Project Plan

Changes in investment market regimes in the post-Covid era

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Client: Veritas

Contents

1 Background

Our client Veritas is a Finnish occupational pension insurance company founded in 1905. It is one of the oldest insurance companies in Finland. The company offers statutory occupational pension insurance (TyEL and YEL) solutions for employees of companies and entrepreneurs in the private sector. Veritas is responsible for the pension security of more than 116,000 people (2022) and pays out more than 600 million euros in pensions annually. As an employment pension insurance company, Veritas invests the funds it collects as pension contributions for future pensions globally in a diversified way with ∼32% in fixed income investments, ∼39% in equity investments, ∼16% in real estate, and other in alternative investments. As of 30.9.2022, Veritas manages approximately 4.1 billion euros in assets [1].

The returns of pension investors can be explained by how their investment portfolio is constructed. The portfolio i.e., strategic asset allocation, can be conducted using optimization and asset-liability models that have specific investment objectives, regulatory, and risk guidelines incorporated into them.

An investment portfolio is a set of different financial investments from different asset classes weighted individually to provide the investor best possible return on their investment. Diversification refers to spreading the investments around so that the exposure to any one type of asset is limited. This is done to reduce the volatility, i.e., risk, in the portfolio over time.

Constructing a well-yielding and diversified portfolio, i.e., an efficient portfolio, involves various steps including e.g., deciding which asset classes to include in the portfolio, deciding weights for each asset allowed in the portfolio, strategically altering the investment mix to benefit from short-term fluctuations in asset class prices, and selecting specific individual securities to achieve superior returns [3]. However, the diversification benefits that are received with a traditional balanced portfolio, e.g., 40 % bond & 60 % stocks portfolio, have been questioned by literature (see e.g., [6]).

The literature suggests that the correlation between stocks and bonds is one of the most important inputs when considering asset allocation decisions. However, the correlation between stocks and bonds can be difficult to estimate, and depending on the macroeconomic conditions, it can change drastically over time. Exposure to macroeconomic factors, such as inflation, drives the stock-bond correlation. It has been found, that prices tend to move in alignment when inflation expectations are high. Thus, portfolio construction that relies solely on point estimates of correlation, e.g., mean-variance optimization, can be misleading if the macroeconomic conditions and regime shifts are ignored [6, 5].

2 Objectives

We aim to give scientifically founded suggestions on improving the portfolio construction process based on our analysis of historical asset class dependence regimes. We provide our client with a view on how the different macroeconomic situations should be taken into consideration in portfolio construction from the point of view of asset class dependency i.e., how the macroeconomic situation affect the relationships between different asset classes and individual investments. With our help, the client can better understand the diversification benefit in their portfolios.

Veritas aims to make investments safely, ensuring solvency and long-term profit despite any economic scenarios that might take place at the time of the investments. Their objective in investment activities is to achieve the best possible return in order to ensure sustainable funding for pensions by building a well-yielding robust portfolio that can withstand uncertainty in the macroeconomic scheme. When building an efficient portfolio, understanding the relationships between the different asset classes and individual assets is as important as understanding the return distributions.

In this case study, the focus is on the analysis of the relationships and dependency structures between different asset classes. One way of going about this would be to look at the historical returns data and calculate a correlation matrix to gain insight into the different dependencies in the assets. However, this method fails to recognize the forward-looking dependency structures and future return possibilities. The case team with the client recognizes that the dependencies between the different invested asset classes evolve and depend on the changes in the macroeconomic environment. The historical data provides insight into different regimes, where the dependency structures are rather constant.

We also aim to explore the tail dependencies between the different asset classes, i.e., what happens to asset prices in extreme macroeconomic schemes. Pension insurance companies, such as Veritas, do not become insolvent due to everyday fluctuations in asset prices, but rather due to unstable market conditions or an economic downturn. Assuming that Veritas' investments do not yield the returns that have been expected, it is likely that it is due to rather intense fluctuations in some of the variables describing the current economic scheme, and for this reason, understanding the possible outcomes of different economic crises can be useful when constructing a profitable portfolio of investments.

In this case study, we hope to verify the presence of dependence regimes, create analysis tools to identify them and to examine the behavior of asset classes within them. Thus, our work is divided into 3 parts. First, we analyze the inter-dependencies of asset-class returns and aim to see if the data can be clustered into regimes. This is done using various historical data points including e.g., stock market index data, commodities data, macroeconomic data such as inflation and consumer confidence, and exchange rate data. Second, we test the efficiency of different clustering methods and the explanatory power of a broad array of assets and economic variables to develop a reasonably robust model for the identification of the regimes. Lastly, once the regimes have been identified, we shift our focus more on understanding the different inter-dependencies between the asset classes. We will look into estimating tail dependency and different asset class risk parameter values in the found regimes.

3 Tasks

The project work can be divided into a literature review, programming tasks, and report writing. First, suitable data analysis methods are chosen for handling the data. Simultaneously, the literary review is carried out as well as the initial data processing. The data must be processed before the analysis work to ensure that the analysis gives good and realistic results. Once the pre-processing of the data is done, the analysis will be conducted. In order to find the most suitable method for identifying the different regimes, we plan to test a few methods for analyzing and clustering the data. The current plan is to test at least the following methods for regime identification:

1. Markov switching models. Such models are popular in econometric literature on regime shifting (see e.g., [4]).
2. Principal component analysis (PCA) combined with a clustering algorithm, such as k-means clustering or DBSCAN. The method is similar to that suggested by [2].
3. Method for picking the most significant explanatory variables (e.g., forward and backward selection, random forest) in combination with some clustering algorithm.

Subsequently, we will conduct a model comparison and analysis of the results. Based on the results we pick the most adequate method for identifying economic regimes and construct and test our final model. Simultaneously, a part of the team will work on the literary review and report writing.

At this point of project planning, the project scope is rather broad and our work remains exploratory. We are interested in looking at the project problem from different perspectives before deciding our final route. For this reason, the schedule and plan are not very specific and will evolve as the work continues.

4 Schedule

An initial timeline for the project is presented in Figure 1. The schedule comprises the following tasks:

1. Literature review
2. Data pre-processing
3. Initial data analysis (testing & validating different clustering methods)
4. Writing the project plan
5. Building and testing our model
6. Writing the interim report
7. Finalizing the model and validating results
8. Writing the final report and documentation
9. Final recommendations to the client

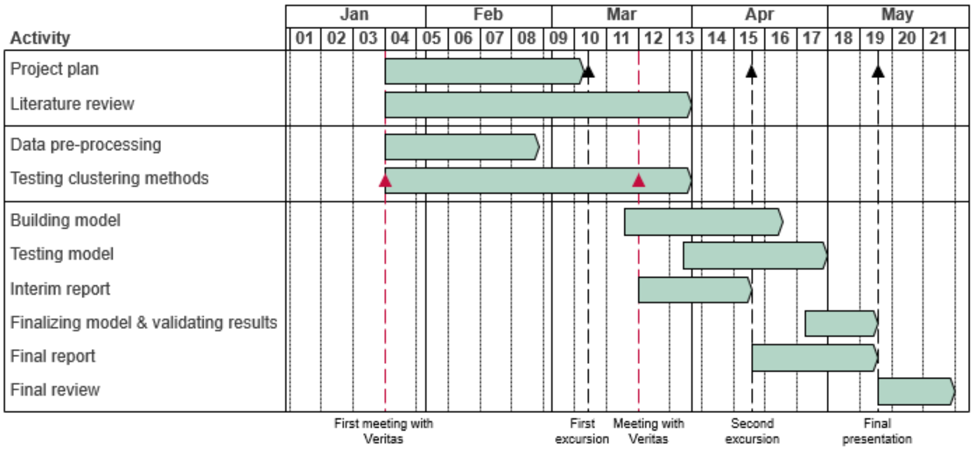

Figure 1: Initial project timeline.

5 Resources

Our case team consists of five students, Tuomas Myllymäki (project manager), Roosa Ilvonen, Aake Kesälä, Konsta Parkkali, and Lassi Ruoppa, all with a background in mathematics and operations research. In addition to mathematics, the team also has knowledge in investment science, data science, and machine learning from previous studies and work. The team is diversified in each student's fields of interests and working background and our aim is to divide the tasks necessary to complete this study in such a way that each member is able to utilize their strengths and interests.

Our contact person from the client's side is Ville Iso-Mustajärvi, a portfolio manager at Veritas with a study background in systems and operations research. He has introduced us to the project with Kari Vatanen, chief investment officer at Veritas with a background in engineering physics and mathematics, and Olli Hemminki, a portfolio manager at Veritas with a background in mathematics. The client team has provided us with the necessary background knowledge and data sources needed to complete our work. In addition to the client team, professor Ahti Salo and teaching assistant Jerry Aunula will be supporting us throughout the project.

The tools we are most likely to be using are Microsoft Excel and Python.

6 Risks

The risks related to the project are listed in Table 1, which provides an assessment of risk probabilities, impacts, and effects. Furthermore, we describe the measures we plan to take to minimize the effects and probabilities of said risks. The risks are arranged in descending order based on the estimated probability of occurrence.

Table 1: Risks related to the project, along with an assessment of the impacts and possible measures to mitigate the risks.

Risk	**Probability**	**Impact**	**Effect**	**Mitigation**
Overfitting model	High	High	Model will not generalize well and will not be useful to the client.	Keeping the model adequately simple and frequently assessing its predictive power. Using as many data points as possible and avoiding using a large number of highly correlated variables in the model.
Misunderstanding complex financial concepts	Medium	High	Methods and models may be implemented or used incorrectly, which in turn invalidates the results and our end product.	Consulting the experts, i.e. our client, if we are unsure whether we understand some particular financial topic, for example, how some asset class functions.
Inability to justify used models with literature	Medium	High	The client has specified that it is necessary for any model to be justifiable according to reliable sources, otherwise they can not use it. As such, even if our end product shows good results, it will be useless to the client if we cannot rationalize the choices done in modeling with literature.	Prior to beginning the development of our model, the team must ensure that each of the chosen modeling tools have a strong scientific basis.
End product fails to meet client's expectations	Medium	Medium	Client is less likely to take part in future renditions of the seminar.	Managing the client's expectations with frequent meetings and discussion on what we consider possible to implement and how it can be brought closer to the client's needs.

Erroneous results due to personal implementations or Python libraries used for difficult mathematical computations	Medium	Medium	Depending on how severely incorrect the computations are, the achieved results will either be mostly unaffected or completely wrong.	Carefully getting familiarized with the theory behind concepts such as tail dependence. Sanity checking results.
Failure to implement a functioning end product that identifies financial regimes.	Low	High	Essentially this means that the objective of the project is not reached in any capacity.	Defining the scope of the project clearly and actively communicating with the client if and when any problems arise.
Poor data quality / low information value	Low	High	Final model will yield poor results.	Conducting exploratory data analysis prior to beginning to implement the model, so that possible data quality related problems can be discussed with client early on.
Team member inactivity	Low	Medium	The workload of other project members will increase, which in turn will most likely result in a lower quality end product.	Active communication between team members, clear division and scheduling of project tasks.
Communication issues with the client	Low	Medium	End product may not meet customer expectations, or in the worst case scenario we may fail to find a suitable approach altogether.	Taking initiative in actively communicating with the client. For example, we could call the client if they do not answer our emails.

References

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