Interim report

Changes in investment market regimes in the post-Covid era

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Client: Veritas

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1 Changes in Objectives and Scope

The main goal of our work has remained unchanged. We aim to find a method to verify the presence of different asset class dependence regimes using historical time series data of multiple asset classes, e.g., stock indexes, commodities, and macroeconomic data such as inflation. We analyze the inter-dependencies of asset class returns to see if the data can be clustered into regimes. At the beginning of our work, we looked at different clustering methods and explored how to preprocess the data the Veritas team provided us. Therefore, we had a rather large and exploratory scope. As of April 10, we are now focusing on clustering methods that have given promising results and have excluded more sophisticated methods based on poor performance. The current project status regarding the used methods is further explained in section 2.1.

The research questions set by Veritas have remained the same and are as follows:

1. Analyse the inter-dependencies of asset-class returns and see if the data can be clustered into different regimes.

2. Test the efficiency of different clustering methods and the explanatory power of a broad array of assets, but also economic variables, is it possible to develop a reasonably robust model for the identification of regimes?

3. Try to estimate asset class risk parameter values in different regimes. The conditional tail behavior is of specific interest as well.

2 Project Status

This section will cover the current status of the project: Already completed tasks, current tasks, and remaining tasks. Overall, the project is well on schedule based on our preliminary timetable seen in Figure 1. One extra client meeting has been scheduled, marked red in Figure 1, to follow up with the client team and to ensure our team stays on schedule with work. The meetings with Veritas have provided us with additional information and supported us with our work.

2.1 Completed tasks

We have completed the literature review focusing on the clustering methods and, for example, feature engineering. The data preprocessing has been completed. Each variable has been normalized in the preprocessing step to ensure well-comparable data. All necessary changes, such as calculating a percent change on some of the variables, e.g., inflation, have also been done. A workshop with Veritas with a theme on the variables was held at the end of March to ensure we have sufficient knowledge of necessary changes. In the workshop, Veritas guided us on the given inputs and how they should be processed and interpreted, which clarified the uncertainties that we had regarding the use of the data.

Based on the literature, we have tested several clustering methods and different ways of dimension reduction. PCA as a dimension reduction tool and Markow switching models have

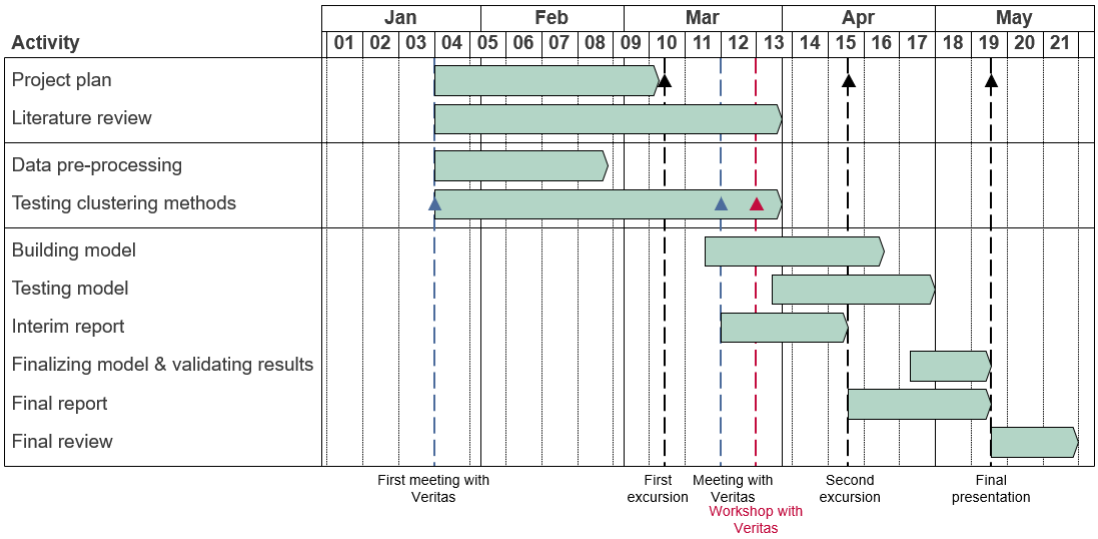

Figure 1: Project timeline

been discarded based on poor preliminary results. The focus of our work has been shifted to using Random Forests for the dimension reduction and k-means, DBSCAN, and Gaussian mixture models for the clustering. Preliminary results have been shared with Veritas.

Experimentation with the different methods and the preprocessed data has been carried out and some sensible but weak preliminary results have been obtained. Based on these initial results we can quite confidently say that the data can be clustered in a way that forms sensible regimes in the time domain. However, as of now, the clustering results are not very robust and the used methods are very sensitive to, e.g., the number of variables used in the clustering algorithms.

2.2 Current tasks

Currently, our team is working on finalizing the implementation of the necessary clustering methods. The different variable/correlation pairs will be gone through with random foresting and clustering and the model for the data analysis will be built. In addition, we are starting to write the final report now focusing on the literature review.

The second question Veritas set to us was to get an idea of whether the clustering methods can be used to develop a robust model. Based on our preliminary results, we speculate that the answer is no. However, this question is still under exploration.

2.3 Remaining tasks

The remaining tasks include selecting the methods for our final model, finalizing the model, testing its robustness, and sharing our results with Veritas. In addition, we aim to find an answer to the third question set by Veritas about the tail dependencies. We aim to schedule a workshop with Veritas about our results later on in the process. In addition to the model and results, the final report shall be written in the next phase.

While finalizing the model, exploratory work on derivatives as variables for the model will be looked into.

3 Updated Risk Management Plan

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.	Before 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.