

VaR and Low Interest Rates

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One of the largest institutional fund managers in North America

- Founded in July 1965
- 34 clients – with net assets of \$248.0 billion* as at December 31, 2015
- One of the world's 10 largest real estate asset managers
- Offices and investments worldwide
- 90% of assets managed in-house / 10% external
- AAA credit ratings from DBRS and S&P and Aaa from Moody's

Four investment sectors

- **Equity Markets**
- **Fixed Income**
- **Real Estate**
- **Private Equity and Infrastructure**

*Canadian dollars



Value at Risk

Definition

- For a portfolio of financial assets, the value at risk, or VaR, of the portfolio represents the minimal potential loss in value of the portfolio, for a given level of confidence over a certain investment horizon

$$VaR_p(v(P)) = \inf\{l \mid \mathcal{Pr}[v(P) < l] \leq 1 - p\}$$

- At the Caisse, to estimate VaR we use the historical simulation method. The principal parameters which define (historical) VaR are:
 - the size of the historical period used for the estimation
 - the measurement frequency
 - the confidence level
 - the investment horizon
- The choice of parameters generally depends on the desired use for VaR

Value at Risk

Size of the historical period

- The longer the historical period, the more distinct events will be present, but this will also lead to a much more stable measure over time
- By contrast, if we use a very short time horizon, the VaR will reflect current market conditions much more

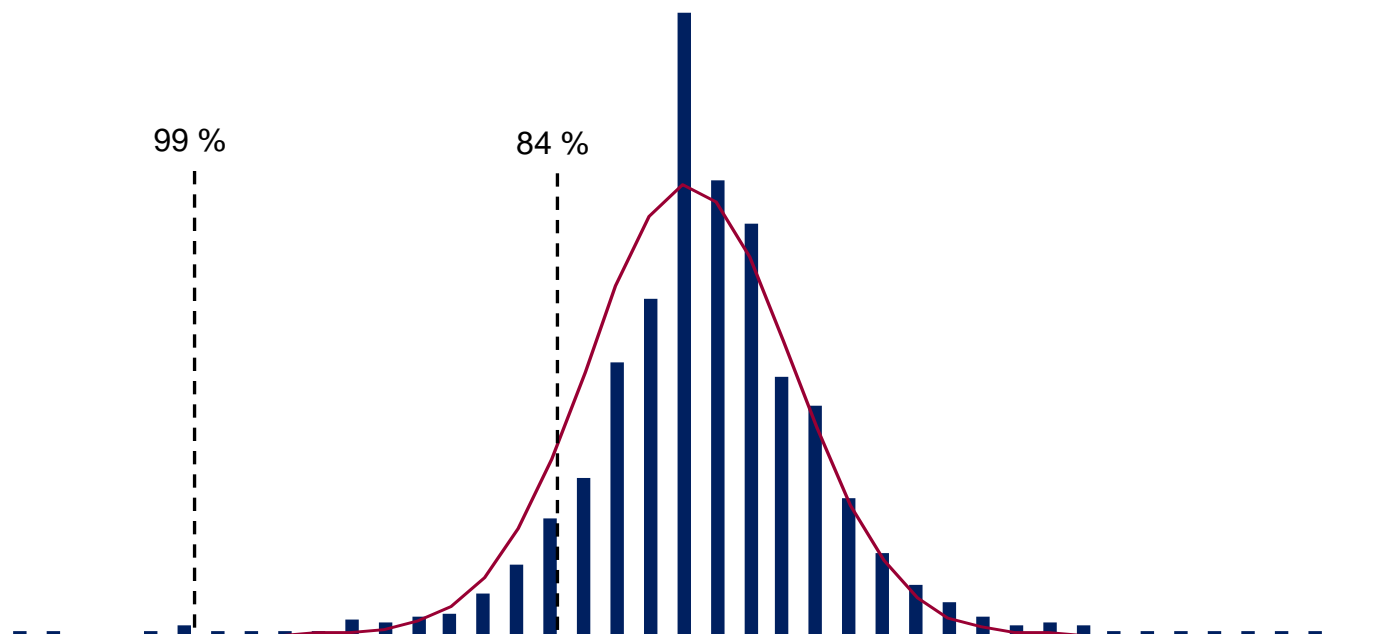
Measurement frequency

- Using a high measurement frequency puts a lot of emphasis on short term variations, which may not be in line with the objectives of the investor. Ideally, the measurement frequency should coincide with investment horizon

Value at Risk

Confidence level

- The higher the confidence level, the more emphasis we put on the tail of the distribution and extreme events



Value at Risk

VaR at the Caisse

- Size of historical period: 10 years
- Measurement frequency: weekly
- Confidence level: 99%
- Investment horizon: 1 year
- We use a historical period consisting of the last 10 years of weekly data with daily overlaps for all risk factors present in the portfolio. This gives us enough data with which to measure VaR, and only introduces a light measurement bias
- Using the current level of each risk factor, we apply the historical variations to create the historical scenarios. We apply these scenarios to our current portfolio holdings in order to simulate potential variations of the portfolio
- We then calculate a weekly VaR, and subsequently annualize this number using the square root of time rule

Simulating Interest Rates and Bond Prices

- For interest rates, the way we create historical scenarios is as follows:

$$\tilde{r}_{m,t_0,t} = r_{m,t_0} + r_{m,t} - r_{m,t-w}$$

- That is, we apply the historical variation $r_{m,t} - r_{m,t-w}$ to the current level of the interest rate r_{m,t_0} . The tacit assumption of this approach is that variations are independent of the level of interest rates
- In order to simulate the value of a bond, we re-value the bond under the simulated interest rates

$$\tilde{V}_{t_0,t} = \sum_{k=0}^n \frac{C}{(1 + \tilde{r}_{k,t_0,t})^k} + \frac{P}{(1 + \tilde{r}_{k,t_0,t})^n}$$

Example and Interpretation

- To illustrate, we consider a short position in a Canadian bond, with a coupon of 4% maturing in June 2017. Its weekly VaR is -0.31%, and so its annualized VaR is -2.2%
- Bond managers are very familiar with the interest rate sensitivities of their portfolios, and so they like to translate VaR into terms of sensitivities. The link is as follows : Duration x Interest rate movement \approx VaR
- As the duration of this bond is 1, using this approximation we see that the implicit interest rate movement is -2.2%. Combined with the fact that current 1 year rates are at 0.5%, this implies that we would need the one year rate to drop to -1.7% for this VaR to be realized...!

What's going on?

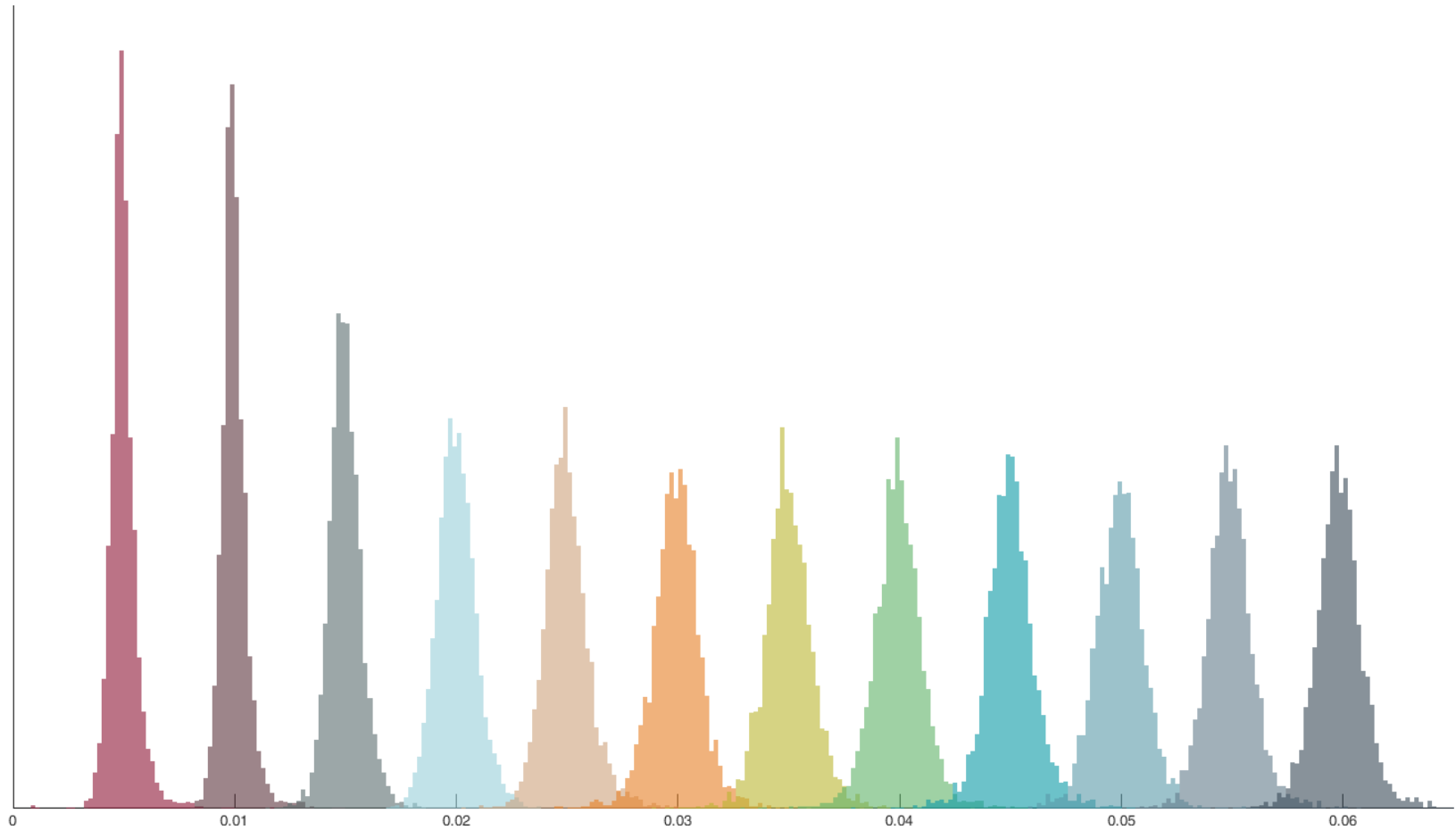
There are two aspects of the VaR calculation that cause this problem

1. Scenario generation: the way we simulate interest movements is by simply adding the historical variation to current values. Is this reasonable?



Interest Rate Dynamics

- The distribution of interest rate variations seems to depend on the level



What's going on?

2. Annualization: in order to transform VaR from the time scale of the measurement frequency to that of the investment horizon, we need our observations to be i.i.d. and normal. How can we obtain an annual VaR in a more correct way?
 - Considering our bond example, the following graphic illustrates the distribution of simulated weekly profits and losses

