



Pension funds rules: Paradoxes in risk control



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ABSTRACT

Pension funds are financial institutions that invest retirement savings from workers to provide pension benefits. Due to this social security function, each country enforces laws to regulate investments. Usually regulations identify pension portfolio's risk level based on the nature of its financial products. After the latest financial crisis, it became evident that such approach may not be sufficient to control the risk. In this paper we measure risk level with a multifractional Brownian motion with random exponent. We show how current rules can lead to paradoxes, where portfolios which comply with the laws are riskier than those that do not.

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1. Introduction and motivation

Security and the uncertainty of retirement incomes are extremely topical issues for young workers and future generations especially in European countries, where a reduction in the ratio of workers over retirees has occurred. In several countries, public pension schemes are progressively adopting reforms to contain public pension expenditure (e.g. by increasing pensionable age or shifting from defined benefit to defined contribution), at the cost of a reduction of replacement rates. At the same time, fully funded pension fund systems have been developed, to provide individuals with a supplementary pension benefit compared to the first pillar, which, unlike mutual funds, must focus on the social security function than speculative one. The demographic structure of developed countries and the related labour market has meant that pension funds have accumulated large capitals over the years so they play an important role as institutional investors (Thomas et al., 2014). Qualitative rules are often used to classify the risks of individual financial products according to their typology: liquidity, bonds, stocks, derivatives, commodities and others. For example, bonds are always considered less risky than stocks. Otherwise, limits may be related to geographical areas of origin, where usually non-OECD countries are considered more risky than the others. Following the financial crisis it has been shown how this classification can often be misleading, either leading to paradoxical situations (e.g. Greek government bonds and the sovereign debt crisis of 2010 in Europe) or to moral hazard policies. There are some restrictions about investments in equity and bonds traded in the over the counter markets and/or in non OECD countries. (OECD, 2014) describes the main quantitative regulation applied to OECD and IOPS countries updated to December 2013, showing also the main changes occurred in the period 2002–2013. The Directive 2011/61/EU, in

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force from July 2013 was enacted to harmonise the laws that first appeared fragmented among the states of the Union. The severe financial crisis of 2008–2009 has led the EU to create a framework that would harmonise national rules to prevent risks to investors, their counterparts, the other operators in the financial markets and, more generally, to the financial stability of Europe. For example, Italy revised the rules of pension fund investments, implementing the Directive 2011/61/EU, that came in force at the end of 2014. It puts the emphasis firmly on the risk management of pension funds and the responsibility of their administrators. The new DM 166/2014 innovates the previous regulatory framework introducing new rules that aim to ensure more flexibility in the management of pension funds, while respecting a prudent management policy. The fund will have to define the horizons of the most appropriate risk-return objectives of the fund and indicate the tolerable upper limit with respect to individual investments and overall the entire portfolio. In this context, defining appropriate models to measure the risk levels of pension fund portfolios: in this paper we develop a model to control the volatility of investments portfolios and we further show how a simple qualitative analysis not only is insufficient but even deceptive.

After the financial crisis of 2008, a number of quantitative risk analysis methods have been proposed to model and control the volatility of investment portfolios of pension funds. [Otranto and Trudda \(2008\)](#) propose a statistical procedure to classify pension funds in different risk classes, in order to monitor the funds based on the study of the dynamics of GARCH volatility associated with the returns of the funds. [Bianchi and Trudda \(2008\)](#) analyse the investment risk in pension funds and they provide a technique for rebalancing pension fund portfolios in function of their pointwise level of risk.

[Impavido and Tower \(2009\)](#) study the key sources of vulnerabilities for pension plans and insurance companies in the light of the global financial crisis of 2008 and they also discuss how the institutional investors transfer shocks to the rest of financial sector and economy. [Halim et al. \(2010\)](#) analyse how funds manage investments and show that funds that manage both active and surplus risk have generated better risk-reward trade offs.

It has been debated that regulation and supervision of the financial sector, in particular for pensions, needs a risk-based approach. In particular [Bernstein and Chumacero \(2012\)](#) evaluate the effect of value at risk limits and quantitative restrictions on portfolio choices in the context of a risk-based supervision for a defined benefit pension fund.

[Bohl et al. \(2011\)](#) study the performance of pension funds in Poland and Hungary where governments impose regulation on the investment of the pension funds which differs from that of Eastern countries (*strongly regulated*) finding that investment limits and performance regulations influence the investment decisions of pension funds in both countries.

[Lippi \(2014\)](#) explores the investment lines choices of occupational pension funds subscribers in Italy from 2007 to 2011. He finds that many subscribers opt for the middle options between the different risk investment lines and he suggests to the regulators to assign this line to people who do not express any preference instead of the so called *no risky line*. [Thomas et al. \(2014\)](#) analyse the stock market volatility in the OECD countries and they observe a significant reduction in volatility of stock prices with the increase of the investment of pension funds.

Classic financial theory on stock market uses Brownian motion to model asset return. Brownian motion is an elegant representation of the stock market, but one of its drawback is the unrealistic hypothesis that successive returns are independent and normally distributed. It is assumed that the price has no memory and a sharp decline one day does not influence the price of future day. For this reason, long run memory models (See [Zai, 2013](#)) were introduced. The fractional Brownian motion fbm is an extension of the standard Brownian motion and it was presented in the pioneer work of Mandelbrot and Van Ness in [Mandelbrot and Van Ness \(1968\)](#). In the fractional Brownian motion the increments are serially correlated, new information has an enduring influence on the process and this involves a certain level of predictability (On this topic see [Rostek and Schöbel, 2013](#)). It is characterized by a slowly decay autocorrelation function depending on the Hurst exponent. One of the problem of fractional Brownian motion is the possibility of arbitrage. An extension of the fractional Brownian motion is the multifractional Brownian motion, in which the Hurst parameter is a function of the time $H(t)$. On this topic see [Peltier and Lévy Véhel \(1994\)](#), [Lévy Véhel \(1995\)](#), [Ayache and Lévy Véhel \(2000\)](#) and [Bianchi \(2005\)](#). By allowing H to be a stochastic process or a r.v, the mBm can be further generalized to the *Multifractional Process with Random Exponent* mpre (see [Ayache and Taqqu, 2005](#)). [Cadoni et al. \(2015\)](#) model the Hurst exponent with a mixture of beta distributions and apply it to different financial instruments and portfolios.

In this paper, using a mpre model ([Cadoni et al., 2015](#)) to measure the volatility, we show that, investments in financial products considered high risk by current legislation (non OECD stocks and bonds) are in fact less turbulent than products defined as low risk (e.g. OECD bonds). In the experimental evaluation, different investment portfolios are simulated: the results show that portfolios constructed with bonds or stocks of non OECD countries, i.e. assets that are classified risky according to the regulations, have a lower degree of (quantitatively measured) risk than that of OECD countries, which in turn are considered less risky by current pension funds investment regulations. Current legislations can therefore lead to paradoxes, where portfolios composed according to investment rules are quantitatively more risky than portfolios that do not conform to regulations.

The remainder of the paper is organised as follows: [Section 2](#) presents the methodology used, in [Section 3](#) the experimental evaluation is performed, in [Section 4](#) the results are discussed and conclusions are drawn up.

2. Methodology

We describe the log price evolution by a multifractional process with random exponent mpre. In the following, we outline the mathematical instruments the method is based on, for a thorough treatment the reader is referred to [Cadoni et al. \(2015\)](#).

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