**Project Goal:** Calculate how high the US Treasury Curve can rise 3 months from now at 67% and 96% confidence levels.

**Background**

Value-at-Risk (Var) is a risk management framework financial institutions use to measure how poorly markets can perform in the future up to a specified confidence level. Assume your confidence level is 96%, your time horizon is one year, and you want to predict the probability of the 10 year US Treasury rate rising (which is bad for financial markets). Then a VaR analysis will fill in X in the statement “We are 96% confident that the 10 year US Treasury rate will not rise above X one year from now.”

Value-at-Risk models use Monte Carlo simulations to answer the question of what X is. In our project we used the Vasicek Interest Rate model to model out the possible paths an interest rate can take into the future. We then ran a Monte Carlo simulation using this model. The output of a simulation looks something like below.

A graph of a graph showing a number of different colored lines

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The model gives a distribution of the 10 year US Treasury rate over the time horizon of the next year. The theta is a mean reversion factor used in the model. You can take the average of all paths at the end of year one to get the expected value of the 10 year US treasury in one year. We are only concerned with the side of the distribution above this average. This is the size that has rate increases, which is our risk, and the side we want to measure. So for VaR analysis we only look at the right 50% of the distribution. From there, we treat it as its own distribution and get the 96th percentile of this ‘new’ distribution.

**Data**

Treasury data is only disclosed as periods of 1 month, 3 months, 6 months, 1 year, 2 years, 3 years, 5 years, 7 years, 10 years, 20 years, and 30 years. The market gets every other possible month’s treasury rate by interpolating between this curve of 11 points to get a full 360 month, 30 year curve. We took 10 years of publicly available treasury rate data from the Federal Reserve of St. Louis.

**Methodology**

We used a 3 month time horizon in our project. Our approach applied a Monte Carlo simulation to each of these 11 rates the Treasury discloses utilizing the Vasicek Interest Rate model. For each simulation we interpolated through each of these 11 rates to get 360 monthly treasury rates. We interpolated using cubic spline interpolation. We ran the simulation 1,000 times to get 1,000 possible treasury curves. To get the 67th and 96th percentiles of possible higher curves, we ordered each curve lowest to highest and took curve numbers 840 and 975 (the 67th and 96th percentiles of the top 50% of the distribution). Below are the results of our model. The blue line is the current US Treasury Curve, and the orange and red lines are how high we believe the US Treasury Curve could increase 3 months from now at 67% and 96% confidence levels.

A graph of different colored lines

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**Conclusion**

Simulations like this are how the world’s largest banks manage their cash, capital, and other resources. We used a time horizon of three months because that’s typically how banks in the real world measure their time horizon.

In general, rising interest rates stimy economic growth and cost the public more money, leading to less spending and potentially higher unemployment. All interest rates that affect consumers are pegged to US Treasury rates. For example, mortgage rates rise/fall directly in line with the US 10 year Treasury rate. Higher 10 year US Treasury rates will lead to less people being able to afford homes, or the homes people can afford will cost them much more money due to the higher interest payments. Our model shows the current 10 year US treasury rate as 4.42%. We are 67% confident it will not rise above 4.76%, and 96% confident it will not rise above 5.13%. This number is important not just for consumers, but mainly for banks. Banks legally have to manage their balance sheets and cash to it so they don’t run the risk of defaulting and being unable to pay back depositors. Models this like are how the world’s financial system assesses its risk of rising rates.