**Market Risk Analytics Project: Overview**

This document summarizes the capabilities developed in our Python-based Market Risk Analytics project, designed to address key responsibilities of a Quant Analyst specializing in Market Risk.

**Project Objective**

To build a comprehensive framework for calculating, validating, and analyzing market risk metrics for a hypothetical trading portfolio, demonstrating compliance considerations relevant to regulatory standards.

**Data Used**

The project utilizes historical daily closing price data for a portfolio of stocks (Cipla, TATACON, BEL) loaded from an Excel file (Historical\_Portfolio.xlsx, sheet: portfolio).

**Key Market Risk Metrics Implemented**

The project currently calculates the following Value-at-Risk (VaR) and Conditional Value-at-Risk (CVaR) metrics:

1. **Historical VaR & CVaR (Expected Shortfall):**
   * **Methodology:** Directly uses the historical distribution of portfolio returns. VaR is the percentile of sorted historical returns, and CVaR is the average of returns worse than the VaR threshold.
   * **Purpose:** Provides a non-parametric measure of risk, making no assumptions about the distribution of returns.
2. **Parametric (Delta-Normal) VaR & CVaR:**
   * **Methodology:** Assumes that portfolio returns follow a normal distribution. VaR is calculated using the portfolio's mean return, standard deviation, and a Z-score corresponding to the confidence level. CVaR is derived using a specific formula for normal distributions.
   * **Purpose:** Computationally efficient, but relies on the assumption of normality, which may not hold true for financial returns (e.g., during extreme events).
3. **Monte Carlo VaR & CVaR:**
   * **Methodology:** Simulates a large number of future portfolio returns based on the historical mean and standard deviation of returns (or more complex distribution assumptions). VaR and CVaR are then derived from the distribution of these simulated returns.
   * **Purpose:** Highly flexible, can incorporate complex portfolio structures and non-linear instruments, and doesn't rely on historical returns being the only proxy for future behavior.

**Scenario Analysis & Stress Testing**

The project includes a framework for conducting scenario analysis and stress testing:

* **Methodology:** Applies predefined, hypothetical percentage shocks to the current prices of portfolio assets. These shocks can represent general market downturns, sector-specific events, or historical crisis scenarios.
* **Scenarios Implemented:**
  + General Market Downturn (e.g., all stocks -15%)
  + Sector-Specific Shocks (e.g., Tech Sector Shock, Pharma Sell-off)
  + Historical Crisis Replications (e.g., approximate impact of 2008 Global Financial Crisis, COVID-19 Market Decline)
* **Output:** Calculates the stressed portfolio value, absolute loss, and percentage loss under each scenario.
* **Purpose:** Provides insights into potential losses under extreme but plausible market conditions, crucial for capital adequacy and regulatory compliance (e.g., Basel III/IV requirements).

**VaR and CVaR Model Backtesting**

The project incorporates a basic backtesting mechanism for both VaR and CVaR models:

* **VaR Backtesting (Kupiec's Proportion of Failures Test):**
  + **Methodology:** Implements **Kupiec's Proportion of Failures (POF) Test**. This likelihood ratio test compares the observed number of VaR exceptions (actual losses exceeding VaR) to the expected number of exceptions based on the chosen confidence level.
  + **Purpose:** To statistically validate the accuracy and reliability of the VaR model. It helps determine if the model is underestimating or overestimating risk.
* **CVaR Backtesting:**
  + **Methodology:** CVaR backtesting is more complex than VaR backtesting as it assesses not just the frequency of exceptions but also the *magnitude* of losses during those exceptions. Common approaches involve comparing the average of actual losses that exceeded the VaR threshold to the predicted CVaR value. While there isn't a single universally accepted statistical test as straightforward as Kupiec's for VaR, methods often involve:
    - **Average Exceedance Test:** Comparing the average of the actual losses on VaR breach days to the predicted CVaR.
    - **Conditional Coverage Tests:** More advanced tests that evaluate both the unconditional coverage (frequency of exceptions) and the independence of exceptions, extended to assess the magnitude.
  + **Purpose:** To ensure that the CVaR model accurately estimates the expected loss in the tail of the distribution, providing a more robust measure of tail risk.

**Relevance to Quant Analyst Role (Market Risk)**

This project directly addresses several key aspects of the Quant Analyst JD:

* **Model Development & Validation:** Demonstrates practical implementation of VaR, ES, and backtesting.
* **Stress Testing:** Provides a framework for scenario and stress analysis.
* **Programming Skills:** Utilizes Python (pandas, numpy, scipy.stats) for data handling, calculations, and analysis.
* **Market Risk Metrics:** Covers core metrics like VaR and ES.
* **Regulatory Compliance:** The concepts implemented (VaR, ES, Stress Testing, Backtesting) are fundamental to Basel III/IV and FRTB compliance.

This project serves as a strong foundation for discussing your quantitative skills, understanding of market risk concepts, and ability to apply them in a practical setting during your interview.