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Optimization of variable proportion portfolio insurance strategy

Sampo Bank Inc.

Project plan
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Introduction

This report presents the project plan for the case study Optimization of Variable Proportion Portfolio Insurance (VPPI) strategy. The main goal of this project is to use VPPI with different constraints to optimize the returns of portfolio with the given risk limit. This study is conducted for Sampo Bank as a part of the project seminar of operations research at the Helsinki University of Technology. Sampo Bank is the third largest bank in Finland and a part of Danish bank conglomerate Danske Bank.

Throughout history investors have sought after strategies to hedge their portfolios against downturns. One of the simplest ideas to avoid risk is to divide the portfolio into two parts, a risky one and another without risk. When the time evolves the amount of risky and riskless assets in portfolio is changed with some strategy.

Perhaps the simplest strategy is a buy-and-hold strategy. Basically it's a "do-nothing" strategy that is characterized by an initial mix that is bought and then held, for example, 60% in risky assets and 40% in cash or bonds. Regardless of what happens to the value of the risky asset, no rebalancing is done.

A slightly more evolutionary strategy is the constant-mix strategy. It implies a constant proportion of the portfolio be invested in risky assets. Whenever the relative values of the assets change, the investor has to rebalance the portfolio ie. buy or sell the risky asset.

Another way to protect the investment portfolio is the so called Option Based Portfolio Insurance. It consists basically in buying simultaneously the risky asset and a put option written on it. The value of this portfolio at maturity is always greater than the strike price of the put, whatever happens on the market. Thus, this strike is the insured amount which is often equal to a given percentage of the initial investment, for example 60%.

Research problems and objectives

The focus of this project is Variable Proportion Portfolio Insurance (VPPI). The logic behind VPPI is to invest certain percentage of the portfolio to risky assets based on the formula e=m(a-f). This means that investor chooses first a guarantee level of the portfolio called the floor (f). And then defines the amount of exposure to the risky asset (e) by time-variant multiplier m. The difference between the portfolio value (a) and the floor is called cushion (c).

Rebalancing of the portfolio is done either periodically or when the value of the risky asset changes a certain predefined percentage. For example, let's assume a portfolio of a=100, a floor value of f=75 and a multiplier of m=2. As the initial cushion is c=25 (100-75), the initial investment in risky assets is e=50 (25x2).

Thus, the initial mix is 50/50 risky asset/cash. Suppose the risky asset depreciates 10%, so the investor's shares will fall from 50 to 45. The total value of the portfolio then a=95, and the cushion is c=20 (95-75). According to the VPPI rule, the new stock position is e=40 (20x2) assuming the multiplier stays the same. This requires the sale of 5 of shares and investment of the proceeds in cash.

The following research questions have been identified:

What method should be used in choosing the multiplier to maximize expected value of the portfolio?

What methods are used in choosing the multiplier?

What are the main benefits and downsides of VPPI compared to other portfolio insurance strategies?

The main target of this project is to optimize the multiplier m. In other words to find a rule for asset re-allocation dynamics that maximizes the expected return of the portfolio while respecting the following constraints:

- Multiplier cannot change more than 1 unit at any one time step due to limited liquidity
- Multiplier must be in the range 1- 5
- Risky asset exposure must be in range 0% - 100%
- Risk cannot exceed some amount (e.g. 90% VaR - method to be chosen)
- Rebalancing costs (fixed amount + percentage of rebalancing notional)
- Time lag (Net Asset Value observation vs. rebalancing)

Methodology

A literature survey concerning VPPI strategies is conducted. University libraries and databases as well as student research projects will be utilized to find relevant literature and articles. In order to thoroughly understand the optimization problem, each member of the project team will carefully study the relevant material.

Aim of the project is to find an optimum rule for choosing multiplier and rebalancing frequency with regards to VPPI in such way that the expected return is optimized. When all the relevant aspects have been identified, the optimization problem will be developed. There are some constraints that must be taken into account. For example, risky asset exposure must be in range 0-100% and multiplier can only change 1 unit at a time step due to limited liquidity. Also the risk mustn't exceed a certain level.

It is possible to give the multiplier a certain fixed, optimized value. In this case, a variable multiplier is chosen and an optimum strategy for changing it will be developed. The multiplier can be chosen by using different criteria. For example, (historical or implied) volatility can be applied. Other possible criteria include: current risky asset value, market trend (bear/bull market), risky asset change and trend of the risky asset value. An optimal rule for multiplier selection is developed by carefully considering each of these possibilities.

The rebalancing frequency can be chosen to be fixed e.g. weekly. Or alternatively, a rebalancing might occur after an adequate change in the risky asset value. Also other strategies will be considered. In essence, the rebalancing strategy must react to market changes quickly enough. On the other hand, the shorter the rebalancing period, the higher the transaction costs will be.

When the optimal allocation mechanism has been found, they will be programmed using Matlab. The constructed models will be tested using real market data delivered by project contact persons at Sampo Bank. Sufficient amount of data is promised to be available. If necessary, additional data can be produced by simulating Brownian motion with occasional jumps. The models will be tested with different kind of data to ensure success in different kind of situations.

This kind of optimization problem has several possible solutions. Different solutions perform very differently depending on the market behavior. VPPI typically performs poor in an oscillating market. The aim is to find a mechanism that could perform well during all kind of market fluctuation. The results of the project will be viewed critically and possible flaws of the constructed model will be identified.

Risk assessment

There are a number of risks related to the project. Their characteristics are regarded in two dimensions: the probability of occurrence and the severity of the outcome when the risk realizes. These risks are summarized in the Table 1.

Table 1. Project risks.

Risk	Probability	Effect	Preventive action
The scope of the project becomes unmanageable.	◔	●	- Clear formulation of the project objective and monitoring of the mile stones reached.
Shortage of resources (Time and special skills).	◑	◕	- Jointly agreed allocation of resources and careful planning. - Monitoring of progress.
The model is poorly chosen.	◔	◕	- Continuous communication with the case company at and between the project mile stones. - Extensive literature study and communication with the course personnel.
The data is analyzed faultily.	◑	◑	- Continuous communication with the case company at and between the project mile stones. - Extensive literature study.
The project outcome doesn't satisfy the case company.	○	●	- Continuous communication with the case company to identify deviations from the objectives early on.

○ None ◔ Low ◑ Medium ◕ High ● Very High

The subject of portfolio optimization is relatively unfamiliar with the group. The main challenge is in identifying the abstractions behind the practical problem and finding the right means to deal with them. We must find an applicable model with relevant variables to describe the behavior of an investment portfolio. A pitfall can be seen in selection of the variables as they define the scale of the model and further on the scope of the project. Clearly formulated objectives and communication with the case company is the route to avoid these problems.

Another risk can be seen in availability of resources. Time and special skills (Matlab and coding experience) are to be underlined here. Careful planning and allocation of resources are imperative for project success. When avoiding all the other risks, the failure in meeting the case company's as well as the project's objectives is highly unlikely.

Schedule

Table 2. Time schedule of the project.

Phase #	Activity	Week													
		5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Project Planning Project Definition														
2	Literature Familiarization Literature Discussions														
3	Problem Identification Model Development Model Testing Conclusions														
4	Interim Reporting Final Reporting														

Project schedule is presented in Table 2 and phases are defined as follows:

- Phase 1: Planning
- Phase 2: Research
- Phase 3: Model creation
- Phase 4: Reporting

Work load will be divided according to ones' own preferences and competence. Final distribution of tasks takes place during the project. So far, planning has been done with everybody's participation in group meetings. Literature research and problem identification will be done simultaneously by two different groups. Model creation requires everyone's effort and subtasks are done in smaller groups. Model testing results will be validated by brainstorming. Due to project schedule critical deadlines are presented in Table 3.

Table 3. Deadlines.

Deliverable	Deadline
Project plans submission	26.2.
Project plan presentation	29.2.
Interim report submission	25.3.
Interim report presentation	28.3.
Final report submission	25.4.
Final report presentation	2.5.

Resources

Project team consists of five members:

- Janne Kunnas (project manager), M.Sc student at department of Mathematics and Systems Analysis, HUT
- Juho Helander, M.Sc student at department of Mathematics and Systems Analysis, HUT
- Sami Mikola, M.Sc student at department of Industrial Engineering and Management, HUT
- Matti Sarjala, Ph.D student at Laboratory of Physics, HUT
- Juho Soinio, M.Sc student at department of Industrial Engineering and Management, HUT

Project manager is responsible for all communications with project client's representatives Antti Malava and Juho Tiri. Sampo will provide the data needed in this project and will also participate in defining project restrictions and targets. Team has also available guidance from course staff Professor Ahti Salo.