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"Asset Liability Management"

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Abstract

This dissertation was written as part of the MSc in Banking and Finance at the International Hellenic University.

This dissertation attends to provide to useful tools for Asset Management. Therefore, it is highlighted the usefulness of asset Liability Management. To reach this goal we implement Asset Liability management methods in some portfolios, compared to mean - variance approach. There is ample evidence from many practitioners who strongly support the importance of the aforementioned technique.

Our findings reveal the Asset Liability Management as the most proper and effective strategy for the construction of portfolios in which the risks are eliminated.

Keywords: Asset Liability Management, portfolios, Mean - variance approach, techniques.

Maria Kallianta

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Preface

In this point, I would like to thank Professor Timotheo Angelidi for his continuous help and support throughout this period.

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Chapter 1: Introduction

For many decades, the financial world has to face a considerable number of risks. This is the reason that compels more and more banks and financial institutions to place greater emphasis in risk management. The high sensitivity of sectors such as these, which are extremely volatile to any kind of exogenous factors, demonstrates the need for greater security in enterprises.

In this thesis we are going to discuss and analyse one of the most significant and useful tools of economics; more specifically, we are going to expand our research into a strategy that seems to be an integral part of the financial system. In order to make the management of risk more efficient, industries adopt a financial instrument that allows them to achieve the best possible results, combining the lowest degree of risk with the maximum attainable profits. Due to the large amount of risk, instability and uncertainty are triggered by any kind of activity and investment. This concern led the analysts towards the development of Asset Liability Management, in abbreviation ALM. This tool is an advanced and more complicated form of the Asset Management, which tries to include all the factors that may affect the outcome of an investment. Below, we will explain more extensively what exactly the Asset Liability Management is and which factors render it necessary. We will also explain how ALM or surplus management, through the proper risk management, can lead to more profitable and secure investments and eventually, how this process works in order to reach the desirable results. Additionally, we will analyse a pioneer and alternative type of Asset Liability Management, the Asset Management. The differences between these two systems will be mentioned too, as well as under which circumstances the expert managers choose to use them. In other words, the essay will report which are the criteria analysts consider when they have to choose the most suitable management tool for a case. Furthermore, the different techniques and methodologies that are used in these two processes will be explained in detail, in such a way as to completely understand the two terms, as well

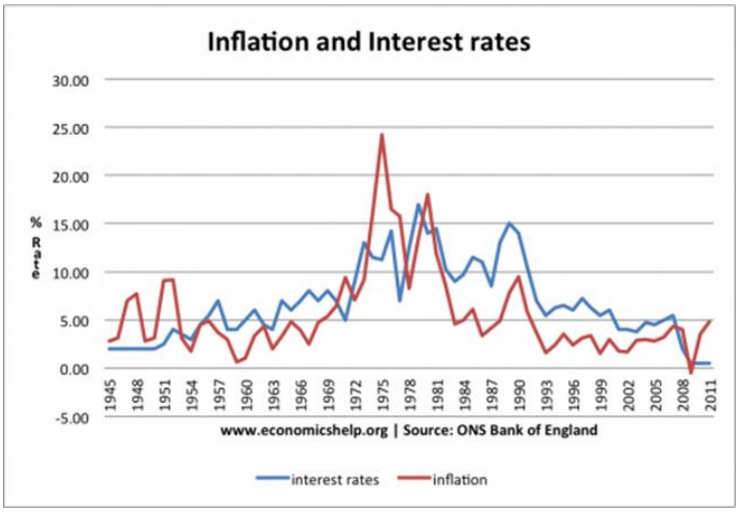
as the procedures that follow in terms of the good strategic planning of an investment.

This thesis will try to examine whether and how the Asset and the Asset Liability Management can be applied in practice. For this reason, we downloaded the data of three asset classes of the United Kingdom stock market for the period from 19901 to 2014. We elaborated the Cash Equivalent Index, the Equity Index and we used the Nominal Bond Index from the Fixed Income asset class and, also, the Real Bond Index. Because the purpose of this dissertation is to compare these two techniques of management, we tried to make a cost effective asset allocation and so, after a good diversification, we created a relatively secure portfolio. Upon this portfolio we applied a strategy of Asset Management and a strategy of Asset Liability Management respectively, but in the second case we used the Real Bond Index as the liability of the portfolio. So, after running these procedures, having the results will allow us to observe the outcomes and compare them, thereby reaching the conclusions.

During this master thesis, we will try to clarify the concept of Asset Liability Management, this essential financial tool, and make more understandable in order to solve some important questions about it. More specifically, our aim is to find answers in three major questions that are connected to the issue of investments. Firstly, we will see the differences in the methodologies between Asset Liability Management and Asset Management. While doing this, we will also see how these two systems work in practice, examining the techniques that are used in both cases. In the end, we will be able to answer the main question of this paper: Is Asset Liability Management the safest and more efficient process for managing an investment?"

1. Asset Liability Management

In the early 1970s, the biggest stock market crash recorded in post-war history took place. This crisis started in New York Stock Exchange in January of 1973 and spread to the strongest stock markets worldwide. The London stock market was a major victim of the crisis, as it suffered losses up to 73% of its value. Simultaneously, during this period, mainly in the late '70s, the UK government had also been confronted, with another great global crisis: A dramatic rise in oil prices and wages inevitably led to the rise of inflation, reaching a staggering 25%. With regard to the stock exchange market, this predicament contributed to the increasing volatility of Interest rates. In this period of time, until the beginning of 1990s, interest rates reached an increase of up to 15%. As we can observe in the table below, which combines both inflation and interest rate changes, despite the wide fluctuations of inflation recorded from 1945 until 2011, the highest inflation is noted between the years 1972 to 1975. A few years later asset prices were readjusted in a certain level, stabilizing at more sustainable rates, and normalized the inflation figures. Interest rates after the crash, started to follow some extreme upwards and then downwards trends presenting their highest rates in the middle of 1978 and shortly before 1990.



(http://www.economicshelp.org/blog/2647/economics/history-of-inflation-in-uk/)

This turmoil in the world economy, compounded by all these events, damaged nearly all the sectors of the UK economy. Except for the reduction of national GDP by 1.1%, the banking sector was severely affected, too, since the crisis coerced the Bank of England to bail out a significant amount of depositors. The British and American finances' vulnerability to a variety of risks such as liquidity, credit and interest rate risk was exposed by the crisis, showing the need to face such problems more effectively in the future, and to be protected against this uncertain environment. When the crisis was mollified, financial risk managers focused on the resolving of the mismatches between assets and liabilities and the risk which they posed. This, known as leverage risk, arises when the future liabilities exceed the assets and cannot be covered from the future cash flows.

This type of risk stems from the failure of the value of assets and liabilities to move with consistency and so devaluing the capital. In the financial sector, due to the relatively small sizes of institutions, the small percentage changes in their assets and their liabilities lead to greater changes in the percentage of capital. So, under these circumstances, the need of ALM became apparent.

The concept of Asset Liability Management has occasionally troubled the community of finance and more specifically asset managers. Although, ALM is a useful and effective financial instrument which can offer definite profits, in practice the analysts have to deal with many difficulties.

By definition, the term ALM is "the process of decision making to control risks of existence, stability and growth of a system through the dynamic balances of its assets and liabilities". In other words, ALM tries to manage the risks which derive from the discrepancy between the assets and their corresponding liabilities, cross-fertilizing risk management with strategic planning. Despite the fact that this tool, initially, started being used in order to serve the financial and banking institutions, years later this term evolved and is now is used in multiple contexts through various ways. Its use became so widespread because the strategies of ALM cover all the

balance sheet items and as a result make this process an indispensable tool for many other industries too.

Generally, the aim of Asset Liability Management is to secure the invested capitals from a broad range of risks. Originally, ALM focused on the two main risks that emerged in the decade of 1970. The liquidity problem has particularly concerned most of the economy sector. The type of funding liquidity risk, wherewith surplus management deals, arises when an institution cannot respond to its obligations and fails to cover the current and future cash flows and the expected and un-expected collaterals. It is probably one of the more frequent occurrences that can take down an establishment. Similarly, great losses are caused by the unexpected movements of interest rates that influence the future cash flows. In the banking sec-tor, this risk results from the mismatches between the deposits and the loans offered to the borrowers. Soon thereafter, the usage of Asset Liability Management concentrated upon other risks that plague the market. As the stock exchange market broadened and the banking industry expanded, the credit and currency risks started to significantly affect the performance of these sectors. The immediate consequences of the default on the response to the required payments elicit losses of the initial capital and interest, and an upheaval of the liquidity and the collection costs of each institution. Credit is maybe one of the most important and most difficult to manage risks; for this reason, a different aspect of ALM is used in order to handle this type of risk with greater effectiveness. Currency risk that arises when there is no equivalence between the exchange rates of different currencies where the cash flows as-sets and liabilities are applied can also be minimized by the use of Asset Liability Management. The function of ALM is hedged and operates based on internal rules. Under these rules, ALM respects all the components that contribute to the expenditure of any kind of investment, such as a set of rules and regulations, as well as the management of all potential risks. Moreover, it is extended to the optimization role in which it attempts to elaborate and finally generate the required results upon the balance sheet position to manage the funding costs as efficiently as possible. How-ever, its field of application does not cover only the prudential

component and the optimization scope. ALM is also used expatiating, in the activities of businesses, in a consultation role. More specifically, ALM is used to analyse all the options and financial conditions, under what circumstances a project will take place, and to identify the possible risks that may arise during the procedure of an investment. In addition, after running this analysis, ALM can also determine whether the permissible conditions exist in order to successfully run the project.

All the aforementioned tasks constitute the reason for the increasingly widespread use of Asset Liability Management. Nowadays, financial organizations and a considerable number of corporations, even pension funds and insurance companies around the world resort to this manner of strategy management, applying at least some of ALM's techniques.

1.1. Contribution of ALM to Pension Funds

A field which demonstrates the essence of the proper ALM strategy is that of pension funds and insurance companies. As mentioned the published paper by the Research Foundation of CFA, Ronald J. Ryan (2013) claims that according to the financial theory, ALM should be applied, under the same conditions, to both the financial and banking sectors as well as to the pension and insurance funds. So, in accordance to this view, since all the liabilities are threatened by the same interest rate risk (known, also, as a systematic risk), the Asset Liability Management should not make any discrimination in its implementation. The efficient management of the pension funds contributes, indisputably, to the proper functioning of a healthy economy. For more than 20 years now, this field comes across a significant amount of shortfalls in pensions due to deficiencies in regulations. In order to find the key answer to this issue, many researchers tried to investigate how the strategy of ALM can be used to affect and optimize the performance of pension funds. One of the first risk managers, who impressed with the efficiency of his surplus management in pension funds, was Ruud Kleynen, a prominent risk manager and consulter with a

brilliant career, in the recent years, as professor of risk management too. He composed an article, referring to the case study of "StichtingPensioenfonds ABP", enforcing, in practical terms, the Asset Liability Management in the Dutch pension.

After a long investigation, in which Kleynen considers the policies of pension index as well the completed investments, he was able to reach some key results. The paper analyses the two procedures that govern the implementation of the ALM in pension fund. Ruud Kleynen, firstly, gives special attention to risks that could arise, recording all the possible returns in each case. For instance, he referred to the investment risk and the wage growth/inflation risk, trying to quote how they can affect the desirable returns. In the next stage, through this article, he tries to explain how efficiency is defined, in order to clarify what is meant, citing the four conditions that a risk/return profile should fulfil. In the next step, the risk manager is able to create the respective risk/return profile which will be efficient and will take into account all the risk factors that may threaten the outcomes of an investment. But, after the careful analysis, Ruud Kleynen also measured and provided the appropriate future predictions for the future returns, through the usage of VAR model, given a risk attitude. Based on some hypothesis, he managed to obtain a global view that would lead to more secure decisions and therefore to more profitable results.

Ruud Kleynen summarizes in this paper the idea that "The ultimate choice of the combination of portfolio composition, target funding level and the size of buffer capital is a matter of policy, with short-term and long-term effects counterbalancing each other". He managed to prove, also that the conditional index is a crucial key factor for the most appropriate and effective risk/return profile.

Asset Liability Management has been used for many years in the sector of pension funds. Another two professional managers of pension funds, Sharpe and Tint (1990) attempt to find approaches that would deal with the liabilities which affect the bene-fits of a portfolio. Their research focused on the equilibrium point of the assets and liabilities where offers to investors provide maximum utility. According to the paper, this utility can be produced by the hedging of liability which

is related to the covariance between the assets and liabilities, as well as the ratio of current assets to cur-rent liabilities, but inversely related to the investor's risk tolerance.

In this article, they take hypothetical cases and analyse the processes for the surplus optimization as well the hedging of liabilities credits and refer what is its real usage in pension funds. Additionally, they extend those to other applications of the strategy and, finally, reach the conclusion that the liability hedging credits allow the offices to make the best decisions for the asset classes considering the impacts of others, exercising control. In this way, they will obtain an optimization in funds in the long run.

1.2. Construction & Techniques of Asset Liability Managements Policy

As we mentioned in the begging, the goal of Asset Liability Management is to manage the gaps between the assets and the respective liabilities of either financial or any other types of investments. Its core, as in most of financial instruments, is split in two main sections. The first one concerns the management of the gaps, while the second refers to the application of dynamic techniques that measure and finally minimize these occurring gaps.

Despite the fact that the technical part has to deal with many difficulties during the course of implementation, the analysis of the both sides of a balance sheet is the key for an efficient ALM. In this first part, all assets and liabilities should be identified, recording, also, the percentages of their maximum sizes based on formal policy. In the next step, in accordance to principles of finance, we must allocate both assets and liabilities, in order to eliminate the high degree of risk. Generally, in this phase of analysis, the diversification relies on historical data considering their trends and their reactions on the market's changes. Nevertheless, the diversification for each side of the balance sheet must be grounded also in

additional factors. For the efficient allocation of assets, the levels of risk must be taken into account as well the returns for each asset in combination with the annual targets which have been set, and the regulations and the restrictions upon the lending process. The case of liabilities allocation focuses on the types of funding and considers also their volatility as well as the differences in the costs that may arise.

In addition, a further aspect of this strategy is to examine the correlation that exists between the maturities and the terms. ALM, also, controls and analyses the liquidity position, reporting the ratios and the predictable Net Cash Flows (NCF), while detecting alternative sources of financing. At the same time, it determines the appropriate techniques in order to control and measure the interest rate risk and the credit risk if it is necessary. Furthermore, its operation area is expanded to financial derivatives too, where it is responsible for the derivative transactions and the analysis of the respective management. In other words, ALM exerts control to the usage of this financial product. Apart from these uses, ALM has an active role in practical decisions up-on the monitoring of ALM's position that an institution holds as also in the selection of the most suitable tool that is going to be used in order to monitor this framework. At completion of the first part of ALM, it is obligatory to inform the board of directors, providing a detailed report of the frequency and the content of the process. Although the ALM policy intervenes in the policy of liquidity, they are both connected and correlated since the investment decisions and securities are co-dependent.

In the sequence, we are going to analyse how the ALM is applied in practice and what techniques are used in order for the analysts to make the best profitable decisions for the investments. For many years, professionals around the world tried to develop different approaches in order to manage the gaps between the assets and liabilities, considering the cash flows analysis, and search for models to adjust them in their own duration tandem. Because the measurement of duration is, usually, impossible, these techniques involve scenario analysis and liquidity risk analysis in some occasions, where they take into consideration some hypothetical cases.

Generally, a series of number processes should be followed so that these techniques can have an effect. In these scenarios, analysts are bound to analyse the movements of several interest rates and record all their possible changes within a pre-specified time. Thus, it would be able to depict, approximately, the entire yield curve. Subsequently, risk managers should make forecasts of the balance sheet, for every single scenario, by implementing different assumptions that refer to the performance of institutions; in which they have included the rates of debts as well as insurance products that the organizations has obtained and the general financial position of either a firm or bank. In the case of poor provisions in scenario analysis, ALCO intervenes in order to readjust the assets and liabilities and clarify the index of exposure to risks.

Unfortunately, because these techniques are based upon theoretical scenarios which are evaluated on market value and might omit some crucial issues running the analyses, the predictions might be misrepresented. Nowadays, due to the extent of the liquidity problem that is accrued, an integral part of asset liability management is the liquidity risk analysis. (http://www.riskencyclopedia.com/articles/asset-liability-management/)

As the financial market was expanding securities proliferated, the need for more hedging strategies arose. So, the use of Asset Liability Management tried to eliminate more risks such as interest rate, liquidity, exchange and also asset-liability risks. In this framework, more corporations seeking protection against the rising risks with-in an open market applied the strategy of Asset Liability Management. Using the most appropriate techniques for each occasion, firms try to minimize their exposure to risks while they attempt to reduce their expenses in order to achieve their goals and gain the maximum attainable profits.

A large amount of surveys have been conducted at times, by professionals from various industries in an attempt to examine whether the techniques of ALM are effective. Amenc, Goltz and Schröder, (2009) carried out a research that examined this type of risk management in the private banking sector. This survey brought to

the surface the potential advantages and challenges of asset liability management, and how the private bankers and the related practitioners react to the risk management using the asset liability management. According to the results, the authors concluded that “Against the backdrop of this critical judgment, ALM is perceived to be a source of sustainable improvements within the private banking industry. The main advantage of ALM is perceived to be its ability to manage clients’ long term- risks.” This paper contributed, to a large extent to private banking industry; as its results focused on the challenges that this industry faces, proving that the implementation of ALM techniques, the new risk management, should be the key for the efficient operating of the sector.

1.3. Supervision of Asset Liability Management-ALCO

In every service of the financial and banking sectors the surveillance board of super-vision constitutes an integral part; thus Asset Liability Management operates under establishment supervision. The Asset Liability Committee of the Board, known as AL-CO, was conceived as a risk management committee, in order to control the good functioning of ALM. Its operations spread in three major fields, imposing its commanding position upon the risk management department of either a bank or financial institution. ALCO constitutes the Chair of the asset liability department and consists of at least four directors who are appointed by the Board of Directors each year. Since the members are appointed the Board of Directors is also responsible for selecting the Head of the council.

The Asset Liability Committee is obligated to hold meetings at least once in every quarter, but whenever deemed necessary ALCO arrange meetings in order to intervene and find solutions in any problem that may arise with ALM.

The main purpose of ALCO is to exercise control on the process of ALM, even though there are many more responsibilities and duties that it has to deal with. Primarily, we must emphasize the most crucial responsibility of it, which highlights

its leading position: ALCO monitors the managing procedure, observing, initially, the function of any institution through the levels of capital, the activities, as well the political bases under which each separate organization operates. In addition, since ALCO has a general overview, it evaluates the efficiency of the management which is applied upon the identification and minimization of risk and tries to impose the risk exposure limits. In this way, the committee ensures the correct function of the ALM Policy, ex-tending its duties to the set of issues that could emerge at any time under different conditions.

However, all these actions derive from an important information system, MIS1, which is provided by the Asset Liability Committee and applied to the activities of Asset Liability Management. When ALCO completes this overview, it conducts a re-port of the financial institution's position with ultimate goal to consider, discuss and analyse the specific ALM Policy used in every single case.

In the next step, the ALM's activities should be approved by the Board of Directors and so in this phase ALCO shows up again with the role of intermediary. Its obligation is to cite the recommendation of both management and ALM Policy to the supervisor; if the strategy seems to be profitable and effective for the firm then it will be implemented immediately. Otherwise, the board of Directors has the right to interrupt the process, searching for another and more efficient strategy of management that would lead to the desirable effects.

In the banking sector, an industry which is extremely volatile and significant for an economy, the existence of an Asset Liability Committee ensures to some extent the stability in the sector's operations and therefore the investments that are carried out. More specifically, ALCO oversees the major policies that are followed by the analysts when they run processes. Since the management prepares and implements the bank's policies, ALCO is called upon to asses all these, and makes conclusions regarding the expected outcomes and the possible threats which may jeopardize the productiveness and the profitability of the sector. These enterprise policies are:

- Investment Policy
- Liquidity Policy
- Interest Rate Risk Policy
- Capital Policy
- Asset Liability Management Policy (ALM)
- Regulation F Policy
- Foreign Exchange Policy
- BOLI Policy2
- Affiliate Expense Policy

Additionally, the committee takes into consideration even more factors that may be dangerous for returns. For example, it exercises control upon the market risk that includes both investments and their derivatives. ALCO monitors exchanges, purchases and the residues of investment's disposition, as well as analysing the status of derivatives, including their maturity profiles, their quality and the risk exposure of the invested portfolio, criticizing, eventually, their performance. Generally, the aim of Asset Liability Committee is to supervise the risk management system of the financial and banking sectors, controlling all the departments, and ensuring the best possible returns in investments. (https://www.fedpartnership.gov/bank-life-cycle/start-a-bank/asset-liability-management-committee)

2. Asset Management

In the early years that the stock exchange market began to thrive in most development countries, the term of Asset Management appeared. In the financial world, with the term Financial Asset Management, analysts refer to the efficient

professional management of investments, funds and clients account on behalf of others. Asset managers are, in other words, responsible for the best decisions making that regards the proper activities which lead to the best achievable handling of money. Such investments may be made by either institutions or private investors who would set the target of earning enough money to achieve their goals.

There is a large variety of securities and assets that can be consolidated in a perfect diversified portfolio, creating a new investment. The way that each investment is managed, professionally, varies according to the different composition and type of investment.

While in most cases the asset management refers to collective investments, many investors prefer another type of asset management in which they handle, on their own, the invested capital and it is known in the financial and banking world as port-folio management or private banking. (http://www.investopedia.com/terms/c/collective-investment)

In the broader sense, Asset Management refers to the different systems which were developed and have been used by managers in order to monitor and exercise control to tangible and intangible assets. Even though Asset Management seems to be mostly relevant for the financial and banking sector, it is also used and can be equally effective to other industries too. For instance, some of these assets are the property of the firm such as buildings, lands etc, the financial assets, the goodwill and the human resources. In the engineering sector, this concept refers to best attainment returns as well the best possible supply of services through an effective monitoring on their systems. (https://en.wikipedia.org/wiki/Asset_management)

In order to apply the most appropriate strategy of Asset Management and reach the greatest returns, analysts try to forecast the results of each strategy. For this reason, they dedicate a lot of their time to the analysis of the financial statements, and the status of each stock and asset which is included in the invested portfolio. They also record in every detail how, efficiently a specific plan is applied,

observing the projected results. The general purpose of Asset Management is to measure the volatility of the market, meaning the risk tolerance for each investor, and, of course, it defines the aims right before the investment takes place.

2.1. Techniques of Asset Management

Asset Management is definitely one of the financial topics started to attract more and more interest from the begging of its inception and implementation. Since the market was, always, extremely prone to any changes in the environment and the overall state of the economy, a high degree of risks has been arising. This is the main cause that high levels of volatility govern the market. Therefore, investors and man-agers took to the usage of different techniques of Asset Management strategies that guarantee more stable returns. The value of the security that Asset Management provides led to a large number of studies tried to prove that the Asset Management could be a useful tool to all industries, providing increased profits and better returns.

Some of the most significant and effective techniques seem to be listed in the paper “Asset Management Techniques”. Seven Germans researchers conducted a deep investigation about how the techniques of Asset Management can be applied to assist electricity markets. Such industries are threatened by the high degree of competition that influences the cost effectiveness of the respective firms in the sector. So, Joachim Schneider and Armin Gaul from the electricity industry, Claus Neumann who joined in the sustainable transformation of European energy system, Jürgen Hogräfer and Wolfram Wellßow involved in the distribution of energy, Michael Schwan and Armin Schnettler who work on the Research Foundation for electrical equipment and power industry eV (FGH), a German non-profit research organization based in Mannheim, (2005) tried to provide another dimension of Asset Management, as well to demonstrate its usage in risk management.

Throughout this paper, the fundamental asset management tasks are defined in an attempt to find equilibrium between the clients' requirements regarding the products, and the services quality related to their prices. Moreover, these tasks should be interrelated to the demands of shareholders, meaning that their invested capital should be returned back as profits.

The sensitivity of these sectors to any exogenous factors that can significantly influence the operations and the returns of each company require the applications of the best available techniques of Asset Management. According to the authors, Asset Management has to deal with four challenges. The first one refers to the classification of the strategy and also to the objectives of shareholders. The second challenge is the significance of the equilibrium between reliability, safety and financial considerations, while the third in the ranking is about the benefits from the performance of the rates. Last but not least, a major challenge that the strategy has to face is the existing regulations which define the regulations and affect the outputs. The four challenges require specific techniques to be overcome.

The paper lists five techniques, which are best suited to the electricity sector, placing the engineering in the background due to the need for short term results and customer services. The technique which is first analysed by the researchers is the Maintenance strategies. They start by analysing the four types of Maintenance strategies referring to the procedures and the appropriate classifications which should be performed for each one of them, as well the respective results. Another technique that is mentioned in this investigation is the Determination of component condition. In this method the whole process is based on the approximations and the statistical aspects that lead to the definition of a certain risk, and so, eventually, compose the appropriate component conditions. The next strategy is based on the usage of dynamic systems, proving how necessary are these systems, and how they may prove effective even when the data is poor. To resolve this, the Asset Simulation is used in order to cover the need of future predictions for long term monetary effects. The procedure which is followed in this strategy is analysed and recorded step by step, providing an analysis of this strategy.

The next strategy analysed in the article is one that concerns the Statistical fault analysis and statistical asset management approach applying Asset Management in Distribution Networks. As the analysts (2005) explain, “Different statistical approaches vary in their level of complexity and the focus of the analysis. The range is from practice-proven methods aiming at preventing the deterioration of components beyond certain levels to comprehensive approaches considering failure and ageing models of the components, which are currently developed by many different institutions worldwide”. They also present both the statistical fault analysis and comprehensive statistical asset management approach, and complete the report of this method with a research project aiming to collection information for the distribution systems and the network operators. The last strategy that is described in this paper refers to life management or, in other words, asset management transmission system. In order to give a better explanation of this method, analysts provide an ex-ample through which the process can become more comprehensible, analysing all the phases of this strategy.

In summary, Schneider, Gaul, Neumann, Hogräfer, Wellßow, Schwan, Schnettler, (2005) claim that “The actual challenge of asset managers is very often not on the methodical side but lies on the IT side to support asset management decisions”. For this reason, they believe that there is essential need for the development of integrated IT systems, which would be include decision tools, evaluation of the results, data analysis and network estimation that would deal with asset management. In this way, asset managers will be able to engage in the best decision making, finding the balance between supply quality and the determined budget.

3. Difference between Asset Liability Management and Asset Management

In this part of the thesis, we are going to mention and analyse the main differences between Asset Liability Management and Asset Management. Although, they have almost the same basic structure in the sense that the goal for both Asset Liability Management and Asset Management is to manage investments, targeting to the highest obtainable efficiency with the maximum attainable returns, there are some differences in many key points.

Despite the fact that their aim is the same, the choice for the most appropriate strategy for each occasion is based upon the needs of the individual or the firm that invests its capital, as well as any obligations that it may have to deal with. Asset managers are obligated to check the financial position of the investor and take into account all the factors of his environment before the investment takes place. In this way, they will be able to accomplish a successful and profitable investment.

The fundamental difference lies in the discrepancy between the term assets and liabilities. With the usage of the term assets we mean the economic value of all re-sources that a company or an individual obtains and expects that in the future this value will be transformed into income. On the other hand, the term liabilities are used in order to describe the economic value of all the obligations that a firm or individual should fulfil in the future. In other words, liabilities are responsibilities which arose due to past transactions that were held.

The major difference between ALM and Asset Management lies in the manner that each of these strategies operates and manages an investment. In Asset Management, professionals aim to apply the most efficient handling of an investment, achieving the highest achievable returns. In contrast to this strategy, Asset Liability Management is responsible for managing not only the assets but liabilities too.

Actually, the ALM works in such a way as to deal with the mismatches that emerge from the assets and liabilities, analysing the gaps between them. This gap analysis is defined by two major concepts which both contribute to the efficient operations of ALM. At first, the gap analysis takes place, including the comparison of the firm's actual performance with the expected performance, taking into consideration whether during the whole process all the available resources were used effectively. The second dimension of the term concerns the other part that Asset Liability Managements aims to cover; the large amount of risks that arise while running an investment. So, an integral part of ALM process is risk management, which is another main difference from the Asset Management. Here, the gap analysis refers to the analysis and the estimation of interest rate risk and liquidity risk which are the most common arising threats, which affect the returns and the profits of investments.

In a survey conducted by Griselda Deelstra and Jacques Janssen, entitled "Interaction Between Asset Liability Management And Risk Theory: An Unsegmented An a Multi-dimensional Study", ALM strategies were applied in insurance companies in order to face mismatches of assets and liabilities that arose because the time of the liabilities' value exceeded the time value of the assets. Unlike the strategy of Asset Management, ALM took into account both the active and passive side of the balance sheet and run the necessary processes of the Jansen Model. In the paper, the authors extend the model and manage to add fixed income securities, extending the investments of insurance sector, which is mainly limited to bonds. They explain that they focused on a model where the assets could be represented only by zero coupon bonds and in cases in which the rates of returns have been presented by an Ornstein-Uhlenbeck process or by a Cox-Ingersoll-Ross process. These two procedures were shown to be quite similar. The authors also estimated the risk at time T, including all the different measurements, into a case study. The results were impressive and rendered this paper not only useful for the implementation of ALM in insurance sector, but also in the investor and broker relation.

Chapter 2: Literature Review

In recent years, the asset- liability management has been a victim of criticism and debate. The reason behind is that there is ample evidence of techniques in order to construct a useful asset and liability management (ALM). Many economists try to investigate the most proper approach for an ALM which produce desirable results.

Amenc et al.(2009), conduct a research about the inflation-hedging properties with the use of either vector-autoregressive model or cointegrated Var. Their analysis is based on real assets and their results present increasing interest. In particular, they focus on the inflation-driven liabilities and the returns of real assets such as bond and real estate in order to find the link between them. They find that the long-term bond liability hedging is a useful investment tool since the cost of inflation is eliminated. According to Amenc et al.(2009) : "novel liability hedging investment solutions, including commodities and real estate in addition to inflation-linked securities, can be designed to decrease the cost of inflation insurance for long-horizon investors."

Mazzola and Gerace (2015), investigate the performance of portfolios using the Capital Asset Pricing Model (CAPM). To illustrate this, the aforementioned optimal portfolios consist of Australian securities and for the aim of their analysis they use different approaches in the two examined portfolios. It is worth-noting that the transaction costs are take into account in this research, since it is believed shown that transaction costs affect CAPM returns in a negative way. The first portfolio uses an approach with a static investment horizon, while the latter is based on a dynamic approach with a rebalancing portfolio. Their results highlight that the dynamic port-folio outperform the one which use a static investment horizon.

Dash et al.(2005), construct a research on asset- liability management for banks using a linear programming model. Their research focuses on the banks' sensitivity in liquidity, profitability, and interest rate risk. They show an optimal set of assets and liabilities in banks resulting in a growing profitability and constant

liquidity position. Their results show that banks in the public sector present the most satisfactory results in accordance with their liquidity and their low amount of interest rate risk. It is stated that the key of success for banks should be the accounting of liquidity, profit-ability and interest rate risk.

Berkelaar and Kouwenberg, (2010) formulate investment portfolios, based on a liability-relative drawdown optimization way (LRDD). Therefore, the pension funds are the case of their analysis and the liabilities of the tested pension funds are included in their research. They suggest that this approach provides many benefits in comparison with mean-variance optimal portfolios. Their research shows that the liability driven optimization is an approach which offers better diversified portfolios with higher returns than surplus optimal portfolios. Moreover, the researchers present that the drawdown portfolios are less vulnerable to abnormal shocks. Similarly, Reveiz and leon, (2008) state that drawdown optimization outperforms mean-variance approach.

There are numerous papers which occupy with the asset liability management (ALM) of banks. Among them is the paper of Lileikiene, (2008) which highlights the significance of the asset liability management strategy for every bank in order to improve their performance. This research also states that net interest income (NII) is a crucial ratio that every country should take into account. For that reason, there are three NII strategies for a successful asset liability management. The author suggests that banks should be careful before choosing the appropriate ALM strategy for them. Finally, Lileikiene, (2008) states that "Trying to hedge against interest rate fluctuations and instability in the financial market the best option would be zero strategy, be-cause the bigger NII, the higher risk the bank faces."

Similarly, the research of Chakroun and Abid, (2013) make an analysis of a Tunisian commercial bank's asset liability management. For the aim of their analysis, they implement a Goal Programming (GP) approach in order to improve the ALM of the tested Tunisian commercial bank. Their results present some notable differences with present values of the tested bank's balance sheet and strongly support that a

Goal Programming approach provides better results compared to the strategy used by the bank. Specifically, the paper indicates that a bank with the use of a GP model can not only enhance its liquidity and maximize its loans and deposits, but also meet its target values efficiently.

Toms, (2014) is a recent study which makes a comparison of discount rates between an accounting- based risk management approach (ABRM) and the capital asset pricing model (CAPM). Discount rates have often been approached by the CAPM while Toms (2014) strongly suggest that ABRM is a useful model that provides better results, compared to CAPM. Regarding their results, it is shown that in the majority of the tested firms, the cost of capital is lower when the accounting-based risk management model is used. In particular, the obtained discount rates are similar in both models (CAPM, ABRM), while the cross-sectional distribution present differences with the use of the two aforementioned models. This fact gives the indication that the discount factors obtained from the capital asset pricing model exaggerate the systematic risk.

Jones and Brown, (2009) note that mean-variance optimization (MVO) is a useful method for a successful asset liability management. Therefore, they use MVO in as-set liability management for an individual investor, while they provide the advantages of such approach. Specifically, it is stated that with the use of MVO, investor are not subjected to extravagant risk. Moreover, Kosmidou and Zopounidis (2004) analyze the balance sheet of a commercial bank in Greece which faces several financial problems, (for example creditworthiness and liquidity) and find difficult to reach the target result in its balance sheet. For the purpose of their analysis, the researchers make use of not only a simulation analysis, but also a goal programming approach. Regarding their results, the largest source of bank's profitability is based on loans and deposits and for that reason it is crucial for banks to make some changes in their operations in order to reach their goals. A previous research which also occupy with a Greek commercial bank in order to improve its profits and eliminate its risk, is the paper by Giokas and Vassiloglou, (1991). To reach their goals,

they establish a goal programming model (GP), highlighting the usefulness of GP approach.

Chapter 3: Methodology and Data

Methodology

In this chapter the aim is to discuss the methodology which is followed in the empirical part of the dissertation. First, data and variables are presented. Then, research methods implemented are discussed.

Data and variables

In order to perform the empirical analysis, data was collected from Bloomberg database. Those are:

1. FTSE-100 index close prices (monthly, 29/5/1992-31/12/2014)
2. Ice LIBOR 3M close prices (monthly, 29/5/1992-31/12/2014)
3. UK Government Bond 20Y Net Generic Bid Yield (monthly, 29/5/1992-31/12/2014)
4. FTSE Actuaries Government Securities UK Index Linked All Stocks (monthly, 29/5/1992-31/12/2014)
5. FTSE-100 companies' close prices (top-20 by volume, monthly, 29/5/1992-31/12/2014)

The FTSE-100 companies which are in the top-20 according to the volume of transactions are: Lloyds Banking Group Plc, Glencore Plc, Vodafone Group Plc, Barclays Plc, BP Plc, Tesco Plc, Old Mutual Plc, HSBC Holdings Plc, Anglo American, Centrica Plc, Legal & General Group Plc, BHP Billiton Plc, International Consolidated Airlines Group, Standard Chartered plc, BT Group Plc, BG Group Plc, Morrison Supermarkets, Royal Dutch Shell A Plc, ITV Plc and Royal Dutch Shell B Plc.

FTSE-100 is actually the market price index for the aforementioned companies. The stock of each firm is regarded as a risky asset. Government bonds are regarded as riskless asset and LIBOR as the risk-free rate.

Research methods

The objective of the research is to establish two trading strategies, which refer to asset management and asset liability management respectively. In order to compare the performance of the two strategies, we will consider that institutions wish to allocate optimally their assets and liabilities in the period 01/01/2014-31/12/14. As data for the aforementioned period was retrieved, it will be feasible to prove the effectiveness of each approach.

The first step is to estimate the efficient frontier and construct an optimal portfolio for the period 29/5/1992-31/12/2013, involving stock returns of FTSE-100 companies, as well as the riskless asset (UK Government bond) and FTSE Actuaries Government securities. Estimation of the efficient frontier is based on Markowitz's mean-variance methodology. The basic components in the Mean-Variance model are the variance-covariance matrix and the vector of monthly returns of the stock returns. According to portfolio theory, the aforementioned quantities are known. Actually, the latter need to be estimated based on the historical returns of stocks. To have meaningful estimation, large number of historical returns is needed (Markowitz and Todd, 2000). In this case, we are interested in constructing efficient portfolios for the period 01/01/14-31/12/14, i.e twelve months. Based on historical returns, for each month we have in total 246 scenarios. This is because we have in total 21 years of historical returns (1992-2013) and 12 months in each year. The only exception is 1992, in which we have six months of data only. Thus, we end up with 246 scenarios. Thus, efficient portfolios for the period 01/01/14-31/12/14 will be constructed taking into consideration desired returns. Following the methodology of backtesting, the periods involved in the model are: 29/05/92-31/01/14, 30/06/92-28/02/14, 31/07/92-31/03/14, 31/08/92-30/04/14, 30/09/92-31/05/14, 31/10/92-30/06/14, 30/11/92-31/07/14, 31/12/92-31/08/14, 31/01/93-30/09/14, 28/02/93-31/10/14,

31/03/93-30/11/14, 30/04/93-31/12/14. This allows maintaining the same number of scenarios (months) in each period's optimization problem. The model will be the following (Markowitz and Todd, 2000):

$$Min\sum_{n=1}^{246} prob(n)\left[\sum_{i=1}^{22} x_i r_i^{\,n} - \sum_{i=1}^{246}\sum_{i=1}^{22} prob(n) x_i r_i^{\,n}\right]^2$$

$$s.t\sum_{n=1}^{246}\sum_{i=1}^{22} prob(n) x_i r_i^{\,n} \geq \mu$$

$$\sum_{i=1}^{246} x_i = 1$$

$$x_i \geq 0, \forall\, i$$

Where n the number of scenarios, each one having equal probability to occur, 1/246, i the number of assets (22 in this case) the weight of each asset in the portfolio and the return of the asset i under the scenario n. Therefore, for each of the 246 scenarios, we will find the weights of the portfolios which intend to minimize risk (objective function) with the constraint of a specific desired total return of the port-folio. As for the constraint, three different cases will be taken into consideration. First, the constraint of the desired return will be ignored. Then, the desired return will be set to 5% and 10%.

Having calculated the weights of each asset involved for each month in the period 31/01/14-31/12/14, it is then feasible to calculate the returns which would have occurred if the institution has followed the mean-variance model to construct the efficient portfolio. The return of the portfolio is the sum of the products of weights with the actual returns of stocks. The variance of the portfolio is the sum of

the product of squared weights with the actual variance of each stock plus two times the product of weights with the covariance between the assets.

Risk-adjusted performance

Having calculated the returns and variances of the portfolios the next step is to find the risk-adjusted performance. Three measures will be taken into consideration. Sharpe ratio, Treynor ratio, as well as Jensen's alpha. Sharpe ratio measures risk-adjusted performance through the combination of expected portfolio return, the risk-free rate and the portfolio standard deviation (Ross and Westerfield, 2012):

$$S = \frac{\overline{r_p - r_f}}{\sigma_p}$$

Where:

S=Sharpe ratio;

= return of the portfolio;

= risk-free rate (here LIBOR rate) and

=standard deviation of the portfolio.

Higher values of Sharpe ratio denote higher risk-adjusted performance of the portfolio (Ross and Westerfield, 2012). As for Treynor ratio, it is similar to Sharpe ratio. The difference is that beta captures the risk of the portfolio instead of standard deviation (Ross and Westerfield, 2012):

$$T = \frac{r_p - r_f}{\beta}$$

Where:

T= Treynor ratio;

= return of the portfolio;

= risk-free rate (here LIBOR rate) and

β=beta of the portfolio.

Betas were calculated with the use of the CAPM model. Return of the portfolio was regressed on the difference between the market's and riskless asset's returns in the period 01/01/14-31/12/14. The coefficient of the difference between market's and riskless asset's returns is the beta of the portfolio. Higher values of Treynor ratio denote higher risk-adjusted performance.

Jensen's alpha does not follow the rationale of the two methods described (Ross and Westerfield, 2012). Taking risk level as given, it calculates abnormal returns of the portfolio (Ross and Westerfield, 2012):

$$\alpha_{p=}\overline{r_p} - \left[r_f + \beta_p(\overline{r_m - r_f})\right]$$

Where:

= Jensen's alpha;

= return of the portfolio;

= risk-free rate (here LIBOR rate);

market return (here FTSE-100 index) and

β=beta of the portfolio.

Again, the higher Jensen's alpha, the higher the risk-adjusted performance.

Slope performance trend strategy

Having constructed efficient portfolios for the twelve-month period 31/01/14-31/12/14, the next step is to compare it with the slope performance trend strategy. The slope indicator refers to calculated betas for each month and for each stock involved in the sample. The strategy uses close prices of stocks as well. Its rationale is based on the simple fact that long position to securities should be taken when the slope indicator has an upward trend for a 12-month period and when the relative close price of the stock has an upward trend too for the same period. This is because upward betas denote that the stock is riskier than the market, thus yielding higher returns. The investor may have a profitable opportunity when he takes a long position in assets that have upward trends in risk and relative prices as well (Maymin & Maymin, 2011). It is important to note that risk levels need to be accompanied with higher returns as well, thus leading to higher risk-adjusted performance. The investor may take short position when the trend of betas and prices are downward. Relative prices are the ratio of close prices of stocks to the close prices of FTSE-100.

We will consider that the investor has followed the mean-variance methodology and invested its wealth in the assets as indicated for January 2014. Then, the investor will follow for the rest of months of 2014 the slope performance trend strategy in order to sell existing or buy new available assets (FTSE-100 companies stock returns, risk-less asset). As the slope performance trend requires at least 12-month data, 1992-2013 returns of assets will be used. The wealth of the investor will be put in assets that exhibit at least 12-month upward trends, especially for the months that they tend to exhibit upward trends. The investor will sell the assets that have downward trends. For each month, return and risk of the portfolio will be calculated as well, along with the risk-adjusted performance. This way, the two trading strategies will be compared in risk-adjusted terms.

The involvement of liabilities

Involving liabilities in portfolios, suggests implementation of different methods. Here, along with assets, portfolios will involve liabilities as well, which is the FTSE Actuaries Government Securities UK Index. The methodology of Sharpe and Tint (1990) will be used for the analysis. Here, the in order to calculate surpluses, full consideration of liabilities will be assumed, i.e k=1. For the efficient portfolios constructed according to both trading strategies (mean-variance, slope performance trend) for 01/01/14-31/12/14, we will consider that the investor chooses to involve the FTSE Actuaries Government Securities UK Index as a liability. Surplus for each month will be calculated as follows (Sharpe & Tint, 1990):

$$S = A - kL$$

Where S the surplus, A the portfolio's value, k the relative importance of liabilities and L the economic value of the index. The economic value is reflected from close prices, which will be considered as a stream of payments. The total value of the port-folio's assets is simply the sum of the products of weights with their close prices. The difference with mean-variance methodology is that here expected utility is maximized rather than minimizing risk. Particularly, the objective is to maximize (Sharpe & Tint, 1990):

$$\max U = E_t(R_A) - \left[\frac{Var(R_A)}{t} + \frac{k}{t} \frac{L_0}{A_0} \operatorname{cov} ar(R_A - R_L) \right]$$

Where:

R_A =the return of assets;

R_L = the growth rate of liabilities;

L_0 =today's economic value of liabilities;

A_0 = today's economic value of assets;

t=the number of periods;

k=the importance of liabilities;

Var=the variance;

Covar=the covariance.

As here evaluations will be made for a 12-month horizon, t=12. Following this methodology, the objective is to find the optimal weights of assets for each period, given the return of assets and growth of liabilities. Here we concentrate on the period 31/01/14-31/12/14. and are known. But and refer to the following period and are typically not known. Writing the return of assets as the weighted sum of returns of assets, the problem suggests that weights of all stocks will be selected optimally. For each efficient portfolio, will be calculated the risk and return, as well as the risk-adjusted measures described above. Finally, the efficient portfolios will be compared, between the cases of asset management and asset liability management.

Results

In this chapter, the aim is to present and discuss the results from empirical analysis. First, the results concerning asset management are presented. Next, results concerning asset liability management are presented.

Asset management

Efficient portfolios (mean-variance)

Here, the results concern the efficient portfolios which were constructed for the months 01/14-12/14, according to the mean-variance methodology. Each portfolio constructed is followed by its return, standard deviation and beta, in order

to calculate the risk-adjusted performance measures. The results for each month are involved in table 1, in the Appendix. As the results for each scenario showed, most of wealth should have been put in Vodafone's stock and a small portion to Royal Dutch B. This holds for every month in 2014. In order to investigate whether the methodology would have achieved minimizing risk, were calculate further the actual return it would have had, as well as the standard deviation and beta. All portfolios are riskier than the market, because betas are higher than unity for all efficient portfolios. In risk-adjusted terms, it seems that the most profitable opportunities would have come in January 2014, February 2014, November and December 2014, because risk-adjusted measures have the highest scores. The next step was to re-run for efficient portfolios in the same period, setting the desired return level equal to 5%. Again, the objective is to examine whether mean variance could have provided profitable opportunities for investors if it was taken into consideration.

The results in table 2, in the Appendix, now show that wealth is dispersed into more stocks. Specifically, mean-variance shows that 46% of wealth should be placed in LG group, 27% in Royal Dutch A, 15% HSBC, 10% in Royal Dutch B and 4% in Vodafone. In risk-adjusted terms, those portfolios are more preferable than the respective with no desired return constraint. This is plausible result, as diversification of the portfolio tends to reduce risk.

The third and final step was to extract efficient portfolios in the case the desired re-turn constraint is set to 10%. As results in table 3 in the Appendix show, wealth now is dispersed to fewer stocks than in the case of 5% desired return. However, it yields more preferable results than in the case when wealth was put into two stocks. 37% of wealth according to the methodology should have been put to Royal Dutch A, 27% to Royal Dutch B, 27% to HSBC and 9% to Vodafone. In risk-adjusted terms, this is less preferable than the portfolio with 5% desired returns. Therefore, in order to proceed with slope performance trend strategy, the latter portfolio will be used.

Implementation of a trading strategy: Slope performance trend

Here, we assume that the investor in January 2014 has already constructed an efficient portfolio, according to mean-variance methodology and based on past historical returns of stocks. His trading strategy now will be based on buying and selling stocks he already has in his portfolio throughout the rest of 2014. To this end, he ex-amines trends of betas and relative prices of all available assets. Those are the 20 stocks, along with Government Bonds and FTSE Actuaries index.

In the appendix, are provided all graphs concerning the evolution of relative prices of each asset as well as the graphs concerning evolution of betas. According to the results, the stocks which worth long position are Lloyds, FTSE actuaries index, Barclays, BG, BT, HSBC, ICAG, ITV, L&G, Morrison, Old Mutual, Royal Dutch B, Tesco and Vodafone. According to this strategy, few stocks worth to be involved into the portfolio. Thus, the investor has to sell Royal Dutch B stocks. In order to see the weights of the new portfolio, mean-variance methodology was implemented, involving only the stocks which worth to be involved in the portfolio. As the results showed, in table 4 in the Appendix, this portfolio is more preferable in risk-adjusted terms. Therefore, the fact that it was implemented the slope performance trend strategy along with mean-variance methodology allowed the investor to have more profitable opportunities for the year 2014.

Asset Liability Management

In this section, a different approach is made, based on the strategy of asset liability management and specifically setting FTSE Actuaries Index as a liability. The objective is to select optimally weights of assets and liabilities so as to increase expected utility generated from surpluses. It is important that asset management did not involve FTSE Actuaries index in efficient portfolios. Again, expected utility

maximizations concerned the same periods as in asset management, constructing efficient portfolios for each month of 2014. Adjusting the portfolios with liabilities, results are different. In order to hedge risk coming from liabilities, efficient portfolios seem to involve at a great percentage UK government bonds. In the previous case, where FTSE Actuaries index was not explicitly considered as a liability, the efficient portfolios involved mainly stocks and not bonds. It is important to note that for each month in the period examined, asset liability management achieves to have returns for the investor. In risk-adjusted terms, the efficient portfolios do not yield the same profits for the investor as in the asset management case. Efficient portfolios are involved in table 5 in the appendix.

Conclusions

The objective of the present study was to examine two different trading strategies, based on asset management and asset liability management. To this end, different portfolios were constructed. In the case of asset management, the results showed that mean-variance methodology could have provided significant returns for the investor. It is important to note that those returns were higher, when mean-variance methodology was implemented along with the slope performance trend strategy. This way, the investor could have identified profitable opportunities based on relative prices and betas of assets. Excluding all other options, he could have constructed efficient portfolios with higher returns.

In the case FTSE Actuaries index was explicitly set as a liability, results were different. In particular, hedging risk in this case meant the involvement of UK government bonds in the portfolio, for at least 50%. The rest of the portfolio comprised of few stocks. Therefore, the main difference between asset management and asset liability management in this case is that it changes the mix of assets held. Asset management techniques showed that only risky assets should be held from the investor. What is more, is that the risk-adjusted performance of both asset

management and asset liability management is good, as it achieves to yield profits for the investor.

Findings are significant, as they show that in the existence of liabilities, techniques used may allow institutions to hedge optimally liquidity risks which stem from them. Another finding that is significant to note, is that specifying for lower desired returns in asset management, yields better results in risk-adjusted terms, because the investor achieves to diversify risk.

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APPENDIX

Tables

Table 1: Efficient portfolios according to mean-variance methodology (no constraint for desired returns)

	Efficient portfolios (Mean Variance)*											
	2014m1	2014m2	2014m3	2014m4	2014m5	2014m6	2014m7	2014m8	2014m9	2014m10	2014m11	2014m12
Weights												
Government Bonds	0	0	0	0	0	0	0	0	0	0	0	0
FTSE Actuaries	0	0	0	0	0	0	0	0	0	0	0	0
Lloyds	0	0	0	0	0	0	0	0	0	0	0	0
Glencore	0	0	0	0	0	0	0	0	0	0	0	0
Vodafone	0,996	0,996	0,996	0,996	0,996	0,996	0,996	0,996	0,996	0,996	0,996	0,996
Barclays	0	0	0	0	0	0	0	0	0	0	0	0
BP	0	0	0	0	0	0	0	0	0	0	0	0
Tesco	0	0	0	0	0	0	0	0	0	0	0	0
Old Mutual	0	0	0	0	0	0	0	0	0	0	0	0
HSBC	0	0	0	0	0	0	0	0	0	0	0	0
AAC	0	0	0	0	0	0	0	0	0	0	0	0

LG group	0	0	0	0	0	0	0	0	0	0	0	0
BHP	0	0	0	0	0	0	0	0	0	0	0	0
ICAG	0	0	0	0	0	0	0	0	0	0	0	0
SC	0	0	0	0	0	0	0	0	0	0	0	0
BT	0	0	0	0	0	0	0	0	0	0	0	0
BG	0	0	0	0	0	0	0	0	0	0	0	0
Morrison	0	0	0	0	0	0	0	0	0	0	0	0
Royal Dutch A	0	0	0	0	0	0	0	0	0	0	0	0
ITV	0	0	0	0	0	0	0	0	0	0	0	0
Royal Dutch B	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004	0,004
Return of the portfolio (actual)	0,52	0,21	0,15	0,11	0,27	0,08	0,09	0,12	0,17	0,16	0,18	0,22
St,Dev, Of the portfolio	5,36	7,38	6,71	7,22	5,43	4,2	6,89	9,12	8,21	7,23	4,23	4,12
Beta	1,52	1,71	2,01	2,03	1,98	1,45	1,34	1,99	1,65	1,59	1,64	1,71
Sharpe ratio	8,77%	3,39%	1,49%	0,83%	4,05%	0,71%	0,58%	0,77%	1,46%	1,52%	3,07%	4,13%
Treynor ratio	30,92%	14,62%	4,98%	2,96%	11,11%	2,07%	2,99%	3,52%	7,27%	6,92%	7,93%	9,94%
Jensen's alpha	22%	15,00%	2,30%	1,40%	15,30%	5,00%	4,00%	3,40%	5,60%	6,40%	7,20%	6,10%

* Constraint for desired return ignored

Table 2: Efficient portfolios according to mean-variance methodology (desired returns 5%)

	Efficient portfolios (Mean Variance)*											
	2014m1	2014m2	2014m3	2014m4	2014m5	2014m6	2014m7	2014m8	2014m9	2014m10	2014m11	2014m12
Weights												
Government Bonds	0	0	0	0	0	0	0	0	0	0	0	0
FTSE Actuaries	0	0	0	0	0	0	0	0	0	0	0	0
Lloyds	0	0	0	0	0	0	0	0	0	0	0	0
Glencore	0	0	0	0	0	0	0	0	0	0	0	0
Vodafone	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Barclays	0	0	0	0	0	0	0	0	0	0	0	0
BP	0	0	0	0	0	0	0	0	0	0	0	0
Tesco	0	0	0	0	0	0	0	0	0	0	0	0
Old Mutual	0	0	0	0	0	0	0	0	0	0	0	0
HSBC	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
AAC	0	0	0	0	0	0	0	0	0	0	0	0
LG group	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46
BHP	0	0	0	0	0	0	0	0	0	0	0	0
ICAG	0	0	0	0	0	0	0	0	0	0	0	0
SC	0	0	0	0	0	0	0	0	0	0	0	0
BT	0	0	0	0	0	0	0	0	0	0	0	0
BG	0	0	0	0	0	0	0	0	0	0	0	0
Morrison	0	0	0	0	0	0	0	0	0	0	0	0

Royal Dutch A	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
ITV	0	0	0	0	0	0	0	0	0	0	0	0
Royal Dutch B	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Return of the portfolio (actual)	0,58	0,26	0,21	0,17	0,33	0,12	0,11	0,13	0,19	0,17	0,2	0,23
St,Dev, Of the portfolio	4,21	4,31	5,36	4,67	4,21	3,71	5,31	7,81	7,21	6,78	3,98	3,71
Beta	1,18	1,19	1,24	1,15	1,78	1,21	1,32	1,12	1,34	1,51	1,61	1,51
Sharpe ratio	12,59%	4,87%	2,99%	2,57%	6,65%	1,89%	1,13%	1,02%	1,94%	1,77%	3,77%	4,85%
Treynor ratio	44,92%	17,65%	12,90%	10,43%	15,73%	5,79%	4,55%	7,14%	10,45%	7,95%	9,32%	11,92%
Jensen's alpha	24,30%	11,34%	8,35%	7,89%	7,81%	4,28%	3,78%	6,71%	8,91%	5,21%	8,32%	9,21%

* Constraint for desired return equals 0.05

Table 3: Efficient portfolios according to mean-variance methodology (desired returns 10%)

	Efficient portfolios (Mean Variance)*											
	2014m1	2014m2	2014m3	2014m4	2014m5	2014m6	2014m7	2014m8	2014m9	2014m10	2014m11	2014m12
Weights												
Government Bonds	0	0	0	0	0	0	0	0	0	0	0	0
FTSE Actuaries	0	0	0	0	0	0	0	0	0	0	0	0
Lloyds	0	0	0	0	0	0	0	0	0	0	0	0
Glencore	0	0	0	0	0	0	0	0	0	0	0	0
Vodafone	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Barclays	0	0	0	0	0	0	0	0	0	0	0	0
BP	0	0	0	0	0	0	0	0	0	0	0	0
Tesco	0	0	0	0	0	0	0	0	0	0	0	0
Old Mutual	0	0	0	0	0	0	0	0	0	0	0	0
HSBC	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
AAC	0	0	0	0	0	0	0	0	0	0	0	0
LG group	0	0	0	0	0	0	0	0	0	0	0	0
BHP	0	0	0	0	0	0	0	0	0	0	0	0
ICAG	0	0	0	0	0	0	0	0	0	0	0	0
SC	0	0	0	0	0	0	0	0	0	0	0	0
BT	0	0	0	0	0	0	0	0	0	0	0	0

BG	0	0	0	0	0	0	0	0	0	0	0	0
Morrison	0	0	0	0	0	0	0	0	0	0	0	0
Royal Dutch A	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
ITV	0	0	0	0	0	0	0	0	0	0	0	0
Royal Dutch B	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Return of the portfolio (actual)	0,53	0,21	0,19	0,18	0,31	0,1	0,1	0,12	0,18	0,16	0,18	0,21
St,Dev, Of the portfolio	5,01	5,04	5,78	4,91	4,98	4,01	5,05	6,91	6,89	5,81	4,01	3,29
Beta	1,41	1,23	1,28	1,17	1,81	1,26	1,46	1,76	1,39	1,56	1,78	1,71
Sharpe ratio	9,58%	3,17%	2,42%	2,65%	5,22%	1,25%	0,99%	1,01%	1,89%	1,89%	3,24%	4,86%
Treynor ratio	34,04%	13,01%	10,94%	11,11%	14,36%	3,97%	3,42%	3,98%	9,35%	7,05%	7,30%	9,36%
Jensen's alpha	20,31%	11,34%	8,35%	7,89%	7,81%	4,28%	3,78%	6,71%	8,91%	5,21%	8,32%	9,21%

* Constraint for desired return equals 0.10

Table 4: Efficient portfolios (slope performance trend strategy)

Efficient portfolio (slope performance trend trading strategy)												
	2014m1	2014m2	2014m3	2014m4	2014m5	2014m6	2014m7	2014m8	2014m9	2014m10	2014m11	2014m12
lloyds	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
vodafone	4,40%	4,44%	4,48%	4,43%	4,57%	4,50%	4,39%	4,47%	4,14%	4,02%	3,89%	3,37%
barclays	12,99%	25,53%	36,71%	32,64%	54,32%	35,93%	19,83%	36,67%	0,00%	0,00%	0,00%	0,00%
tesco	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
oldmut	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
hsbc	16,73%	16,16%	16,32%	15,61%	16,49%	17,18%	16,91%	16,51%	15,15%	12,79%	12,57%	10,84%
lggroup	22,26%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
icag	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
bt	25,74%	35,86%	24,33%	27,57%	0,00%	11,45%	26,02%	8,70%	46,88%	50,39%	42,57%	28,26%
bg	12,08%	13,38%	13,34%	13,15%	12,39%	11,85%	11,48%	11,18%	10,78%	10,69%	9,24%	5,53%
morrison	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
royaldutcha	5,80%	4,64%	4,82%	6,60%	12,23%	19,08%	21,37%	22,47%	23,06%	22,12%	31,72%	51,99%
itv	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
ftse_actua~r	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Return of the portfolio	55,00%	31%	22%	25%	29%	23%	21%	19%	18%	17%	16%	13%
St.Dev of the portfolio	3,71	2,91	2,93	3,91	1,87	2,91	1,91	1,21	2,91	4,01	3,97	4,04
Beta	1,29	1,19	1,21	1,57	1,12	1,19	1,11	1,22	1,81	2,01	1,98	2,12
Sharpe ratio	13,48%	8,93%	5,80%	5,12%	12,83%	6,19%	8,38%	11,57%	4,47%	2,99%	2,77%	1,98%
Treynor ratio	38,76%	21,85%	14,05%	12,74%	21,43%	15,11%	14,41%	11,48%	7,18%	5,97%	5,56%	3,77%
Jensen's a	11,00%	19,00%	10,00%	11,00%	19,00%	14,00%	15,00%	9,00%	3,00%	4,00%	5,00%	2,00%

Table 5: Efficient portfolios (asset liability management)

	Efficient portfolio (asset liability management)											
	2014m1	2014m2	2014m3	2014m4	2014m5	2014m6	2014m7	2014m8	2014m9	2014m10	2014m11	2014m12
Government Bonds	55%	52%	50%	51%	48%	47%	44%	54%	52%	49%	48%	45%
Lloyds	0	0	0	0	0	0	0	0	0	0	0	0
Glencore	0	0	0	0	0	0	0	0	0	0	0	0
Vodafone	2%	3%	2%	3%	4%	2%	2%	1%	2%	3%	3%	3%
Barclays	0	0	0	0	0	0	0	0	0	0	0	0
BP	0	0	0	0	0	0	0	0	0	0	0	0
Tesco	12%	15%	17%	11%	18%	19%	15%	16%	16%	16%	17%	18%
Old Mutual	15%	11%	12%	13%	14%	13%	13%	13%	11%	11%	12%	12%
HSBC	8%	8%	7%	9%	8%	8%	9%	8%	7%	8%	9%	9%
AAC	0	0	0	0	0	0	0	0	0	0	0	0
LG group	5%	10%	10%	10%	7%	9%	10%	7%	10%	10%	8%	7%
BHP	0	0	0	0	0	0	0	0	0	0	0	0
ICAG	0	0	0	0	0	0	0	0	0	0	0	0
SC	0	0	0	0	0	0	0	0	0	0	0	0
BT	0	0	0	0	0	0	0	0	0	0	0	0
BG	0	0	0	0	0	0	0	0	0	0	0	0
Morrison	3%	1%	2%	3%	1%	2%	7%	1%	2%	3%	3%	6%
Royal Dutch A	0	0	0	0	0	0	0	0	0	0	0	0
ITV	0	0	0	0	0	0	0	0	0	0	0	0

Royal Dutch B	0	0	0	0	0	0	0	0	0	0	0	0
Return of the portfolio (actual)	0,18	0,15	0,11	0,12	0,21	0,22	0,23	0,24	0,25	0,21	0,17	0,11
St,Dev, Of the portfolio	3,21	3,73	2,95	3,05	3,15	3,22	3,98	2,91	3,21	3,45	3,67	3,21
Beta	0,81	0,95	0,96	1,01	0,98	0,76	0,98	1,04	1,1	1,05	1,07	0,97
Sharpe ratio	4,05%	2,68%	2,03%	2,30%	5,08%	5,28%	4,52%	6,53%	6,23%	4,64%	3,27%	1,87%
Treynor ratio	16,05%	10,53%	6,25%	6,93%	16,33%	22,37%	18,37%	18,27%	18,18%	15,24%	11,21%	6,19%
Jensen's alpha	12,00%	7,85%	4,22%	4,64%	11,25%	17,09%	13,84%	11,74%	11,95%	10,60%	7,95%	4,32%

Graphs

Evolution of relative prices

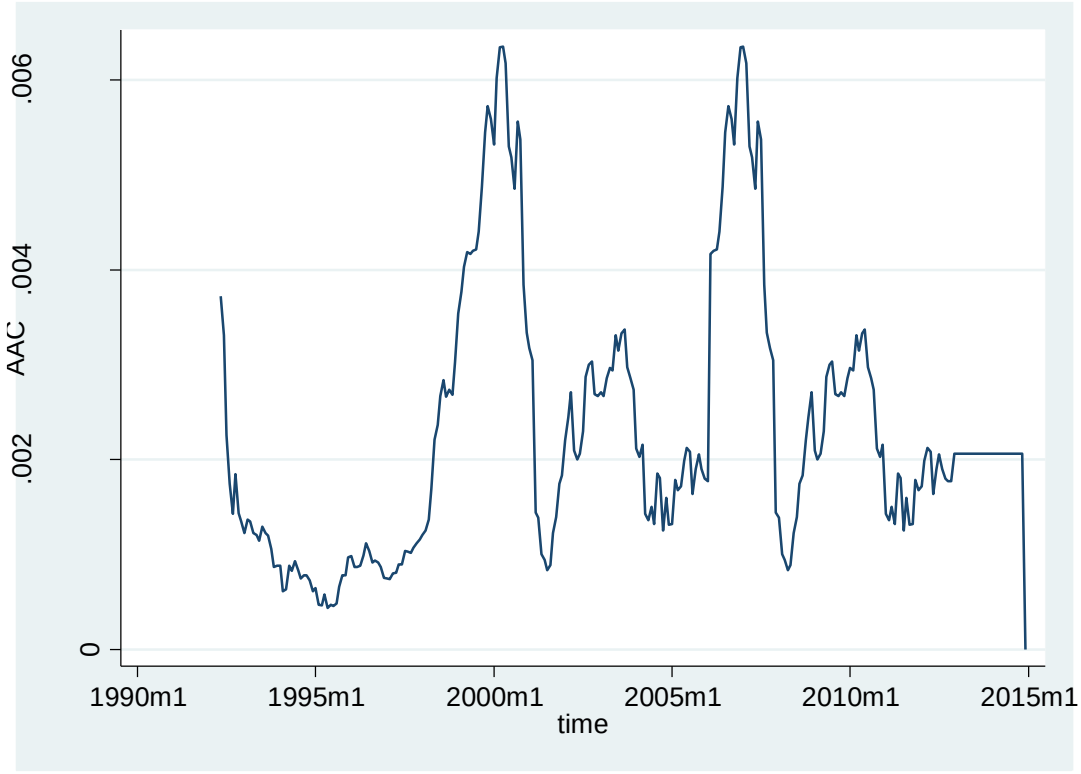

Figure 1: Relative price evolution (Lloyds)

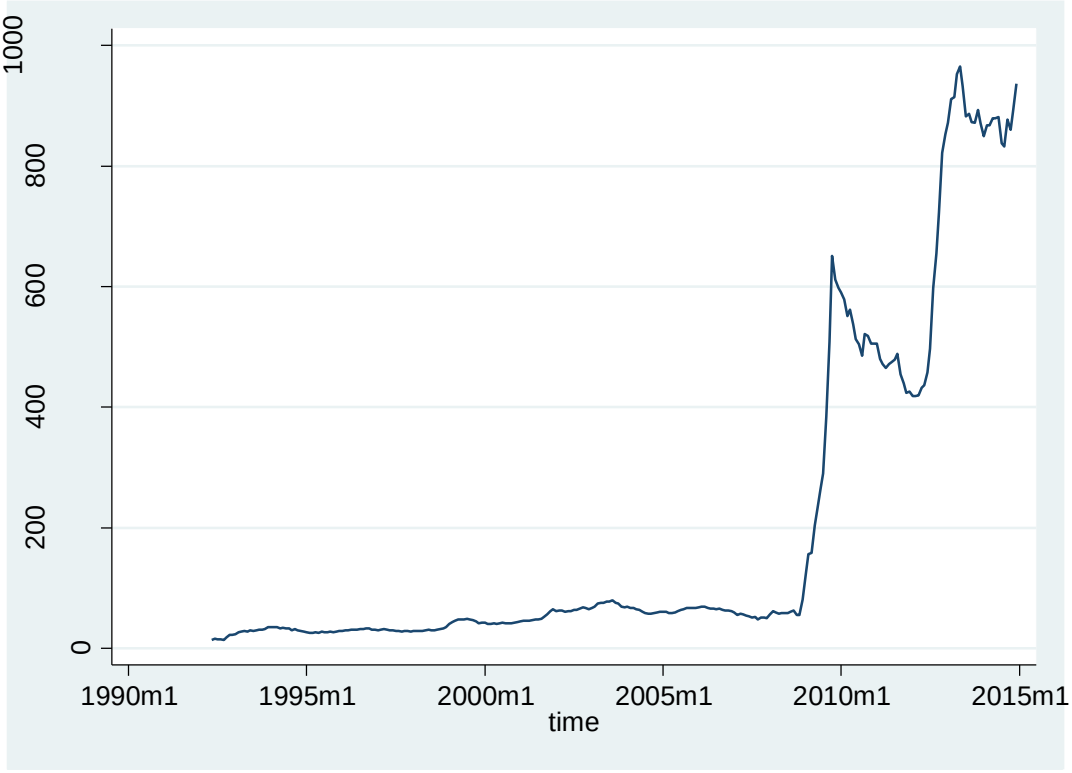

Figure 2: Relative price evolution (FTSE Actuaries index)

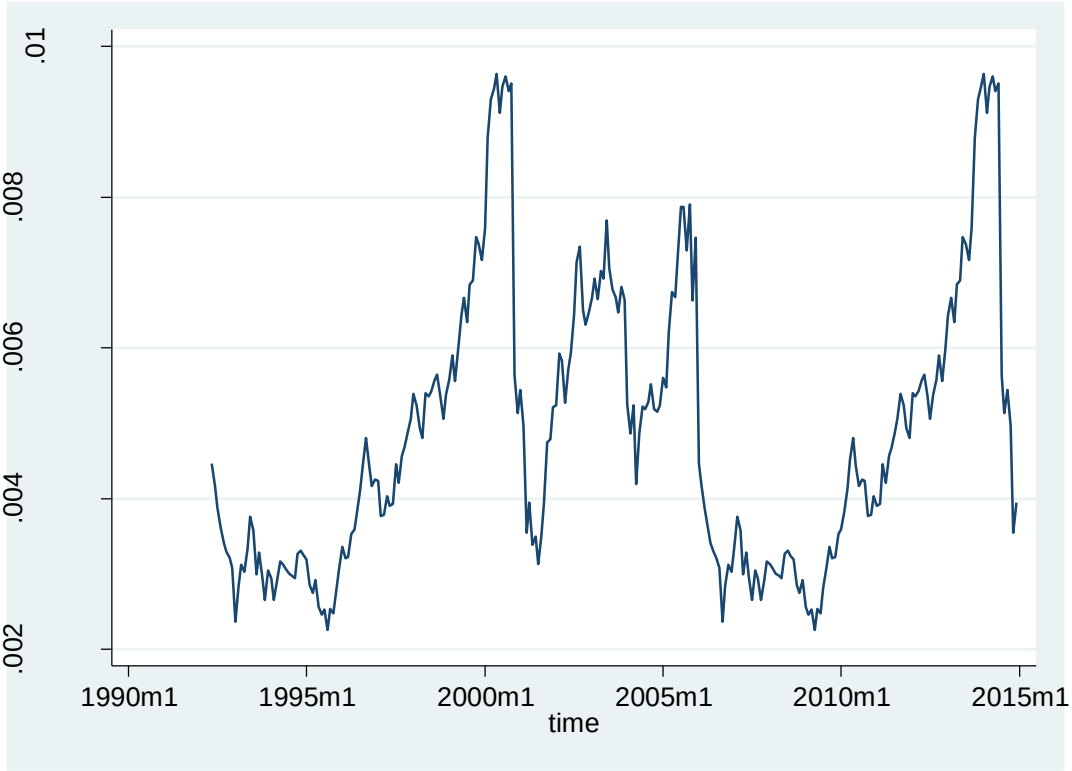

Figure 3: Relative price evolution (Barclays)

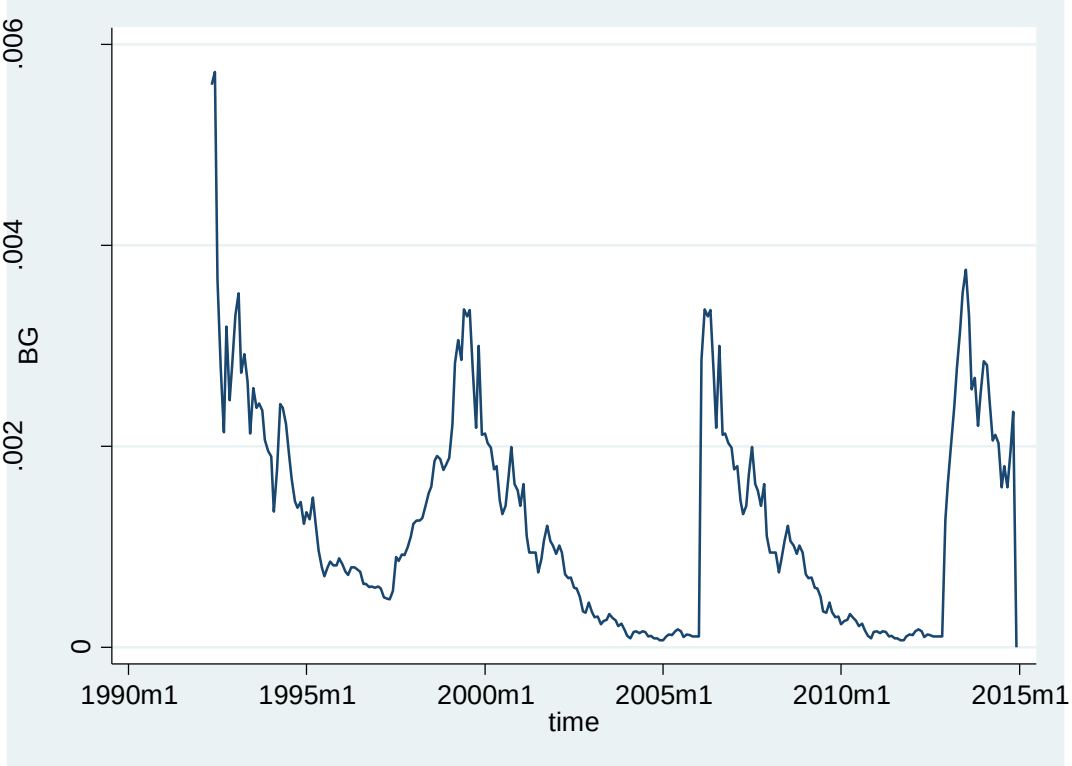

Figure 4: Relative price evolution (BG)

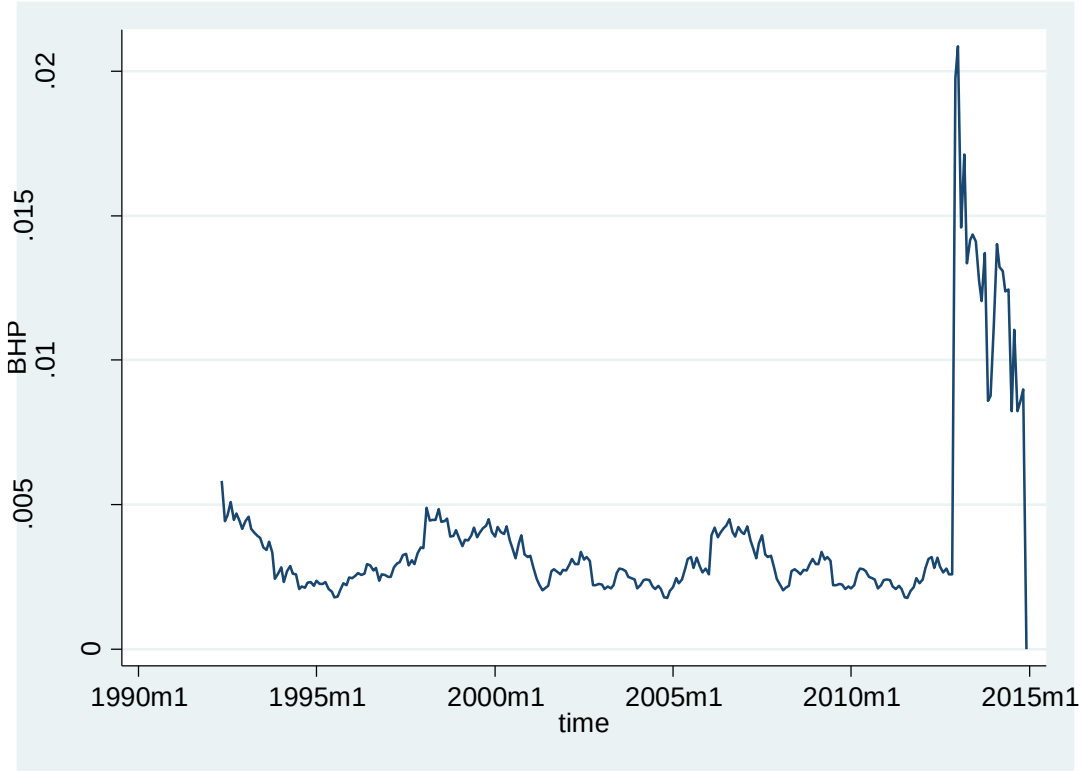

Figure 5: Relative price evolution (BHP)

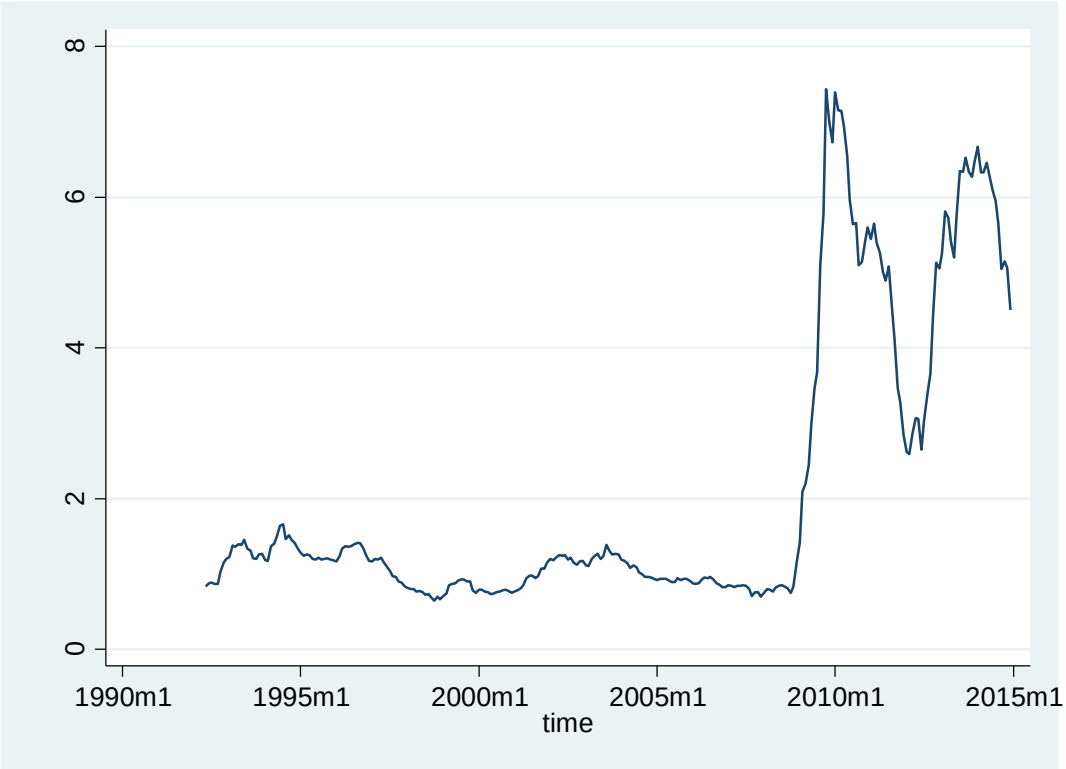

Figure 6: Relative price evolution (UK government bonds)

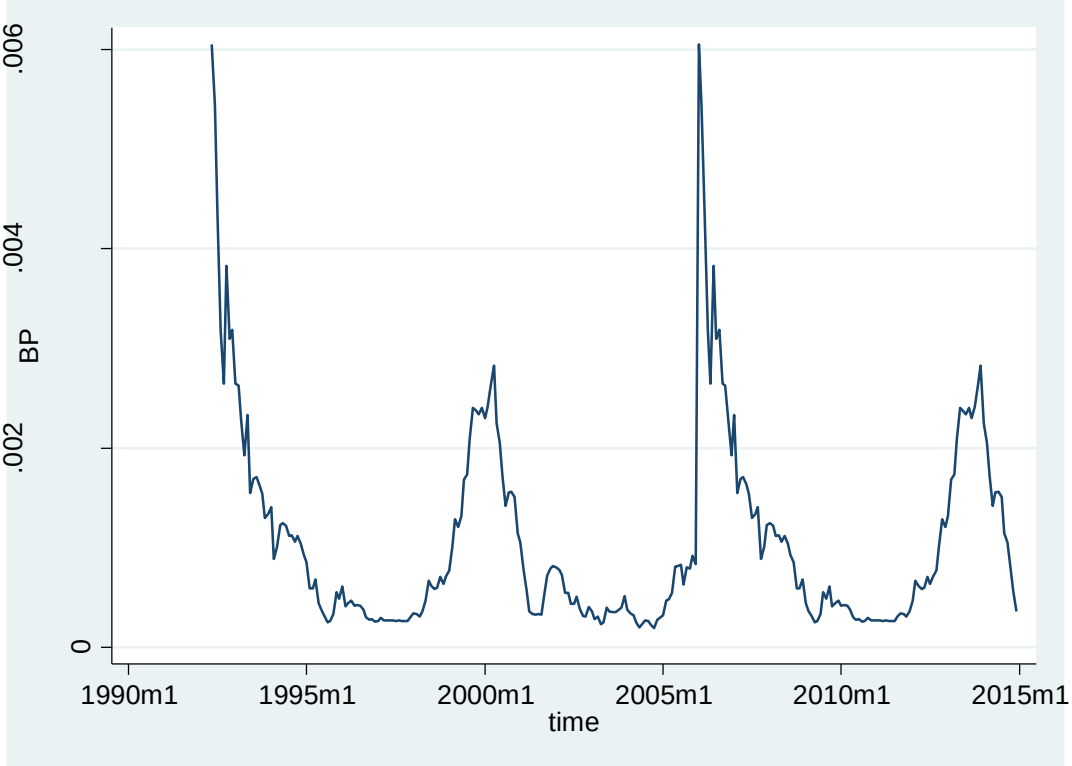

Figure 7: Relative price evolution (BP)

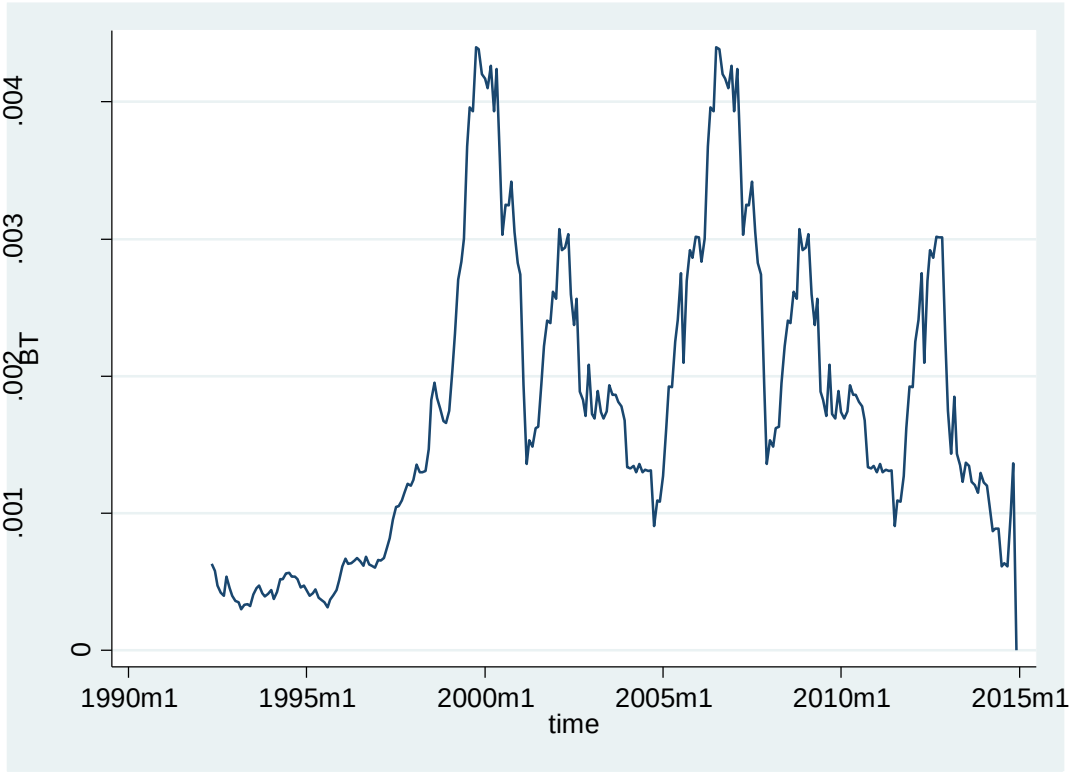

Figure 8: Relative price evolution (BT)

Figure 9: Relative price evolution (Glencore)

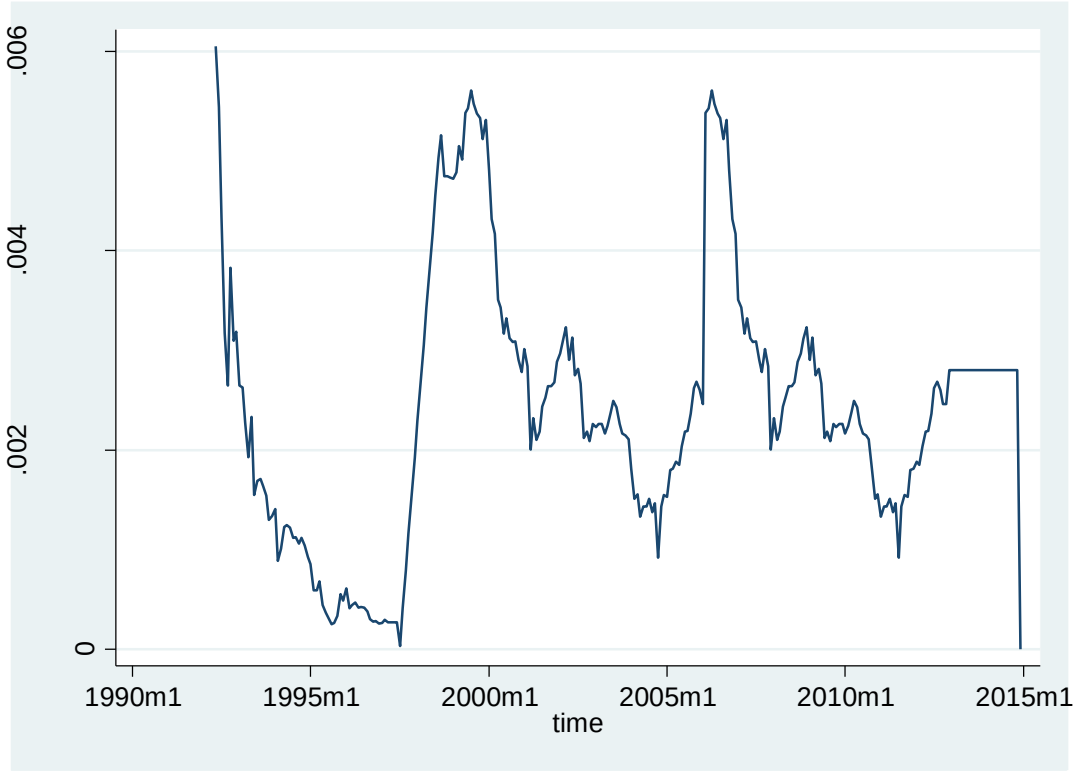

Figure 10: Relative price evolution (HSBC)

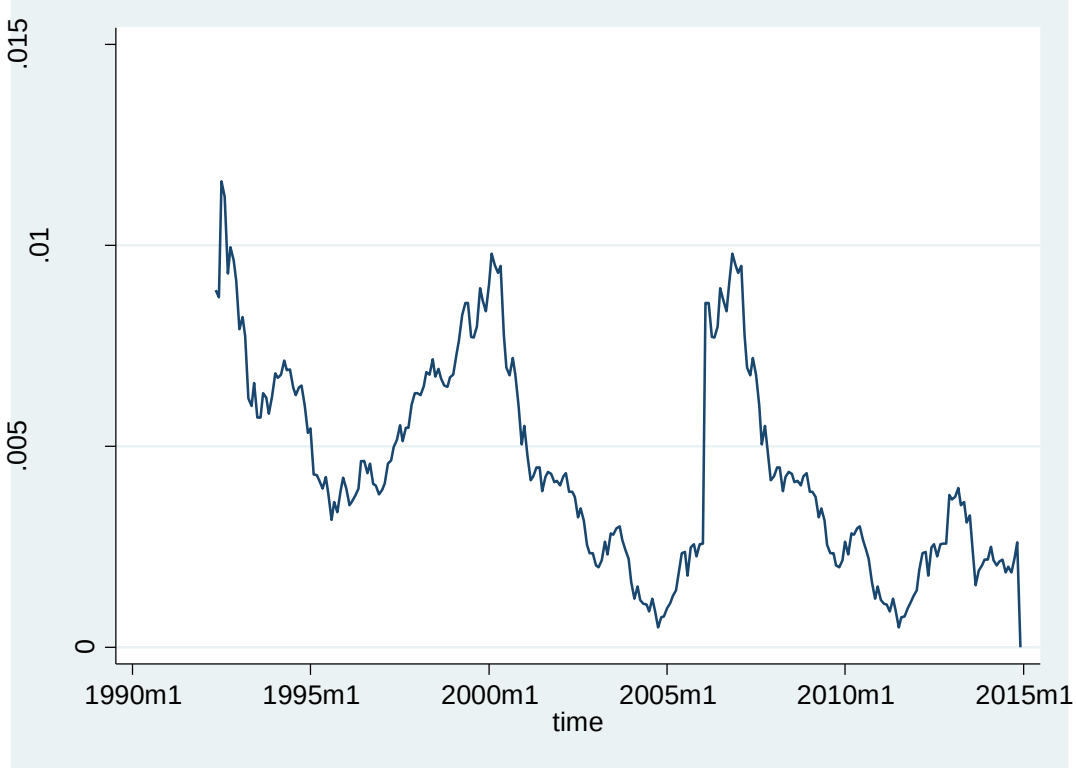

Figure 11: Relative price evolution (ICAG)

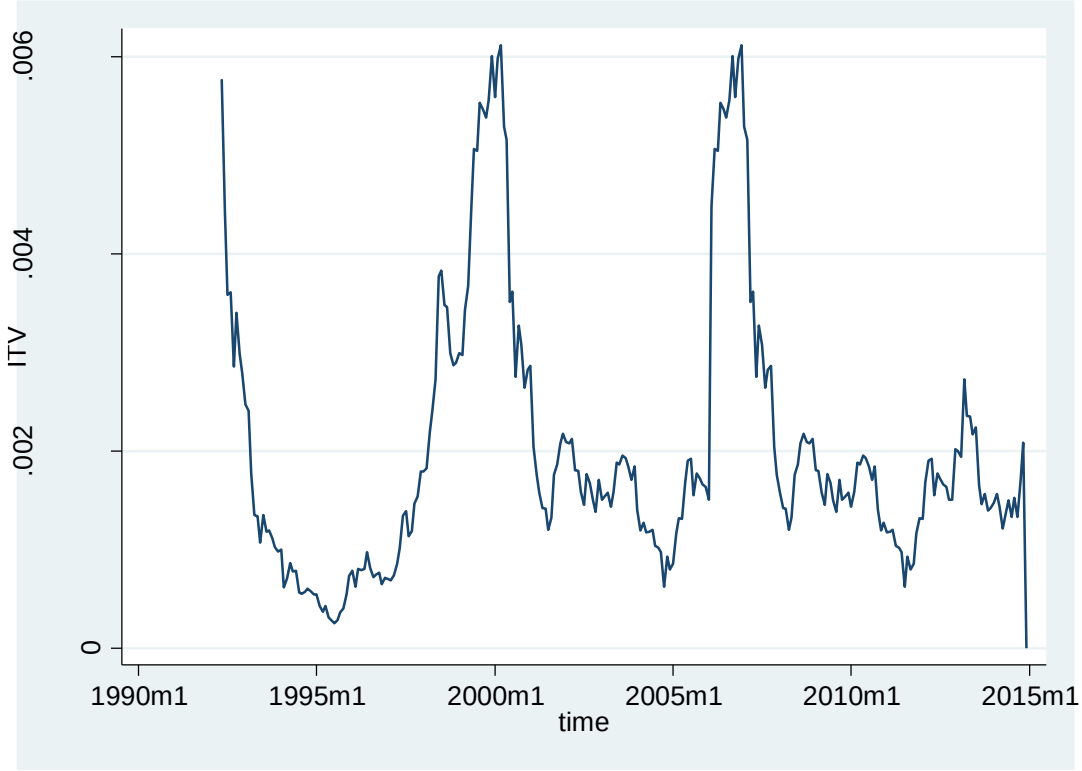

Figure 12: Relative price evolution (ITV)

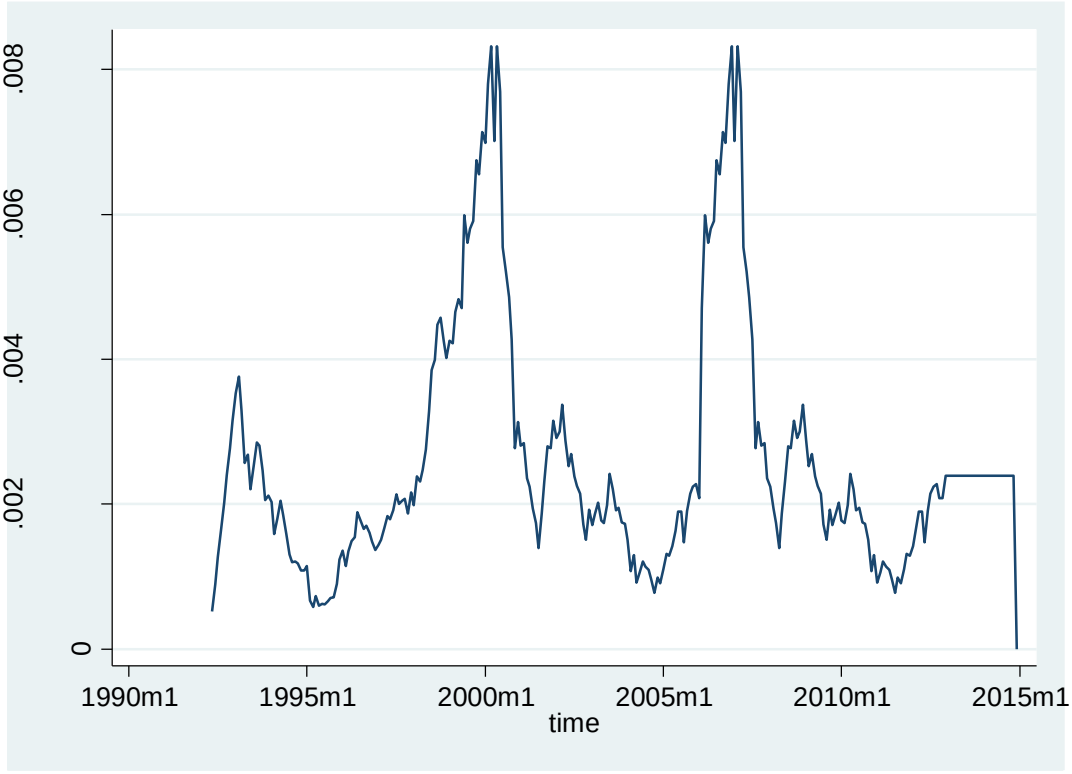

Figure 13: Relative price evolution (L&G)

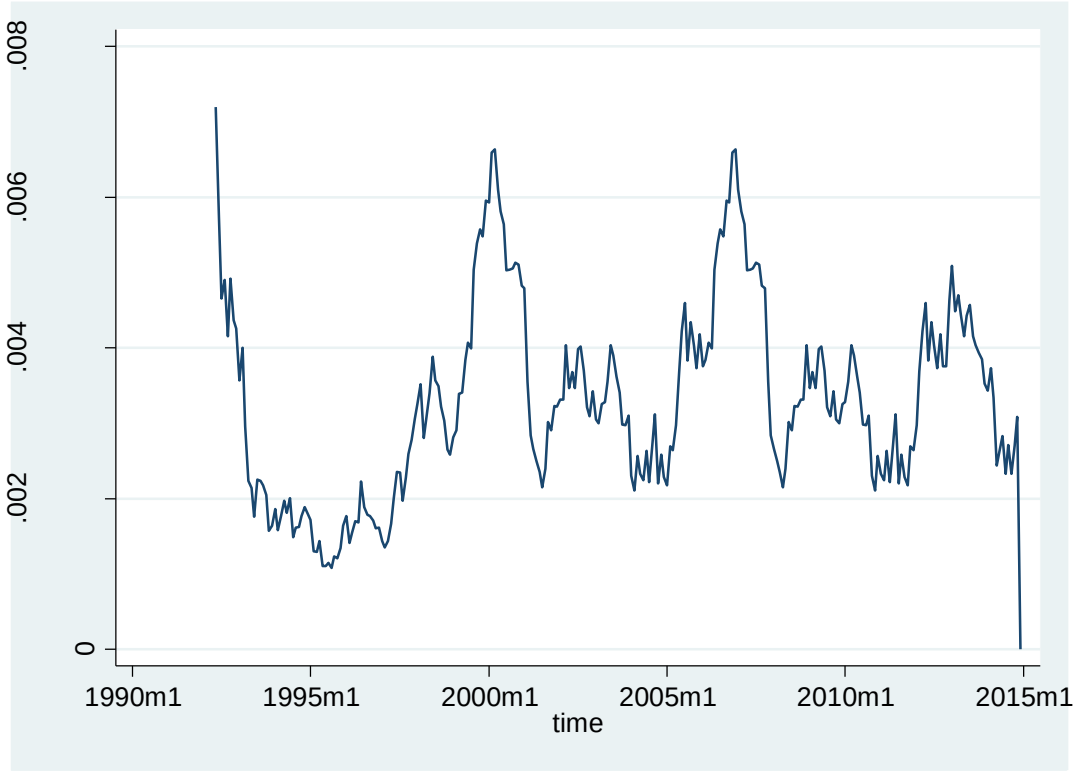

Figure 14: Relative price evolution (Morrison)

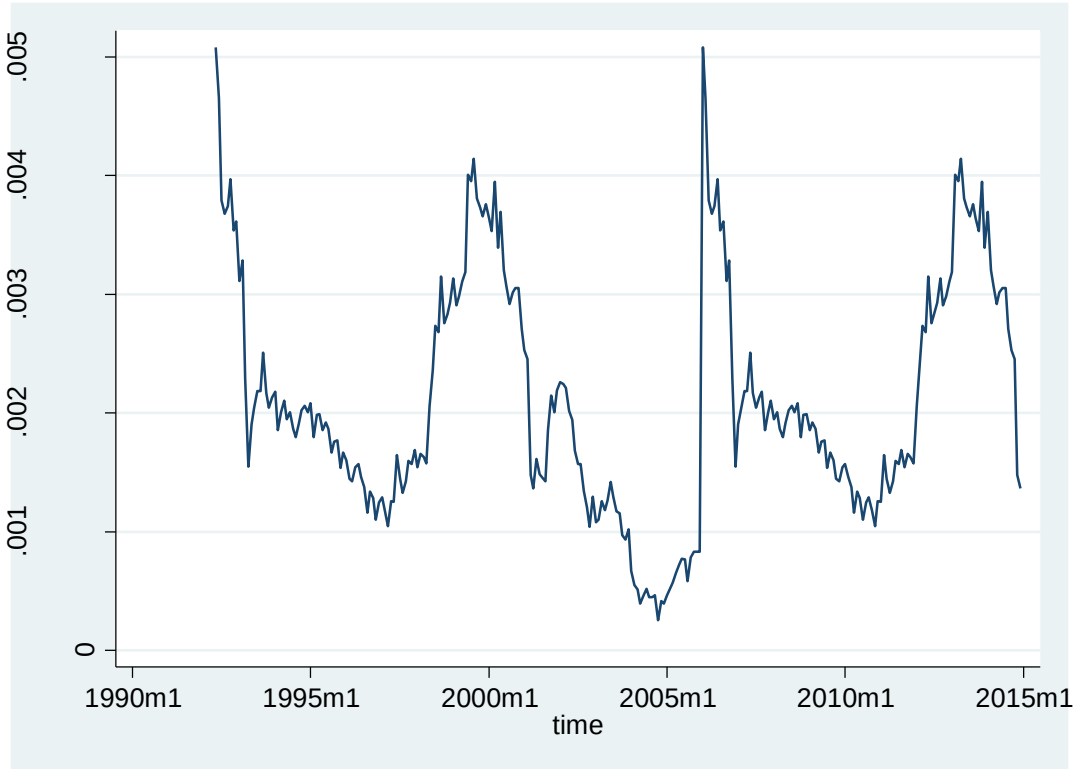

Figure 15: Relative price evolution (Old Mutual)

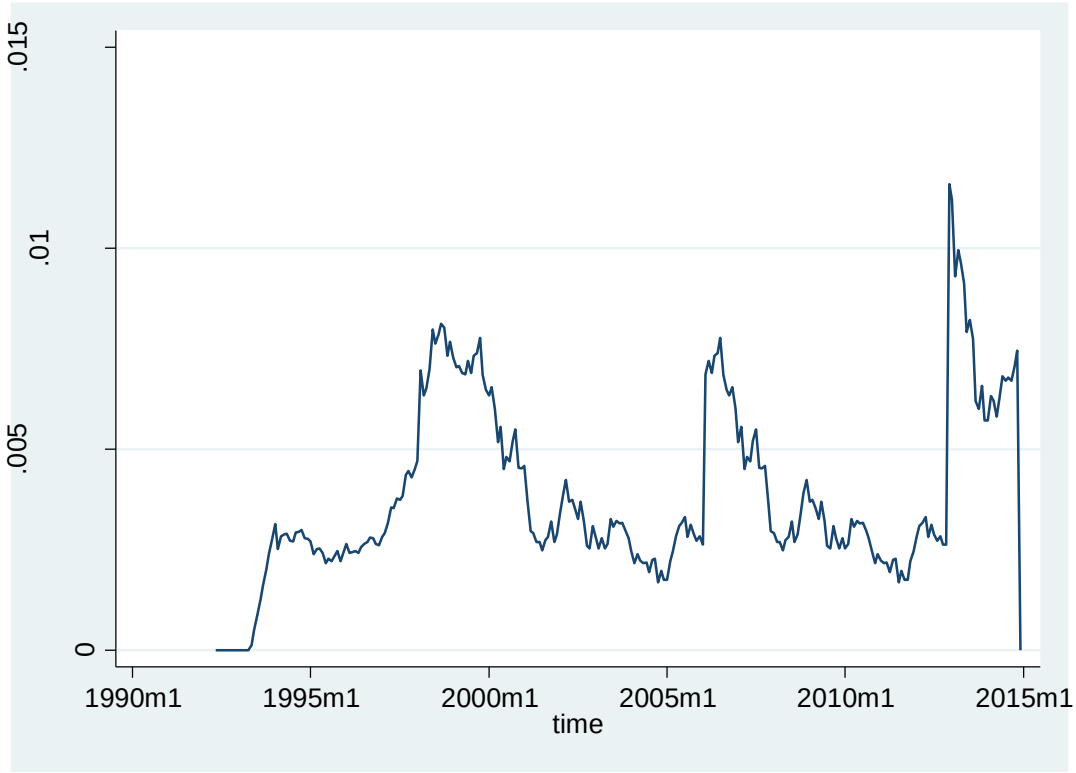

Figure 16: Relative price evolution (Royal Dutch A)

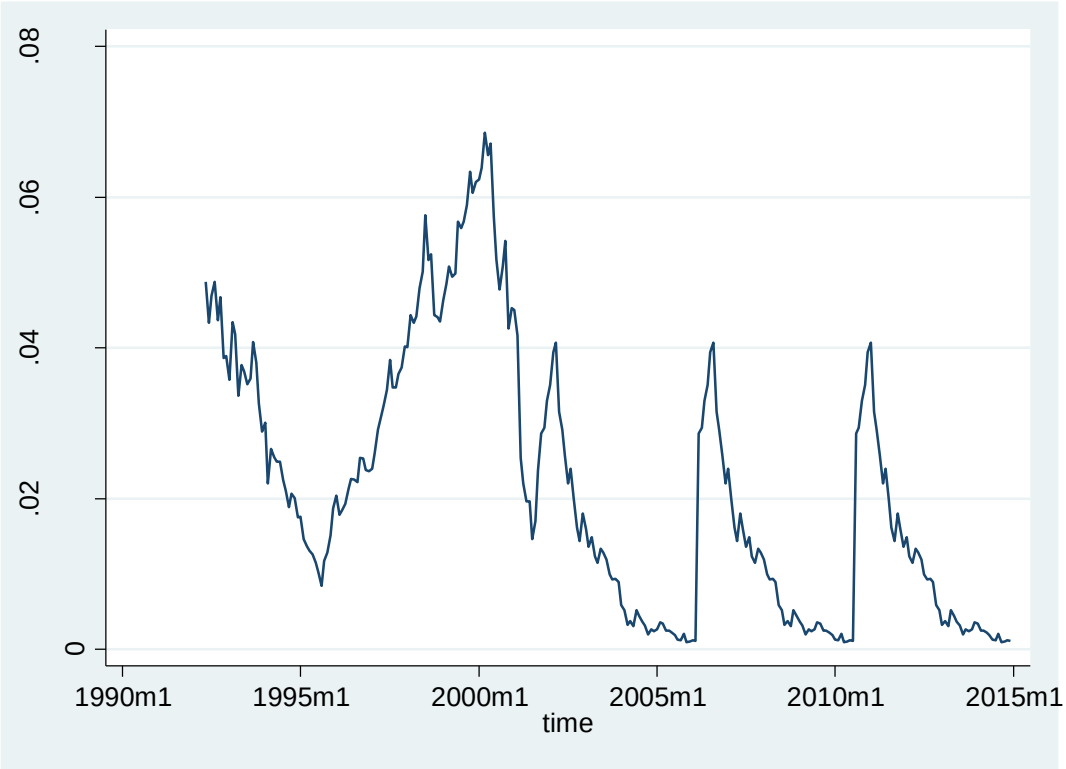

Figure 17: Relative price evolution (Royal Dutch B)

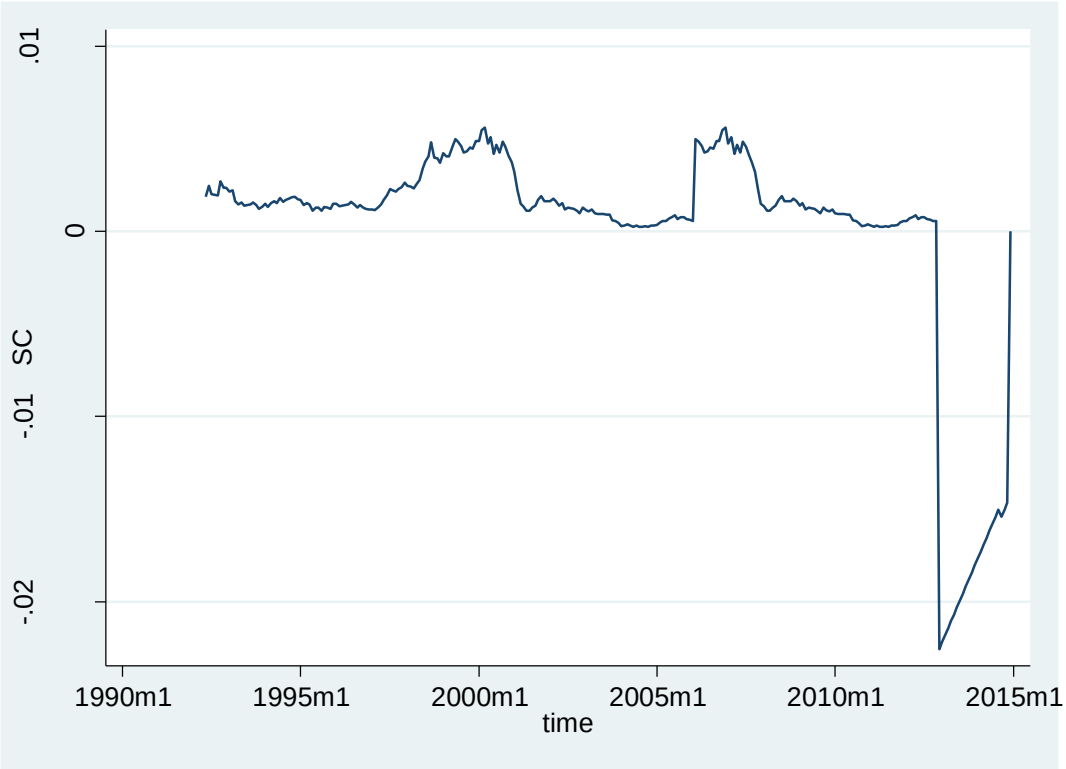

Figure 18: Relative price evolution (SC)

Figure 19: Relative price evolution (Tesco)

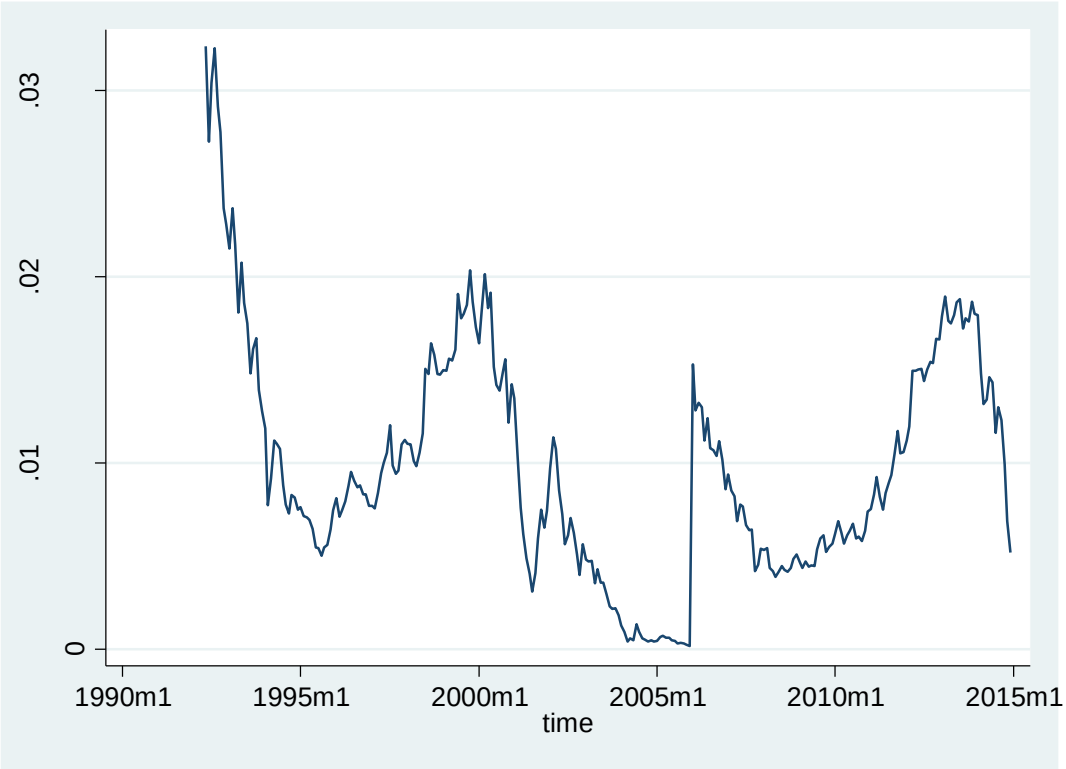

Figure 20: Relative price evolution (Vodafone)

Evolution of betas

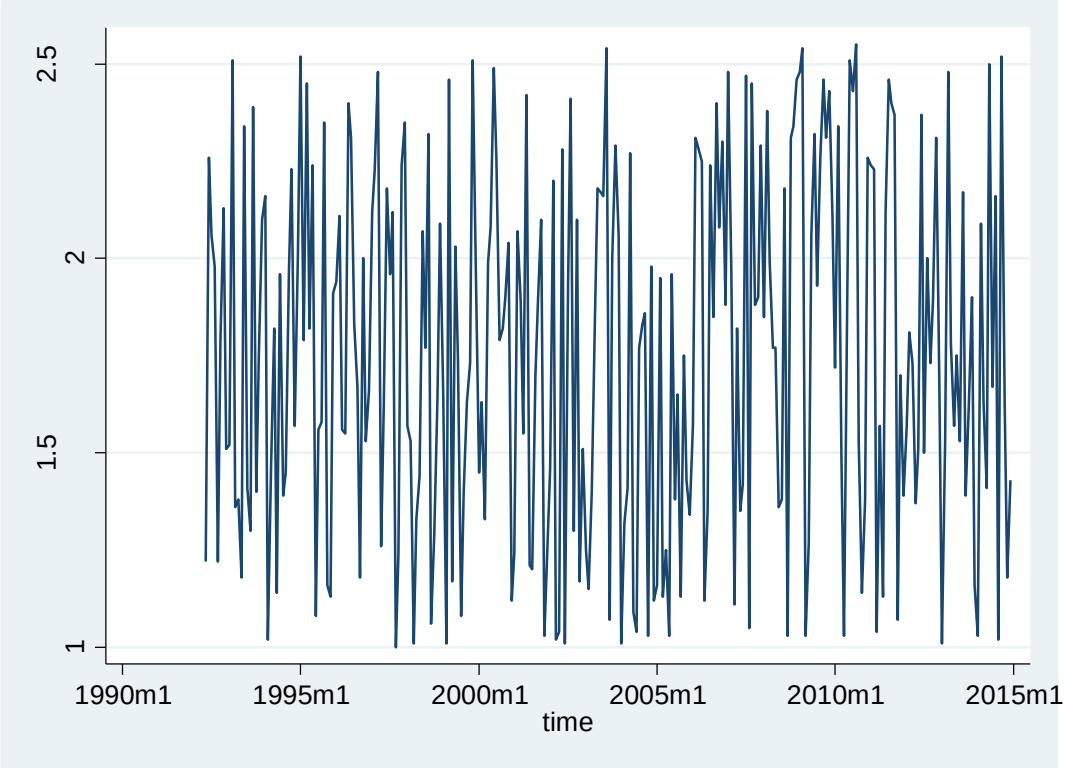

Figure 21: Evolution of beta (AAC)

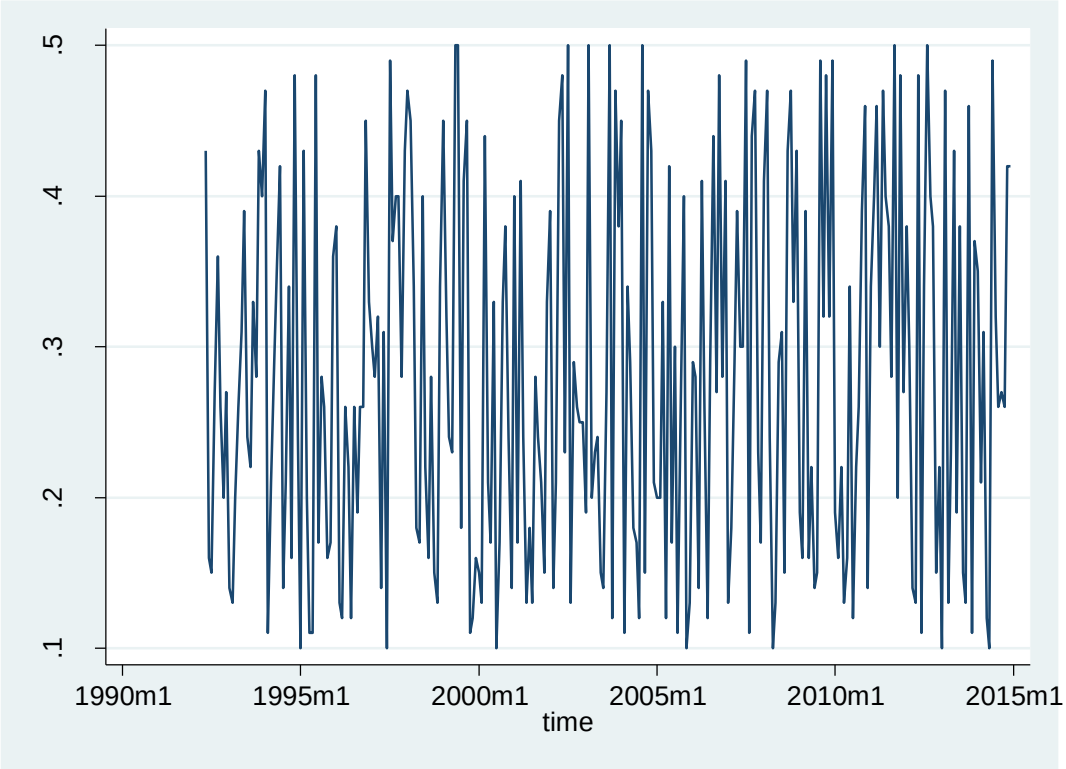

Figure 22: Evolution of beta (FTSE Actuaries index)

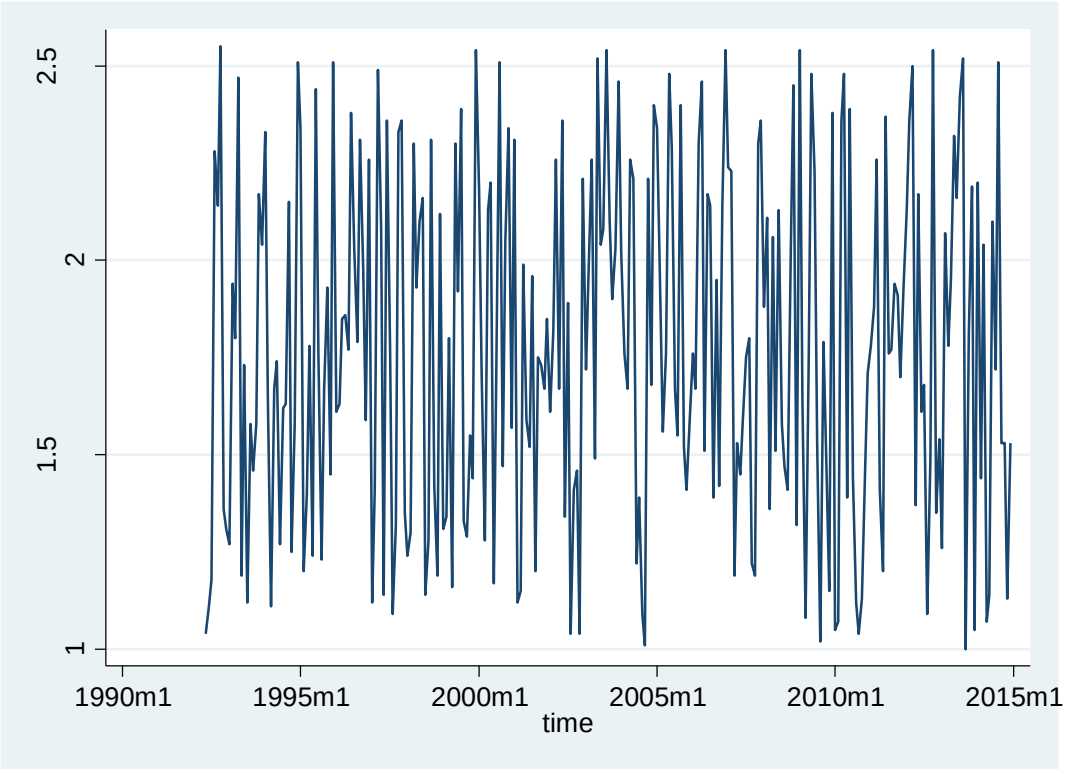

Figure 23: Evolution of beta (Barclays)

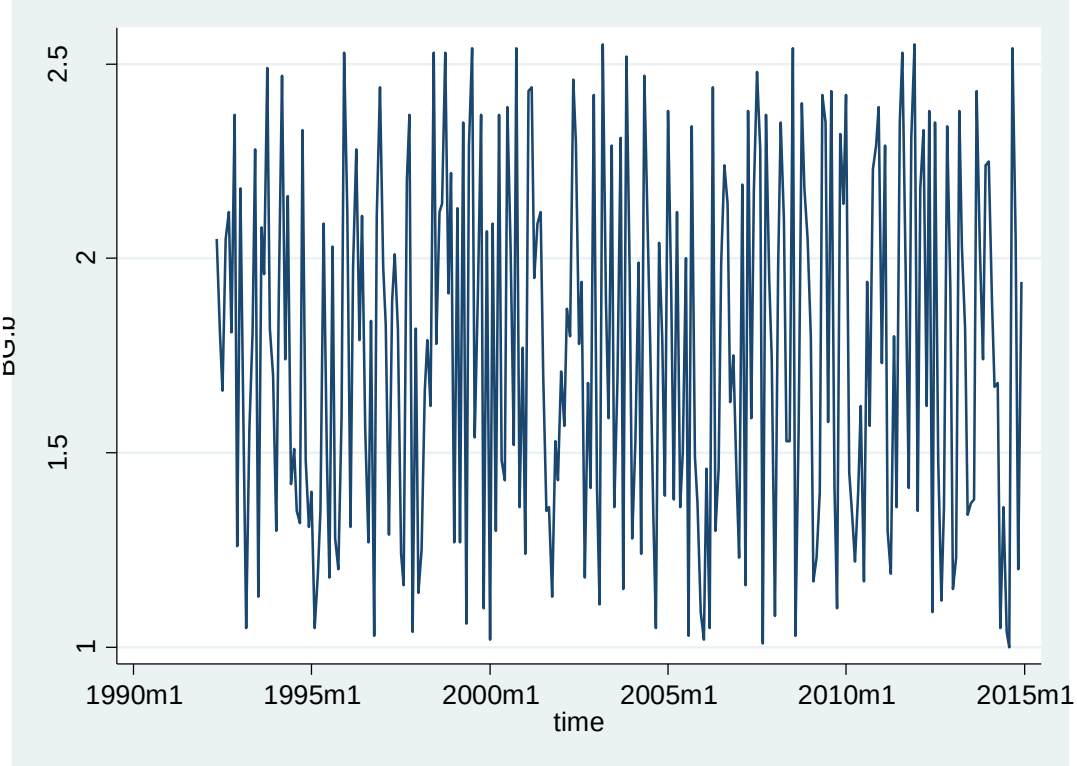

Figure 24: Evolution of beta (BG)

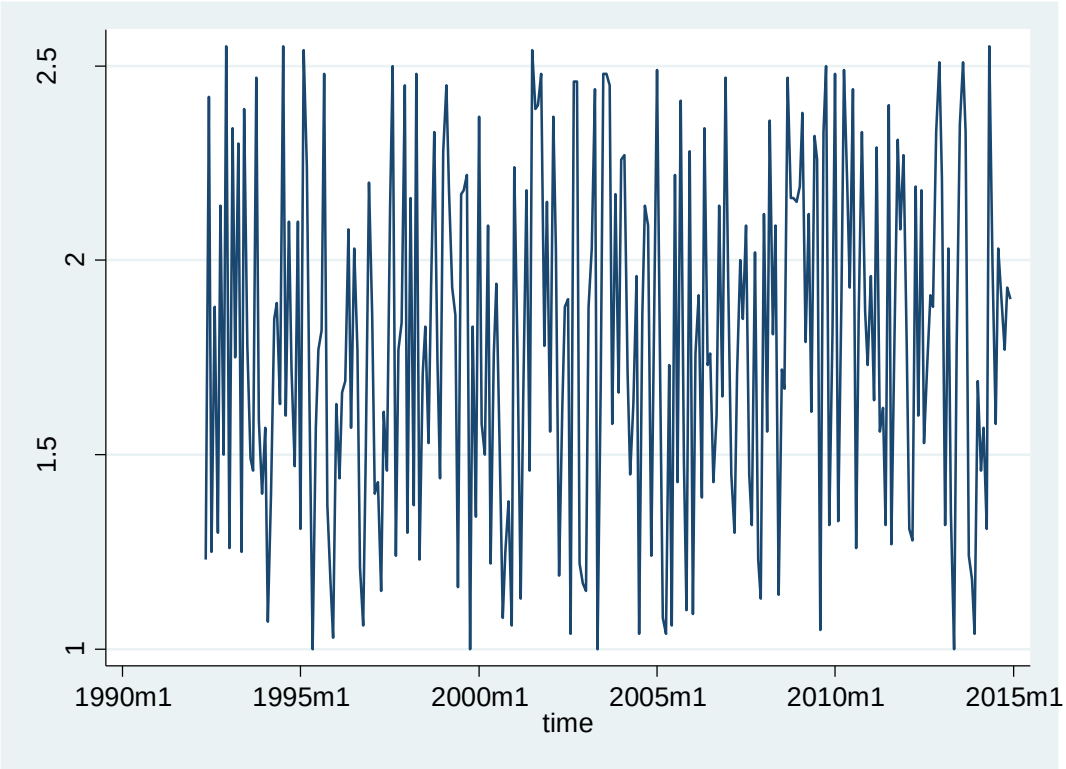

Figure 25: Evolution of beta (BHP)

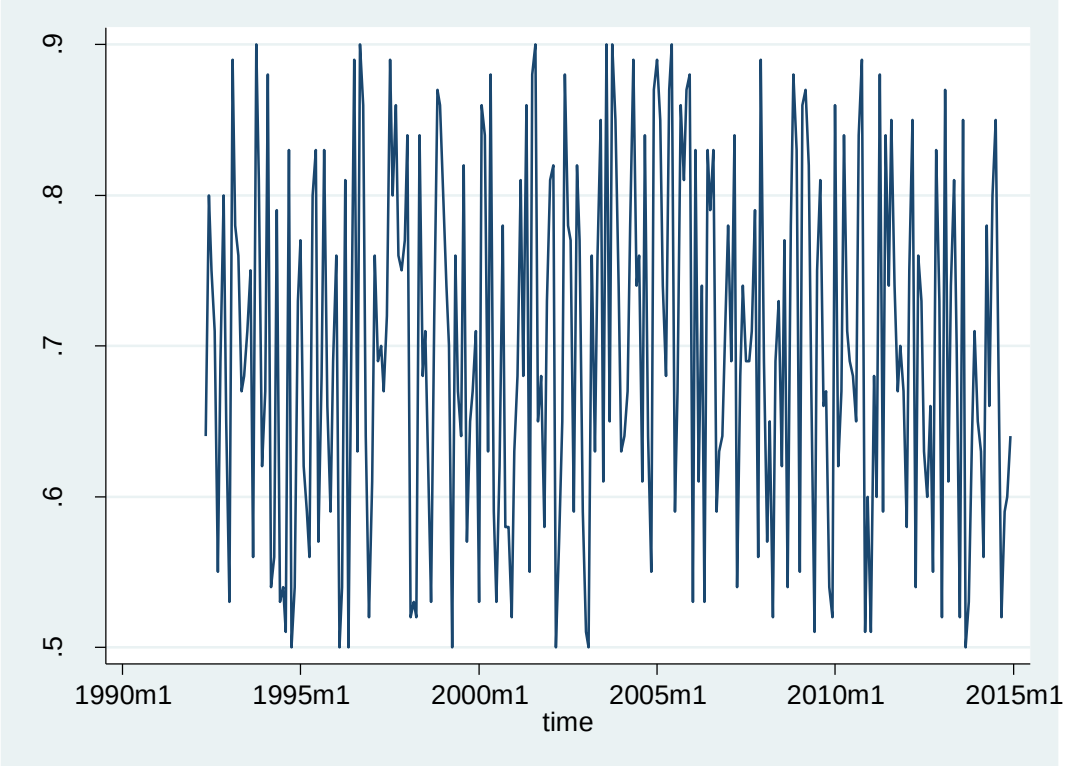

Figure 26: Evolution of beta (UK government bonds)

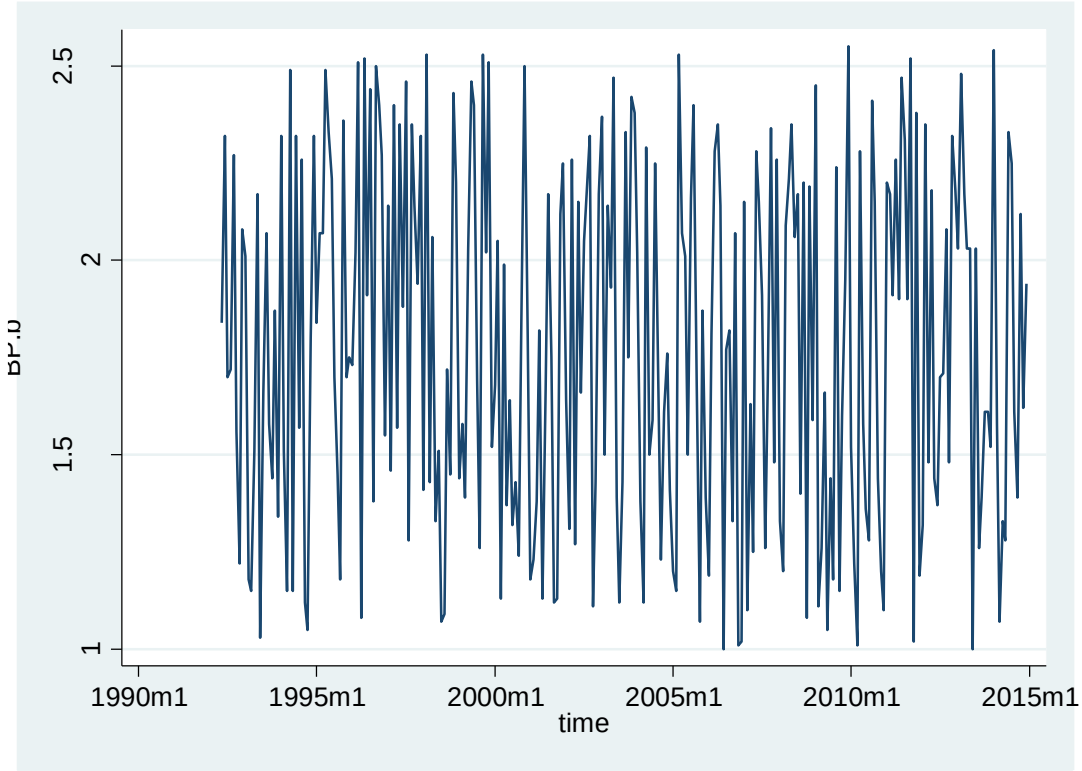

Figure 27: Evolution of beta (BP)

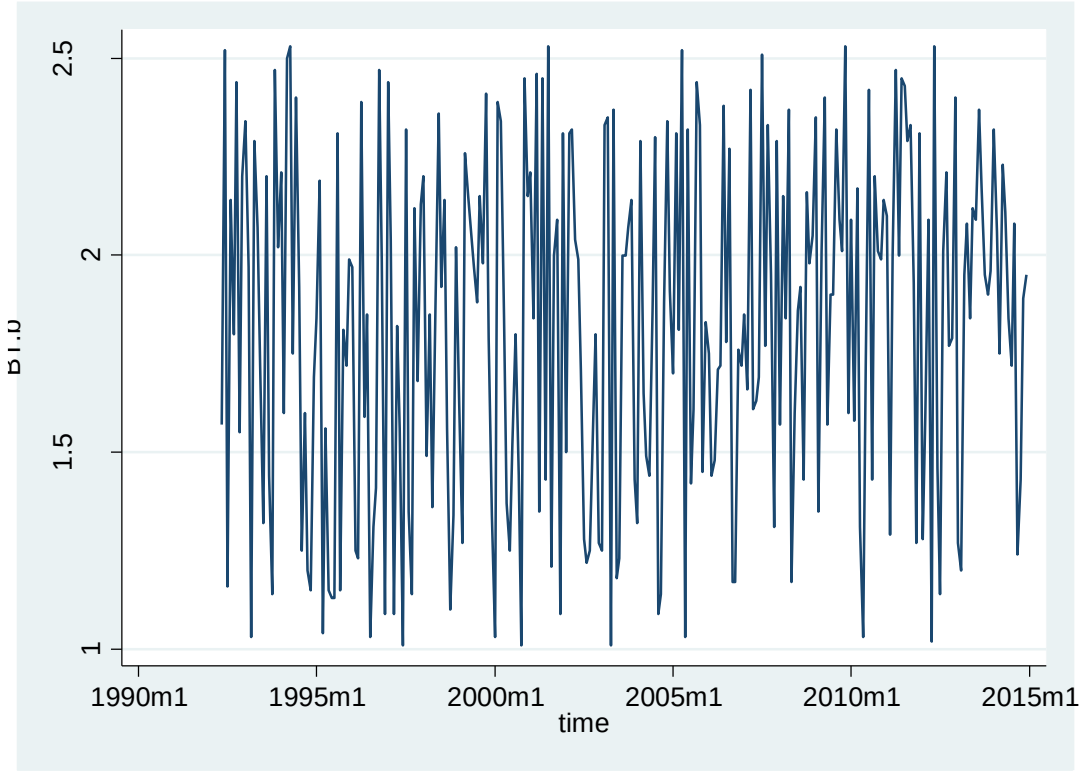

Figure 28: Evolution of beta (BT)

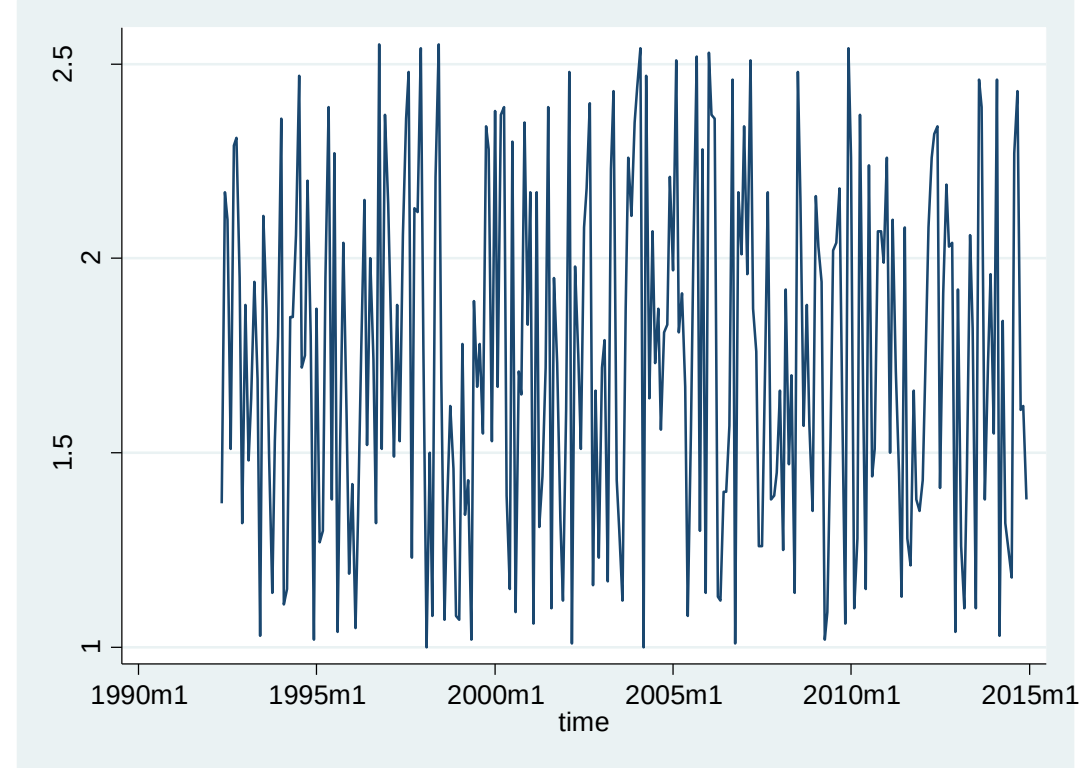

Figure 29: Evolution of beta (Glencore)

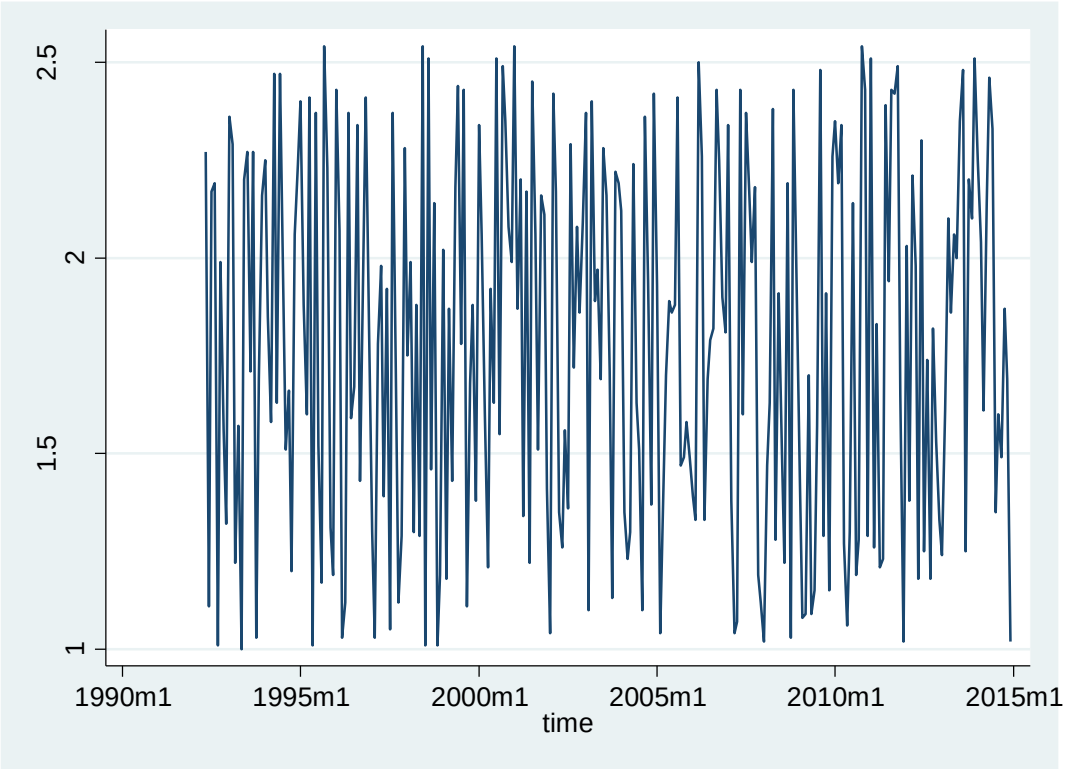

Figure 30: Evolution of beta (HSBC)

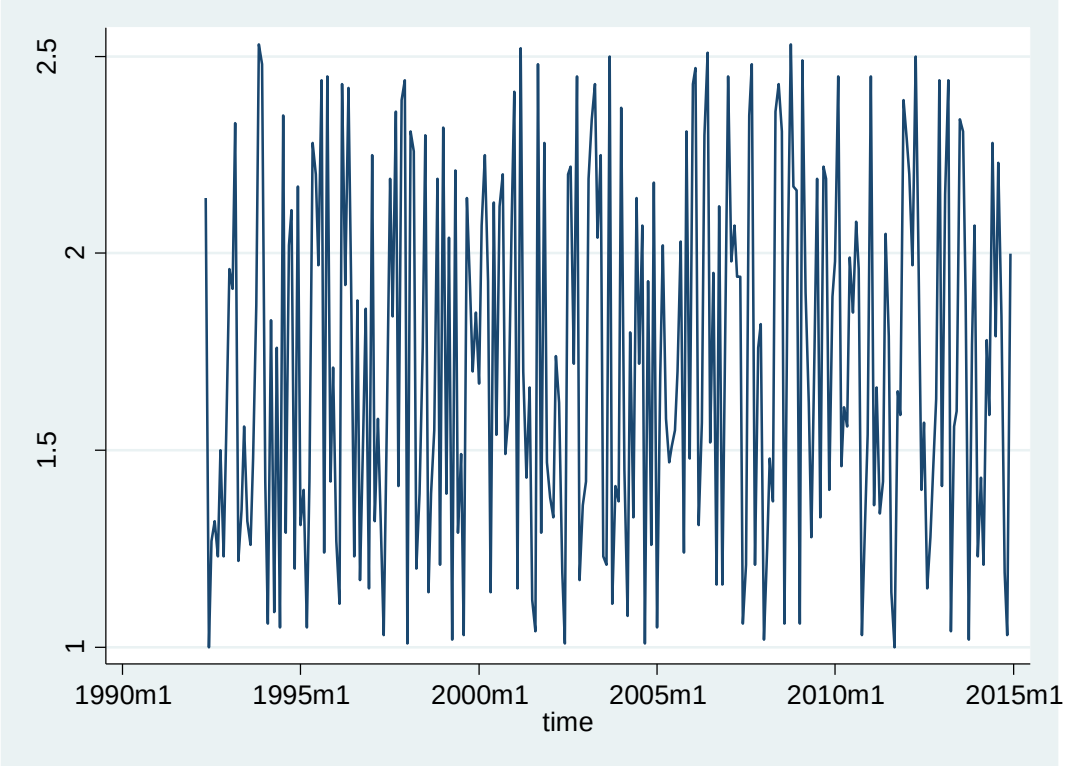

Figure 31: Evolution of beta (ICAG)

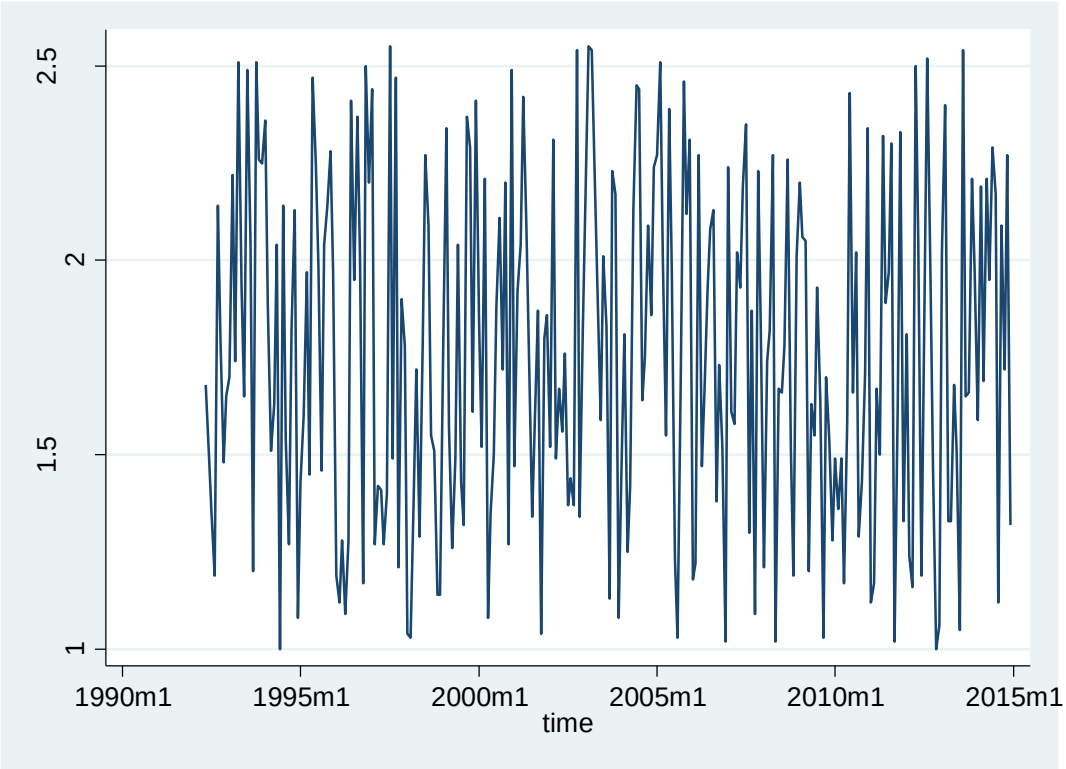

Figure 32: Evolution of beta (ITV)

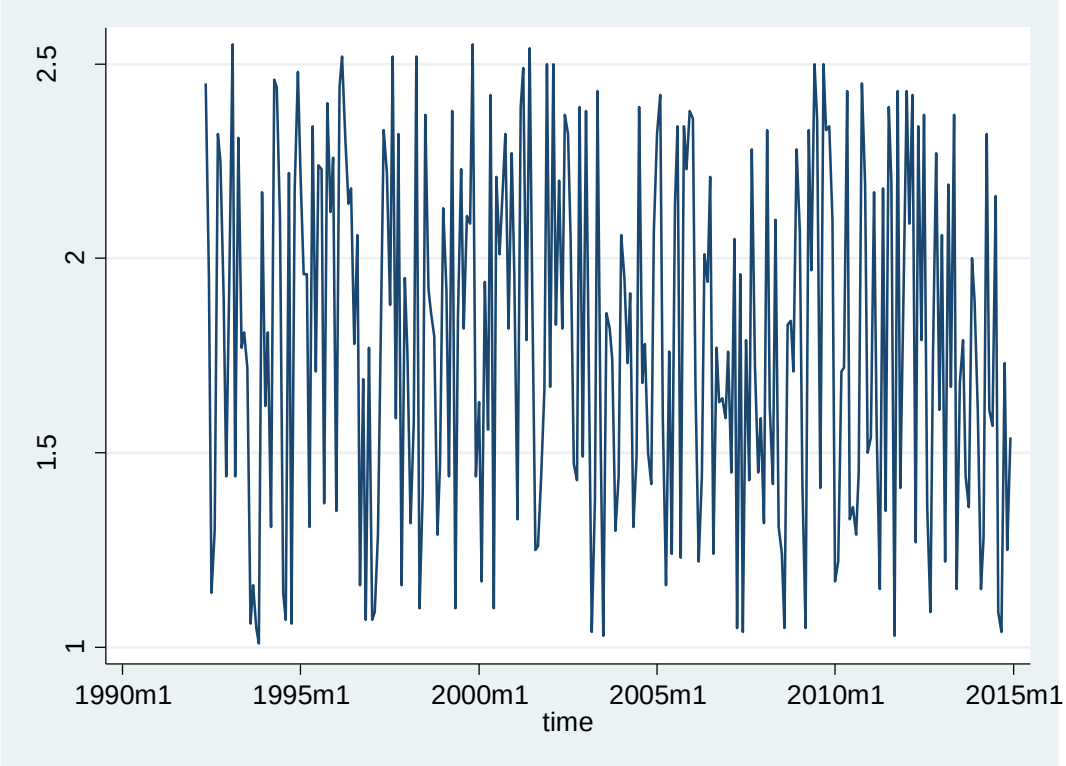

Figure 33: Evolution of beta (L&G)

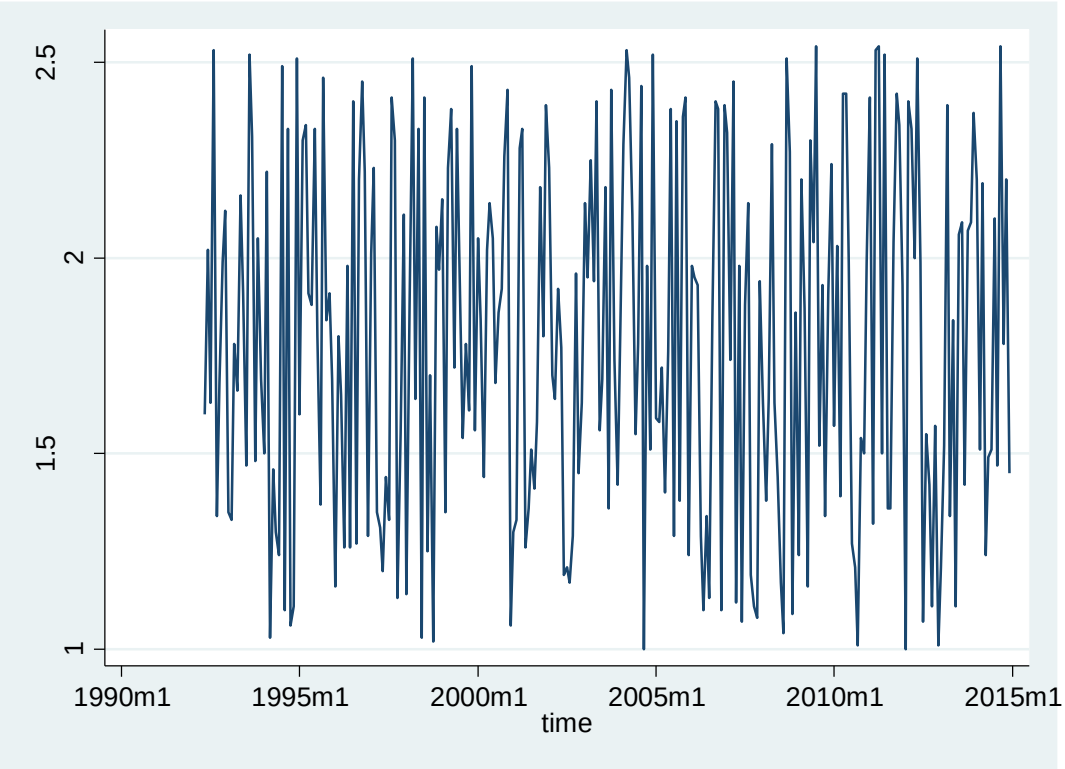

Figure 34: Evolution of beta (Lloyds)

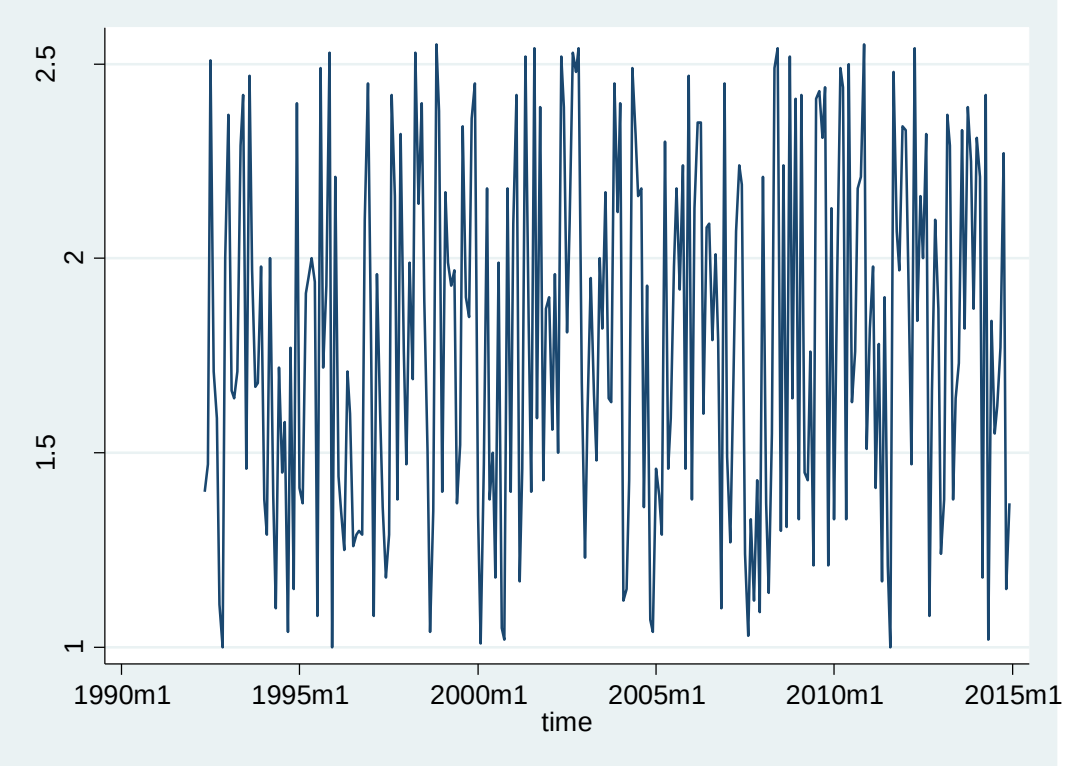

Figure 35: Evolution of beta (Morrison)

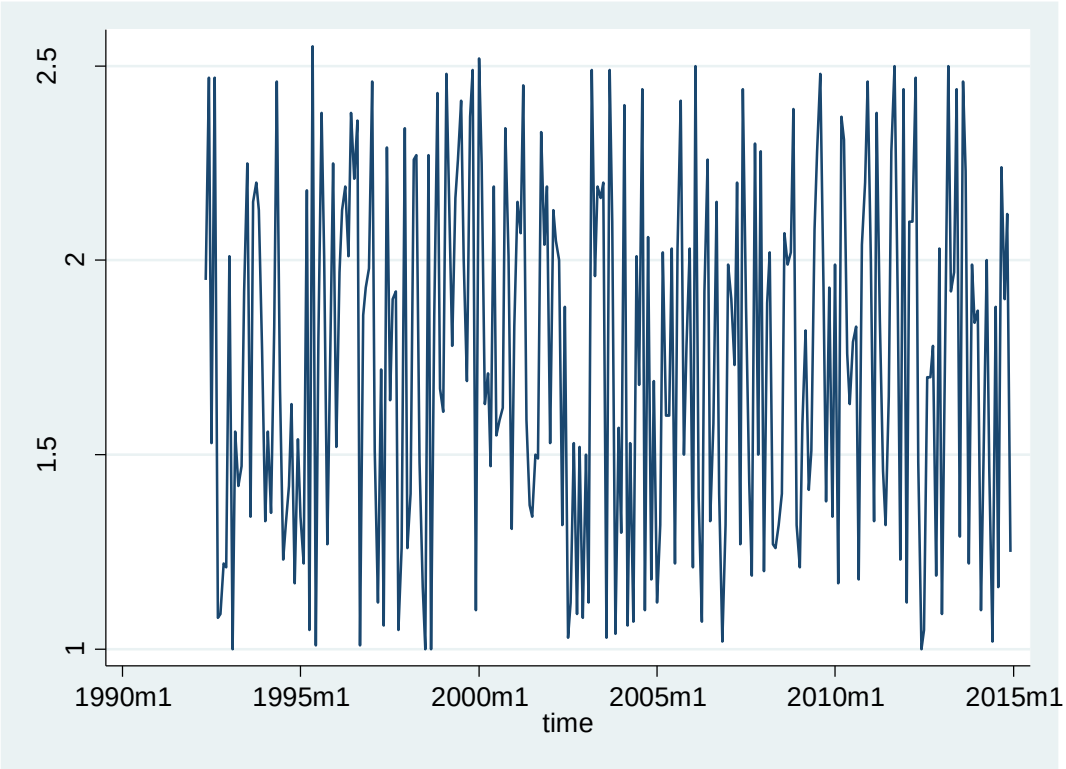

Figure 36: Evolution of beta (Old Mutual)

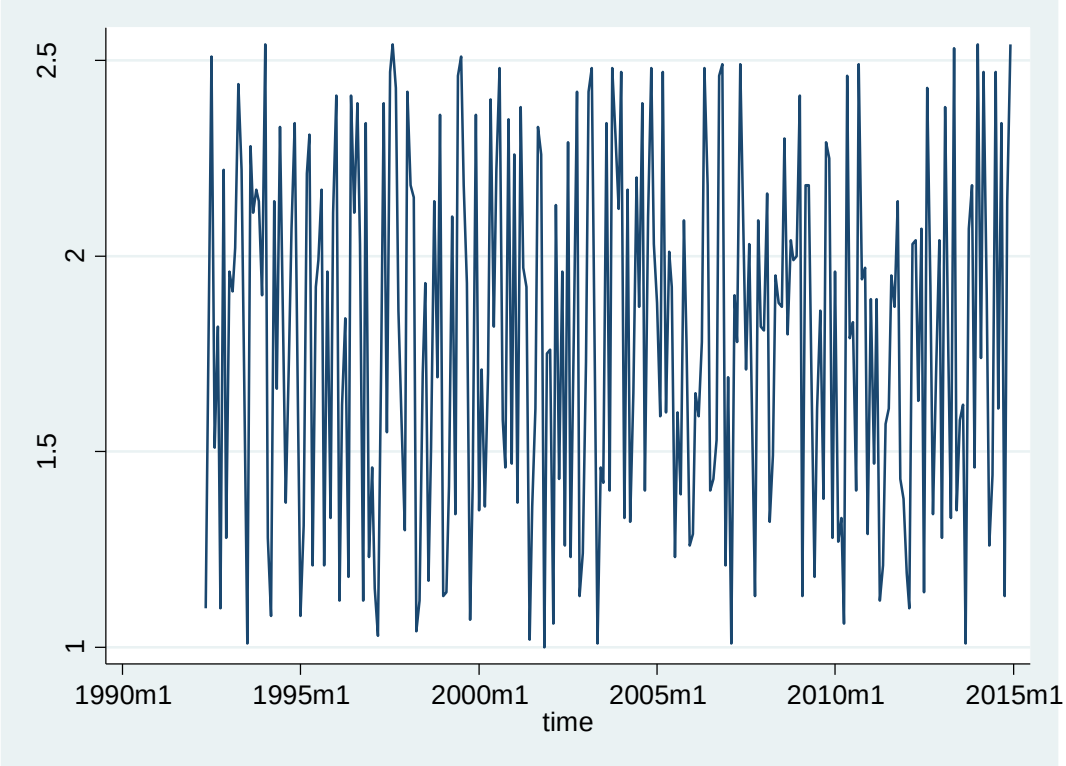

Figure 37: Evolution of beta (Royal Dutch A)

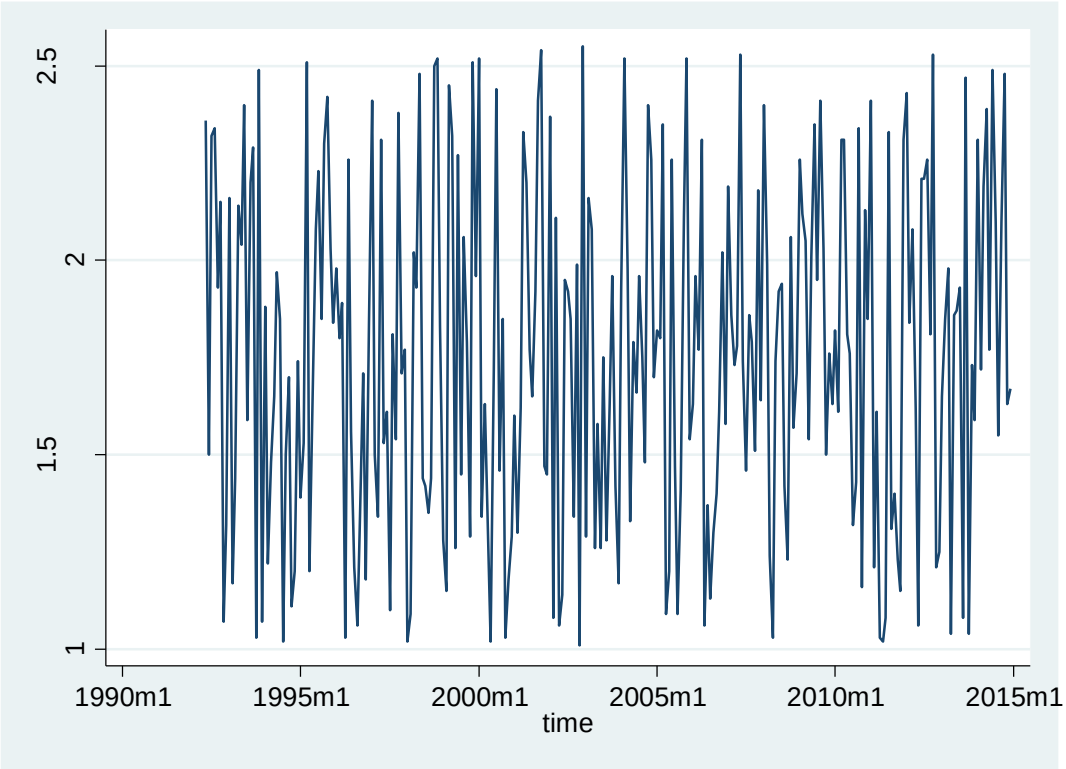

Figure 38: Evolution of beta (Royal Dutch B)

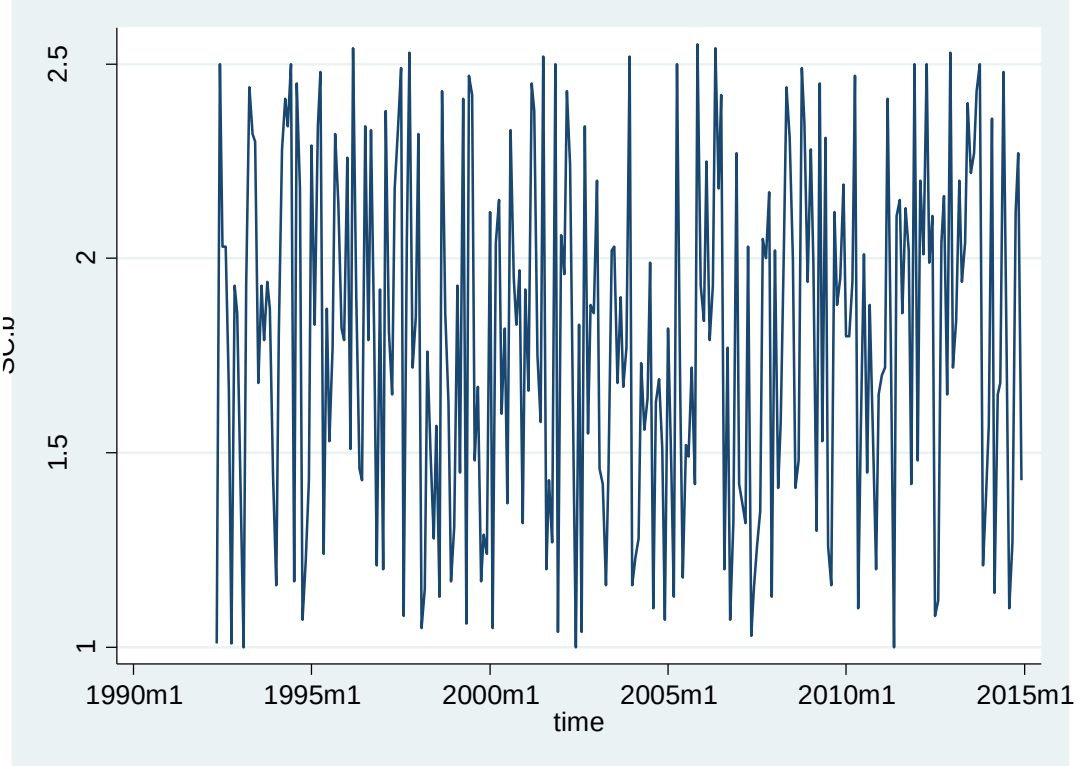

Figure 39: Evolution of beta (SC)

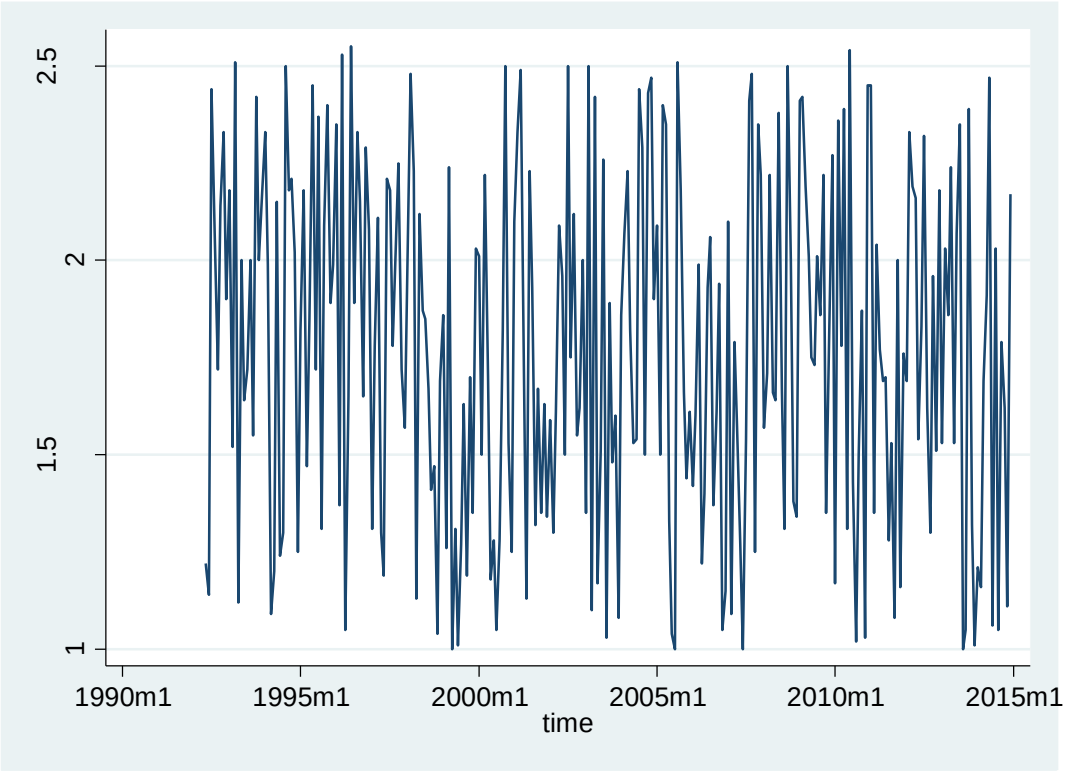

Figure 40: Evolution of beta (Tesco)

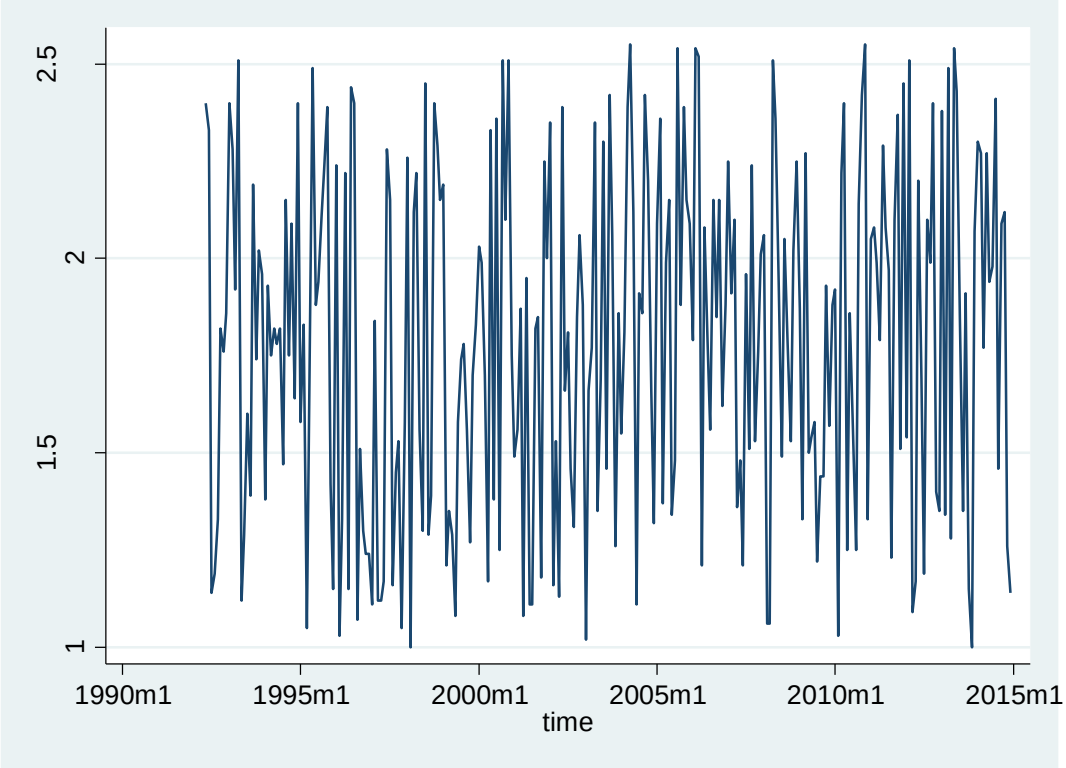

Figure 41: Evolution of beta (Vodafone).