CSE-400 Fundamentals of Probability

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Scribe Reflection: Probabilistic Modeling

Scribe Question 1: Project System and Objective

The probabilistic problem addressed in the project is the estimation of market risk for a portfolio of financial assets exposed to various sources of uncertainties. The returns and prices of financial assets increase due to changes in market conditions, investor sentiment, economic factors,and unexpected events. Consequently, portfolio performance in the future cannot be known with certainty.

The primary system goal is to provide an estimation of the one, day 99% value, at, Risk(VaR) of a portfolio. VaR represents the maximum loss expected with a given confidence level over a certain period of time, i.e the losses exceeding this value occur only with 5% probability.This measure of risk is very popular among financial risk managers and is also the basis of some regulatory capital requirements.

The main uncertainties of the system are asset return random behavior, changes in correlation between sources if market risk, volatility fluctuations, and the problem of identifying the true parameters of the model based on a limited sample of past observations.The project thus uses a probabilistic modeling approach to formalize uncertainties and gain insights into the behavior of extreme loss.

Scribe Question 2: Key Random Variables and Uncertainty Modeling

The finacial system includes some of the most important random variable in the object:

- Portfolio returns(R): The random variable that is modeled based on the past price data.Under the **Monte Carlo** method of returning, the returns are supposed to be normally distributed with mean and variance calculated using the historical data.
- Risk Factor returns $(F_1, F_2, ..., F_n)$:Under the factor based model,market risk factors are assumed to be jointly distributed random variables.Their uncertainty is represented with the help of a multivariate normal distribution which reflects correlation between factors.

- Simulated (Future) Portfolio Returns($\hat{R}$): The model is generated by a Monte Carlo simulation of future returns by repeatedly sampling the assumed distributions to approximate the distribution of the possible future.

Present probabilistic models consist of normality of returns, constancy of these parameters of distribution in the estimation time, linear regress pf the returns of the portfolios on the risk factors and conditional independence of the observations in case the model parameters are known. These are some assumptions that make the process of modeling easier, but can be refined.

Scribe Question 3: Probabilistic Reasoning and Dependencies

The methodology of the project is probabilistic reasoning. In the return based model portfolio returns are supposed to be independent, and identically distributed and then the future returns can be generated with estimated distribution parameters.

The factor based model explicitly represents dependencies in a linear regression between portfolio returns and risk factors underlying them.Conditional dependence on the portfolio of the factors is represented by regression coefficients. Sampling of a multivariate normal distribution maintains correlations between the risk factors, and the behavior of the risk factors is realistic.

Contraction probability is applied to deduce the distribution of portfolio returns under simulated factor realizations. The VaR estimate is derived as a lower-tail quantile of the simulated distribution of returns, probabilistic inference is directly connected to the decision making and risk assessment.

Scribe Question 4: Model–Implementation Alignment

The model described in the paper are implemented in a way that closely follows the theoretical assumption and methodology structure.Return based model assumes that the portfolio returns follows normal distribution.This assumption is applied in practical by fitting normal distribution to the historical data and using the estimated parameters to run Monte Carlo stimulations.

Factor based model is also implemented exactly same as described in the theory.Factor sensitivities are estimated by using regression analysis and important statistical checks.Correlated factor returns are simulated using multivariable normal distribution and simulated factors are then converted back to portfolio based on estimated sensitivities.

Backtesting follows regulatory standards (Basel III) using both fixed and rolling windows to test VaR accuracy.The both fixed window and rolling window VaR models are then tested against with from sample returns and violations are evaluated using traffic light approach.Overall the models are implemented as designed-there is no major gap between theory and practice in this study.

Scribe Question 5: Cross-Milestone Consistency and Change

Across every different stage of the project:model construction,simulation and backtesting the core structure of the model remains consistent.The same portfolio,same data,same confidence level are used throughout which makes the result more comparable across all the milestones.

As we move from standard backtesting to rolling backtesting a big change takes place.In rolling backtesting the model is updated by the everday available data instead of keeping its data consistent in its whole period.Due to which the model adjusts itself better in changing market conditons.And as a result there are much less VaR violations for both and improvement happens.

This change does not that there is a problem in the project.Instead it is an improvement.Rolling backtest is on the original model but it updates more than normally it shows that same model can give better results when it refreshes regularly this change is logical,easy to follow and supports the results.

Scribe Question 6: Open Issues and Responsibility Attribution

Even though the models are well designed paper clearly points onto some limitations

- The first of all major issue is that both models follow a normal pattern which leads to a large losses and specially during market stress
- The second issue is that factor model assumes linear relationships which is not fully complex and have non linear behaviour of financial markets.

There is also some of subjectivity in choosing the factors and fiximg the model limits.For example in deciding the factors that how much power is required which is totally depends on personal judgement and the decisions are not strictly based on rules but also on the reasearchers judgement.

The responsibility for those limitations lies on the people who design the model and run the model.Regulators are given some general guidelines but it is the practitioner's job to make sure that the model is perfect,checked day to day and is updated when the condition'sare been made.This paper shows the responsibility by discussing that the model's limitations and by suggesting the improvements such as stress testing and using it at differnt times for the calibrations.