

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.

PORTFOLIO MANAGEMENT USING THE BLACK-LITTERMAN MODEL

Individual Report

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A Project carried out on the Master in Finance Program, under the supervision of Martijn Boons from Nova SBE and Pedro Frada and Paulo Ribeiro from Caixagest

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1. Theoretical and methodological context

The mean-variance optimization process is essential for the asset allocation theory, which defines the optimal portfolio as the maximisation of the expected returns with respect to a certain level of risk. However, in practice this optimization process is not widely used since pitfalls, such as high sensitivity to small changes in expected returns and the assignment of extreme positions in some assets (corner solutions), does not lead to intuitive investments.

Black and Litterman (1992) introduced a model to overcome these pitfalls of the modern portfolio theory by combining a portfolio optimization model with forward-looking investor's views on the market, which leads to more intuitive, diversified portfolios.

The aim of this project was to apply the Black Litterman model (BL) to a portfolio of asset classes provided by Caixagest, which is the asset company of the group Caixa General Depósitos (CGD) and is specialized in the mutual fund management and the portfolio fund management. We first focused on the estimation of a robust variance-covariance matrix, as it constitutes an important input for the BL model and portfolio theory in general. After firstly implement the original BL model, we were required to adapt the model in accordance to an active portfolio management environment with a special focus on the investment strategies of Caixagest and the constraints of the investors. The problem of the reformulation is that the initial model aims to maximize the Sharpe Ratio, whereas under active management settings the investor have the intention to maximize the Information Ratio, which involves the portfolios alpha per unit of tracking error. The problem of implementing the Black Litterman model in an active management environment leads to active trades even though no views are specified. This is due to the fact that the Information Ratio optimization is included in the original BL framework, which follows another optimization function (Sharpe Ratio optimization).

2. Development of one particular content theme of the project, focusing on the diagnostic of the challenge, research and analysis and development of recommendations

During the project, I focused on the implementation of the original Black Litterman model. As we were not familiar with the model and its implementation, we first applied the BL model without considering an active portfolio management setting. This gave us the possibility to focus on the actual model and to deepen our knowledge and understanding of all its inputs. Throughout the implementation process, we were guided by several literatures and working papers developed by companies that already applied the Black Litterman model in their operations. In addition, we were in permanent contact with our academic supervisor and the Caixagest team to get feedback on our work.

The literature does not provide a clear explanations for some input parameters and some papers provide several user choices between different definitions for specific inputs and thus, makes the implementation of the model more difficult:

The Black Litterman model is usually introduced with a portfolio that only includes one asset class, however we applied the model for a portfolio with different asset classes, such as stocks, fixed income and a commodities index. Due to the lack of an appropriate and detailed description of the input parameters of the model provided in literature, the calculation of the implied returns and the implementation of investor's views caused several questions, which required more comprehensive investigations of the model by searching for papers, which described particular procedures more explicitly.

In addition, in order to get a better sense of the impact of the investor's views on the optimal BL weights and subsequently, on the overall portfolio performance, I performed a simulation exercise. The challenge in this simulation exercise was to build a user friendly excel sheet, which could be easily rebuild by a third party. The construction of the formulas, especially for the P and Ω matrix, was quite demanding, however, with the help of our academic supervisor

we were able to build both matrixes by using only one formula, which allows the user to insert as many view simulations as required by simply dragging down the formula. It should be carefully analysed if the portfolio implied by the BL model will be pushed towards the market portfolio in case the investors are less confident in their views. In addition, the simulation also provides insights of the models behaviour to applied constraints. It is often the case that portfolio managers are constrained in their investment strategies. This can lead to a limitation of the Black Litterman model.

Moreover, during the implementation process, we needed to define Ω , which represents the uncertainty of the views. In literature, there is no clear definition of this input parameter and several different definitions exist. Most papers, however, refer to He and Litterman (1999), who describe Ω as a diagonal covariance matrix with zeros in all the off-diagonal positions. Meucci (2005) describes Ω as a non-diagonal matrix, which simplifies the BL expected excess returns. However, this formulation of Ω requires the P matrix to be invertible. In our calculations, according to Meucci's definition the P matrix is not invertible. Thus, in the end, we decided after consulting the Caixagest team and our academic supervisor that further research should be undertaken in order to find a user friendly solution when applying the Meucci approach building the omega matrix. We agreed that we will continue our calculations with Ω defined by He and Litterman (1999) since most working papers refer to their definition.

The Black Litterman model overcomes the pitfalls of the mean-variance optimization and it benefits from the forward looking optimization process by allowing the investors to input their own views. To get a better sense of the model and its inputs, it would be interesting to analyse changes in the estimation of expected excess returns, such as different definitions of Ω or the impact of tau on the estimation of the confidence matrix.

3. Personal reflection on the work done and on the learnings you were able to draw from the practical experience during the project

Personally, I was not aware of the Black Litterman model before dealing with it during this project. Thus, I needed to deal with a completely new topic. On the one hand, I was very excited to study something new, without having any background, on the other hand, I knew that difficulties will come up that I was not confronted with before. Nevertheless, throughout the project, I was feeling very confident since I could discuss any issues or opened questions with my team members or our academic advisor and business advisor, who gave us on a regular basis feedback on our recent work. Moreover, I became more confident to ask questions to my team members or to my supervisor without feeling scared. Only when I fully understand the context of the model, I will be able to do deeper research and perform better.

During the project, I was able to apply recently learned knowledge and skills by modelling a user friendly excel sheet and by performing a simulation exercise including a VBA code or I shared my theoretical knowledge with my team members. We were often faced with problems that only came up during the application process of the Black Litterman model. Since I was confronted with the same problems as a portfolio manager, I realized that the implementation of theoretical knowledge into practice is not always straight forward and it might be the case that difficulties will arise, which will not be foreseeable and need further research. Solving an actual business problem helped me to realize that a professional might have a different perspective on difficulties than one person with a theoretical background. We were often put in situations where the Ciaxagest team pushed us away from the theoretical components and advised us to approach to a solution from the perspective of an active manager.

Furthermore, I learned during this project that team work is about working together, aiming the same goal and reaching a high quality work for the client together as a team. This requires that each member accept both positive and negative criticism. It is important to realize if you are

wrong; conversely, one should also represent his/her opinion and ideas clearly to the colleagues. In some cases, however, we were set in situations where one needs to put aside his/her individual viewpoint in favour for the team. I understood that showing respect and being sensitive to each other, especially when you criticise someone and his/her work, are important attitudes to avoid a bad work environment throughout a project. Everyone should motivate the other team members in order to strive the best out of everyone.

The work in a team over a time frame of about five month showed me that after a while you get to know not only the strengths of yourself, but also from the other group members and thus, we were able to split different task accordingly. Nevertheless, it is important that every group member is on the same level of information and everyone should know what the other team members are working on. During the project, we had at least three fixed days per week to work together on the project, which helped us to update each other or to work together on the same task. The other days, we usually tried to do literature research in order to work together on the implementation of the model. Having individual work time improved my time management and organisational skills by scheduling tasks and prioritizing work.

Not only the communication within the team is important, but also the interaction with the client, in our case Ciaxagest. Usually, we were working at the company's office. This has the advantage that we are present for the client and any questions can be addressed immediately and in person, which avoids misunderstandings. However, we missed to have only one person who is responsible for the communication with the client and our supervisors. An improvement in terms of communication could be that the client and supervisor have a single contact person; otherwise this can lead to a lack of information or conversely, to a huge flow of information, which leads to confusions.