to the disadvantage of young workers, and this trend will continue in the next years. The result could be a conflict between generations, between "those that benefit from the previous and more generous system ("retributivo"), claiming for their rights, and young people, that don't understand why they must pay so generous benefits that will never obtain" (Il Sole 24 Ore, 2017). Colombo (2017) adds that "some young workers with discontinuous job careers, low salaries and absence of contributions in their first years of work, may not accrue pensions higher than 1,5 times the social assistance (670 euro) and they should wait until 73 years for a sufficient pension" (according to Fornero reform).

The decision to focus the thesis on pension risks and their management derives mainly by the innovativeness of this research topics, that has not received yet great importance by the academic literature. In my experience, professors at university of Bergamo mainly focus their teaching on risks in banks and insurance companies, without introducing the peculiar features of pension funds. However, I think students should know also some basis concepts about "less common" financial intermediaries. Acquiring a clear knowledge of pension systems is essential to educate young people to spend appropriately and save for their uncertain future. Millennials will need for sure additional private pensions to maintain adequate standards of life after their retirement.

Another motivation of the research is represented by the willingness to know more about recent evolution of the retirement industry in the European framework. The "Markets in Financial Instruments Directive" (MiFID), introduced by the European Parliament in 2004, was the first step to the creation of a unique, efficient, harmonised and competitive financial market. After that, other EU directives have been introduced in order to create a homogeneous financial market: Basil I, II and III introduced new standard requirements for all European banks, while Solvency I and II extended additional regulation to insurance companies. Finally, one of the objective of the

"Capital Markets Union project" is to introduce a single European market with standardised private pensions.

The edition 2017 of "Il Salone del Risparmio" hosted a conference titled: "Fostering pensions in Europe: personal pensions and other initiatives". The aim of this session, organised by Assogestioni, was to monitor the present situation of private pensions in Europe, and "investigate the possible evolutions in the national and European frameworks that are continuously and rapidly changing" (Il Salone del Risparmio, 2017). In particular, the speakers presented the intention to enhance and harmonise private pensions. The European Commission (2017) is discussing about the introduction of "PEPPs (pan-European personal pension products), with standard features, sold by a broad range of financial institutions (banks, insurance companies, pension funds)". These innovative tools are complementary to existing public pensions, and they do not substitute or harmonise national personal retirement systems.

Concerning the structure of the thesis, there are two main parts: a literature review and an empirical analysis. The next pages introduce the three pillars that constitute the basis of retirement systems in OECD countries. The thesis then focuses on the second pillar, represented by collective pension funds. An introduction about the features of retirement schemes and the different types is given, as well as a section dedicated to the main actors involved in the management. After that, the main risks faced by pension funds are described: some are common to banks, such as credit or market risks, while others are more peculiar to the retirement industry, like longevity risk. Operational risk has been divided into different sub-risks, like HR risk or reputational risk, because it has a very wide definition and it comprises several other risks. The same happened for political risk, that comprehends legal and regulatory ones. Liquidity risk is at the end of the paragraph, since pension plans invest over a long time horizon and, thus, they suffer less from this risk. The last section of the literature review makes an overview of the most common tools used by fund managers in order to hedge against risks: they use several types of financial derivatives, such as credit default swaps, interest-rate swaps or longevity swaps, but also credit ratings or asset-liability management techniques. Stress tests are simulations that monitor the stability of retirement schemes in adverse situations.

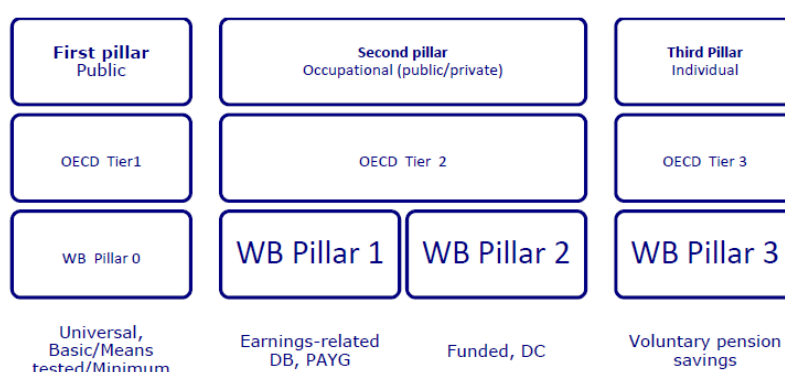
The second part of the thesis is dedicated to compare the risk management and its evolution in two pension funds. First of all, there is an overview of the major risks faced by European pension funds, such as low interest rates or equity risk, and an overview of the most recent trends in the retirement industry, among which the gradual shift from DB to DC plans. Secondly the pension funds chosen, which are the Government Pension Fund-Global, and Unicredit Group's pension fund, are presented, focusing on the most relevant characteristics, their histories and investment strategies. The analysis refers to the period of the global financial crisis (from 2006 to 2009) and to 2016. For each year, the market situation is introduced, and then for each fund the return achieved is explained on the basis of the risks faced. In this case there was more awareness of the Norwegian pension fund towards risk measurement and management techniques, not only because of its size, but also due to strict limits imposed by the ministry of finance. Unicredit's pension fund, instead, reformed its structure and introduced new tools to measure risks from 2008. In 2016 the gap between the funds in managing risks reduces, but there is a little harmonisation in the procedures adopted.

In conclusion, since EIOPA is evaluating to create a single European retirement market and introduce homogeneous pension products, it would be very important to adopt standardised methods to manage risks.

## 2. AN OVERVIEW ABOUT RETIREMENT SYSTEMS

As shown in the figure below, there are different schemes adopted to explain the retirement systems worldwide: the most common one (that is used also in this thesis) is the OECD classification into three tiers, or pillars (OECD, Private Pensions, 2005). Another pension system taxonomy, used by the World Bank, is the four pillar scheme (from pillar zero to pillar 3).

**Figure 1: World Bank/OECD taxonomy: Different types of retirement income provisions**



Source: OECD (2005b, 2013), World Bank (1994).

Source: European parliament (2014). Pension schemes. Study for the EMPL committee. <http://www.europarl.europa.eu/studies>

The OECD classification of pension benefits is called also multi-pillar system.

1. The first tier includes mandatory public state pensions, that aim to ensure "a minimum standard of living for all pensioners" and to prevent poverty after retirement. This objective is reached in different ways, for example with "a universal or basic flat rate pension, a minimum pension or provisions in the social security system" accessible to all retired people (European Parliament, 2014).
2. The second tier is a complementary level to basic state pensions and it is managed collectively. It aims at ensuring that "retired people have an adequate replacement rate and not just a poverty-preventing absolute standard of living" (OECD, 2005). The participation is still voluntary (even though in the last years the governments in the majority of EU countries are promoted these

supplementary forms because of insufficient public pensions). It comprises occupational plans and other pension funds, created for satisfying only certain categories of workers and, therefore, accessible only to them: they can be pay-as-you-go defined-benefit, or defined-contribution funds (European Parliament, 2014).

3. The third tier comprehends individual schemes (in the Italian system the so-called PIP- "piani individuali pensionistici"), that cover "personal pension plans in the form of savings and annuities" (OCSE, Private Pensions, 2005). They are privately managed and beneficiaries are free to make voluntary contributions to these funds; therefore, pensioners with specific needs can personalize retirement schemes.

### **Features about pension funds**

Pension funds are peculiar institutional investors, defined as "the pool of assets, forming an independent legal entity, that are bought with the contributions to a pension plan for the exclusive purpose of financing pension plan benefits" (OCSE, Private Pensions, 2005). The participants, both sponsors and beneficiaries, collect savings during their working life in order to be sure that they will have enough resources during retirement to satisfy their consumption needs. Moreover investments in the retirement industry generally have a fiscal advantage compared to other institutional forms, and this is an incentive to direct part of the income into this channel.

Retirement schemes are characterised by long-term liabilities, and for this reason they "increase the supply of long term funds to capital markets" (Davis, 2000). They usually hold high risks and high return instruments because they operate in large transactions, achieving economies of scale and reducing transactions and custodial costs. The composition of their portfolios varies a lot, even though they usually have a great percentage of long-term assets, such as "government bonds and high-grade corporate bonds". Retirement schemes contain also a very well-diversified portfolio of debt, even if sometimes the control of some parts is transferred to the originator.

Retirement schemes are mainly classified as defined-contribution plans, if beneficiaries' returns depend exclusively on the market, or defined-benefit plans, if they are covered

with a "guarantee of the rate of return by the sponsor". In this last case they face also the risk of a possible bankruptcy of the sponsoring company. In defined-contribution schemes contributions are fixed, they are invested and the final capital collected becomes a guaranteed payment for the elderly, like a pension income annuity (OECD, 2005). On the opposite the retirement benefit is variable and it is computed considering "worker's age, earnings, contribution rate, investment return and normal retirement age" (Howell et al., 2014). Conversely in defined-benefit plans retirement benefits are known, even though the contribution rate varies according to different factors, among which the number of working years.

Recently defined-contribution funds, which shift all the risk burden onto beneficiaries, have grown quicker compared to defined-benefit ones, first of all because employers are trying to reduce their risks, whereas employees are seeking plans where it is easy to transfer between different employers (Davis, 2000). Kakabadse et al. (2003) add that "the DB promises members a pension based on years in service and earnings with employers bearing all the risk of investment", while in DC plans the risk is completely faced by employees and the amount depends completely on how much has been invested and on market conditions.

Another classification is between institutional retirement schemes, that have an "independent entity with legal personality and its own internal governing board" (Yermo, 2008); and pension plans of contractual type, where the fund is constituted by a separated set of assets with no legal personality, and it is controlled by different entities, such as banks, insurance companies or pension fund management companies.

Following the previous classification, it is important to distinguish also between open pension funds, which hold plans that are not restricted on membership to particular employees and can be accessible by all workers, and closed pension funds, which promote exclusively retirement schemes restricted to certain workers (those of some employers or belonging to determined categories (Yermo, 2002). There are several types of closed pension funds: single-employer (they mix "the assets of pension plans established by a single sponsor"), multi-employer (pooling more assets of retirement schemes set up by different sponsors). Finally "individual pension funds manage the assets of a single member and his beneficiaries" (OECD, 2005).

## **Governance of pensions funds**

Several players are involved in managing pension funds: firstly the beneficiaries, i.e. the workers who contribute to the scheme and who will receive benefits after retirement. The sponsor or sponsoring company, instead, is the employer or some employers working together (for example different companies or public corporations). Both these players are usually contributors to the retirement plan and they are responsible to check how the scheme is managed and if the management is efficient. The sponsors and the beneficiaries may "sign binding agreements on some aspects of the fund" (Besley and Prat, 2003): for example they decide how much vigilance should be exerted on the fund management by each party.

A third player, that usually manages the assets of the scheme, is the fund manager. Another important players are monitors. "Under the trust form, which is the legal form used by pension funds in common law countries", the pension plan is usually set up as a trust deed (a legal document that contains the rights and obligations of each party). "The trustees legally own the pension fund assets" (Yermo, 2008) and they monitor and administer them solely in the interests of the scheme's members. The participation of more beneficiaries (that usually constitute a big dispersed player) generates a free-riding tendency in their vigilance (Besley and Prat, 2003) and therefore the presence of third-party trustees tries to solve this problem. Kakabadse et al. (2003) summarize their role in the following sentence: "trustees have the responsibility of ensuring the continued performance of funded occupational pension scheme assets and of ensuring that fund assets can cover benefits". Furthermore there are two different types of trustees: outside trustees are external experts, that have a well-known experience and exercise very effective vigilance; but at the same time they do not have a real interest for the plan and they need to be motivated through external incentives. On the opposite, inside trustees have less experience in managing pension plans, but they are more intrinsically committed to the beneficiaries (Besley and Prat, 2003).

However the Myners' report points out that asymmetrical information is still a big problem and it reduces considerably the effectiveness of governance in pension plans. There are difficulties in observing trustee's willingness and the interests of fund managers and service providers aren't always transparent. "Few defined benefit plans

hold elections for trustee boards; most trustees are nominated and appointed by the plan sponsor" (Clark, 2004) This report refers exclusively to UK, but the tendency analysed is similar also in other EU countries.

In conclusion, focusing on the peculiar Italian situation, recent reforms related to the governance of retirement schemes required the introduction of a supervisory board (that is called "organismo di sorveglianza"). Members of this board must satisfy independence requirements established by law, and they control that the retirement plan operates in the only interests of beneficiaries. Moreover if "at least 500 members belong to the same firm, the law requires that members of the board are also appointed by workers and the firm" (Yermo, 2008). In conclusion fund directors (translated in Italian "responsabili dei fondi") must be selected for all retirement plans. They have to check that the scheme follows the interest of participants and it is managed respecting legal rules and statutory provisions.





### **3. RISKS FOR PENSION FUNDS**

Pension funds are financial intermediaries exposed to both investment risk, that primarily relates to the assets, and liability risk, that is related to the liabilities (Kemp and Patel, 2011). The former has been defined by Sugita (2009) as "the risk of loss inherent in achieving investment objectives, including market, credit, counterparty and liquidity risks".

The peculiar features of pension funds, that represent an important difference with banks or insurance companies, are the relevance given to liabilities and to long-time investment periods (usually from 30 till 40 years), which explain the low liquidity of their assets. Fund managers can have difficulties to apply risk management tools designed for different financial sectors, such as banks (Franzen, 2010).

In the following paragraphs the main categories of risks faced by retirement schemes are discussed: credit risk, market risk, operational risk (with some subcategories, like HR or strategic risk) and political risk (including legal and regulatory risk) are treated in a similar way as the other financial intermediaries, while longevity risk regards almost exclusively pension funds. Finally it has been decided to analyse liquidity risk as the last category, since this type of risk is not very relevant for pension plans.

However there are some limitations in this analysis. First of all classifying risks into two opposite categories can underestimate the different exposures affecting at the same time the asset side and the liability one of the balance sheet (Kemp and Patel, 2011). Secondly it is possible to underemphasize the value of intangibles, for example intellectual property or customer goodwill, that are reflected only imperfectly in financial statements.

#### **CREDIT RISK**

Kemp and Patel (2011) state that it is "the risk that the creditworthiness of a counterparty to which an entity is exposed declines". This can bring to variable losses for the pension fund and in the worst case to the default of the counterparty. Moreover, the multinational professional firm Ernst & Young (2017) defines it as the hazard due to the possible inability of counterparties to meet their payment obligations.

Gallo (2009) distinguishes two different types of credit risk associated to pension funds: the first is the risk that the issuers of bonds (contained in the balance sheet) are not able to pay the promised benefits. It includes spread risk and migration risk.

The former is linked with a increasing spread required in the market for borrowing bonds (Resti and Sironi, 2007). The spread on a bond equals the difference between the interest rate of that bond and the risk-free rate of government bonds, usually German bonds or US treasury bonds (Kemp and Patel, 2011).

The latter, called also "downgrading risk", is the risk associated with the expectations of how likely the counterparty may default. The price of a bond depends also on the credit rating given to the instrument by a credit rating agency or an internal credit ratings team. The rating can change over time and the market may disagree with the view expressed by credit rating agencies in this respect (Kemp and Patel, 2011).

The second type of credit risk is called sponsor covenant risk and it is very important for many defined benefit pension schemes. It is the exposure to the current and future creditworthiness of the sponsor of the fund, that might not be able to pay its part of contributions. Gallo (2009) states that most of the time the financial weakness of the retirement scheme is linked to a corresponding weak position of the sponsor, because they are both influenced by macroeconomic factors. Different factors can influence whether and when companies default. Kemp and Patel (2011) point out that "how firmly the trustees seek to protect the scheme's beneficiaries against sponsor default may influence the probability of default and the loss the beneficiaries might suffer".

## **MARKET RISK**

Market risk can be defined as the risk of loss because of unfavourable market movements. The focus is usually on the effects that market conditions can generate on the situation of a pension fund. For this reason it can belong to the category of the asset-liability risks. It can bring to variable losses resulting "from fluctuations in equity and commodity prices, interest and foreign exchange rates" (Sugita, 2009). The amount of portfolio that is invested in equity, therefore, depends on the risk of negative variations of prices and it may vary from the estimate.

Retirement schemes often issue liabilities with a shorter maturity than investments in loans or bonds. The result is a mismatch "between maturities of assets and liabilities, which implies interest rate risk-taking" (Resti and Sironi, 2007). This is the risk that variations in interest rates (both on assets and liabilities) affect the performance and the value of a pension fund.

Another market risk for pension funds is currency risk (also called exchange-rate risk), that is present when investments are made in other currencies different from the one used for computing the value of assets and liabilities. "It is a typical risk for large pension funds who usually invest their assets in international diversified portfolios" (Gallo, 2009).

Finally inflation risk refers to the grade to which the financial situation of the fund depends on inflation. An increase in this variable might bring to more benefit payments and to larger values of liabilities. As pointed out by Gallo (2009) "active participants, deferred members and retired people are concerned about the risks with respect to indexing, because they benefit from indexation pension rights".

## **LONGEVITY RISK**

A peculiar risk of pension systems is the longevity risk, i.e. the risk that people will live for a longer period than that forecasted by the annuity provider, mainly because of medical improvements or declining diseases. This is a challenge worldwide, mainly because of a significant increase of life expectancy after the retirement (Jones, 2013). In other words, this risk can derive by the fact "that future mortality and life expectancy outcomes turn out different than expected" (Antolin, 2007).

Stern (2016) reports that in the world "life expectancy at birth has more than doubled" since 1800s' and for people of 65 years it increased almost two months per year in last ten years. "For each additional year of life expectancy not assumed it can be expected to add 3% - 5% to current liabilities". The future trends of mortality and life expectancy is very uncertain and two opposite views are followed: first of all some people state that life expectancy has no limits. They assume "mortality is likely to level off after some threshold and longevity would keep increasing in the next decades" (Antolin, 2007). On the opposite other people believe that there are natural limits to the length of lives and

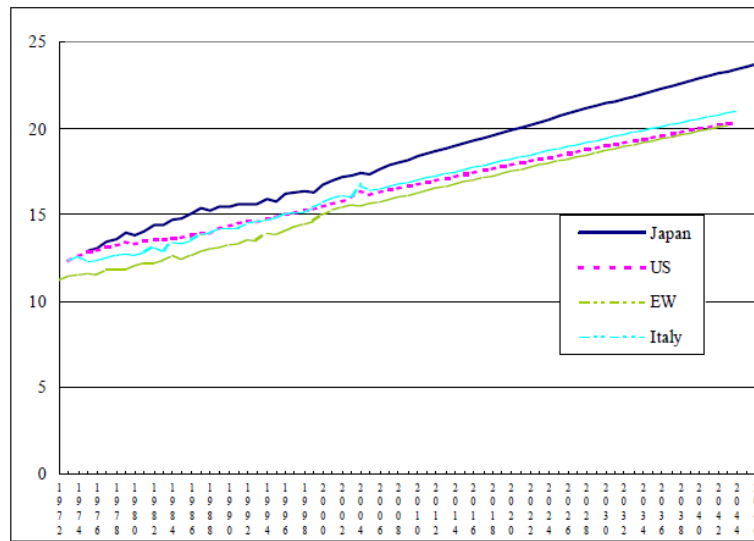
they point out that "the increase in life expectancy will slow down" or even stop (Antolin, 2007).

Only defined-benefits funds, which guarantee lump sums and annuities, face longevity risk. On the opposite a defined-contribution fund does not offer payments after people retired, and "the policyholder holds the risk of living longer, although it may be insured where the DC saver annuitizes" (Duijm, 2015).

Longevity risk is divided into two parts: idiosyncratic or specific risk and aggregate risk (Favero, 2012). The first one, that is based on an individual level and depends on the working category (for example workers in mines or in chemical factories differ from people working in the service industry), may be reduced by increasing and diversifying the "clients" of retirement schemes. The other element, instead, can't be eliminated through diversification due to uncertain future trends about mortality rates. Therefore, predicting mortality rates become very difficult because of their volatility and fluctuations, but it is still necessary for pricing the risk and evaluate pension liabilities (Nakagome and Kawaguchi, 2008).

Longevity risk is a very important and sensitive issue not only for pension funds, but it also affects governments, that need to maintain promises to retired people with public pensions, but have too less contributions from citizens. Moreover, Jones (2013) mentions that it affects "corporate sponsors, that fund retirement obligations to former employees accrued over many years". The consequence is that people will reduce their confidence towards the governmental system and sponsoring companies for the funding of their pensions (Jones, 2013).

Figure 1: The extension of the average life expectancy at age 65 (The data until 2005 are based on the actual mortality rates. The data after 2006 are based on the forecasts using the Lee-carter model. )



Source: Nakagome and Kawaguchi (2009). The Longevity Risk Associated with the Pension Liability.  
[http://www.afir2008.it/Download/Papers/AFIR2008\\_Paper\\_Nobuyuki\\_Nakagome](http://www.afir2008.it/Download/Papers/AFIR2008_Paper_Nobuyuki_Nakagome)

## OPERATIONAL RISK

This risk is associated to losses that result from "inadequacies or failures in internal processes, human performance and systems, or from external events" (Basel committee on banking supervision, 2011). Causes of this risk can be administrative or IT mistakes, "internal or external fraud, employment practices [...], damage to physical assets, business disruption and system failure or process management" (Stewart, 2010). Operational risk, differently from previous risks, is involuntary, and it is always present when the fund conducts some operating activities. It also differs since there are no tools to hedge against it. Another important fact is that operational risk is a pure risk, and not a speculative one. This means that this risk can cause only negative results and losses and it can't guarantee profits (Resti and Sironi, 2007).

The types of operational risk faced by pension funds are usually different from those faced by the sponsor. Pension funds themselves do not have to worry about the security of raw materials' supply. The management of some operational risks can be outsourced to other regulated entities, such as member record keepings or office services. However they should consider the presence of "contractual and service level agreements" that define what they can outsource and what they can obtain from external parties (Kemp

and Patel, 2011). The parts might be even closely allied, as in the case where pension funds received services from their sponsors.

Pension schemes should be very careful in receiving services from the sponsors and they should consider some potential problems. Kemp and Patel (2011) mention that for some unfavourable reasons the sponsor can disappear overnight or it cannot be able to give support to the fund as in the past (for instance "its computer system falls over when a payroll transfer to the scheme occurs"). Is the pension fund still able to collect data itself and continue its operations?

In a broader definition operational risk might also include not only HR risk, but also legal, reputational and strategic risks.

### **Employment/Human Resources Risk**

In the past pension funds mitigated human resources risk because they recruited and retained workers. They were a solution against the diminishment of workers during the crisis period, when operating activities slowed down. "Employers were able to offer enhanced early retirement benefits to those who were being made redundant", in case of presence of the minimum required conditions for anticipated retirement (Kemp and Patel, 2011).

Nowadays the trend in all developed countries is toward the increase of the state retirement age that is applied to social security arrangements. In fact since life expectancy is increasing, it is necessary to rise participation rates also for older people. It has, therefore, become very complex to retire older workers that have a lower performance than younger ones, especially if these people have not the requisites. Kemp and Patel (2011) believe that "sponsors may still be able to offer enhanced pension benefits to facilitate such retirements, even though the costs to maintain a similar take-up rate may increase".

This type of risk is very subjective to each single country and it is evolving since social norms are changing. Generally, in paternalistic cultures this problem directly falls on employers that need to sort out it on their own, while in other societies states are directly involved (Kemp and Patel, 2011).

## **Reputational Risk**

It is the risk of losing reputation, image or credibility due to different factors happened internally or externally (Basel committee on banking supervision, 2009). It affects negatively the public opinion and the confidence of stakeholders, and it causes losses in investment opportunities. This is usually linked with other risks. For instance a pension fund, that invests in areas with unstable political situations, faces not only political risk, but also reputational risk. Clients can decide to blacklist the plan and this can have serious effects on its profitability.

Differently from traditional businesses, defined-benefit pension schemes usually aren't greatly exposed to this type of risk. Kemp and Patel (2011) state that their "beneficiaries will normally have little practical scope to utilise the profit motive to penalise poor service". Moreover they add that shifting to another retirement scheme can be not the best solution, since it can even bring to more favourable conditions for the fund's finances. Reputational risk can affect also managers and trustees of the pension fund if they are considered to have provided an insufficient service to members: this is a very sensitive issue for the sponsoring company, in case it wants to give a positive image of itself to its employees and members.

Finally defined-contribution occupational pension schemes are more exposed to reputational risk than defined-benefits funds. Kemp and Patel (2011) point out that in UK for example "beneficiaries of collective DC schemes may be more able to vote with their feet and if enough of them do so it may damage the arrangement's ongoing viability".

## **Strategic Risk**

It comprises the risks faced by a pension fund that follows inadequate "strategic or business plans, resource allocation or other strategic business decisions" (Sugita, 2009). It can arise because of the lack of responsiveness to variations in the operating environment, too.

Strategic risks are "related to demographics, competition, technology, reinsurance [...], and political stability" (IOPS, 2012). They comprehend missing the opportunity to be in



the right market before competitors, but also dealing with a strong competition or being in an environment that changes continuously (including taxes and regulations). Unexpected results might of course be favourable for pension schemes: for this reason, as stated by Kemp and Patel (2011) "one of the 'arts' of strategic management is spotting emerging trends before the competition and positioning the business and its trajectory accordingly".

However, pension schemes don't have the possibility to choose among several strategic decisions, because they are created for specific outcomes, i.e. for providing future benefits to their members. The use of the word 'strategy' is appropriate if linked to retirement schemes governance. The areas of intervention of trustees, that manage the assets of the pension fund, are limited and the main real strategic manoeuvre can be "to trigger a wind-up of the pension scheme" (Kemp and Patel, 2011); but also for this decision the beneficiaries should approve. On the opposite the sponsoring company has the possibility to choose among more strategies: for example it can "close the scheme or alter the benefit accrual structure, either to new entrants or to existing members" (Kemp and Patel, 2011). It can also "set up new pension schemes (or new remuneration structures)" and even merge different retirement funds that it owns.

### **Project Risk**

It might be classified among the category of operational risks and its relevance depends primarily on the size of specific projects carried out by the pension fund.

There are a lot of cases where project risk is present and large scale transfer of assets and liabilities to a third party must be managed correctly. For instance, the fund may desire to move the entire administration of members to a new provider. Or it would like to start an exchange programme where members can swap part of the benefits to a different scheme: this might involve a transfer from a DB scheme to a fund with greater extent of risk sharing. In this case project managers should consider both the different aims and risk profiles of all stakeholders, the sponsoring company and members (Kemp and Patel, 2011). During the implementation of projects, they should also try to minimize the probability that exchange programmes don't reduce the risks the fund or the sponsoring company aimed to diminish or cancel.

The aim of managing this type of risk is to complete large IT and infrastructure projects effectively, in a proper time and using optimal costs. Project managers not only should verify that "project objectives are compatible with the overall aims" of the fund or the sponsor (Kemp and Patel, 2011), but they should also monitor that they don't generate extra risks.

### **Accounting Risk**

It can be described "as the risk that an adverse accounting outcome is shown either in the balance sheet or in the P&L account" of the pension fund or the sponsoring company (Kemp and Patel, 2011). Possible reasons of this risk can be erroneous valuations of assets (for example intangible assets) or liabilities, that bring to an unreal situation and to possible wrong decisions.

The problem arises also in situations where underlying economic reality and data reported on financial statements differ. In these cases it will be unclear how to identify the underlying position and which data to consider.

### **POLITICAL RISK**

According to Sugita (2009), it is the risk due to unpredicted political situations that can influence negatively occupational schemes.

Political risk can arise because strong relationships with political parties and local governments may become weaker in the future; the tax system in which pension schemes operate can change; and "previously discretionary benefits or those dependent on best endeavours might become more guaranteed" (Kemp and Patel, 2011).

This risk usually increases with the presence of other risks: for instance, if a government defaults there will be relevant economic and socio-political consequences in the nation, and uncertainty will influence the performance of pension funds (Kemp and Patel, 2011). Nowadays sovereign risk is a critical topic in Mediterranean countries, such as Greece or Italy, and there are lots of considerable uncertainties related to the future of retirement systems.

## **Legal Risk**

Legal and regulatory risks can be considered as subcategories of political risk. The International Organization of Pension Supervisors measures them looking at how likely are unfavourable consequences due to the failed tentative to follow the most important laws and regulations. They include future uncertainties about variations "in legislation and risks of complying with inappropriate or unclear regulation" (IOPS, 2012).

Kemp and Patel (2011) point out that legal risk is present when operations don't follow the law, with reference "to external legal frameworks within which the entity operates or legal documents governing the specific behaviour of the entity".

For instance, if the scheme follows a Trust Deed, its members may lack to follow its contractual clauses, or they may not understand them. The terms can be ignored by legislation, too. Even though a scheme adopts all the legal conditions required, it may happen that some legal actions claim it has not. Therefore, the category of legal risk would normally include unexpected costs for not following those claims and for managing the time incurred in solving this problem (Kemp and Patel, 2011). In addition, legal risk might be related to unclear legislation, which can produce unexpected outcomes for the scheme.

A particular type of legal risk faced by pension funds is related to employment law. If beneficiaries of these schemes are employees of the sponsoring company, "what the sponsoring company can do for the scheme can be constrained by employment laws" (Kemp and Patel, 2011).

## **Regulatory Risk**

Sugita (2009) defines it as the risk of losses because pension managers don't follow current regulations and industry practices. Moreover, Kemp and Patel (2011) refer to it as the possibility that general regulatory frameworks applied to pension schemes may vary in a negative way, or the relationships with legislators change.

The change of regulations may influence the scheme transfer values. This will have a negative impact for the aggregate pension fund, its members and the sponsoring

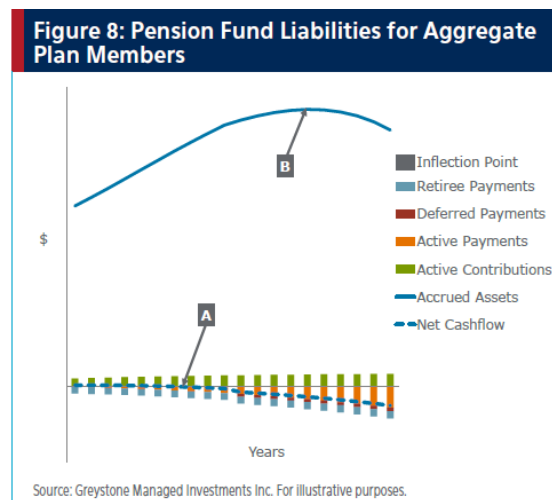
company. For retirement schemes it might be related both to the current benefit payments and to their funding. There is the possibility that in the next years all European pension funds will become subject to Solvency II, that has already been applied to all EU insurance companies. In case the pension fund does not consider relevant to operate according to Solvency II, since it is not yet applied and it "has adopted funding approaches or investment strategies that do not sit well in such a regulatory framework, then it may be ill positioned to cope with such a shift if it occurs" (Kemp and Patel, 2011).

In recent years there has been a great debate among EU governments and institutions about the mandatory adoption of Solvency II and common capital requirements, for all pension funds. Initially the European Commission proposed to include retirement schemes under the Solvency II framework, but it found the strong opposition of the key pension industry players. These actors were worried that the new regulatory framework would have damaged benefits of pensioners and forced the worst-affected funds to close down (Maassen, 2008). Maassen focuses on the differences between pension funds and insurance companies: the former are more flexible than the latter, not only in terms of contributions, but also time horizon, and the pension premise varies on the strength of the sponsor. Later in 2010 there were again some discussions about regulatory framework during the consultations for the Green Paper on pensions (financed by the European Commission) and the conclusion was that the second and third pillar of Solvency II could actually be used for risk management also in other financial intermediaries. There were no responses that suggested "that the qualitative requirements of Solvency II would be unsuitable for pension funds" (EIOPA, 2012). Finally, in April 2016 EIOPA published a document called "Opinion to EU Institutions on a Common Framework for Risk Assessment and Transparency for IORPs", where it was suggested as an additional method for managing pension funds to adopt a common method to evaluate risks and communicate them to supervision authorities. However, this was not mandatory and the opinion didn't aim at introducing a new solvency requirement for retirement schemes (COVIP, 2015).

## LIQUIDITY RISK

Kemp and Patel (2011) define liquidity risk as “the risk that an entity cannot generate sufficient cash to meet its payment obligations”, or it is able to fulfil its payments only at unfavourable conditions. It refers also to the case in which the fund is not able “to support investment opportunities in a timely and cost-effective manner” (Sugita, 2009).

Liquidity risk is usually not very significant for a pension scheme. However, it has two critic points to consider (as shown in the graph below): “the inflection point (A) shows that net cash flows stop to be positive and payments of benefits start to go beyond contributions”. After this moment, the fund’s assets diminish their growth significantly. The other critical point (B) shows that payments of benefits become bigger than contributions and earnings from investments. In this case the asset value of the scheme start to reduce (Greystone Managed Investments Inc., 2015). After this cut-off, the scheme needs a very high liquidity.



Source: Greystone Managed Investments Inc. (2015). Managing liquidity risk for institutional investors.

According to some scholars, pension funds are often thought as providers of liquidity to other financial institutions, such as banks, that are more exposed to this risk. They obtain a premium for ‘renting out’ their balance sheet to external subjects (Kemp and Patel, 2011). This interpretation assumes that there are only a few cases where liquidity is relevant for pension funds, and they usually don't have to “sell or buy large parts of their assets or liabilities involuntarily”. This is not always the case: according to Dupont

et al. (2010) the retirement scheme is always in a risky positions because it should be able at any time to provide liquidity and satisfy unforeseen cash needs. Regulatory capital directives give indications on how to compute the capital required for avoiding distress. The stress can impose to the fund "to buy out liabilities or to transfer them to industry-wide protection arrangements" at any time, even when these operations follow different conditions from the investment contracts signed before the distress (Kemp and Patel, 2011).

Furthermore, liquidity risk is associated with the sponsor and its payment commitments: it needs to have the necessary liquidity to meet its obligations. In difficult situations one possible solution for trustees is to try to modify the schedule fixed for contribution, and look for "more money more quickly to provide protection against a weakening sponsor covenant" (Kemp and Patel, 2011).

### **3.1. TOOLS FOR MANAGING RISKS**

#### **CREDIT RISK**

Pension funds can adopt different tools in order to manage credit risk. The equation below expresses the most common method used to describe credit risk exposure, at least for the expected loss (Resti and Sironi, 2007):

$$\text{Expected Loss (EL)} = \text{Exposure at default (EAD)} \times \text{Probability of Default (PD)} \times \text{Loss Given Default (LGD)}$$

Where:

EAD = it represents to which extent the fund is exposed to default, including the possibility of changes in the loan's size;

PD = "probability that the borrower will default";

LGD = "percentage of exposure which the pension fund believes not to be able to recover", after collaterals and guarantees.

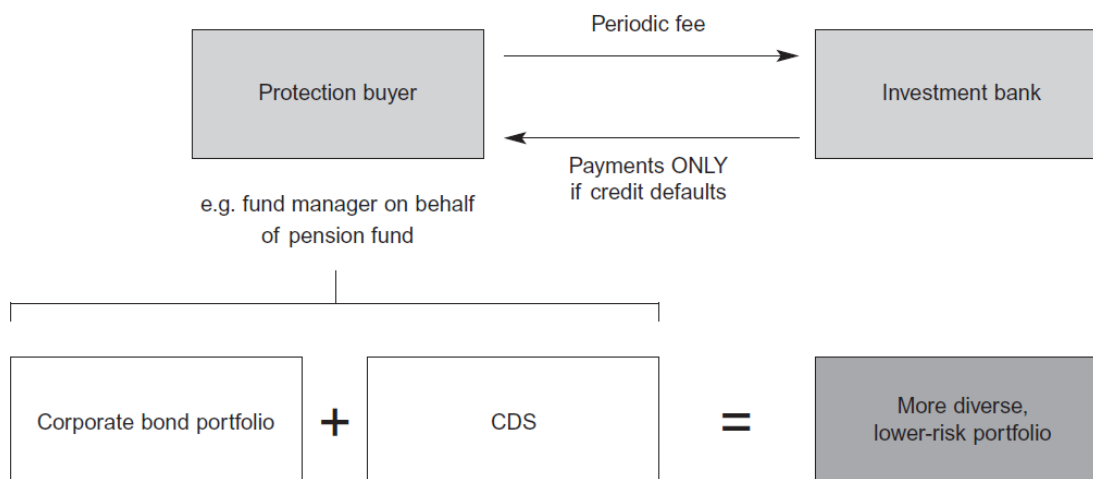
Pension funds may estimate ex ante this value and, therefore, protect against this risk before it happened; nevertheless, when considering the real credit risk, another variable

should be taken into consideration, the unexpected loss, that can be hedged with an effective portfolio diversification (not only across different countries, but also sectors).

Pension funds can use credit ratings issued by international credit rating agencies (Moody's, Standard & Poor's or FitchRatings) for evaluating the issuers of bonds contained in their balance sheets. As stated by Resti and Sironi (2007) these are some external "concise evaluations of the creditworthiness" of their counterparties.

Other tools used for hedging and transferring credit risk from pension funds to other financial intermediaries are credit derivatives (the use of derivatives by pension funds gradually increase in the last years). In a credit derivative there is no a real underlying asset (a stock or a bond), but a reference entity, that is a party, such as a "company or a sovereign state, involved in a loan for which the credit risk is being transferred using the derivative contract" (Resti and Sironi, 2007).

The most common and used credit derivative in the retirement industry is credit default swap (CDS). Thanks to this type of contract, pension funds can transfer credit risk to other parties. As shown in the graph below, a fund manager (protection buyer) pays regularly a premium to the counterparty (protection seller) in order "to protect its portfolio from a specific company defaulting on its bond payments". Pension funds obtain the opportunity "to sell bonds issued by the company in case the credit event occurs and the other party agrees to buy them at the total face value (notional principal)" (Hull, 2013). If the company defaults, the counterparty, that is now bearing the all credit risk, is obliged to make the payment agreed in the contract (National Association of Pension Funds, 2005).

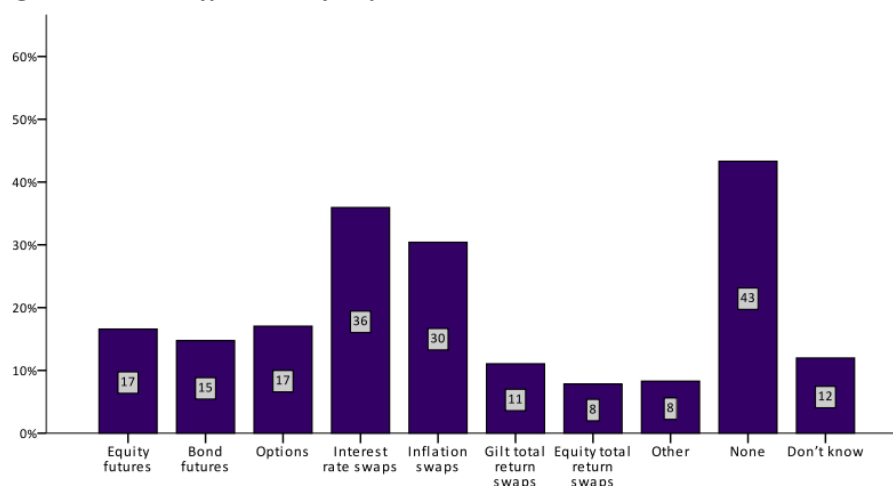


Source: NATIONAL ASSOCIATION OF PENSION FUNDS (2005). Fixed-income derivatives made simple. <https://www.actuaries.org.uk/documents/fixed-income-derivatives-made-simple-what-trustee-needs-know>

## MARKET RISK

Financial derivatives may be used by pension funds for hedging market risks. The most common ones (as shown in the graph for UK, but also for other OECD countries) in the balance sheets of retirement schemes, are interest rate swaps and inflation swaps. The "use of derivatives allows asset managers to change asset allocations more cheaply and rapidly than by selling or buying a large volume of assets" (David, 2000).

Figure 1: Derivative types in use by UK pension schemes

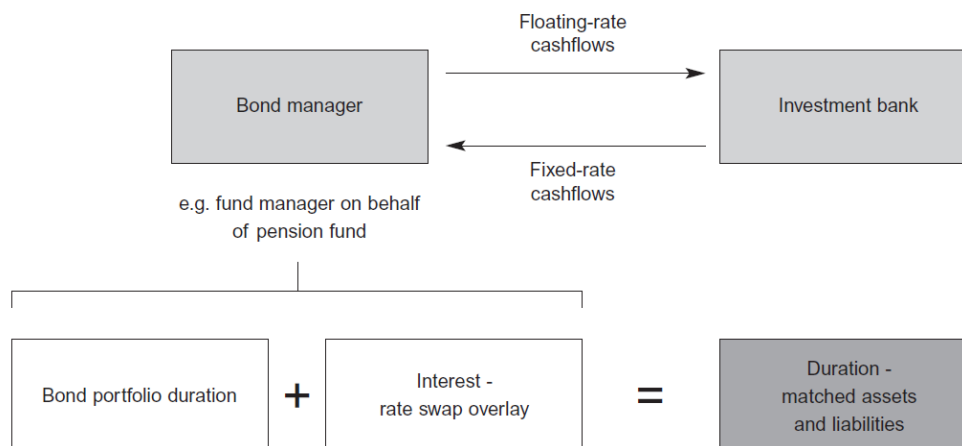


Base: 191 respondents

Source: NATIONAL ASSOCIATION OF PENSION FUNDS (2003). Margin requirements for non-centrally cleared derivatives: a response by the National Association of Pension Funds. <https://www.bis.org/publ/bcbs242/naopf.pdf>



Interest-rate swaps (IRS) are contracts where "two parties agree to trade, periodically, two flows of payments computed by applying two different rates to the same notional capital". The most common are plain vanilla swaps. A party decides to make payments at a fixed rate over a fixed period, while it receives payments at a floating rate always for the same amount of time (Hull, 2013).

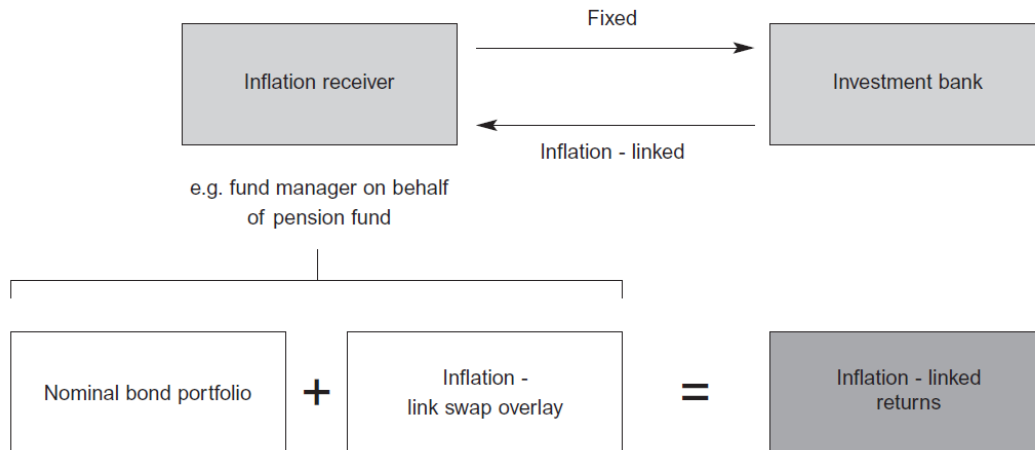


Source: NATIONAL ASSOCIATION OF PENSION FUNDS (2005). Fixed-income derivatives made simple.  
<https://www.actuaries.org.uk/documents/fixed-income-derivatives-made-simple-what-trustee-needs-know>

In addition another type of interest-rate swaps are basis swaps, where the two opposite cash-flows are uncertain, not fixed in the contract and vary according to two different benchmark rates (Resti and Sironi, 2007). Fund managers may use these tools for matching the duration of portfolio's assets with that of the corresponding liabilities. "This insures against the possibility that future interest-rate changes will create a mismatch in the values of the assets and the liabilities" (National Association of Pension Funds, 2005).

A pension fund may aim at gaining "more inflation exposure as their liabilities are dominated by inflation sensitivity" (BlackRock, 2015). With the use of inflation swaps, a pension fund exchanges with a counterparty, usually an investment bank, fixed amounts for uncertain variable cash-flows (linked to inflation). First of all, fund managers purchase a well-diversified portfolio of traditional bonds, including also non sovereign ones. Then "it swaps the cash-flows generated by this portfolio (including

future coupon and principal payments) for counterparty's inflation-linked cash-flows" (National Association of Pension Funds, 2005).



Source: NATIONAL ASSOCIATION OF PENSION FUNDS (2005). Fixed-income derivatives made simple. <https://www.actuaries.org.uk/documents/fixed-income-derivatives-made-simple-what-trustee-needs-know>

Asset-Liability-Management (ALM) strategies are another solution used by defined-benefit retirement schemes to manage risks. "ALM should help a pension fund to find acceptable policies that guarantee the solvency of the fund and all the promised payments" (Gallo, 2009). The largest pension plans in Netherlands and Germany adopt these tools for obtaining "the key pension variables such as the rate of contribution for employers and employees or the annual increases in pension benefits" (Franzen, 2010). ALM tools are expensive, in particular because they are developed by external professionals with a great reputation.

The simpler and more conventional ALM strategy is the "immunisation" (called also duration matching), while another innovative technique is called "Liability-Driven-Investment (LDI)" (Gallo, 2009).

First of all, the duration matching is the process that aims at reducing the interest rate risk by constructing a portfolio in which durations of future liabilities match the durations of future assets. The portfolio (composed mostly by bonds, but also interest-rate swaps and other financial instruments) is hedged against interest-rate movements,

not only because its present value is the same of the PV of liabilities, but also because the duration of its assets equals that of the liabilities (Gallo, 2009).

Furthermore, the another investment strategy, called liability-Driven-Investment (LDI), is a new innovative form of ALM. It considers classical assets as illiquid and weak short-term hedges for liabilities: the consequence is that "the asset portfolio can be volatile and unpredictable compared to the liabilities dynamics" (Gallo, 2009). This technique is mainly driven by liabilities, that are considered the benchmark for the asset allocation, and it aims at securing the predicted liability cash-flow at the lowest cost. This strategy implements "a customised liability-hedging portfolio in order to immunize the impact of unexpected changes in risk factors affecting liability values". Finally, it match the features and behaviours of the liabilities and it reduces interest-rate risk. (Franzen, 2010).

## **LONGEVITY RISK**

A possible way to hedge longevity risk is to transfer it to third parties (Stern, 2016). "Insurers are buyers of pension buy-ins, buy-outs, and longevity swaps, whereas reinsurers and investment banks typically buy only longevity swaps" (De Nederlandsche Bank, 2015). Longevity bonds, instead, may be sold to single investors in the market.

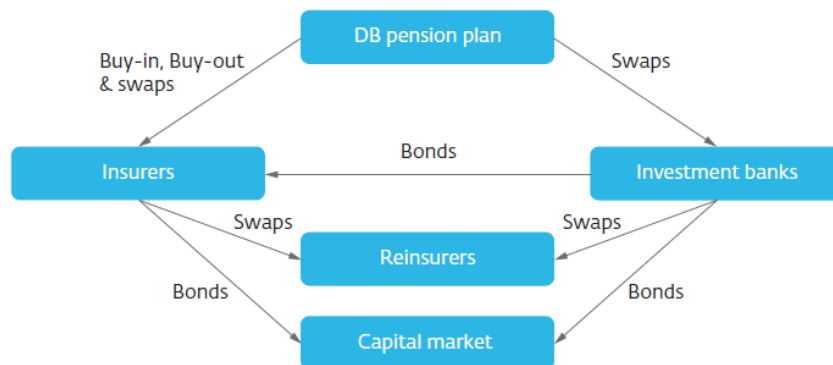
There are four different types of operations that can be chosen by pension funds for transferring longevity risk:

1. Buy-out transactions: they involve the transfer of retirement schemes' assets and liabilities to a protection seller, such as a regulated life insurer, in exchange for an upfront payment (Bertocchi et al., 2010). The insurance company is completely exposed to longevity risk, even though it has the possibility to manage independently the underlying assets. Moreover, it "is also responsible for the pension payment to individual members" (De Nederlandsche Bank, 2015).
2. Buy-in transactions: the retirement scheme, differently from the previous operation, maintains the legal obligation to pay the benefits to the beneficiaries,

but it "transfers the assets to the insurers in return for periodic payments, that match the pension payments" (De Nederlandsche Bank, 2015).

3. Longevity swaps: the pension fund, that buys protection against the increase in life expectancy of its beneficiaries, "pays an agreed periodic premium based on mortality assumptions to the other counterparty", usually a reinsurer (De Nederlandsche Bank, 2015). In exchange, the latter undertakes to pay a variable premium to the former, that increases "if life expectancy is higher than what predicted (OECD, 2008).
4. Longevity bonds: in the first type, called principal-at-risk, investors may lose the entire principal or part of it in case a specific mortality event happens. In the other type of longevity bond, called coupon-longevity bond, the coupon-payment depends on the mortality. Blake et al. (2006) state that "the investor loses some or all of the coupon if the mortality index crosses some threshold", while he receives higher coupons if survival rate is high. However, longevity bonds are still not widely available in the market, since "there are only a few potential investors in longevity risk" (De Nederlandsche Bank, 2015).

Figure 1 overview of LRT activities



Source: Joint Forum report, December 2013.

Source: DUIJ (2015). Longevity Risk Transfer activities by European insurers and pension funds (No. 1305). Netherlands Central Bank, Research Department.

In conclusion, longevity can become a source for diversifying the portfolio, especially in a long period, and a private investor might have benefits from the purchase of

longevity bonds (Favero, 2012). According to some studies, "including a longevity-linked security helps diversification of a portfolio of equity and bonds, and this effect varies with the investment horizon" (Bisetti and Favero, 2014).

## **LEGAL AND REGULATORY RISK**

In order to minimize political risk in pension funds, the European Insurance and Occupational Pensions Authority suggests the introduction of "a EU framework for risk assessment and transparency, that uses common valuation rules and a standardised risk assessment". EIOPA's suggestions aim at protecting members and beneficiaries and at distributing equally the shortages among generations. Moreover, the disclosure of significant information for enhancing transparency will open a discussion "on the long-term sustainability of occupational pension promises and encourage timely adjustments" (EIOPA, 2017; from annual report 2016).

The current debate focuses not only on the adoption of Solvency II and mandatory capital requirements for all EU pension funds (see the discussion in the previous section), but also on the introduction of a new type of individual pension products, called PEPP (Pan-European Personal Pensions). According to the COVIP's annual relation in 2015, the typical structure of PEPP should comprehend:

- an investment option, given by default and based on a life-cycle setting (the percentage of investments diminish gradually until the retirement age); in this case PEPP can be distributed without special channels and also using web-sites.
- a limited number of other optional investments opportunity.
- highly standardized information for members, in order to let them compare and evaluate different retirement alternatives.
- flexibility for the retirement age in different EU countries, and the application of an favourable tax treatment to PEPP, compares to other national pension products already in the market.

Finally this proposal should help EU countries where occupational schemes are not very common among the population, and individual pension products are still characterised by high costs (COVIP, 2015).

## **STRESS-TESTS**

An individual paragraph is dedicated to stress-tests, since these tools are adopted as a transversal solution for managing and reducing several risks faced by pension funds. They are particularly useful for evaluating negative consequences due to market movements (for instance because of the volatility of interest-rate or inflation), but also longevity risk (unpredicted increases in life expectancy).

In 2015 the first European-wide "stress test exercise of Institutions for Occupational Retirement Provisions (IORPs)" were conducted. They included as participants 140 defined-benefit schemes and 64 defined-contribution plans, from 17 EU countries. As stated by the annual relation of COVIP (2015), it covered approximately the 47% of the total assets of DB schemes in Europe, and the 55% of DC plans.

The stress tests analysed how different severe market scenarios impacted "on retirement income and replacement rates of three representative plan members with respectively 35, 20 and 5 years to go before retirement" (EIOPA, May 2017). The stress-tests aimed to test the resilience of pension plans to unfavourable market movements and increases in longevity, and to identify their risks and vulnerabilities, that require proper attention not only from pension funds, but also from supervisors. The overall objective was to provide useful recommendations for creating safer and more sustainable pensions.

The results of the stress-tests were very heterogeneous in each country; nevertheless they showed "a significant increase in the deficits of assets over liabilities" (EIOPA, Annual Report 2015). The ratio between assets and liabilities of DB pension funds was 95 % and this deficit was mainly due to English and Dutch retirement schemes, that represented the majority, even though the plans in other countries, such as Italy, were in equilibrium (COVIP, 2015). The final suggestion was to have more capital in the balance sheet in order to cover unexpected losses.

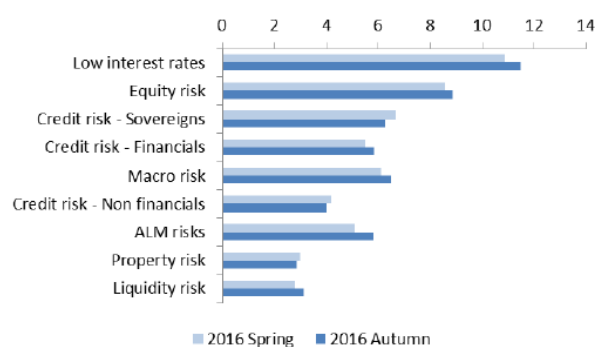
In 2017 EIOPA decides to conduct additional stress-tests on retirement plans. The main objective is to deepen the analysis of risks and vulnerabilities of pension funds, and understand better "the second-round effects on financial stability and the real economy". The application of different stress-tests is needed to comprehend deeper how prudential rules deal with macroeconomic shocks in different nations and the effects of "the additional pressure put on sponsors to increase their payments to secure benefits" (EIOPA, May 2017).

## 4. AN OVERVIEW OF RISKS IN EUROPEAN PENSION FUNDS

The EIOPA stress-test, conducted in 2015, analysed the risks and vulnerabilities of European occupational pensions. The aggregate results pointed out significant shortfalls before and after the stress-tests, if both assets and liabilities of defined-benefit pension funds are considered (EIOPA, 2017). These studies suggest to cover the shortfalls with the support of sponsors and with benefit reductions, or with "future investment returns in excess of the risk-free interest rate". Moreover, the outcomes of the DC sector showed that older members of the schemes, which are closer to retirement, are "relatively more vulnerable to an instantaneous fall in asset prices", whereas young defined-contribution beneficiaries are greatly affected by low interest rates (EIOPA, IORP Stress Test specifications, 2017).

Based on these outcomes, EIOPA started to conduct regularly "bottom-up surveys among national supervisors to rank and monitor the key risks to financial stability for the retirement industry" (EIOPA, Financial Stability Report 2016).

*Figure 5.2: Risk assessment for the pension funds sector*



Note: Risks are ranked according to probability of materialisation (from 1 indicating low probability to 4 indicating high probability) and the impact (1 indicating low impact and 4 indicating high impact). The figure shows the aggregation (i.e. probability times impact) of the average scores assigned to each risk.

Source: EIOPA, Financial Stability Report, June 2017





Source: EIOPA, Financial Stability Report, December 2016

Low interest rates have been ranked as the highest risk "in terms of probability of materialisation and in terms of impact" (the results in the figure above show the probability times the impact). Interest rates decreased significantly during the last years. Defined-benefit schemes, that represent more or less the "75% of the sector in terms of assets", are influenced by the variations in interest rates; the problem is that they promised determined levels of pension to retired employees, and they have to honour the fixed benefits, despite the future market conditions (that can become adverse for pension funds). Furthermore, they are characterised by a large "degree of risk-sharing between employers, current and future plan members" (EIOPA, Financial Stability Report, June 2017). Low interest rates influence the solvency conditions of pension funds, not only because the value of the claims to pay to beneficiaries increase, but also because new investments in bonds have a lower return (COVIP, 2015).

Also defined-contribution plans are influenced by low interest rates. Nevertheless, since they haven't a strict liability structure, they adjust instantly to macroeconomic variations. Low interest rates mean lower returns on investments and also unfavourable conditions for converting the capital accumulated into a yield: the benefits given to members can be lower than those expected (COVIP, 2015).

The contest of lower interest rates pushes pension funds to search for new types of investments, in order to maintain adequate benefits: this means searching for extra-yields and adopting a new organizational structure for managing portfolios with higher risk profiles (COVIP, 2015). Finally, considering the last survey conducted in 2016, "the future expected risk of a prolonged period of low interest rates remains very low" (EIOPA, Financial Stability Report, June 2017).

Other relevant risks for the retirement industry are equity risk and macro risk, that includes both legal and political risk. The trend of investing in equity is increasing, even though it is not very common in all pension funds and there isn't a clear sign of a radical investment shift (EIOPA, Financial stability report 2016). Macro risk is increasing, too, since the present macroeconomic scenario creates big issues for EU pension funds". For example, "the aggravation of the refugee crisis, or the sovereign debt problem of Greece and other peripheral countries" are geopolitical events that constitute significant challenges for EU retirement sector (EIOPA, 2016).

Additional risks faced by EU pension plans are liquidity risk, that has increased slightly since the beginning of 2016, and property risk, that will continue to grow in the next years (EIOPA, 2016). On the contrary, both ALM risk and credit risk for EU pension schemes tend to decrease on average in the period between 2016 and 2017.

On the basis of recent data collected by EIOPA, some trends may be highlighted in the European retirement industry:

1. The first tendency is a slight increase in investments in equity, in particular for defined-contribution plans. In countries that have adopted euro, a 2% increase is shown, especially because Netherlands are highly exposed to equity. However, because of the bigger size of the UK pension system, where this trend is not significant, the tendency cannot be observed in aggregate (EIOPA, Financial stability report 2016). "The increased investment in equity is driven by the ongoing low interest rate environment as well as by the positive market development in equity". Consequently, pension plans are more exposed to market risk (EIOPA, Financial Stability Report, June 2017). The UK is an exception, because pension plans are gradually increasing investments in fixed-income securities (especially sovereign bonds) in order to reduce the risks of their balance sheets. Pension funds still prefer to invest in sovereigns, financial bonds and different types of fixed instruments: 47 % of pension funds' assets was exposed to them in 2015, whereas the percentage of exposure to equity remained only 28 (EIOPA, 2016). However, fixed securities can hide some risks: for example, "many sovereigns have been downgraded so far in 2016, including the UK after the result of the referendum on the EU membership".

Figure 4.3: Investment Allocation for 2013 to 2015 (in per cent)

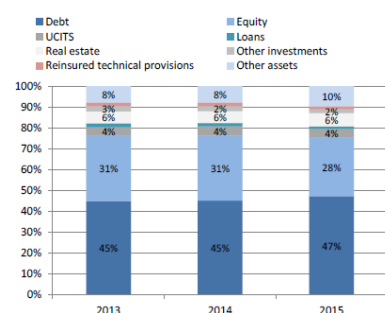
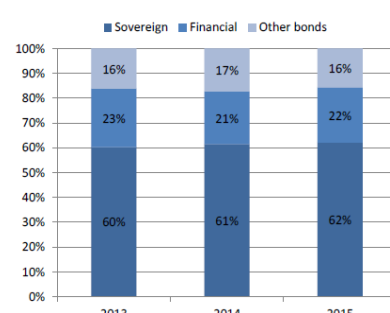


Figure 4.4: Bond investments breakdown for 2013 to 2015 (in per cent)



Source: EIOPA

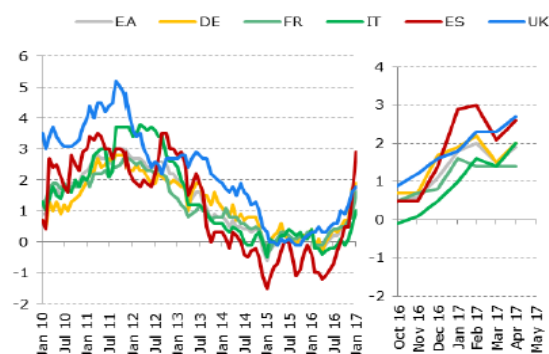
Note: UCITS stands for Undertakings for Collective Investment in Transferable Securities. For all variable definitions please refer to the statistical annex published at:

<https://eiopa.europa.eu/financial-stability-crisis-prevention/financial-stability/statistics>

Source: EIOPA, Financial Stability Report, December 2016

- The second trend shown by some sponsors is the "search for yield", and the shift to more "risky" and "higher yielding" investments, because of the low returns of bonds (EIOPA, 2016). Risks are quite high, even though recent data point out that inflation is increasing, and this is reflected in "higher short-term interest rates and in a slight upward shift of the yield curves". This phenomenon enhances the possibility that a recovery process for interest rates will start soon. Inflation in the Euro-area increased significantly since January 2015 when it reached its minimum level (see the graph above) (EIOPA, 2017).

Figure 1.3: Inflation: HICP - All-items excluding energy and food (annual rate of change in %)



Source: ECB and Eurostat; Last observation: 30/05/2017

Source: EIOPA, Financial Stability Report, June 2017

3. Due to low interest rates and increasing life expectancy, defined-benefit plans are struggling in order to obtain returns that are aligned "with those needed to fund the promised benefits". They are obliged to adjust either the contribution rate or the benefit level (EIOPA, IORPs Stress Test report, 2015). Sponsor companies have difficulties to continue facing relevant market and longevity risks associated to DB plans (COVIP, 2016). A gradual shift towards defined-contribution plans has been noticed worldwide: the main reason is that sponsors want to cut "the cost of providing pension benefits and the exposure to risks in general" (EIOPA, IORPs Stress Test report, 2015). The reform of DB funds typically include a revision of how to share risks among pension funds, sponsors and members; the risks associated to the accumulation and supply of benefits are taken in a large extent by members (COVIP, 2016).
4. In April 2016, EIOPA published the "Opinion to EU Institutions on a Common Framework for Risk Assessment and Transparency for IORPs". This document explains the need to introduce a common method for evaluating risks in EU pension funds and communicating to supervisory authorities. EIOPA underlines the importance of this tool as an additional way to manage risks in the retirement sector; in the beginning it will not be mandatory for all pension funds. The opinion does not want to introduce a new Solvency regime for pension funds, since IORPs directive is already under revision (COVIP, 2015).



## 5. EMPIRICAL ANALYSIS

This section presents an analysis of two different European pension funds: Unicredit Group's pension fund and the Norwegian Government Pension Fund-Global. First of all, the two funds are introduced and the main features are shown; then an analysis about the evolution of risk management in the two different funds has been conducted since 2006, so that the effects of the financial crisis are taken into consideration.

The first one is a closed plan, since only employees of Unicredit Group can participate, while the other is a open plan, and all Norwegian citizens can take part into this fund. As the picture below shows, the Norwegian plan has been ranked as the EU largest pension fund and the second in the world, considering the size of total assets, that are \$865.943 million (Willis Towers Watson, 2016). Unicredit pension fund, instead, is much lower and it overall administers "only" about 3.8 billion of euro. It has more than 50.000 members, among which about 41.000 are employees and 11.700 retirees (Fondo pensione Unicredit, 2017).

TOP 20 PENSION FUNDS			
Rank	Fund	Market	Total assets (in US\$ million)
1	Government Pension Investment	Japan	1.163.203
2	<b>Government Pension Fund- Global</b>	<b>Norway</b>	<b>865.943</b>
3	Federal Retirement Thrift	U.S.	443.328
4	National Pension	South Korea	435.405
5	ABP	Netherlands	384.271
6	National Social Security	China	294.939
7	California Public Employees	U.S.	285.774
8	Central Provident Fund	Singapore	211.373
9	Canada Pension	Canada	201.871
10	PFZW	Netherlands	186.471
11	California State Teachers	U.S.	181.875
12	Local Government Officials	Japan	176.160
13	Neew York State Common	U.S.	173.541
14	Employees Provident Fund	Malaysia	161.707
15	New York City Retirement	U.S.	155.120
16	Florida State Board	U.S.	147.819
17	Texas Teachers	U.S.	125.327
18	Ontario Teachers	Canada	123.985
19	ATP	Denmark	106.640
20	GEPF	South Africa	103.147
...	<b>Unicredit Group's Pension Fund</b>	<b>Italy</b>	<b>3.832</b>

Source: adaptation from Willis Towers Watson, 2016

Some scholars may criticise that the funds chosen are different for their characteristics, such as typology (open vs. closed), or participants (citizens vs. employees.). They may add that the plans operate in different countries, with different economic and political situations. These critics make sense; however, the decision to take into consideration those funds depended firstly on the information disclosed and freely accessible. Several Italian pension funds still lack a sufficient disclosure of risk management techniques. Secondly, the objective of this thesis is to analyse the European situation of the retirement industry, and not only the peculiarity of one single country.

Moving on to the history of Unicredit pension fund, a first retirement form, called "Cassa di previdenza", was created in 1905 in favour of the employees of "Credito Italiano". In 1949 it was renamed "Fondo di previdenza" and it was extended to all the others companies acquired by Unicredit Group in the following years. In 1998 a referendum, opened to all members, established the creation of a separate section for the new participants and the fund was finally called "Fondo pensione per il personale delle aziende del Gruppo UniCredito Italiano". In 1999 the fund was registered by the Italian authority for pension fund (COVIP) in the official list of Italian funds (D.lgs.124/93) and in 2009 it became legally an independent entity (Fondo pensione Unicredit, 2017).

The history of the Norwegian pension plan starts in 1960, when the government claimed the "sovereignty over the Norwegian continental shelf" and they conceived the idea of a national oil fund. In 1983 a report (NOU 1983:27), with the proposal to create a fund in which the government could "store the current temporary rush of oil revenue and spend only the real return", was submitted. In 1990 the parliament decided to create "the Government Petroleum Fund". The objective was to "transfer capital from the government's petroleum revenue to the fund" (Norges Bank Investment Management, 2017), and help the state management of it in a long-time horizon. In 1998 the "Norges Bank Investment Management (NBIM)" was set up in order to manage the fund for the Ministry of Finance, which "owns" the plan for the Norwegian people and he is the responsible for the investment strategies. Moreover, "NBIM manages the Government Petroleum Insurance Fund" (Norges Bank Investment Management, annual report 2006). In 2006 the Government Petroleum Fund was renamed "Government Pension Fund-Global", but it maintained the same functions and investment strategies. In

addition, the scheme is completely integrated in the state annual budget and the net allocations to the plan depend on the total budget surplus, that includes petroleum revenues (Norges Bank Investment Management, 2017).

Focusing on the investment strategies adopted by the two pension funds, Norges Bank Investment Management seeks to take advantage of the long-term investment horizon and the considerable size. The fund mainly aims at generating high returns and safeguarding savings of Norwegian "future generations, through active management and active ownership" (Norges Bank Investment Management, 2017). The assets are invested across more countries, since "the aim is to have diversified investments that bring a good spread of risk and the highest possible return". The plan must respect the constraints fixed by the Ministry of Finance, and the major changes require always the parliamentary approval, in order to prevent the pension fund from becoming a political instrument (Norges Bank Investment Management, 2017).

In order to describe the investment strategies of Unicredit pension fund, it is necessary to introduce its peculiar structure, with different sections for employees. The fund is divided into four sections:

- Section I (collective capitalization) is reserved for the employees of Credito Italiano that started their job before the 28 April 1993, or other workers hired until the 31 May 2007, that chose Section I and they were already enrolled in other complementary retirement schemes before the 28 April 1993. The benefits are computed according to the contributions paid (Fondo pensione Unicredit, 27 aprile 2017). This section presents only one segment, and the unique strategy adopted consists in maintaining a pre-determined return as a target (decided using calculations made by actuaries, and according to the most recent rules), that leads to a financial equilibrium of the section and it guarantees the payment of future benefits.
- Section II (individual capitalization) is opened to all Unicredit workers that started from the 28 April 1993 and they didn't have a previous pension fund, and to employees starting their job after 31 May 2007, or that, after this date, have transferred their position from other pension funds within Unicredit Group. The pension yield is computed on the basis of the accumulated capital through



contributions paid and their revenues. This section is divided into three segments, plus one insurance segment with guaranteed capital (D. Lgs. 252/05). The participant can choose among more investment lines, characterised by different risks and return profiles (Fondo pensione Unicredit, 27 aprile 2017). The three different segments (Comparto breve periodo - 3 anni, Comparto medio periodo - 10 anni, Comparto lungo periodo -15 anni) are diversified according to the risk profile, expressed in terms of volatility and return. These denominations should clarify the time-horizon required for each investment, and it should help participants to make the most appropriate decision according to their individual needs and the professional life. The less-risky type of investment is called "garantito", and it offers a return aligned to the indexing of TFR to beneficiaries. The other lines offers higher expected returns compared to TFR, but they face higher volatility (Fondo pensione Unicredit, 2017).

- Finally section III and section IV (both defined-benefit) manage respectively the benefits of the ex-"Fondo Cassa Bipop Carire" and the benefits of the ex-"Fondi Interni" (that don't have legal autonomy and board of directors), which are been included into Unicredit Spa balance sheet at the 31 of December 2016 (Fondo pensione Unicredit, 27 aprile 2017).

## **5.1. Evolution of risk management during the financial crisis**

### **2006**

- **The market situation**

In 2006 the global economy was characterised by a strong growth, driven especially by emerging markets, such as China and India, but also by Japan and the Euro Area. Nevertheless, from the second semester the situation changed: the housing market in US slowed down, as well as the growth rate. "The decline in interest rates was related to reduced inflation expectations and to the end of the monetary policy tightening cycle in the US" (NBIM's annual report 2006).

- **Government Pension Fund Global**

In 2006, before the global financial crisis started, the Government Pension Fund-Global adopted several tools in order to measure risks. For example, the annual report of 2006 contained a section dedicated to the analysis and management of different risks. It provided clear and accessible information about risks to all Norwegian participants (NBIM's annual report 2006).

Market risk was measured looking at "the composition of the benchmark portfolio, the share of equities [...], fluctuations in equity prices, exchange rates and the interest rate". Moreover, the fund chose to engage in active management, in order to obtain higher returns (but also higher costs). The fund's return was 7.9 percentage using the international currency" (5.9 % in NOK). As shown in the picture below, NBIM computed different values, for example the standard deviation of the return on the actual portfolio for absolute risk (NBIM's annual report 2006).

<b>Table 1-3: Return measured in NOK and risk as at 31.12.2006. Annualised</b>				
	2006	2004–2006	2002–2006	1998–2006
<b>Return/excess return*</b>				
Pension Fund	5.89	7.94	4.07	5.92
Benchmark portfolio	5.74	7.36	3.57	5.44
Excess return	0.15	0.58	0.50	0.48
<b>Investment portfolio</b>				
Benchmark portfolio	5.18	6.62	4.33	5.69
Benchmark portfolio	5.05	6.43	4.04	5.49
Excess return	0.13	0.19	0.29	0.20
<b>Insurance Fund</b>				
Benchmark portfolio	1.34	2.59	4.34	3.45
Benchmark portfolio	1.31	2.47	4.21	3.37
Excess return	0.03	0.13	0.13	0.08
<b>Standard deviation**</b>				
Pension Fund	8.95	8.37	9.29	8.52
Investment portfolio	8.98	8.07	8.06	7.15
Insurance Fund	8.15	7.31	7.23	6.52
<b>Tracking error***</b>				
Pension Fund	0.37	0.34	0.31	0.38
Investment portfolio	0.14	0.15	0.17	0.23
Insurance Fund	0.04	0.06	0.07	0.15
<b>Information ratio (IR)****</b>				
Pension Fund	0.39	1.60	1.58	1.22
Investment portfolio	0.85	1.15	1.65	0.82
Insurance Fund	0.64	1.98	1.79	0.50

\* Calculations of the returns on the actual and benchmark portfolios are based on monthly returns which are linked together using geometrical methods. The figures are percentages and have been annualised. The excess return is calculated using arithmetical methods.

\*\* The standard deviation is a measure of variations in the return/excess return during a period. Each monthly return/excess return is compared with the mean for the period. The higher the standard deviation, the greater the variations relative to the mean and the higher the risk.

\*\*\* Tracking error is explained in section 3.1.7

\*\*\*\* The IR is a measure of risk-adjusted return and is an indicator of skills in investment management. It is calculated as the ratio of excess return to the actual relative market risk to which the portfolio has been exposed. The IR indicates how much excess return is achieved for each unit of risk.

Source: NBIM's annual report, 2006

There was more awareness of risk management techniques in the Norwegian plan, compared to Unicredit Group's retirement scheme: since January 2002, after Enron's scandal, the Ministry of Finance issued some guidelines in order to manage effectively pension funds. In addition, he introduced a limit for the expected tracking error, defined as the "expected value of the standard deviation of the difference between the annual returns on the actual portfolio and the benchmark portfolio" (NBIM's annual report 2006). The value must not exceed 1.5 percentage points.

Table 3-16: The regulation's risk exposure limits						
Risk	Limits	Actual				
		31.12.05	31.03.06	30.06.06	30.09.06	31.12.06
<b>§ 5</b> Market risk	Maximum tracking error 1.5 percentage point	0.33	0.34	0.50	0.33	0.28
<b>§ 4</b> Asset mix	Fixed income instruments 50-70 %	58.4	59.1	59.8	59.8	59.3
	Equity instruments 30-50 %	41.6	40.9	40.5	40.2	40.7
<b>§ 4</b> Market distribution, equities*	Europe 40-60 %	47.3	48.5	49.0	49.1	50.1
	Americas and Africa 25-45 %			36.1	35.5	34.4
	Asia and Oceania 5-25 %			14.9	15.4	15.5
	Americas, Africa, Asia and Oceania 40-60 %	52.7	51.5			
Currency distribution fixed income instruments*	Europe 50-70 %	55.1	55.5	60.8	59.8	60.4
	Americas and Africa 25-45 %	34.8	34.2	32.6	34.7	34.3
	Asia and Oceania 0-15 %	10.1	10.4	6.6	5.5	5.3
<b>§ 6</b> Ownership interest	Maximum 5% of a company	2.7	3.9	4.7	4.5	4.5

\* The Ministry of Finance changed the regional weights in 2006 (cf. section 3.11.1)

Source: NBIM's annual report, 2006

In order to protect against credit risk, the regulation of the Government Pension Fund-Global suggested to include some countries and currencies in the fund's benchmark portfolio. "Up to 0.5 % of the market value of the fixed income portfolio may be invested in government bonds with ratings equal or less than BB or Ba" (NBIM's annual report 2006). Conversely, the fund has no rating limitations for investing in bonds issued by other parties different from governments. Also "investments in unsecured bank deposits and unlisted derivatives are included in the fund' portfolios": the ministry of finance established that all the issuers must hold a rating higher or equal to A- from Fitch and Standard & Poor's, or A3 from Moody's.

Table 3-26: Bond portfolio at 31.12.06 by credit rating. Percentage of market value			
Moody's		Standard & Poor's	
Rating	Percentage of total	Rating	Percentage of total
Aaa	55.88	AAA	54.05
Aa	20.00	AA	10.63
A	11.59	A	16.39
Baa	5.98	BBB	6.81
Ba	1.66	BB	2.16
Lower rating	0.97	Lower rating	0.68
No rating	3.92	No rating	9.28

Source: NBIM's annual report, 2006

Finally, Norges Bank used important standards and market practices to manage operational risks, such as failures in internal control, human or system errors. In 2006 the Government Pension Fund-Global "established a new framework for managing operational risk, based on Kredittilsynet's regulation on internal control in financial institutions".

- **Unicredit group's pension fund**

In 2006 the risk management practices in Unicredit Group's pension fund were less developed compared to the previous plan. Less information about the management of different risks was disclosed in the annual report. The board of directors decided to reduce the percentage of real estate, that reached 50%. During the year, the scheme maintained high liquidity because of the high volatility and uncertainty of markets (especially bond market). This was a positive choice because the financial markets registered negative results in 2007. Unicredit's pension fund obtained among the best results in the retirement market: 5,68% for "old" participants and 4,78% for new beneficiaries (Unicredit pension fund's annual report 2006).

**SCOMPOSIZIONE RENDIMENTI (calcolati sui saldi medi dei patrimoni)**

	GESTIONE IMMOBILI	PLUSVALENZE IMMOBILI	GESTIONE FINANZIARIA	ALTRI PROVENTUONERI	GESTIONE AMMINISTRATIVA	IMPOSTA SOSTITUTIVA	TOTALE
ISCRITTI ANTE	+1,84	+0,62	+3,23	-0,01	-----	-----	+5,68
ISCRITTI POST	+1,79	+0,03	+3,43	+0,11	-0,08	-0,55	+4,73
DIFFERENZE	+0,05	+0,59	-0,20	-0,12	+0,08	+0,55	+0,95

Source: Unicredit pension fund's annual report 2006

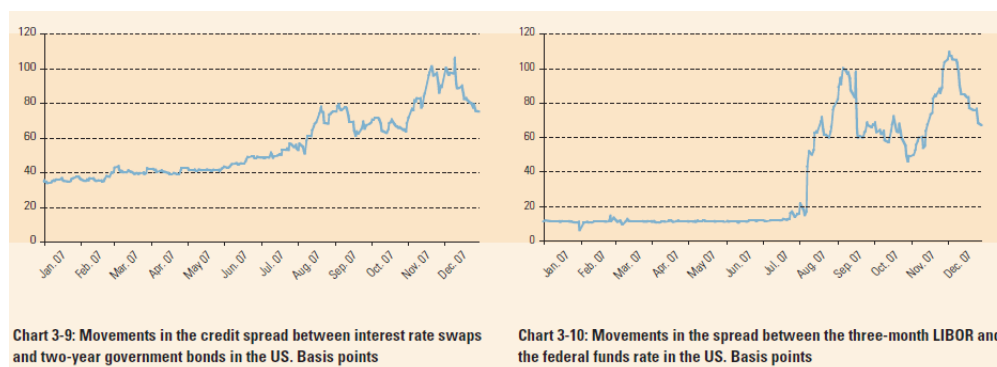
Moreover, Unicredit Group's retirement plan adopted both internal and external audit controls, the latter given to Deloitte & Touche SpA, even though their final opinions were not attached to the final annual report. However, the audit firm concluded that there were not elements of uncertainty in the activity of the pension fund.

## 2007

- **The market situation**

During the first months of 2007 a strong economic growth was registered worldwide and the situation in the markets remained stable: low volatility enhanced investments in high-risk assets (such as loans with low credit ratings). But since the half of 2007 an expected turbulence in financial markets started: house prices in US fell from the half of 2006 and default rates on sub-prime mortgages rose. The problems associated to "sub-prime mortgages in the US developed during the year into a more general and deeper credit and liquidity crisis" (NBIM's annual report 2007).

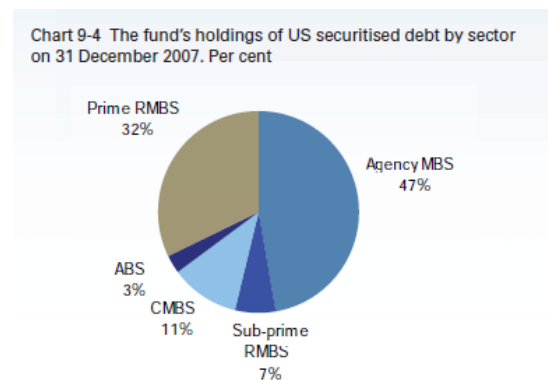
The spread in chart 3-9 measures the difference in yields between interest rate swaps and 2-year US government bonds. The value increased steadily in the first months of 2007, but until July it was associated to difficulties in the credit market. It was impossible for the majority of investors to see any danger signals of systematic risk in financial markets only on the basis of prices. Chart 3-10 points out that in the second half of 2007 there was a considerable repricing of risk. "The spread moved from 15 basis points to 100 in only one month. The result was a rapid increase in liquidity and credit premiums" (NBIM's annual report 2007).



Source: NBIM's annual report 2007

- **Government Pension Fund Global**

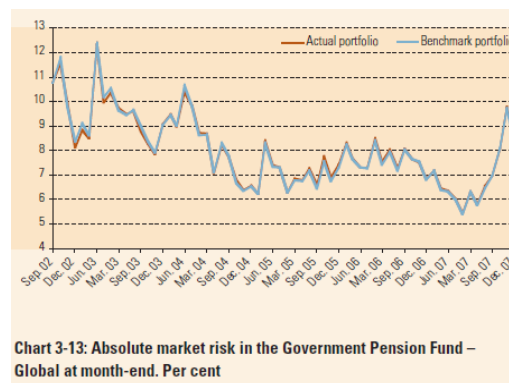
Focusing on the Government Pension Fund–Global, fixed-income portfolio invested only partially in US subprime mortgages. The losses due to these investments represented "less than 10 % of the negative result in 2007". The majority of the securities had very high credit rating. However, the absence of instruments against currency risk was a serious limit for the Norwegian fund: investments were "in foreign currency, and the market value of the portfolio in NOK" moved greatly due to variations of the exchange rate (NBIM's annual report 2007).



Source: NBIM's annual report 2008

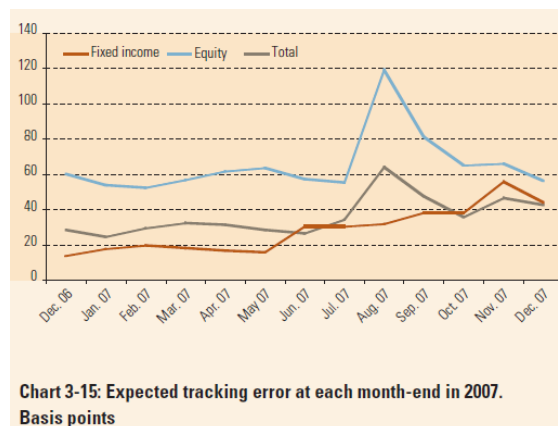
The return increased until August 2007 and later it fell sharply, because "the portfolio was short on liquidity risk and long on credit risk" when the financial crisis started. In 2007 the return of the fund remained positive, 4.3 % measured in international currency, and -3.9 % in NOK (NBIM's annual report 2007). The difference between the two values depends on the fluctuations of the krone exchange rate.

The graph below points out that portfolio risk decreased until March 2007, but there was a rapid and unexpected increase from August, because of the financial turbulence in the market. The risk depended also on the effects of diversification across fixed income and equity instruments: the risk remained high until 2006, but it significantly reduced in 2007. Therefore, "part of the increasing markets' volatility did not materialise in the fund's risk (NBIM's annual report 2007).



Source: NBIM's annual report 2007

In 2007 the situation was uncertain, because of very different values of the expected tracking error. August was extremely volatile, since the "tracking error in the equity portfolio increased". NBIM had already adopted these tools before the starting of the crisis, but only in the second half of the year it realized that the model appeared not precise, since it "underestimated the actual risk in the portfolio" (NBIM's annual report 2007).



Source: NBIM'S annual report 2007

Moving on to credit risk management, the Government Pension Fund–Global had to follow strict rules given by the ministry of finance for the choice of counterparties. "All bonds in the benchmark portfolio had an investment grade rating, which means at least BBB from S&P and Fitch and Baa from Moody's" (NBIM's annual report 2007). Securities of lower rating were not included in the portfolio.

<b>Table 3-12: Portfolio of fixed income instruments on 31 December 2007 by credit rating from Moody's. Millions of NOK</b>								
	<b>Aaa</b>	<b>Aa</b>	<b>A</b>	<b>Baa</b>	<b>Ba</b>	<b>Lower</b>	<b>P-1</b>	<b>No rating</b>
Inflation-linked bonds	40 369	8 210	30 791	-	-	-	-	18 928
Securitised debt	382 811	13 810	2 558	1 268	389	839	-	43 033
Corporate bonds	21 058	87 150	89 743	70 435	5 306	2 023	-	15 342
Short-term certificates	-	-	-	-	-	-	4 198	164
Government and government-related bonds	114 568	98 381	32 126	8 039	1 272	752	-	26 976
<b>Total bonds and other fixed income instruments</b>	<b>558 806</b>	<b>207 551</b>	<b>155 218</b>	<b>79 742</b>	<b>6 667</b>	<b>3 614</b>	<b>4 198</b>	<b>104 444</b>

Source: NBIM'S annual report 2007

Furthermore, the Norwegian ministry of Finance determined to increase gradually investments in equity to 60 % in 2007, whereas investments in bonds decreased to 30-70% (from 50-70% of the previous year), and to include small-cap companies in the equity's portfolio.

<b>Table 3-13: Risk exposure limits stipulated in the regulation</b>							
<b>Risk</b>		<b>Limits</b>	<b>Actual</b>				
			<b>31.12.06</b>	<b>31.03.07</b>	<b>30.06.07</b>	<b>30.09.07</b>	<b>31.12.07</b>
<b>§ 5</b>	Market risk	Max. tracking error 1.5 percentage points	0.28	0.32	0.26	0.48	0.43
<b>§ 4</b>	Asset mix	Fixed income instruments 30-70%	59.3	59.9	57.7	54.6	52.6
		Equity instruments 30-70%	40.7	40.1	42.3	45.4	47.4
<b>§ 4</b>	Market distribution, equities	Europe 40-60%	49.7	49.7	49.7	50.1	48.8
		Americas and Africa 25-45%	35.0	35.0	35.1	34.4	36.4
		Asia and Oceania 5-25%	15.5	15.3	15.3	15.5	14.8
	Currency distribution, fixed income	Europe 50-70%	60.4	59.7	60.0	59.8	59.4
		Americas and Africa 25-45%	34.3	35.0	34.6	34.7	35.1
		Asia and Oceania 0-15%	5.3	5.3	5.4	5.5	5.5
<b>§ 6</b>	Ownership interests	Max. 5% of a company	4.5	4.5	5.0	5.0	5.0

Source: NBIM'S annual report 2007

Finally, there was awareness of operational risk, too: in 2007 NBIM adopted a framework based on COSO principles, established by the "Committee of Sponsoring Organisations of the Treadway Commission". These principles, adopted worldwide for internal controls, were useful for managing operational risk (NBIM's annual report 2007).

- **Unicredit group's pension fund**

Even in 2007 Unicredit Group's pension fund disclosed only a few information about risk management. However, after the beginning of the crisis, it is notable that it gave more importance to the measurements of risks and transparency to the public. For the



first time the annual report contained the judgement of the audit firm Deloitte & Touche SpA, that analysed the correctness of the values in the annual report.

The decision to maintain high liquidity for the introduction of different sections in 2008, and the prudence in making risky investments, were considered appropriate choices during the period of high volatility in financial markets. The following returns, among the best in the pension funds' scenario, were obtained: 9,58% for old members and 5,54% for new participants. The difference was due to the fact that the fund's portfolio for new participants reduced the percentage of real estate, from 50% to 35% of the other portfolio, since the current regulation indicated 20% as the maximum amount to reach for new entrants. (Unicredit pension fund's annual report 2007).

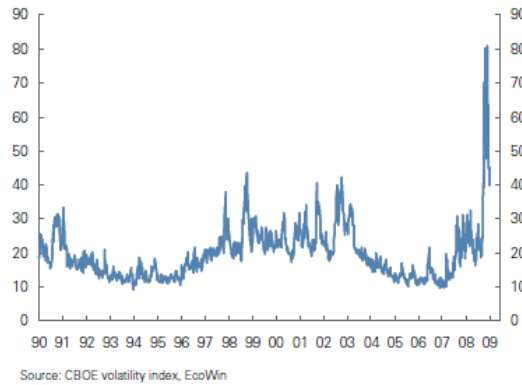
In conclusion, the positive results of Unicredit's fund in term of risk-return, compared to other financial institutions, were achieved thanks to the extensive diversification strategy, the alternative investments (in RE for example), the highly liquid position, and thanks to the effective currency risk's hedging: this risk was totally hedged ("currency overlay"), and outsourced to a specialized company (Rothschild).

## **2008**

- **The market situation**

In 2008 the financial crisis from US spread across the other countries worldwide. After "the Lehman Brothers bankruptcy, market volatility climbed to maximum values" (see graph). The equity market, characterised by constant high returns until 2007, declined sharply, as well as the values of commodities. The financial crisis, originally started with the default of insolvent financial institutions, turned to be a liquidity crisis: lots of beneficiaries of pension funds started to ask for their repayments, but this search for liquidity worsened the situation: several plans stopped their reimbursements, while others defaulted because of lack of immediate liquidity (NBIM'S annual report 2008).

**Chart 7-1** Expected volatility in the US equity market (VIX index)



Source: NBIM's annual report 2008

- **Government Pension Fund Global**

The Government Pension Fund-Global was hit hard by the financial crisis in 2008, and it reached the weakest result in its history, with a negative return of -23.3 % in international currency (-40.7 % on equity investments and -0.5 % on the fixed income investments). In 2008 the US securitised debt market collapsed: lots of borrowers were not able to refinance their mortgages, and the numbers of defaults increased. Moreover, the value of collaterals "was eroded by the fall in house prices. The market for mortgage-backed securities saw dramatic drops in the value of the underlying assets" (NBIM's annual report 2008). This segment explained about 40% of the negative performance of fixed-income securities. NBIM gave mandates to external managers to invest in this market, but after significant losses, the number of collaborators was cut from 22 to 9.

The crisis showed several problems in the active management. First of all, bond investments did not result to be very well-diversified as expected: the fund was "exposed to changes in the price of liquidity and it had extensive holdings difficult to trade" in the current market. Taking advantage of its size and of the long-time horizon, NBIM made important changes to the fund's investment strategy, that led to a "better diversification of the equity portfolio, better representation of the equity market, and greater exposure to above-average returns historically" (NBIM's annual report 2008). In 2008, the Norwegian parliament decided that maximum 5 % of the plan could be

invested in real estate. Moreover, the ministry of finance agreed on the introduction of "19 new emerging equity markets in the benchmark portfolio".

Chart 1-4 Regional breakdown of the equity portfolio on 31 December 2008. Per cent

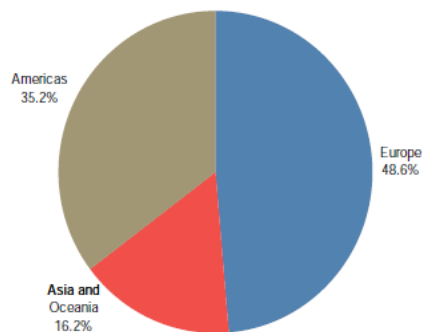
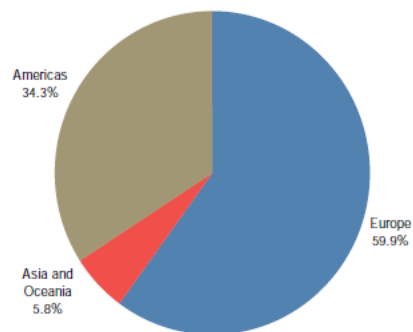


Chart 1-5 Regional breakdown of the fixed income portfolio on 31 December 2008. Per cent



Source: NBIM's annual report 2008

Market volatility remained very high in equity and fixed income segments, and this trend was confirmed by the fund's expected tracking error. In September 2008, the value for the equity portfolio went up to 200 basis points, exceeding the limit given by the ministry of Finance. The main reasons, that explained this big risk, were the changes in the composition of the portfolio, with the increasing allocation of equity and the new investments in emerging markets.

Chart 10-5 Expected tracking error 2008. Basis points

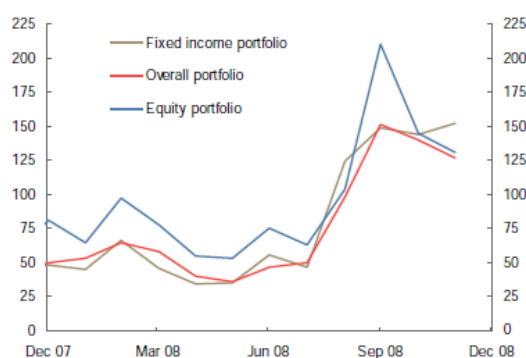


Table 5-1 Key figures on 31 December 2008. Annualised data

(Measured in an international currency basket)		Past year
Portfolio return (per cent)	-23.30	
Benchmark return (per cent)	-19.93	
Excess return (percentage points)	-3.37	
Standard deviation (per cent)	14.01	
Tracking error (percentage points)	1.84	
Information ratio	-1.83	
Gross annual return (per cent)	-23.30	
Annual price inflation (per cent)	1.3	
Annual management costs (per cent)	0.10	
Annual net real return (per cent)	-24.38	

Source: NBIM's annual report 2008

Credit ratings were used by NBIM to check variations in the credit quality of bonds. Concentration analysis monitored the absence of concentration "in terms of geography, sector or issuer", so that the portfolio remained well-diversified. All securities in the benchmark portfolio had to hold a credit-rating with investment grade. On the opposite, there was "no requirement for a credit rating for the fund's portfolio of fixed income instruments" (NBIM's annual report 2008). Nevertheless, the Government Pension Fund-Global aimed at finding counterparties with a good credit rating: the chart below shows that in 2008 most of government bonds, inflation-linked bonds and securitised debt had triple-A credit rating.

*Fixed income portfolio by credit rating*

	Aaa	Aa	A	Baa	Ba	Lower	P-1	None	Total
Government and government-related bonds	495 032	182 737	36 906	6 928	1 993	639	-	1 394	725 630
Inflation-linked bonds	75 634	48 754	1 963	-	-	-	-	-	126 351
Corporate bonds	18 629	67 627	111 240	78 577	5 912	2 657	-	2 690	287 332
Securitised debt	442 645	14 981	9 926	2 418	983	1 792	-	-	472 746
Short-term certificates	0	-	-	-	-	-	177	-	177
<b>Total bonds and other fixed income instruments</b>	<b>1 031 941</b>	<b>314 100</b>	<b>160 035</b>	<b>87 923</b>	<b>8 889</b>	<b>5 088</b>	<b>177</b>	<b>4 084</b>	<b>1 612 236</b>

1) Based on credit ratings from at least one of the following rating agencies: Moody's, Standard & Poor's and Fitch. The "No rating" category consists of securities not rated by these three agencies; these securities may, however, have been rated by other, local agencies.  
Source: NBIM

Source: NBIM's annual report 2008

Finally, the Government Pension Fund-Global faced sharply increasing liquidity risk. Several fixed income instruments experimented a considerable drop in liquidity because lots of participants claimed money unexpectedly and their activities were significantly scaled back. The plan had a big size, and, thus, excessive losses of liquidity presented significant investment challenges.

- **Unicredit group's pension fund**

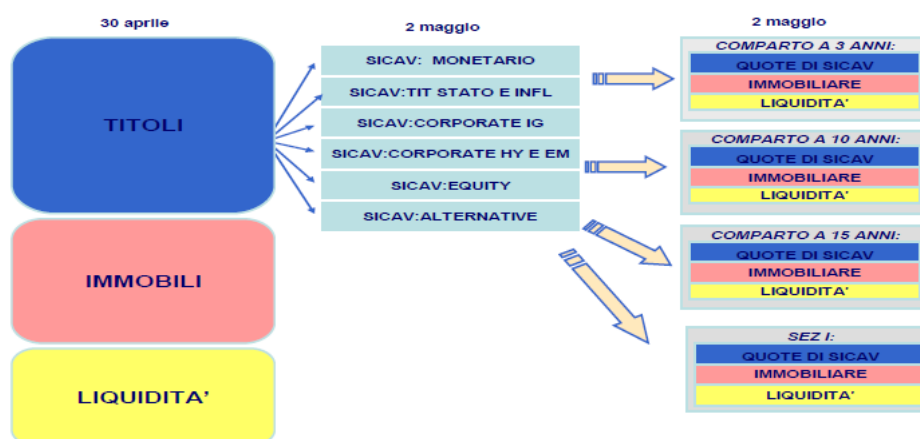
Unicredit group's pension fund introduced the multipillar management for section II on the 2nd May 2008. It comprised three different investment segments (3-year, 10-year and 15-year), with different risk and return profiles (Unicredit pension fund's annual report 2008). The denominations refer to different time horizon of investments, and they should help the participants to choose on the basis of their residual life. Young members, usually, prefer a higher risk on their investments in the short term, but a

higher return in the long run. On the opposite, old employees aim at maintaining a lower risk profile and they don't want to have huge losses just before their retirement. However, the majority of participants (68%) opted for the most prudent segment, and the fund had to manage riskier components, such as stocks and alternative investments.

The resources of the two sections have been managed by a vehicle from Luxembourg, called "Effepilux" (that is a SIF, Sicav). Effepilux has six sub-funds, and each of them focus on a different strategy and risk (Unicredit pension fund's annual report 2008):

- Monetary
- Government and inflation-linked bonds: the segment can invest up to 25% of the total portfolio in corporate bonds with investment grade; up to 10% in credit default swaps, with underlying assets having at least rating AA/Aa3; less than 10% in government bonds of emerging markets.
- Corporate investment grade "worldwide": the maximum exposure towards a company is 15%, while a single emission can't overcome 10%
- Corporate high yields and bonds in emerging markets: the exposure to the same company can't be more than 10% of total assets, while the single emission can't be more than 5%.
- Equity: the objective of this sub-fund is to enhance the capital invested in the long term, and the risks taken are very high. The maximum percentage that can be invested in a company is 5% of total assets.
- Alternative: the objective is to obtain a return that is not correlated with the main financial markets (bonds and stocks), increasing the capital invested in a long framework. Single investments cannot be more than 20% of total assets.

As shown below, section I and each segment of section II have been invested in the six sub-funds and in real estate:



Source: Unicredit pension fund's annual report 2008

There were several benefits associated to this new structure:

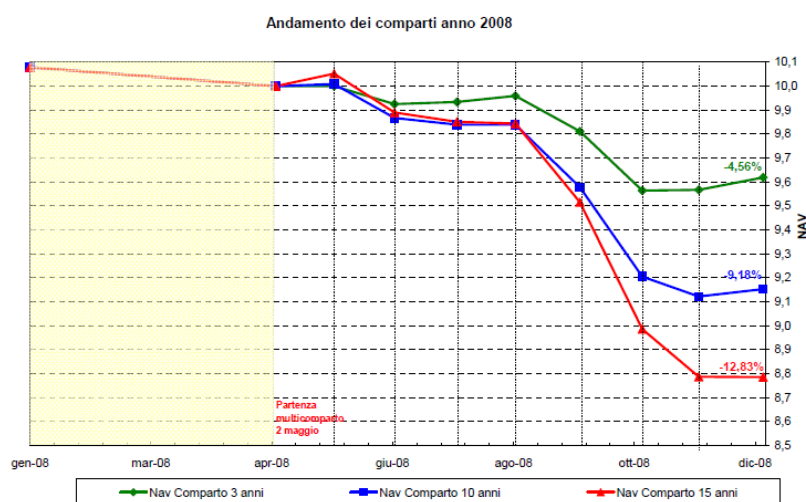
- more efficiency, because of cutting management costs;
- more operational controls, and more attention given to risk management (the fund is under the supervision of two different audit firms, following also the regulation in Luxembourg);
- more transparency and disclosure of corporate governance and decisions.

The increasing attention given to risks was confirmed by the introduction of a specific section dedicated to risk management in the annual report of 2008. There were different levels for the risk measurement in the pension fund: the segments, the single sub-funds, the funds/mandates where the sub-funds have been invested. Several tools were used in order to compute market risk and the expected volatility of returns, such as the expected error (Unicredit pension fund's annual report 2008). The advisor used the methodologies shared with the fund to measure risks and performances and to report them. For particular risks, such as concentration and counterparties risks, a periodic monitoring of the exposure (also indirect) has been established.

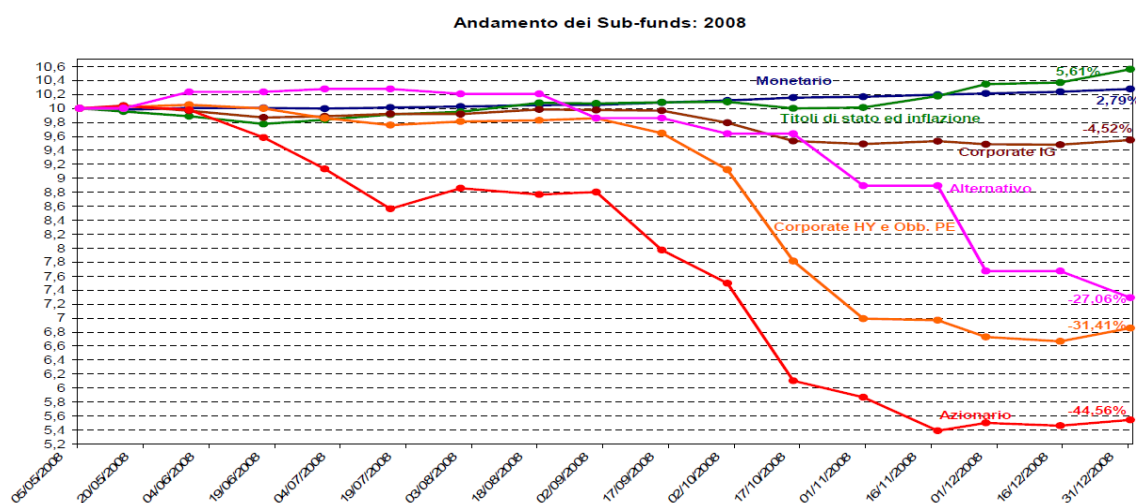
Looking at the performance of each segment, the following results were obtained:

- 3-year segment: - 4,56%, in particular because of the high initial percentage of stocks and quite limited exposure towards real estate and monetary sub-fund.

- 10-year segment: - 9,19%. Losses remained limited because the segment was under-exposed to alternative investments, high-yield bonds and emerging markets, while it remained over-exposed to real estate and monetary sub-fund.
- 15-year segment: - 12,83% The segment had several benefits from the original structure and composition of the section II: under-exposition to stocks, alternative investments, government bonds and corporate investment grade. Conversely, the over-exposition to real estate and monetary/liquid funds had a positive effect. The return of real estate in 2008 was approximately 4,4%.



Source: Unicredit pension fund's annual report 2008



Source: Unicredit pension fund's annual report 2008

## 2009

- **The market situation**

In order to recover from the financial crisis, policymakers helped the market with massive and coordinated support packages to introduce liquidity and avoid the bankruptcy of other financial institutions. These reforms were successful, and financial markets stabilised from March 2009. "There was a general price increase in the stock, bond and commodities markets, a better liquidity in the bond market and an improved expectation of growth in the global economy" (NBIM's annual report 2009). However, the crisis pointed out some shortcomings in the markets, and supervisory entities tried to overcome them, with the revision of credit-rating models, changing capital requirements, and setting systems for trading.

- **Government Pension Fund Global**

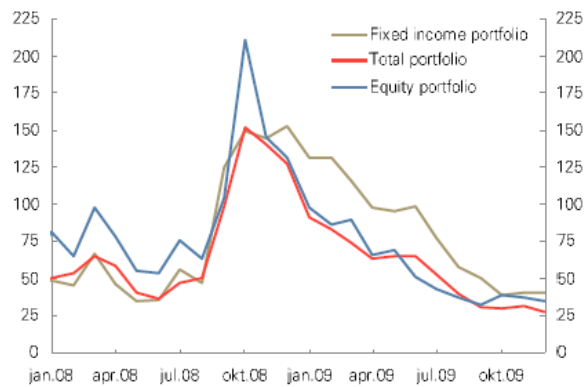
The Government Pension Fund-Global succeeded in becoming stronger after the crisis, thanks to an extensive reorganisation of the retirement plan and a new governance model. The income strategy changed in order to include reduced leverage and use less derivatives and trades exploiting price differences between securities. The results were "rising prices for many fixed income instruments as the market thawed and liquidity returned" (NBIM's annual report 2009). The fund posted a record return of 25.6 % measured in international currency, 34.3 percent for the equity portfolio and 12.5 percent for fixed income investments.

Talking about risk management, concentration analysis was applied to monitor the risk of investments deviating from the benchmark portfolio. This tool measured "the concentration of investments in individual companies, sectors and regions", and it stated that in 2009 NBIM invested in small-cap stocks more than the benchmark index. Moreover, Norges Bank calculated regularly market risks "using both parametric calculations and Monte Carlo simulations" in order to generate a large series of returns and determine the risk parameters (NBIM's annual report 2009). Expected tracking error of total portfolio reduced drastically to about 30 basis points in October 2009. The main



reasons were lower volatility in financial markets and lower correlation between the fund's investments.

Chart 9-3 Expected relative volatility 2008 -2009. Basis points



Source: NBIM's annual report 2009.

In 2009 the Norwegian pension fund developed new credit-risk models for fixed-income assets. Credit ratings were always used, and the fund introduced "different expressions of the probability of default in the bond portfolio, including either volatility and capital structure, or the price of bankruptcy insurance" (NBIM's annual report 2009). To hedge against counterparty risk, NBIM used "bilateral netting agreements for OTC derivative instruments and foreign exchange contracts".

Finally, in 2009 the fund continued to reduce operational risk, by diminishing the complexity of investments and internal processes: the number of investment instruments was reduced, as well as trading in complex derivatives was prohibited.

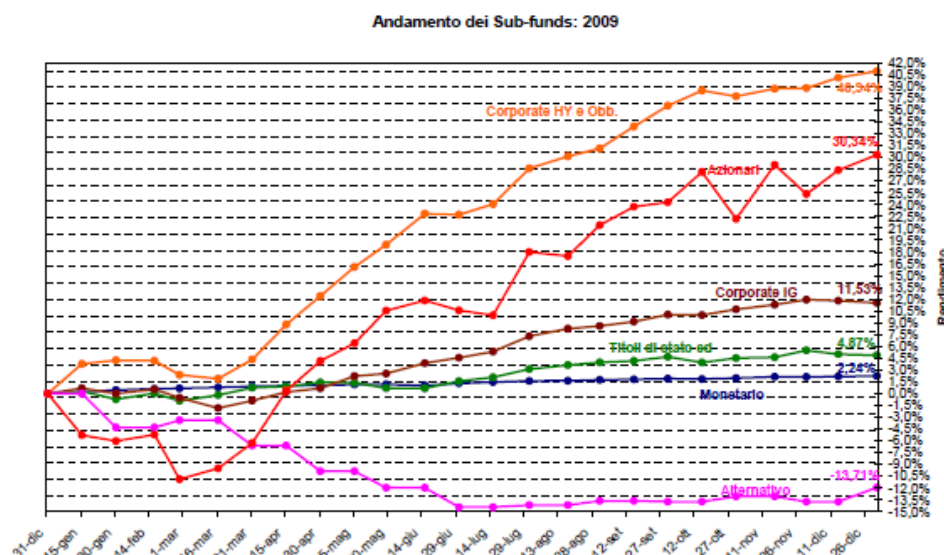
- **Unicredit group's pension fund**

Unicredit Group's pension fund shifted Effepilux from a SIF-SICAV into a Sicav Ucits III, and separated the sub-fund alternative into an independent SIF (Effepilux Alternative). This choice was explained by some advantages of the harmonization, for example the stronger risk management's structure required by the regulation in Luxembourg for a Sicav (Unicredit pension fund's annual report 2009).

During 2009 the percentage of real estate in the three segments of Section II was gradually reduced, and the relative return moved from 4,4% in 2008 to -7,46%. However, the overall return of the segment "3-year" was 4,28%, 6,84% for "10-year" and 7,31% for "15-year".

In 2009 the fund continued to maintain a prudent management, especially for the riskier high-yield sector, because of uncertainty about the future performance and economic growth. New strategies were introduced for the portfolios managed, in order to mitigate risks in future adverse scenarios.

As shown in the graph below, the returns of all sub-funds were positive in 2009, with the exception of the Alternative one, that was affected by costs of entrance and management of Private Equity's investments.



Source: Unicredit pension fund's annual report 2009

The risk management of the Italian fund was divided into several levels:

- the first level of controls, committed to the sponsoring company and the custodian bank, aimed at mitigating the risks due to human errors and operative losses;
- the second level monitored and managed the risks of Section I and single investments lines of Section II. The controls comprehended ex-ante risk analysis of portfolios, using

"VaR, expected shortfall, tracking error volatility"; but also periodic stress tests to check the stability of the financial system.

- the third level of controls were given to Unicredit Audit and to an external audit firm, Deloitte & Touche SpA.

## **5.2. The situation in 2016**

- **The market situation**

During 2016 financial markets were characterised by three different phases: until February the uncertainty, linked to the development of the Chinese market, remained. In the second phase, until May, markets stabilised, while during the second half of the year they became stronger, "despite the results of the UK referendum and US presidential election. The global economy saw higher growth and inflation, interest rates increased, and the dollar continued to strengthen" (NBIM's annual report 2016).

- **Government Pension Fund Global**

In 2016 the return of the fund was 6.9% using international currency. "Equities returned 8.7%, bonds 4.3% and real estate 0.8%" (NBIM's annual report 2016). In the period 2006-2016, especially after the financial crisis, the governance of the fund increased the risk management, and it gave higher importance to disclose risk information to the participants. During 2016 not only the annual report of NBIM was issued, but also additional papers related to risk and return, and real estate investments.

Starting with the measurement of market risk, the Norwegian fund had to follow strict limits given by the government (see table below): the ministry of finance required that "expected relative volatility (or expected tracking error) did not exceed 1.25 percentage points". In 2016 it was 0.28 basis points.

Table 28 Key figures for the fund's risk and exposure

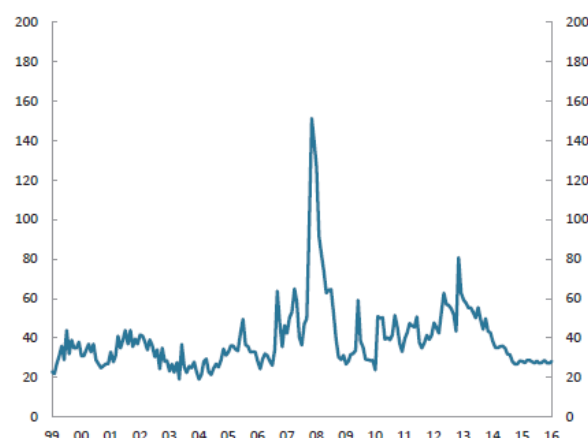
Limits set by the Ministry of Finance		31.12.2016
Exposure	Equities 50 - 70 percent of fund's market value <sup>1</sup>	62.1
	Real estate 0 - 5 percent of fund's market value	3.2
Market risk	1.25 percentage points expected relative volatility for equity and fixed-income investments	0.3
Credit risk	Maximum 5 percent of fixed-income investments may be rated below BBB-	2.2
Ownership	Maximum 10 percent of voting shares in a listed company in the equity portfolio	9.6

<sup>1</sup> Equity exposure includes underlying economic exposure to equities through derivatives.

Source: NBIM's annual report 2016

The calculation of the tracking error changed in 2011 to suit better the long-term investment horizon of the plan. No more daily price observations, that gave higher importance to recent prices than past ones, were used; the new process measured risk "using weekly prices and a three-year price history, making it less sensitive to short-term changes in market conditions".

Chart 33 The fund's expected relative volatility.  
Basis points



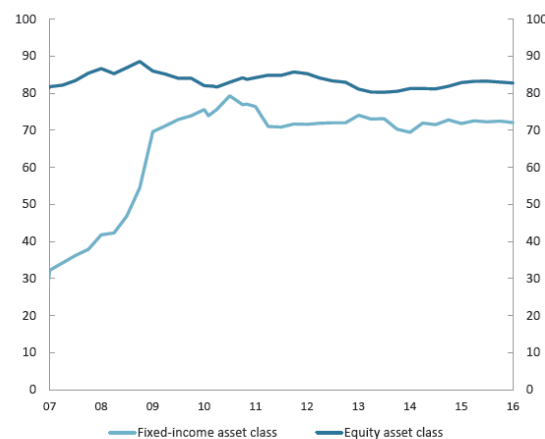
Source: NBIM's return and risk 2016

Tracking error described only normal market conditions. In order to have more information about the worst situations (tail risk), NBIM computed the expected shortfall, that measured the expected losses for the plan's portfolio in case of extreme events at a 97.5 % confidence level. The result showed "an expected negative deviation of the portfolio from the benchmark index of 0.87 % point annually" (NBIM's return

and risk 2016). In March 2006 the executive board introduced 3.75 % as maximum limit.

Another relative risk measure, introduced by the Norwegian fund to compute market risk, was the benchmark overlap, that showed "how closely the portfolios match the benchmark indices". NBIM introduced the "limit for minimum overlap between the equity and fixed-income portfolios and the corresponding benchmark indices of 60 %" (NBIM's return and risk 2016). In 2016, it was 82.8 % for equity and 72.0 % for bonds.

Chart 35 The fund's benchmark overlap. Percent



Source: Norges Bank Investment Management

Source: NBIM's return and risk 2016

Furthermore, the plan had a "higher weight of stocks of greater volatility than the average in the benchmark, and a higher weight of small companies". For this reason the ministry of finance decided to modify the benchmark index for 2017 ("only" 62.5 % of equity and 37.5 % of fixed-income instruments).

Shifting to credit risk, the fund had to face a higher risk compared to 2015: the group of lower-rating bonds increased to 2.2 % (compared to only 0.7 % in 2015). The main reasons were the "downgrades for Brazil and Turkey as a result of lower growth forecasts and unstable political conditions" (NBIM's return and risk 2016). Gross and net risk exposure became higher, because of large "holdings in unsecured bank deposits and securities lending, but also in interest rate swaps cleared".

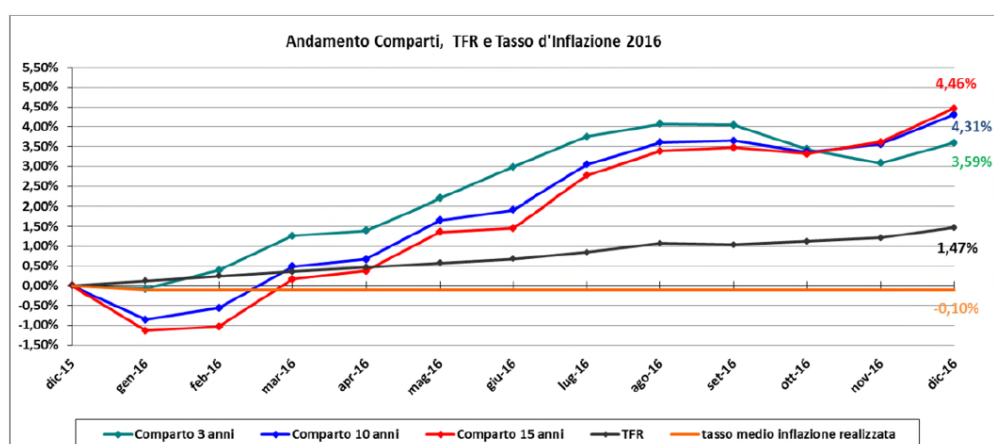
In addition, the Government Pension Fund-Global has always been very aware to reduce the effects of operational risks: the board established that the "probability that operational risk factors will result in gross losses of 750 million kroner or more" in a period of 1 year should be lower than 20% (NBIM's annual report 2016).

Finally, at the end of 2016 the NBIM published a separate report about real estate investments, that contained also the analysis of their risks. Market risk, for example, was due to fluctuations of the RE portfolio's values. Several risk measurement techniques, such as "concentration analysis or portfolio simulation", were adopted. In order to reduce market risk, "the composition of the fund's real estate investments was continuously evaluated", taking into account geographical, industrial and time-related variables (NBIM's real estate investments 2016). The pension fund hedged against climate risk, too. "Extreme weather and shifts in climate patterns may impact the physical condition of the properties and the business continuity" (NBIM's real estate investments 2016). Therefore, the Norwegian pension plan signed insurance contracts to protect against climate risk, and it monitored local policies, such as "new building code regulations, initiatives to build stronger coastal defences or drainage systems".

- **Unicredit group's pension fund**

In 2016 the reduction of benefits in section I was inevitable, because of the changing actuarial situation and the persisting financial crisis. However, section I obtained a positive return of 3,27%, while section II achieved a return of 3,59% for the 3- year segment, 4,31% for the 10-year and 4,46% for the 15-year one. These positive results were even more significant if considering the contest characterised by interest rates near zero (Unicredit pension fund's annual report 2016).

The aim of the pension fund's management team was to achieve higher returns than the return of TFR in each segment of section II. The target return was expressed in terms of spread compared to the inflation rate and considering the time horizon: the spread equals 150 basis points for the 3-year group, 250 bps for 10-year and 300 bps for 15-year.



Source: Unicredit pension fund's annual report 2016

In Unicredit's pension fund the management of financial resources was given to two vehicles established in Luxembourg. The first one was a SICAV Ucits IV, called "Effepilux", composed by 5 sub-funds (monetary, government and inflation-linked bonds, corporate IG, corporate high yields and emerging markets, equity). The difference in the risk management from 2009 was related to the second vehicle, a SIF-SICAV non harmonised, called "Effepilux alternative" (Unicredit pension fund's annual report 2016). In 2016 the SIF was composed by three sub-funds:

- Alternative, that comprehended less liquid assets, among which hedge funds;
- Real estate, that aimed at diversifying the portfolio by investing in countries outside Italy. This asset class was particularly strategic in 2016 because of low interest rates of securities;
- Private debt, constituted in December 2016, that invested directly in bonds, and indirectly in funds that give liquidity to SMEs and increase the capital invested.

The risk management in the Italian pension plan was always divided into three different levels, as in past years. The second level increased its intervention to monitor the most relevant risks faced (Unicredit pension fund's annual report 2016). It conducted the following activities:

- Ex-ante analysis of portfolio's risk profile, using for example measures of relative risk (tracking error) and measures of absolute risk (Value-at-Risk using the historical simulation method);

- Scenario analysis and periodic stress-tests in adverse historical situations (such as the 11th September 2001 or the global financial crisis in 2008), but also simulations of possible evolution of interest rates and other macroeconomic factors.

The annual report 2016 disclosed some information about these simulations: the total risk profile of section I (about 1,90%) resulted in line with the volatility values of the main asset classes. The average VaR (Value-at-Risk, that shows the potential loss in a defined time horizon, 1 year, with a confidence level of 95%, if adverse events happen) was € 78 million (6,24% of the total assets). Talking about investments in section I, the main contributions to generate risks were the Equity and Alternative sub-funds, while the Real estate sub-fund contributed to diversify and reduce the total risk. Unicredit's team monitored the longevity risk, too, and the mortality tables used were correct for containing the risk of increasing life expectancy and increasing costs to pay pension benefits (Unicredit pension fund's annual report 2016). The portfolio of section I maintained great stability in 2016: in the simulations of the biggest financial crisis in the last decades, only the scenario of 2008, with the crisis of subprime loans, had an impact more than the 5% of the capital.

Moving to the section II, in 2016 the risks measurements showed an increase in the riskiness of all the three segments: the 3-year segment registered a VaR of € 68 million (7,60% of the total assets), the 10-year segment a VaR of € 43 million (12% of the € 345 million of total assets), and 15-year segment a VaR of € 55 million (14,5% of total assets). However, during the second part of the year the volatility gradually decreased because of the effective diversification.

SEZIONE II - ANNO 20162016	RENDIMENTO	VOLATILITA'	VAR
COMPARTO 3 ANNI	3,59%	1,66%	7,6%
COMPARTO 10 ANNI	4,31%	2,00%	12%
COMPARTO 15 ANNI	4,46%	2,33%	14,5%

Source: Unicredit pension fund's annual report 2009

Finally, some stress-tests have been conducted to evaluate the exposure of the plan's portfolio to extreme events: for the section II the maximum losses were connected to the 2008 scenario, with the crisis of subprime loans (Unicredit pension fund's annual report



2016). The 3-year segment registered about 20% of losses in the simulation, while for the 10-year and 15-year the losses were respectively 29% and 33% of their values.

In conclusion, during the last decade, especially after the global financial crisis in 2008, Unicredit Group's pension fund has enhanced the risk management's techniques and increased the disclosure of risk information to the public. Nevertheless, it remains a step behind the Government Pension Fund-Global, that has developed some best practises since 2006.

## 6. CONCLUSION

The thesis analyses the evolution of risk management techniques adopted by the Government Pension Fund-Global and Unicredit Group's pension fund in the last decade, in particular in the light of the global financial crisis. The objective is to understand how and how effectively different European retirement schemes, not only in terms of size, but also typology and beneficiaries, have managed risks. The analysis conducted shows that both plans achieved positive returns in 2006 and 2007; but, after the spread of the global financial crisis outside US, they were significantly affected by the subprime loans' crisis in 2008. The Norwegian fund was more exposed towards the US market, not only because of its size, but also in terms of investment percentage in American treasury bonds and stocks. In 2008 it reached its worst performance since it was constituted, -23.3% in international currency. On the opposite, in the same year, Unicredit's pension fund registered more limited losses (the average return of the three segments of section II was -8.83%), especially because its investments were concentrated in South and East Europe.

In addition, the research points out that the Norwegian pension fund recovered better to the financial crisis than the Italian retirement plan. After the negative performance of 2008, GPFG recovered strongly, reaching the best performance in 2009, with a record return of 25.6 % measured in international currency. The average return of section II of Unicredit's fund was much less, "only" 6,14%. This is due to the fact that the Norges Bank Investment Management gave a higher attention to risk management since 2006, and it respected the limitations introduced by the ministry of finance. Before the beginning of the global financial crisis, it had already adopted several tools to measure the risk exposure; during the crisis, it reduced the use of derivatives and it analysed the effects of adverse scenarios with Monte Carlo simulations. Conversely, Unicredit reformed its organization, introducing the multipillar management, after Maroni's law in 2005, and it completed the restructuring process only in the middle of the crisis. It had much more difficulties in implementing the new organisation: in 2008 the majority of participants chose a more prudent profile, and Unicredit's pension fund had to delete a great number of risky securities from its balance sheet. Furthermore, the Italian

government did not intervene with special rules to protect pension funds, and did not impose limits to fluctuations of their assets.

At the end of 2016 the situation slightly changed. The Government Pension Fund-Global continued to adopt innovative risk management techniques, measuring for example the expected shortfall or the benchmark overlap. It followed new limits imposed by law for market and credit risks. Also Unicredit's plan made big improvements in managing risks, for example computing the VaR, tracking error or stress-tests. Nevertheless, the Italian government did not introduce any limit, and did not pay a great attention to regulate the private pensions' industry. To conclude with the empirical analysis, both funds improved their risk management systems during the decade 2006-2016, and the initial gap between the two funds greatly diminished. However, there is still a lot to do in order to harmonise the European pension systems, and introduce similar risk management strategies.

Additional research is certainly required: it would be very interesting to focus on pension funds operating in the same country to evaluate if there are big differences between risk management in open and closed pension funds. Another research topic can be the comparison of retirement schemes (and their ways to manage risks) in several EU countries, with different historical traditions: Anglo-Saxon countries (e.g. UK) where private pensions have been historically more developed, and Mediterranean ones (e.g. Greece) where public pensions still represent the majority income for retired people.

The discussion about the future sustainability of pension systems is a current issue in every country in the world, especially because of the increasing life expectancy and decreasing number of active workers. In the long term, public pensions will be insufficient for retirees, because they will gradually decrease and will be not enough for an adequate life. All citizens need to enrol into pension funds or other private forms (for example insurance policies), to supplement low public pensions. The European Parliament is paying high attention to the topic, too: EIOPA was established in 2011 and it received the mandate to study and analyse the retirement situation in Europe. The authority verified the stability of the system conducting some stress-tests in 2015; in 2017 it started a second round of stress-tests because of changing economic situations, but the results will be published only in December 2017. In conclusion, the advice of

EIOPA (2016) is to introduce "a European framework based on common valuation rules and a standardised risk assessment, that would enhance current risk management and transparency of IORPs".



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