
Morningstar Historical Scenario Analysis

Methodology

Morningstar Quantitative Research

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Overview

In this methodology, a scenario is a time series of simulated or historical market return distributions which generates simulated behavior of a portfolio. This document describes:

- ▶ The purpose of scenario analysis from an investor perspective
- ▶ How to identify a scenario: Assume the probability distribution is just the historically observed value – a simple distribution.
- ▶ Once we have a sequence of return distributions, we can build out a description and summary statistics of the portfolio under the scenario. The description of the scenario will also depend on the particular returns.

Purpose

For many investors, scenario analysis is a tool which provides a common language for communicating risks. It is difficult to formalize the idea of “what happens to my portfolio if the market suffers a big crash”, because the notion of “a big crash” will be different for different people. It is useful, therefore, to define a notion of a particular portfolio risk which will be similar for many investors and immediately comprehensible.

“What would happen to my portfolio if markets suffered some well-known historical event?” This comprehensible question which investors at all levels of sophistication can comprehend conveys useful information about risk - “how bad is it likely to get?” In these historical scenarios, the key statistic of interest is usually drawdown.

To answer this natural question, we take the historical returns for companies, and analyze those returns as if the event were happening again today.

Scenario Identification

To identify a historical event, we look back at the history of financial market, and pick the events that created large volatility, such as the Financial Crisis during 2008-2009. We also consider those events that analysts believe to have potentially significant return impacts, like oil price drops, Brexit, and the recent US election. We then identify a start date and an end date for the scenario. We try to make the scenarios shorter rather than longer, to make the scenarios comparable. But of course, different scenarios have different lengths.

Scenario Analysis under a Simple Distribution Assumption

Method:

- ▶ The historical risk premia themselves form the “return distribution” – i.e. in the scenario, the factor premia are the scenario.
- ▶ Assume the returns from idiosyncratic risk is zero.
- ▶ Then, the expected returns of the stocks, funds and portfolios will be the historical premia multiplied by the current exposures of the stocks, funds, or portfolios respectively.

Input:

- ▶ A scenario generation date (e.g. the current date)
- ▶ A scenario start and end date (e.g. the start and end of the Brexit event)
- ▶ Sequence of daily factor premia from the start date to the end date of the scenario.
- ▶ The current portfolio holdings as of the scenario generation date.
- ▶ The exposures for the portfolio as of the scenario generation date.

Output:

- ▶ A single time series of returns whose length is the time between the start date and the end date.
- ▶ A standard collection of time series descriptive statistics:
 - ▶ Returns
 - ▶ Volatility
 - ▶ Max drawdown
 - ▶ Alpha
 - ▶ Tracking Error

Calculation Details

We multiply the portfolio weights by the exposure matrix to produce portfolio level exposures.

$$p_k = \sum_{i=1}^N w_i X_{i,k}$$

w_i = portfolio weight in asset i

$X_{i,k}$ = kth factor exposure in asset i

N = number of assets in the portfolio

p_k = kth factor exposure for the portfolio

For each day multiply the full set of portfolio exposures by the full set of factor premia for that day, and sum the result to calculate an expected portfolio return. Together these will construct a portfolio return for that day. Repeat this for every day during the scenario event. This will form a portfolio return series.

$$R_t = \sum_{k=1}^K p_k f_{k,t}$$

p_k =kth factor exposure for the portfolio

$f_{k,t}$ =kth factor premia at time t

K = number of factors

R_t = portfolio return at time t

Calculate a variety of time series metrics (e.g. max drawdown) for the various portfolio return series.

Notes - Idiosyncratic Risk

We are ignoring idiosyncratic risk in this scenario. This will entail a small underestimation of dispersion-based statistics, in particular volatility. However, the forecast max drawdown – probably the key statistic of interest to investors - will be the expectation of the max drawdown in a more sophisticated model.

Notes - Market Holidays

Particular securities will not trade on particular days – generally market holidays, but also in markets where suspensions and multi-day trading halts are possible. In the pre-defined scenario analysis framework as described above, we generally ignore this kind of problem. We generally assume the stock is trading on the market holiday, even if it would not ordinarily trade on that day, and, pump the return through the model to produce a return. Similarly, if the stock historically was suspended or in a multi-day trading halt a return should be calculated.

This does not apply to weekends and global holidays (e.g. New Year's Day) where we calculate no factor premia. On these days, no return for any stock should be calculated and the day should be excluded from the scenario.

Scenario Definitions

Global Macro Scenarios

2003 Bond Selloff with Start Date: 6/12/2003 and End Date: 8/31/2003

Bond markets had their largest selloff since 1994 in 2003. US dollar, Yen and Euro yields all increased sharply. Ten year US Treasury yields increased from 3.11% on the 13th of June to over 4.40%, Japanese government bond yields rose 50 basis points, and bunds rose 70 basis points. Yields continued to rise at longer maturities until late August in Japan. There was little direct impact on equity markets over this timeframe, and the relative price of financial institutions did not move substantially as compared to the rest of the equity market. Based on BIS quarterly review 2003.

2007 – 2008 Oil Price Rise with Start Date: 1/18/2007 and End Date: 6/27/2008

Oil prices experienced a sustained rise from around \$40/bbl in January 2007 to just less than \$150/bbl on July 15, 2008. This rise coincided with substantial falls in global equity markets.

2007 – 2009 Subprime Crisis and subsequent Financial Crisis with Start Date: 10/1/2007 and End Date: 2/27/2009

This scenario follows the track of the subprime crisis and subsequent banking crisis and recession. In October 2007, Ben Bernanke delivered a speech suggesting that the banking system was healthy, but that the ultimate implications for financial markets were uncertain. Over the next year, approximately a million houses entered foreclosure. Credit markets froze through the successive bank failures worldwide. The S&P500 fell 57% over this time period.

2014 – 2015 Oil Price Drop with Start Date: 6/1/2014 and End Date: 1/15/2015

The oil price fell from around \$115/barrel to below \$70/barrel from June 2014 through to January 2015, after around 5 years of reasonably stable prices. Equity markets rose through this time.

US Focus Scenarios**2006 Amaranth Hedge Fund Collapse with Start Date: 9/15/2006 and End Date: 9/30/2006**

On September 18, 2006, the founder of the Amaranth Advisors hedge fund advised investors that the fund had lost 50% of their assets in the month-to-date, and a total of \$6.6bn losses by the end of September. The fund essentially had a large losing bet on North American natural gas prices. Ultimately the collapse did not cause substantial systematic distress in financial markets as counterparties quickly stepped in to stabilize the natural gas market. Based on EDHEC working paper.

2011 US Debt Ceiling with Start Date: 5/20/2011 and End Date: 9/30/2011

The US Public Debt Acts impose a limit on the total borrowings of the US government. In 2011, the US Congress delayed raising the debt ceiling for a time, which caused some speculation around the possibility of a default on the US debt in the press. The US suffered its first credit rating downgrade from S&P on August 5 2011, and both Moody's and Fitch moved to a negative outlook. The downgrade was associated with substantial falls in world equity market prices. But bond prices rose, yields on 10 year treasuries moving from 2.56% to 2.34%.

2013 Taper Tantrum with Start Date: 5/22/2013 and End Date: 8/21/2013

On May 22, 2013, Federal Reserve Chairman Ben Bernanke announced that the Fed could begin tapering its bond purchases over the next several months, which triggered a global panic and a subsequent spike in the U.S. Treasury yields. Although the market continued to recover, the so-called "taper tantrum" persisted through the summer of 2013 when it was revealed on Aug. 21, 2013, that the Fed was still on track to wind down asset purchases.

2018 Market Volatility with Start Date: 9/20/2018 and End Date: 12/24/2018

Despite signs that the U.S. economy was doing well, with record low unemployment, solid gross domestic product growth, and low inflation, the S&P 500 lost nearly 20% in the last quarter of 2018. The trade war with China and a slowdown in global economic growth drove the market anxiety, as well as concerns that the Federal Reserve was raising interest rates too quickly.

Emerging Markets Scenarios**2004 Emerging Market Crisis with Start Date: 5/5/2004 and End Date: 5/17/2004**

In May 2004, a substantial increase in US Treasury long-term yields appeared to drive a substantial

increase in emerging-market spreads, especially for the most risky credits. This caused large falls in many emerging market equity markets.

2006 Emerging Market Selloff with Start Date: 5/1/2006 and End Date: 6/15/2006

In May-June 2006, emerging market equities suffered their worst decline since the 1998 Russian debt crisis, a correction after strong increases in those markets in the earlier part of the year. Developed markets were less affected, the Nikkei-225 fell approximately 15%, the Eurofirst-300 just over 9% and the S&P500 by 6%. Based on IMF June 2006 Financial Markets Update

European Markets

2010 Greek Crisis with Start Date: 4/1/2010 and End Date: 5/31/2010

In April 2010, after a series of scandals that revealed that Greek government debt statistics were unreliable, all major credit rating agencies downgraded Greek government debt to junk. On May 2, the IMF, European Commission and ECB provided a EUR 110 loan to cover repayments of Greek government debt, contingent on the implementation of austerity measures to reduce public spending and increase tax revenue. The measures triggered a general strike in Greece on May 5 and ongoing political instability. The outstanding Greek government debt was largely held by Greek and other European banks, and the crisis provoked a selloff in European financial sector equities.

2011 European Debt Crisis with Start Date: 2/13/2011 and End Date: 9/18/2011

Beginning in February 2011, after Greek debt was cut to “junk” status by a third rating agency, the gradually unfolding European debt crisis entered a particularly turbulent phase, with weak performance across all the European indexes. By mid-September, as the alarm over the crisis was growing and the terms of the expanded EU bailout were being negotiated, the markets bottomed out.



About Morningstar® Quantitative Research

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