

A Work Project, presented as part of the requirements for the Award of a Master Degree in Finance from the NOVA – School of Business and Economics.

ACTIVE PORTFOLIO MANAGEMENT USING THE BLACK-LITTERMAN MODEL

Individual Report

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This work project was developed in partnership with Caixagest. Caixagest is the asset management subsidiary of the group Caixa Geral de Depósitos (CGD) and is specialized in the mutual fund management and portfolio fund management; having a huge portfolio of different funds diversified by global financial markets¹. Furthermore, Caixagest currently has a portfolio of varied funds, diversified by major world financial markets, enabling any investor to set up an investment portfolio properly adapted to his needs and risk profile. As referred in section 1 of the report, the aim of this project was to apply the active BL model to a real portfolio of assets that was given to us by the company. In order to fulfill this purpose, we closely followed the work that was performed by some investment banks that are already using the model to allocate weights to the assets included in a portfolio. The project was also supported and has its basis in many academic papers that study, for instance, the implications, advantages and disadvantages of using this model under active management. This project came associated with some business challenges in the sense that we needed to adapt the initial model developed by Black and Litterman in the early 1990s for each type of Caixagest's investors and to its investment strategy. Thus, the main goal of using this model was to obtain a more diversified portfolio with not much concentration in just a few assets, allowing to a higher diversification of risk. As a result, we needed to reformulate the original framework in which the model was built and to study the inclusion of some constraints on it, such as a risk target per type of investor or account for the fact that no short selling is allowed. Finally, another challenge that we needed to face was based on the difficulty of building some of the inputs needed to implement the model, an issue discussed in existing literatures.

We worked as a team, and gathered at Caixa Geral de Depósitos headquarters three days per week. On a daily basis we had to perform many tasks: from treating data, solving excel problems to reading academic literature that would address the many challenges to overcome.

¹ In <https://www.caixagest.pt/Default.aspx>

We divided tasks; for instance, someone would read academic literature, when the other two were working on excel or gathering data. During the days at Caixa we would build our excel file and each one of us would check the work of another member, to be sure everything was completed right and nothing was left behind. Every two weeks, we had a meeting at Caixa Geral de Depósitos with our mentors Paulo Ribeiro and Pedro Frada and our academic supervisor Martijn; where the mentors' needs were discussed and all the advances we would made were explained.

The chapter I focused more on the entire work project, was the variance-covariance matrix which is a vital input to the Black Litterman model. The challenge was to build a robust covariance matrix in terms of predictive power consistent with Black Litterman. As there are many different methods of building a variance-covariance matrix that come with different advantages and disadvantages, choosing the right one to input into the model was not straight forward. The academic literature is abundant as the variance-covariance matrix is a very important input in financial applications, especially in asset allocation models (portfolio theory). I actively researched academic papers from authors that are prominent in the literature on modelling variances for financial applications. Robert Engle and Bollerslev (1986) are some examples of relevant literature that address the need to have a GARCH model to accurately capture the volatility behaviour. Others authors like Alexander and Leigh (1997), Laplante, Desrochers and Préfontaine (2008) provide research about the predictive abilities of the methods studied in this work project. The academic literature served to deeply understand the theoretical concepts, but proved as well, to be of great help for the implementation of the methods I chose to implement. I chose to study three different methods of estimating the variance-covariance matrix: the historical method, the EWMA and the GARCH. It is important to mention that the historical method does not capture neither the asymmetry of volatility nor the time dependency of volatility data and more sophisticated methods like EWMA and

GARCH exist and are capable of capturing long term mean reversion of volatility and capture some persistence of volatility data as well. A part from building these three different matrices, assessing their forecasting effectiveness was another challenge as it was important to choose the one with more predictive power. Thus, I preformed some studies on the forecast accuracy of each method using the in-sample testing, where one estimates the volatility using all available data, and then compares the fitted values with the actual realizations. The results of the forecast tests showed that the GARCH and the EWMA proved to be the most effective forecasting methods, based on some statistical indicators (i.e: MSE, MAPE, MAE). No clear conclusion between the EWMA and the GARCH method was obtained, nevertheless the GARCH is not as robust as the EWMA method as the correlations inputted in the variance-covariance matrix estimated by the GARCH were the ones obtained with the EWMA. Therefore, the GARCH variance-covariance matrix lacks of robustness, thus, the variance-covariance matrix obtained through the EWMA was the chosen to input into the model. It is important to note that the literature showed no consensus on which method to use to systematically model volatilities.

In the report I explain all the challenges that we overcame, and the importance of this exogenous input of the Black Litterman model. I carefully wrote a literature review analysing the most important academic research, and described all the theoretical concepts before explaining the practical implementation of those same concepts. The practitioner should be aware that some topics still need to be deepened: it is important to mention that more complex methods of modelling volatility are available and are worth being mentioned, as there is not a “best model” to estimate volatilities. As a matter of fact, it is very difficult to fully capture the future behavior of volatility. Moreover, volatility has different characteristics depending on the asset class studied and many authors have shown that the predictive ability of a model depends on the type of asset studied and on the sample size. For instance, there are some models that can capture accurately the volatility of commodities and not that accurately the equities’

volatility. Thus, we recommend one not to gird to the three methods described in our work project and broaden the implementation of estimating variance-covariance matrices to other methods as any method has its upsides and downsides. The ARCH, ARMA and the implied standard deviation models, that use volatility implied by the pricing in the options market, are just some other methods of modelling volatility.

Besides the chapter I focused more on the written report, I putted great effort in building the excel file and on the numerical part. Always checking the excel, and incorporating the changes in it to solve the problems, we gradually encountered. I had an active voice in the meetings and contributed to solve some problems and needs that the mentors Pedro Frada and Paulo Frada exposed. All of this contributions were the main reason this project was so rewarding in terms of practical learnings.

With regard to the experience itself, I learned many things. Having deadlines to finish some tasks (for instance we had to finish the 1st task until mid-October), required from us great time management skills. Setting goals, prioritizing tasks, creating a schedule, and making lists were some of the things that helped me accomplish my tasks. By dint of good time management, I dramatically improved these skills, which I think to be vital in the professional world. Besides that, I improved my team working skills as the entire semester I worked alongside with two more students. We worked together three days per week at Caixa Geral de Depósitos headquarters, and got together many times at university to solve some more demanding problems. The atmosphere was great, and we got along very well, which made this experience very enjoyable. We spent much time together, and I learnt a lot from my colleagues. The communication was very good, and effective as well. The most important lesson I take from this project, is the importance of active listening. Being fully concentrated on what was said by the project mentors whether on a daily basis or on every group meeting at Caixa Geral de Depósitos, helped me perform better when doing my daily tasks. I understood that good active

listening skills will make one understand faster the tasks that one is assigned to do and to complete them in the most competent way possible. Moreover, doing applied research that had a real impact on how CaixaGest manages its portfolio was priceless. Having been directly exposed to the industry made me fill the gaps between the academic world and the professional one. As a matter of fact, this practical experience led to a deeper understanding of the academic concepts taught during the master in finance in courses like Financial Econometrics and Investments. This gave me confidence to deal with future difficulties that I may find in my future professional career. All in all, the experience was absolutely great and meaningful to my academic path and my future career.

Finally, I would like to take advantage of this individual report to acknowledge the help of all of those who contributed for a great experience. In particular, I would like to thank the thesis supervisor Martijn Boons for all his guidance and all the effort putted on helping our team. I would like to thank Paulo Ribeiro and Pedro Frada as well for all the support and availability they brought to the project and for all the advice given. Further, I would like very much to thank each member of my group: Theresa Felder and Catarina Muacho, who made the project possible, and made this a great learning experience.