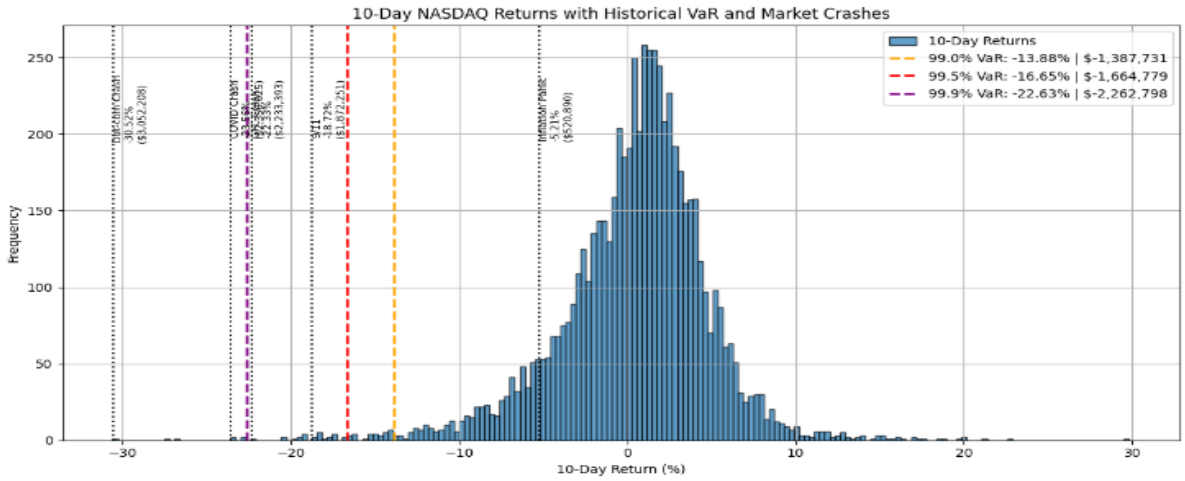
WHAT DOES IT MEAN: 1-IN-200 or 1-IN-1000 EVENT?

Dotcom, GFC, COVID — all within 25 years, and all worse than the 99.9% VaR.



The month-end liquidity reports I worked on recently were generated based on Historical VaR, using a group portfolio with a default confidence level setting of 99.5%. As part of stress testing exercises, I was asked to derive an implementation based on a 99% confidence level as an alternative metric.

Given the number of month-end reports for business units and the number of scenarios underpinning these results, it can often be overwhelming to interpret the key aggregated nominal VaR results, MTM values, and stressed results. The default and reported VaR was adopted to be Historical VaR because of calibration possibilities to actual market stresses since the 2007/2008 financial crisis—although MC VaR was available only as a benchmark, it also lacked up-to-date calibration of VaR-coverage data.

The Group owned a licence of SS&C Algorithmics Workspace Analyzer (known as AWA) for all risk aggregations — a powerhouse tool for risk aggregation and reporting, which was flexible and allowed our team to enhance it for internal use. Basically, we wrote our own code and deployed it to improve its capabilities. For example, its interface had a risk parameter setting that allows users to view the default VaR confidence level setting. Furthermore, depending on the business unit's request, we implemented several enhancements to this reporting tool. However, as users interact with SS&C's AWA reporting tool, it's easy to spot various features in the settings, such as the scenarios, VaR confidence level, horizon, etc. In my experience, most often users tried to experiment with the confidence level setting.

Despite the complexity in the underlying models and the process for scenario generation, I would sometimes hear simple questions such as: ***What is a 1-in-200 event anyway? And what does this mean to the business unit's month-end VaR?***

Just a quick reminder that *VaR is defined as worst loss over a target horizon that will not be exceeded with a certain confidence level. The VaR at the α% confidence level gives a loss value that will be exceeded with no more than $(1 - \alpha)$% probability*.

According to John Gregory (2010), a 99% VaR over a 10-day horizon is potentially a "modellable" quantity, since a one-in-100 10-day event is not particularly extreme. This statement aligns closely with the kinds of questions we hear from stakeholders. So, let's break this statement down numerically.

Suppose our confidence level is 99.5%, meaning α = (100% − 99.5%) = 0.5%. Therefore, 1 / 0.005 = 200. This represents a one-in-200 event. For a 10-day horizon, this translates to 200 × 10 = 2000 trading days — or roughly once every 8 years.

Can you observer many 10-day losses at the 5% percentile if you have sufficient 10 year historical data. This is probably one of the reason risk committee's decision to use Historical data starting from 2007 for all liquidity risk computations:

- It captures **real observed market behaviors**, not synthetic distributions.
- Events like the **2007–2008 financial crisis** are built directly into the risk model.
- It **avoids distributional assumptions** like normality, which tend to underestimate tail risks.

Now, suppose you examine the return distribution of your portfolio and the associated 10-day loss or VaR. Is it possible to observe such a loss once or more within an 8-year period?

If we repeat this for a 99.9% confidence level and a 10-day horizon, we will get an event that occurs once every 10,000 trading days, or once every 40 years. Such an event is in the realm of a market meltdown or crash. Such events are almost impossible to model quantitatively, and institutions should rely more on experience, intuition, and methods such as stress testing to quantify such risks (Gregory, J., 2010). Table 1 provides an overview of various confidence levels and their corresponding 1-in-n event for 10-day horizon.

Table 1: confidence level and 10-day horizon

						once in every	once in every
confidence level	confidence level	alpha	alpha	1-in-# event	horizon days	n-trading days	event in yrs
100.00	99.00	1.00	0.01	100.00	10	1,000.00	4
100.00	99.50	0.50	0.005	200.00	10	2,000.00	8
100.00	99.90	0.10	0.001	1,000.00	10	10,000.00	40

Usually, VaR calculation on a portfolio of mix of assets that are linear and non-linear such as derivatives (ccy swaps, inflation swaps, cds, equity index options, FX Options, etc) and other linear assets such as corporate and government bond, cash and other liquid

instruments are complicated and involved process as it requires scenario calibration, scenario building on indivual asset level plus calculations on stresses. For example, we computed 25000 scenarios for each individual instruments, their stresses and then drive their PnL for each scenarios. These are then aggregated to compute the Historical VaR (decomposed VaR) on individual assset level and then on Portfolio Level. So, then for each of the business units portfolio, we deliver, lets say, 2000 lines of decomposed VaR, MtM, and Stressed values on instrument level. But also a headline aggregated Decomposed VaR. This report has all the ingredients to derive the groups Liquidity Coverage Ratio for that month. Its very convenient, users can receive the complete report, filter them for stressed assets (all highly liquid instruments) and also all stresssed derivatives. So, this is involved and complex process that requires inter-departmental collaborations. i.e Market data processes, methodologies configurations, overnight and intraday batch processing, etc.

Lets just use for now instead very simple and naïve example that involves returns from Nasdaq index since 2000. We download the underlying end-of-day close data and compute the 10-day rolling returns. Suppuse we have a portfolio value of 10Mln. and we compute the historical VaR at set of confidence levels.

Figure 1. 10-day Nasdaq Return distributions since 2000.

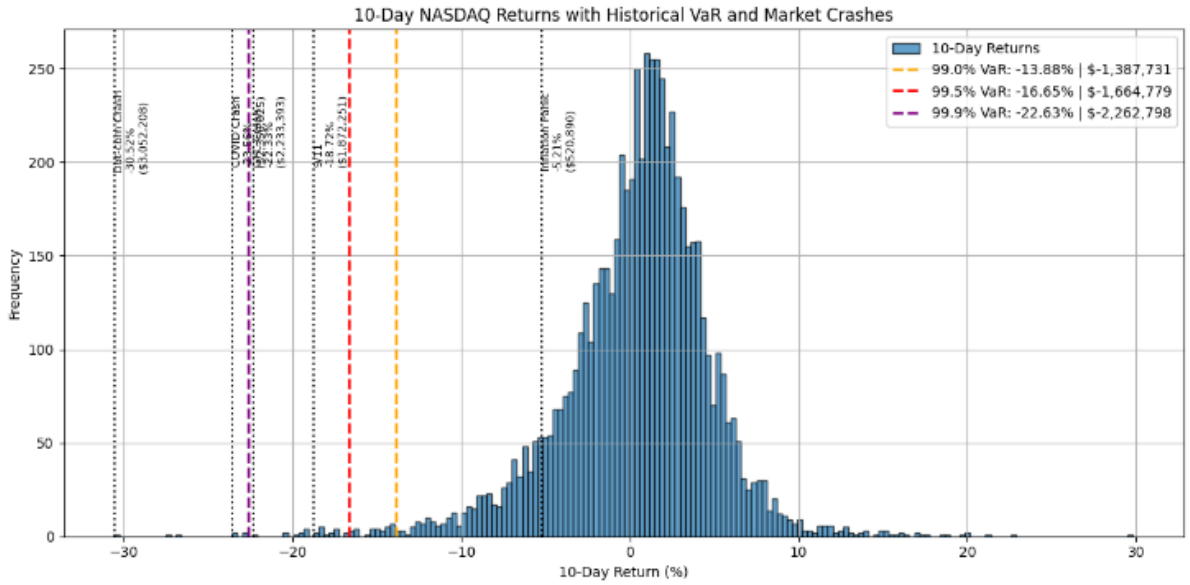


Figure 1 shows the 10-day NASDAQ return distribution, VaR thresholds, and major crash annotations.

10-Day Value at Risk (VaR) Analysis for $100 Million Portfolio:

Confidence Level (%)	Alpha	10-Day VaR (%)	10-Day VaR (USD)	1-in-# Event (days)	1-in-# Event (years)
99.0	0.01000	-13.88%	$-1,387,731.26	1,000	4.00
99.5	0.00500	-16.65%	$-1,664,778.61	2,000	8.00
99.9	0.00100	-22.63%	$-2,262,797.69	10,000	40.00

At the 5% significance level, over a 10-day horizon, and with a portfolio size of 10 million, we can expect a loss of −16.65% or more. This translates to a loss amount of $1,664,778, which corresponds to a loss frequency of once every 8 years. When we look at the 99.9% confidence level—or the 0.1% significance level—we can expect a loss of −22.63% or more, translating to $2,262,797, with a loss frequency of once every 40 years.

But historically, we have seen drops of more than 22% in the index within the last 25 years. Table 2 displays the 10-day Historical VaR at different confidence levels and the corresponding crash events for the index.

Table 2: 10-day VaR and Crash events

Line / Event	Description	10-Day Return (%)	Estimated $ Loss (10M USD Portfolio)	Interpretation
99.0% VaR (orange)	Worst expected loss with 99% confidence over 10 days	-13.88%	$1,387,731	Losses worse than this happen ~1% of the time (1 in 100 ten-day periods)
99.5% VaR (red)	Worst expected loss with 99.5% confidence	-16.65%	$1,664,779	A more extreme threshold — expected only once every ~200 ten-day periods
99.9% VaR (purple)	Worst expected loss with 99.9% confidence	-22.63%	$2,262,798	Extremely rare — only 1 in 1000 ten-day periods exceed this
Dot-com Crash	Market crash during tech bubble burst	-30.52%	$3,052,208	Far exceeds 99.9% VaR — rare, systemic event
COVID Crash	Pandemic-induced selloff (March 2020)	-22.38%	$2,238,355	Matches the 99.9% VaR threshold — real-world tail event
9/11 Attack	US markets after reopening post-terror attacks	-18.72%	$1,872,251	Between 99.5% and 99.9% thresholds
GFC Crash (2008)	Global Financial Crisis volatility spike	-22.33%	$2,233,353	Nearly identical to COVID crash — confirms model estimates align with history
Inflation Panic (2022)	Short-term fear-driven dip in equities	-5.21%	$520,890	Moderate correction, not a tail-risk event

Figure 2a. Nasdaq daily returs since 2000.

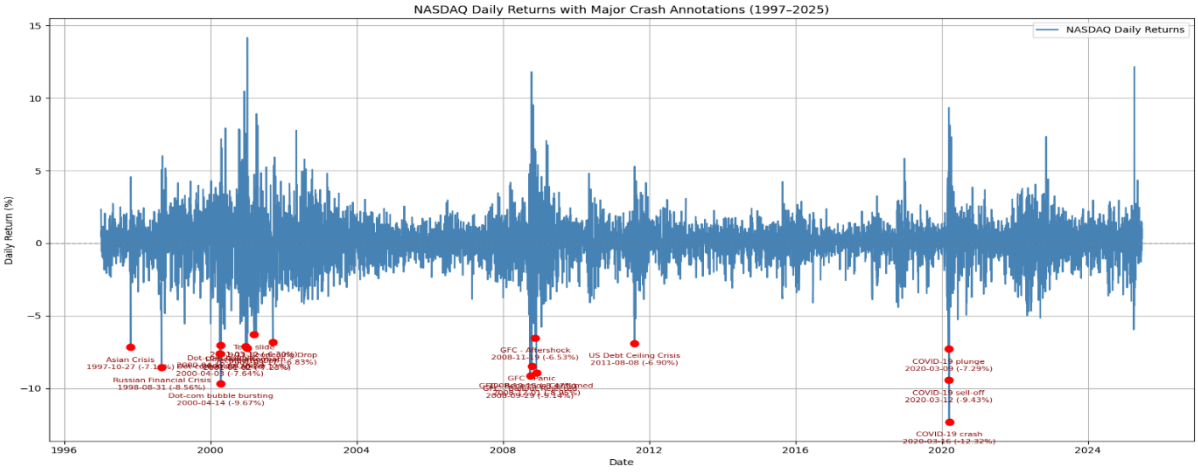
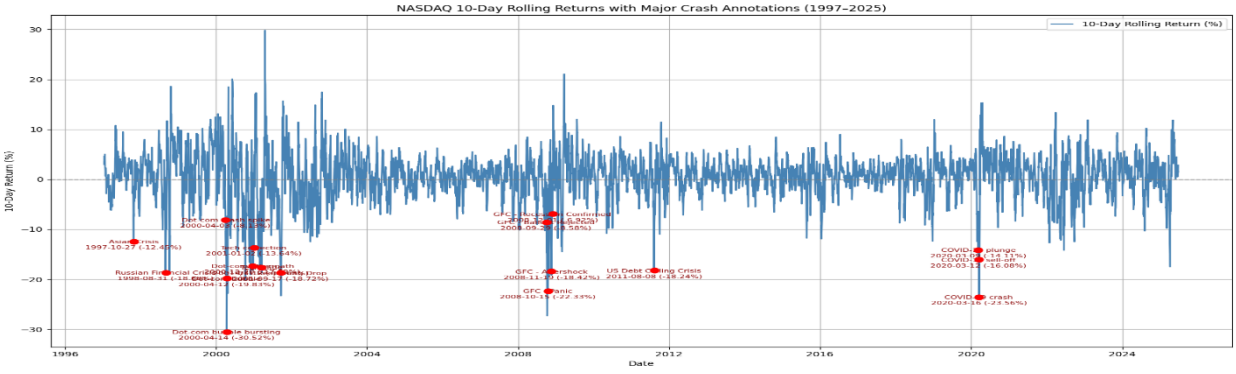


Figure 2b. *10-day rolling* returns since 2000.



To avoid any confusion, we show both the daily Nasdaq returns as well as the 10-day rolling returns. 10-day returns = compounded (or summed) daily returns over 10 consecutive trading days. If multiple large single-day losses occur within a short window, the rolling 10-day return will reflect the cumulative pain. Therefore, if you consider the 0.1% significance level, the 10-day return showed around -22% loss but we can see the actual 10-day rolling loss is so extreme at -30% loss which occurred sooner (once in the last 25 years – the Dotcom event) - that the one-in-10,000 event – 40 years. See table 2 how the 10-rolling returns compares to other events such as covid-19, GFC, and other corrections. The complete dataset and python code is available on the following Github repository: https://github.com/abukar10/Nasdaq_Returns_analysis