

# 14th Webinar on Data Science & Analytics

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**Operational Challenges in Implementation of Market  
Risk Framework for Financial Institutions**

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# Agenda

- *Background to Market Risk Calculations*
- *Introduction to Process Flow for Market Risk Operations*
- *Business & Regulatory Background for Market Risk*
- *Implications for Data Analysis in Market Risk*

# Introduction to Market Risk Framework



- Market Risk is the Risk that firm may incur losses due to movements in market variables like Prices and Volatilities
- The Market Risk Framework is the system that a financial institution develops towards accurately & periodically quantifying the level of Risk present in their portfolio.
- This Framework is guided by requirements set by relevant regulators governing the institution as well as business objectives to accurately assess risk to the Firm's profitability
- Financial Institutions therefore create a separate division to accurately quantify this Risk and periodically publish these metrics to the relevant audience

# Why is Market Risk Calculated



## ***Business Objectives.***

Market Risk Metrics allow the firm to quantify the level of Risk they hold & the potential losses they could face. It gives firms the opportunity to reduce the chance of large losses, regulatory fines & reputational damage

## ***Regulatory Requirements***

Regulators stipulate that firms should quantify & publish Market Risk metrics based on regulatory guidelines. This allows regulators to gauge & address the level of risk at a firmwide and systemic level

## ***Fiduciary Responsibilities***

By quantifying Risk Metrics, The firm can address concerns regarding the firm's profitability and stability arising from the level of risk they hold to their investors, clients, customers and other stakeholders.

# Risk Metrics & Calculation Methods



## ***Risk Metrics***

VaR – Value at Risk

ES- Expected Shortfall

## ***Primary Calculation Methods***

Delta Normal Method

Monte Carlo Simulation Method

Historical Simulation Method

## ***Revaluation Methods***

Partial Revaluation

Full Revaluation

## ***Stress Period Generation***

Historical Stressed Period

Stressed Scenarios

# Common Risk Metrics

***Value At Risk(VaR)*** – VaR is the worst expected loss on a portfolio for a given time horizon and confidence interval. Despite severe criticism, it continues to be the most widely used metric and it is still a required metric for several regulators

Advantages – Easy to understand, Relatively easy to implement ,widely used

Disadvantages – Heavily dependent on parameters used, excludes Extreme Tail Risk

***Expected Shortfall (ES)*** – ES is a measure of the average of all potential losses exceeding the Var at a given confidence level. Developed to address some of the shortcomings of VaR, it is gaining increasing traction with more Regulatory Bodies requiring Firms use this measure

Advantages – Captures Extreme Tail Risk, More Conservative Measure than VaR

Disadvantages – Low probability, high impact losses could give excessively conservative figures

# Primary Calculation Methods

## ***Delta-Normal Method***

- Calculates Risk using Normal Distribution for identifying tail values
- Assumes price movements are Normally Distributed
- Very easy to implement but rarely used due to assumption of normality and it is not suitable for complex portfolios

## ***Historical Simulation***

- Calculates Risk using the Historical Data for identifying tail values
- Most Widely used method. It is easy to comprehend & implement and does not assume normality
- Dependent on Time Series period used for Testing & assumption of History predicting future performance

## ***Monte Carlo Simulation***

- Calculates Risk using Monte Carlo Simulations to generate tail values
- Generated by applying drift values to Historical Data
- Can produce Tail Values beyond those observed in Historical Data but Computationally Intensive which makes implementation challenging

# Revaluation Methods

Revaluation Approaches are the approaches that are used to handle the impact of Derivative Securities, in particular non-linear derivatives present in the portfolio as the risk impact and exposure of a derivative to is dependent on the dependent on the underlying security. The 2 approaches are the sensitivity-based approach and the full revaluation approach.

## Sensitivity Based Approach

- Calculates the sensitivity of derivative securities to Risk Factor changes and applies the sensitivity charges on the portfolio.
- Less complex, easier to implement but produces a less comprehensive metric

## Full Revaluation Method

- Performs a “Full Revaluation” of the portfolio based on running the portfolio through a wide range of scenarios.
- More Complex and computationally intensive but produces a more comprehensive metric

# Scenario Generation Methods

During periods of Financial Market Stability, Historical Data used for Risk Metric generation might not include periods of Financial Market Downturns and the Metrics would not accurately reflect the impact of the portfolio during a sudden stressed period. Regulators thus require the generation of Metrics during periods of Financial Distress. The firm can use actual historical stressed periods or hypothetical stressed scenarios

## ***Historical Stressed Period***

- Uses Price Movements & Correlations from Historical Periods like 2008 GFC
- Less Computationally Intensive
- Requires proxies for missing history

## ***Stressed Scenarios***

- Calculates Price Movements based on sensitivity towards Risk Factors like Interest Rates, Inflation, Economic Indicators & Market Indices
- Requires Intensive Computations of Estimated Sensitivity & Correlation towards Risk Factors

# Additional Calculation Parameters



## ***Confidence Level***

- Risk Increases with higher confidence levels
- Risk is calculated at multiple confidence levels usually at 95<sup>th</sup>, 98<sup>th</sup> & 99<sup>th</sup> Percentile

## ***Holding Period***

- Risk Increases with Holding Period
- Longer Holding Period preferred when Portfolio is large with illiquid securities
- 1-Day & 10-Day Holding Periods commonly used

## ***Time Weightage***

- The Risk Model could give greater weightage to more recent data points & reduce the importance of Older Data
- Impact of current price regime & Financial Market Scenario increases when recent data is weighted

## ***Time Series Window***

- The length of Historical Time Series used to calculate Risk Metrics. 1yr, 2yr, 3yr periods frequently used.
- Longer Windows likelier to have stressed periods

# Market Risk Operations



Within Market Risk Divisions, It is divided into Coverage & Operations. Market Risk Operations processes input data, calculates Risk Metrics and publishes Risk reports. Market Risk Coverage analyses the reports and works with Front Office Teams to manage Risk Exposure. As a cost centre, Market Risk Operations are frequently based in low-cost geographies like India, Philippines & Poland.

## Market Risk Operations Teams

- Division Level Teams (Teams are divided at the Division Level. They calculate Risk & manage the positions data for the division. Divisions can be based on Geography, Products or both)
- Time Series Management (Manages the Time Series used for Risk. Calculates impact of Time Series Changes across Divisions)
- Scenarios Management (Manages the Scenarios used for Stressed Testing)
- Risk Limits Management (Manages the Risk & Exposure Limits at Division & Firmwide Level)
- Model Validation & Methodology Management (Analyses the performance of Risk Models & maintains the methodology used. Assists Model Development Team)

# Audience for Risk Metrics Reports



## Internal

### Risk Coverage

Co-ordinates with Front Office to manage Risk at division level based on Report Figures

### Trading & Front Office

Takes actions to manage Risk within Business objective based on Coverage Guidelines

### Compliance

As a regulatory requirement, Compliance monitors Risk Reports to ensure that the process is above board

### Senior Management

Firmwide Risk Reports have CXO Level Audience as they require broad overview of Risk Levels in the Org

## External

### Regulators

Regulators use Risk Reports to identify level of Risk within the Org and across the Financial System

### Investors/Analysts

Risk Metrics are published in Qtrly/Annual Reports allowing Investors & Analysts to gauge stability of Org

# Objective of Market Risk Operations (MRO)



## ***Maximize Accuracy***

MRO validates the input data going into calculations, ensures any errors are corrected and tests the impact of new data before releasing them into the system.

## ***Minimize Time Taken***

MRO must ensure the process is completed as quickly as possible as reports are published daily, and quicker reports gives coverage more time to analyse the numbers and take action to manage risk.

## ***Minimize Cost***

MRO can minimize cost by being in low-cost geographies but also through strategic automation and streamlining of processes requiring less Human interaction

# Inputs of Market Risk Calculations



## ***Positions***

Details of securities & risk factors to which the firm has exposure to on a given day. Reported daily & captures trade & price movement activity. Also includes calculated risk factor sensitivity.

## ***Time Series***

Historical price information for securities held by the firm. Also includes indices information for proxy purposes. Captures daily price history & can include risk factor time series.

## ***Models***

Risk Model that details the parameters to be used for Risk Metrics along with additional rules & logic to correctly capture risk. Model Complexity proportional to that of portfolio. Uses Positions & Time Series data for Risk.

# Process Flow of Market Risk Calculations

## Positions Data Generation

Aggregated Holdings reflecting the latest trade, price & security activity. Sent through from Front Office & Product Control to the Market Risk Team.

## Time Series Data Generation

Latest Daily Price Information is appended to the TS Database. Sent from exchanges, internal & external providers through to the Market Risk Team.

## Market Risk Positions Process

Validation, Enrichment & Testing of Positions Data

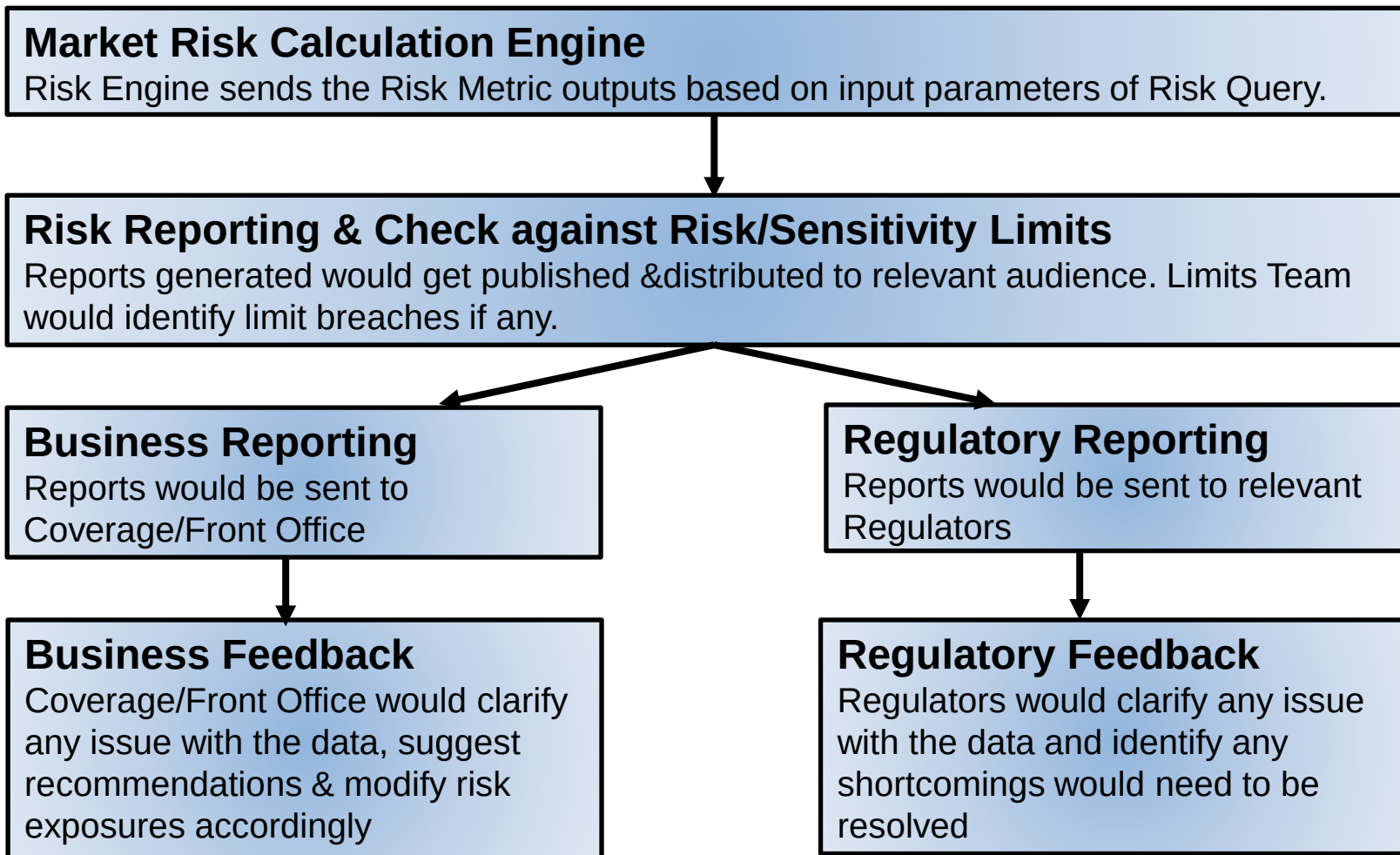
## Market Risk Time Series Process

Validation, Enrichment & Testing of Time Series Data

## Market Risk Calculation Engine

Risk Engine collates the positions for a particular date, maps the position to the relevant time series, calculates shocks & applies it to the security positions to generate risk metrics & aggregates it at multiple business entity levels

# Process Flow of Market Risk Calculations



# Positions Process Flow



## Position & Trade Data Generation

Front Office sends daily trade information to Product Control at an Entity/Trader Level. They might send raw trade data along with consolidated holdings.



## Enrichment, Classification, Standardization

Product Control would classify, enrich & standardize the positions so that it can be processed by Risk Systems & also generate Risk Factors



## Market Risk Position Validation Checks

Divisional teams would validate the positions data to check for any issues with the quantity or quality of data, rectify any errors & initiate testing of positions data on risk metrics



## Iterative Risk Metric Testing

Divisional Teams would compare risk metrics from the latest positions data against the previous day's data. Any issues observed during this phase would get rectified.



## Publishing of Final Positions Data

The Risk Metrics generated would be sent to Coverage for Approval. Upon Approval, it would be published in the Risk Engine to be used for that date going forward

# Challenges for Positions Process Flow



## ***Accuracy of Source Data***

- Positions data could potentially be incorrectly generated from the source & pass-through checks if it doesn't stand out.
- Due to quantum of data, validation & rectification of bad data causes delays

## ***Accuracy of Risk Factor Calcs***

- Product Control calculates the sensitivity of securities to individual risk factors (Greeks)
- The methodology used to calculate the estimated Risk Factors can generate sensitives that do not reflect the actual numbers

## ***Data Enrichment/Standardization***

- Classification & Standardization rules might fail to account for complex, bespoke security types
- Incorrect classification might cause inaccurate risk metric generation

## ***Time Constraints***

- Positions data is received daily & has to be published the next day
- Delays due to issues with data systems, process, validation, calculation & rectification of issues cause stale and inaccurate data in the system.

# Time Series Process Flow



## Time Series Data Generation

Daily Security/Index Prices from Exchanges/Data Providers appended to DB. Prices for OTC Securities provided from internal source. Historical Data onboarded for new positions



## Time Series Validation

Spikes, flat & missing data are validated & rectified. Correction of current & historical timeseries. Updating Index timeseries & Risk Factor Timeseries



## Market Risk Iterative Risk Metric Testing

After validation, the timeseries team would compare Risk Metrics generated from latest timeseries window against previous window using same positions data. Any issues observed during this phase would get rectified.



## Publishing of Final Time Series Data

The Risk Metrics generated would be sent to Coverage for Approval. Upon Approval, the new timeseries window would be published in the Risk Engine to be used for that date going forward

# Challenges for Time Series Process Flow



## ***Exception Handling***

- Exception Rules are required for identifying data spikes, flat data
- Strict Rules could cause a lot of time to be wasted in validation
- Lax Rule could cause bad data to flow into the system.

## ***Data Quality Requirements***

- DB can exclude Time Series with few datapoints, missing datapoints or extreme movements
- Proxy used for these securities
- Balancing act between excluding valid data & including poor data

## ***Index Construction***

- Proxy Time Series used when security history not available or modellable
- Indices can be external or internally constructed
- Methodology to construct indices has disproportionate impact when proxied security has material holdings

## ***Time Series Window Update Lag***

- Due to operational limitations, there can be a lag of a week or more between timeseries received for a date and its use in the risk engine.
- This can cause differences between market conditions and risk metrics

# Model Process Flow

## **Business & Regulatory Feedback for Risk Metrics**

Front Office & coverage might clarify any issues arising from Model Parameters & Assumptions.



## **Recommending changes to Model Details**

If Front Office/Coverage feedback is accepted, Model Development can tweak the model and/or provide feedback to Positions/TimeSeries to accommodate model changes



## **Back testing model changes**

Model Validation will back test new model across multiple dates, scenarios & risk metrics & compare the numbers against the previous model



## **Regulatory Approval for Model Changes**

New Model might need to be sent to regulators for their approval along with justification, documentation & results of back testing exercise



## **Publishing Final Model Parameters**

New model is published and the parameters, assumptions & methodology are added to the risk engine to be used for calculations going forward.

# Challenges for Model Process Flow



## ***Business Incentives***

- Front Office compensation is impacted by Risk Metrics for their desk
- They might pressure Model Teams to artificially deflate Risk Metrics

## ***Operational Limitations***

- Model output as good as model input (GIGO) & issues with operations impact model performance.
- E.g. - Time Series Window lag where trades taken on latest data, but risk calculated on stale data

## ***Changing Regulations***

- Global firms have market exposures across multiple geographies governed by different regulators with different & changing requirements
- Maintaining & updating multiple models alongside business & ops limitations is challenging

# Repercussion for Inaccurate Metrics

The efficacy of risk metrics is calculated by back testing the value of risk metrics over the period it projected. Common back testing tool is analysing number of days where actual losses over past year exceeded VaR. If number of days significantly higher than predicted by confidence level, regulators might fine firms & require them to hold additional capital to safeguard against losses.

## ***Projected Risk > Observed Risk***

- Regulatory requirements compel the firm to hold capital proportional to their calculated risk
- If firm overstates risk, they have to hold additional capital as result.
- As firm cannot utilize this capital productively, overstating risk reduces firm profits by needlessly diverting capital towards loss prevention

## ***Projected Risk < Observed Risk***

- If firm understates risk, they hold less capital to safeguard against losses
- The firm can face Risk Charges from back testing exceptions
- The firm can be fined for inadequate models & processes
- The firm is more vulnerable to extreme losses & worst-case scenarios include bankruptcy & contagion

# Regulations governing Market Risk Calculations



**Basel Accords** – A set of accords set up by the BCBS establishing a framework for banking regulations and setting guidelines for risk management calculations, processes & capital requirements. Basel guidelines forms backbone of regulations in many countries including RBI in India. Basel Accords are frequently updated based on market participants & regulatory feedback.

**FRTB** – Fundamental Review of Trading Book. FRTB is a set of guidelines from BCBS governing the market risk process. FRTB guidelines formalises distinction between banking books & trading books (regulated under market risk rules), emphasises the use of ES in addition to VaR, incorporates risk of market illiquidity & non-modellable risk factors & emphasises the use of internal models over standardised models

**CCAR** – Comprehensive Capital Analysis & Review. The US Federal Reserve recommends a stress test regime for US Banking entities to determine how resilient they are to periods of stress. Banks must run their portfolios through 3 scenarios sent by the Fed (baseline, adverse, severely adverse) that applies shocks to economic, financial & market factors. The Fed compares banks numbers vs their internal calculations to determine if the Bank is passing.

# Importance of Data Analytics



Risk Metrics Operations is a very computationally intensive field requiring complex mathematical Models applied to extremely large datasets that also depend on the integration & co-operation of multiple global teams. As a result, data analytics is crucial to the Market Risk process. Analytics helps in identifying problem areas within the process and opportunities to more efficiently manage risk

## ***Data Analytics for Calculation Inputs***

Large firms calculate market risk on positions worth billions using millions of positions and time series data points. Analytics help identify problem needles in the haystack making the process faster & smoother.

## ***Data Analytics for Calculation Outputs***

Multiple Risk Metrics are calculated for all firm divisions at increasingly granular levels. Analytics helps sort out this deluge of risk metric data to identify questionable metric values & get them rectified.

# Potential for AI & Advanced Analytics

## ***Data Classification & Enrichment***

- A sufficiently advanced AI Tool can automatically apply classification & enrichment rules to the data, removing elements of human error & ambiguity while speeding up process

## ***Data Validation***

- There is significant scope to automate the identification, validation & rectification of incorrect datapoints again reducing human error & time taken

## ***Real Time Calculations***

- With greater automations, Risk calculations can be performed as close to real time as possible, providing more accurate risk metric numbers

## ***Automated Analysis***

- The analysis of risk metric reports can be further automated allowing for much more granular analysis of risk & more efficient risk management

***Questions***

***Comments***