Basic Risk Definitions

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INDEX

1.1 Risk measures
   1.1.1 Value at Risk (VaR)
   1.1.2 Stress analysis

1.2 Market risk
   1.2.1 Sensitivity measures
   1.2.2 Methods for measuring market VaR

1.3 Credit and counterparty risk
   1.3.1 Credit risk measurement elements
      1.3.1.1 Probability of default
      1.3.1.2 Default correlations
      1.3.1.3 Portfolio concentration
      1.3.1.4 Exposure
      1.3.1.5 Loss severity
   1.3.2 Loan portfolio risk measures
      1.3.2.1 VaR
      1.3.2.2 Expected loss
      1.3.2.3 Unexpected loss
Risk

The word risk comes from the Latin “risicare” meaning “dare”. In finance, the concept of risk is related to the possibility of an event occurring that translates into losses for financial market participants, such as investors, borrowers or financial entities. Risk is the result of uncertainty about the value of financial assets in response to adverse changes in factors that determine their price. The greater the uncertainty, the higher the risk.

1.1 Risk measures

In 1952, Harry Markovitz proposed using variability in financial asset returns to measure risk. Asset return variance remained the universally accepted risk measure until the end of the 1980s and the beginning of the 1990s, when it became clear that it is more a measure of uncertainty than risk. Parallel to the big financial crises of this period there was a need for the measurement of risk to be expressed in terms of potential losses with a certain probability of occurrence.

1.1.1 Value at Risk (VaR)

Currently, the most accepted measure of risk is “Value at Risk”. VaR is an attempt to provide an idea about the loss that could be incurred over a given period of time, but as losses and gains are uncertain, probabilities must be associated with different potential losses. A more formal definition\(^1\) is that the VaR is a loss level (of the asset/s in question) such that the probability “\(\alpha\)” of the loss exceeding that amount in a given period of time corresponds to a certain confidence level chosen by the analyst. Thus, the analyst establishes the confidence level he or she wishes to work with and the period of time in which the loss in the financial assets for which risk will be measured may occur beforehand. Using these two parameters, the VaR corresponds to the quartile associated with the established level of confidence of the loss and gain probability distribution of a series of assets over a given time horizon based on conditions of uncertainty prevailing in the market at the time.\(^2\)

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\(^1\) Formally expressed as: \(\text{VaR}_{\alpha,T} = \{x \in \mathbb{R} \mid \Pr(\text{loss at } T) > x \} = \alpha\)

\(^2\) This definition is important and is a criticism of the measure.
1.1.2 Stress analysis

Although the VaR risk measure is a well-accepted one, it does have limitations, the main one being that the outcome depends directly on data used to calibrate the models and/or the history contemplated in the exercise. Thus, the view held is that the VaR is a good measure of the risk of losses under “normal conditions” in markets but is not very helpful during crises. The stress analysis seeks to make up for this weakness in the VaR and consists of valuing the portfolio taking into account large impacts in the level of risk factors. It complements value at risk as it estimates the value of a portfolio under market conditions that are not considered normal.

Depending on the situation at hand, stress scenarios can be classified as follows:

- **Stylized extreme scenarios**: modest or extreme changes in diverse risk factors including interest rates, exchange rates and share prices.
- **Historical extreme scenarios**: consist of valuing portfolios taking into account risk factors that occurred during historical crises.
- **Hypothetical extreme scenarios**: consist of hypotheses about the values risk factors could assume in the event of a completely unforeseen situation with no precedent; for example, a major earthquake, terrorist attack or given political situation.
1.2 Market risk

Market risk is the potential loss in the value of financial assets derived from adverse changes in factors which determine their price, also known as risk factors; for example, interest rates or the exchange rate.

1.2.1 Sensitivity measures

Duration

Duration analysis is a method traditionally used by institutions that wish to measure the risk of a loss in the value of their assets due to parallel and adverse adjustments in interest rates. Duration is defined as the change in the value of a financial instrument owing to a change in interest rates. Duration is what is known as a local measure of the price sensitivity of the financial asset to interest rate adjustments and mathematically it is the first derivative of how the price of a bond changes in response to interest rate changes. The main advantage of this measure is that it is easy to obtain.

Sensitivities (DV01)

The “Dollar value of a basis point” known as DV01 and the “Price value of a basis point” (PV01), is the change in the price of a financial instrument resulting from a parallel change of 1 basis point (bp) in the intertemporal curve due to interest rate maturities. The measure is commonly used as a tool for making quick decisions for negotiating purposes (buying and selling of financial assets) within bank and brokerage firm treasuries.

1.2.2 Methods for measuring market VaRs

VaR parameter

These parameters are characterized by the assumption that asset returns are distributed in accordance with a density curve, which generally speaking is the stable one, and on the assumption of asset value linearity. Using the assumption of stability and an average return equal to zero, the parameter model which determines the value at risk of a position is as follows:

\[ \text{VaR} = F \times S \times \sigma \times \sqrt{t} \]

F = Factor determining the confidence level of the calculation
S = Total investment amount
\( \sigma \) = Standard deviation of the asset’s returns
t = Time horizon
However, in practice it has been found that most assets do not necessarily display random behavior that can be successfully approximated using a stable distribution, and so results obtained by measuring risk assuming stability generally tend to underestimate the real level of portfolio risk.

**Historical simulation**

Intuitively, the historical simulation is an exercise that examines possible financial asset portfolio values and their corresponding losses and gains with respect to their current value assuming that past scenarios can be repeated. It consists of valuing the assets of a portfolio of instruments in the historically-observed risk factor scenarios over a certain period of time. The loss or gain related to each scenario is the difference between the value of the current portfolio and that of the portfolio valued using the risk levels of the scenario in question. Based on the losses and gains associated with each scenario, a loss and gain probability distribution of the value of the portfolio is defined from which VaR can be obtained which, as explained, corresponds to the referred distribution’s quartile chosen by the analyst. The historical simulation method is well accepted because it is not based on correlation and volatility assumptions which during extreme market adjustments may not occur. Neither does it rest on the assumption of stability and is applicable to non-linear instruments.

**MonteCarlo simulation**

Unlike the historical simulation, the MonteCarlo method consists of randomly generating risk factor occurrence scenarios which impact the value of assets contained in a portfolio of financial assets. Once the scenarios are generated, the same procedure applies as with the historical simulation; in other words, the portfolio is valued using the risk factor values associated with each scenario such as the difference between their current value and the one corresponding to the scenario. As a result, the loss and gain probability distribution and the VaR are obtained, the latter, as the quartile of the distribution corresponding to the confidence level chosen. Besides being applicable to non-linear instruments, an effort is made to include scenarios that could occur but have not previously been observed; not even similar ones. Limitations to the technique are, on the one hand, the assumptions about probability distributions which characterize the performance of risk factors as well as their correlations, which can lead to the generation of scenarios that are inconsistent with the real performance of markets even during crises; and, on the other hand, that the demand on calculation resources to generate a sufficient number of scenarios which make results statistically reliable is considerable.

**1.3 Credit and counterparty risk**

Counterparty risk exists when there is the possibility of one of the parties to a financial contract defaulting on their contractual financial obligations leading the other party to incur a loss. Credit risk is when the contract involves a loan and
the borrower is unable to pay it. In addition to default, recently, events have been included that impact the value of a loan without it necessarily implying default on the part of the debtor. This typically occurs as a result of changes in the quality of the loan when an agency downgrades it. When this happens it means the rating agency has raised the likelihood of the issuer of the debt defaulting and so the credit is worth less as it is discounted at a higher rate.

1.3.1 Credit risk measurement elements

Factors that should be taken into account when measuring credit risk are: probabilities of default and/or shift in the borrower’s credit quality, default correlations, portfolio concentration, each borrower’s exposure, and the recovery rate in the event of default.

1.3.1.1 Probability of Default (PD)

It is the measure of how likely a borrower will default on contractual obligations. Its minimum value is zero, which indicates that default is impossible and its maximum value is one when default is certain. By loan type, PD is normally estimated using the default rate observed in each type of loan which is the percentage of borrowers or loans that stop paying within a given time period versus those that were performing in the previous period.

1.3.1.2 Default correlations

The “peer to peer” correlation measures the dependency or degree of association between the credit performance of two borrowers. Its value is between +1 and -1, and the size of the relationship depends on how tight the relationship between the behavior of the borrowers is. A positive correlation indicates that one borrower’s default makes default by the other more likely. Furthermore, the relationship is symmetrical, as if a borrower is meeting his/her obligation the other is also more likely to be meeting theirs. When the correlation is negative, behavior is opposite; in other words, compliance on the part of one of the borrowers makes the other’s default more likely and vice versa. When the correlation is zero, one borrower’s default has no impact on the other borrower’s credit performance.

1.3.1.3 Portfolio concentration

Concentration means that there is a lot of credit in few hands, which can be risky. Concentration can take many forms and is more dangerous when it occurs in risky portfolio segments. For example, concentration can occur in an economic sector (e.g. textiles, cars, services and retail, etc.) or in a specific geographical region or by loan type (e.g. credit card, mortgage, fixed-asset loans, etc.). It is usually measured using an indicator that summarizes in one number how a loan portfolio or one of its segments is distributed by balances. A well-known indicator for measuring concentration is the Herfindahl Hirshmann Index (HHI), which uses values between the reciprocal of the number of borrowers or loans (N) of a portfolio.
and one. Thus, a totally diversified portfolio in which borrowers owe exactly the same would produce an index value of 1/N, while if the index’s value is one, the loan is fully concentrated in a single loan or borrower. The reverse of this index called “the Adelman numerical equivalent” is interpreted as the minimum number of loans of the same size that would yield that index value.

1.3.1.4 Exposure

It is what the borrower owes at a given moment in time in the event of default. The acronym used is EAD.³

1.3.1.5 Loss severity

This is what the creditor loses in the event of the borrower defaulting and it is measured as a percentage of exposure. Its complement with respect to the unit (1-loss given default) is called “Loan recovery rate”. In the credit risk jargon, severity is represented by the acronym LGD.⁴ Summing up, it is the net cost of a borrower defaulting; in other words, the unrecovered part when the borrower defaults after implied recovery costs (e.g. the cost of collection and legal fees, etc.).

1.3.2 Risk measures associated with a loan portfolio

The risk measure of an individual loan is its likelihood of default.⁵ As with market risk, in the case of a loan portfolio, a credit loss and gain probability distribution (P&L) associated with portfolio loans is required. The following are measures related to this loss and gain distribution.

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³ EAD means “Exposure at Default”.
⁴ LGD means “Loss Given Default”.
⁵ The estimate in itself can be very complicated.
1.3.2.1 VaR

As with market risk, the value at risk of a loan portfolio is the quartile of losses and gains associated with the loan portfolio for the chosen time period and confidence level. It is usually broken down into what is called expected and unexpected loss.

1.3.2.2 Expected Loss (EL)

EL is the measure of the loss and gain distribution; in other words, it indicates how much can be lost on average and it is usually associated with the institution’s loan-loss provisions policy on credit risks. It is estimated as the result of the likelihood of default, exposure and loss given default (LGD) by borrowers.

1.3.2.3 Unexpected Loss (UEL)

It is a larger-than-expected loss measured as the VaR – EL that the creditor can incur owing to default by its borrowers. It can be expressed as a multiple of the standard deviation of the loss and gain probability distribution. These losses determine the economic capital the creditor requires to meet unexpected losses.