2015

Seminar on Case Studies in Operations Research (Mat-2.4177)

CLIENT: NORDEA

RISK ANALYSIS OF A DERIVATIVES PORTFOLIO

PROJECT PLAN 6.3.2015

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1. Introduction

This project is assigned to us by Nordea, a large Nordic-based financial services group. In this project, we model the credit risk of a derivatives portfolio. Credit risk is the risk that a borrower will default on any type of debt by failing to make the required payments. Credit risk arises whenever a borrower is expecting to use future cash flows to pay a current debt. The risk primarily consists of disruptions to cash flows which can occur for example by bankruptcy. Due to recent financial crises, analysts in banks have been giving more thought to how to prevent growing risks which has made them to build models for such tasks. Credit risks are vital in fixed-income investing, which is why rating agencies such as Standard & Poor's evaluate the credit risks of thousands of corporate issuers continuously [1], [2].

Credit risk associated with the counterparty in a derivative contract is defined as counterparty risk. Derivative portfolio's counterparty risk consists of individual contracts' counterparty risks. Derivatives carry counterparty risk which arises when the counterparty of the contract defaults, resulting in a loss equal to the contract's market value. Besides modeling the risk, this project is to explain the changes in the portfolio's risk between two selected days. Changes depend on the individual derivative's market values and can be calculated using market variables. Derivatives used in this case are outlined to be foreign exchange (FX) forwards, FX swaps, interest rate (IR) swaps and cross currency swaps [3].

2. Objectives

The ultimate objective is to build an easy to use Excel-tool to be used on a daily basis, supporting Nordea's risk management tasks associated to the counterparty risk of their multi-million-euros derivative portfolios. The aim is to explain which drivers and to what extent have influenced to a change in the counterparty risk level of a portfolio over a determined period of elapsed time. By drivers we mean market variables, such as interest or foreign exchange rates as well as operational events, such as fixing days. The question the model is required to answer is "Why has our risk changed?" and the answer should include all the key drivers contributing to this phenomenon. In addition to explaining changes in the risk we will research methods for simulating the market values of individual contracts as well as the counterparty risk associated with them.

As the change in counterparty risk of a portfolio is directly determined by the change in market value of the portfolio, the analysis of counterparty risk is made through the drivers of changes in market values. The analysis is initiated by identifying the drivers and their influences on market values for each individual contract within the portfolio, whereafter the results are aggregated to the customer-level (sub-portfolio) and further to the overall portfolio-level. Hence, the analysis is made on three levels, enabling to deal with each level separately. The portfolio consists of at least tens of thousands of individual contracts.

The resulting Excel-tool will present both graphically and in tabular format the underlying drivers of change in the counterparty risk for the desired (sub-) portfolio or contract over the given period. Therefore, it will be easy to see which drivers and to what extent have changed the counterparty risk level, and what would have been the impact in case that one or more of the drivers did not exist. Additionally, the tool will enable to examine which contracts or customers' portfolios have had influence within the overall portfolio and to what extent.

3. Tasks

The tasks can be divided into these following parts.

1. **Preparation and planning with the client**
   The first task after planning is to get familiar with the project and discuss about the goals, objectives and schedule with Nordea's representatives. We receive relevant material about derivatives and information about the drivers. We also receive an informative example data which gives us insight how to begin the construction of the Excel model.

   Responsibilities: Everyone

2. **Project planning**
   This project work starts by planning the project and writing the project plan. Project plan includes background, objectives, tasks, schedule, resources and risks.

   Responsibilities: Joonas (background and tasks), Veikko (objectives and schedule), Aleksi (risks) and Jussi (resources)

3. **Literature review**
   As this is kind of a new field of study for each project member, we decided to start the project work by reading articles about credit risk modeling and the literature on valuation of the derivatives used in this project. We will examine different alternatives for explaining the changes with mathematical and statistical tools, e.g. valuation formulas for different derivatives, estimation methods for market variable distributions, and risk budgeting models, such as Value at Risk. Probably we will have to find new research papers throughout the project.

   Responsibilities: Everyone, specific areas of study will be decided later

4. **Model architecture**
   As stated in the objectives–chapter, we need to find out how the market values for each instrument type are calculated. With this information we can calculate the change in counterparty risk at customer-level by summing the changes in the risk associated with each individual contract in the sub-portfolio. The mathematical methods for this will be selected based on informed judgment. One possible way to do this is using Taylor approximation including terms in respect to each market variable. Each project team member is assigned with one instrument type and they have the responsibility to find out the pricing formulas and calculate the prices' sensitivities respect to the market variables used in this project. In case we have any problems, Nordea's employees will cooperate with us and help us to get the formulas. Also, we need to broaden this approach to the whole portfolio by summing the changes in the risk associated with each sub-portfolio.

Responsibilities: Joonas (FX swap), Veikko (IR swap), Aleksi (FX forward) and Jussi (cross currency swap)

5. **Constructing the model**
   Once we have the proper architecture, we also need to build the actual Excel-based model. This will be based on the data provided by Nordea and it's going to include all the formulas, macros and mathematical tools needed. The result sheet will also be constructed in Excel using infographics.

   Responsibilities: Joonas and Aleksi (VBA programming), Veikko (infographics)

6. **Examination of a simulated portfolio**
   In addition to our previous literature review, we will compare different methods to use the model to explain changes in the risk of a simulated portfolio. This may however be limited to just deciding whether it's sensible to simulate the portfolio as a whole or simulate each derivative separately.

   Responsibilities: Everyone

7. **Producing interim report**
   The project includes an interim report which is an update of the status of the project. This is going to be presented on April 17th.

   Responsibilities: Everyone

8. **Validating the results with a stress test**
   We will use the model with different scenarios and with different portfolios to see how accurate results we can get. By comparing the changes in the risk calculated using our model with the corresponding realized changes we can see how well the constructed model works. Validation will determine the intended uses for the model which is a vital piece of information to the users. Also, we need to provide the complete list of all the assumptions made to prevent any improper use of the Excel-tool.

   Responsibility: Jussi

9. **Writing the final report**
   The final report will have a thorough literature review, description of the model architecture in detail, all the mathematical methods used and instructions how to use the model with Excel. Results and validation will also be included.

   Responsibilities: Everyone

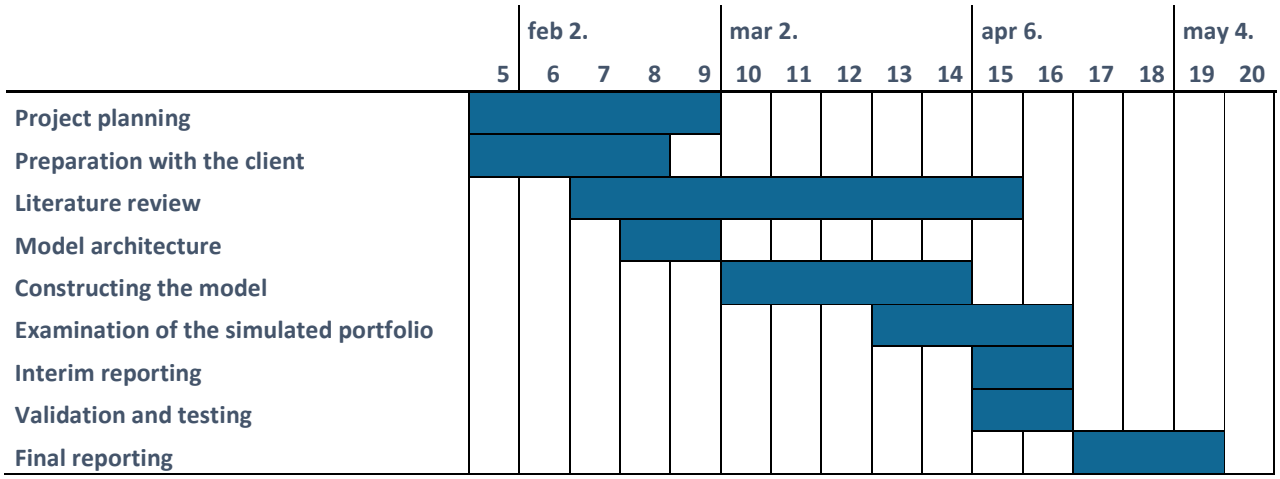
4. Schedule

Project plan, model building, and writing the final report are the three main phases of the project schedule. The given material and additional literature will be studied, and the written project plan, including clear plan of the structure and features of the final product, will be completed by 6.3.2015. The model will be built, tested, and finished to the final format by 17.4.2015. The final report will be written, and the project completed by 8.5.2015. Table 1 illustrates the schedule.

Important dates:

- Project plan by 6.3.
- Interim report by 17.4.
- Final report by 8.5.

Table 1 Project schedule



5. Resources

This project will be executed by a team consisting of Joonas Lanne (Project Manager), Veikko Kovanen, Aleksi Seppänen and Jussi Hirvonen. All members have a keen interest in financial markets and our project manager has experience in working for an investment management company**.** It is necessary that the co-operation between the team and the client is frequent, as it is the only way to ensure that the client is informed about how the project is progressing.

Literature on derivatives, risk budgeting and portfolio theory will be used to build understanding of the theory behind the problem and to evaluate different solutions proposed hitherto. Also the client will provide data on a hypothetical portfolio of derivatives as well as time series of interest rates, currency exchange rates and other market variables.

6. Risks

At the beginning of the project the risk assessment is initialized. It is conducted in order to avoid risks, reduce their effect and increase readiness to cope with the risks if they are realized. For each identified risk the probability is estimated on a four stage scale (remote (Probability: $P < 0.1\%$) – unlikely ($0.1\% < P < 1\%$) – probable ($1\% < P < 10\%$) – likely ($P > 10\%$)), the effects are described qualitatively and preventive as well as mitigating actions are presented. The results of the risk assessment are collected in table 2.

At this stage of the project, the most apparent risks are related to resources and workload. It seems unlikely to face problems regarding to team member absence or inactivity as everyone in the project team is committed to the project. It is important to distribute the workload evenly in order to maintain pace and team spirit. The scope of the project is well defined, but if the workload turns out to be still too much, it is possible to redefine the scope with the client. The probability of realization of each risk, as well as possibility of new risks, will be observed throughout the the project.

Regarding the Excel-tool, the main risks are data quality and the performance of the software. Most of the data is acquired from the client, so if there are errors in the data, the client should be informed and we could get new data. The performance of Excel might not be enough for all of the preferred requirements of the tool. As the client asked specifically Excel-based tool, there is not much we can do about it if this risk realizes. Either way, we should clearly inform the client about the limitations of the Excel-tool. It is also possible that the produced tool does not provide sufficiently accurate results. To prevent this from happening, we must understand the theory of the financial instruments and their valuation. As the project is restricted to only the most common derivatives, the realization of this risk seems unlikely.

Table 2. Project risk assessment

Risk	Probability	Effects	Preventive actions	Mitigating actions
Team member absence or inactivity	Unlikely	Project is delayed, workload grows for other members	Agreed commitment to the project, personal healthcare	Redistribute workload, adjust schedule
Workload or difficulty exceeds resources	Remote	Project does not meet the objectives	Workload distributed evenly, well defined project scope	Negotiate project scope with client
Data quality	Likely	Increases workload	Careful inspection of the data	Filter corrupted data, ask for new data
Poor accuracy of the tool	Unlikely	Failure to deliver useful tool	Acquire deep understanding of the underlying theory	Try to improve tool
Excel turns out to be insufficient software	Unlikely	Failure to deliver useful tool	Well defined requirements for the excel tool, proper validation	Inform client about tool limitations

References

[1] Edward I. Altman and Anthony Saunders:

Credit Risk Measurement: Developments over the Last 20 Years, 1998 (Provided by Elsevier in its Journal of Banking & Finance vol. 21 pages 1721-1742, New York, NY)

[2] Anthony Saunders and Linda Allen:

Credit Risk Management In and Out of the Financial Crisis: New Approaches to Value at Risk and Other Paradigms, 2010 (Published by John Wiley & Sons, Inc., Hoboken, New Jersey)

[3] National Association of Pension Funds Limited (NAPF):

Derivatives and Risk Management Made Simple, 2013 (Published by NAPF)