Introduction:

I have recently built a web facing app (link here) that uses a repository I made in GitHub (link here, example here). The repo exclusively contains python code. The overall goal of this project is to create indicator like functions for volatility.

Methodology:

The data used in these experiments involves pulling data from yahoo finance by using the yfinance python API (see documentation here). The data was pulled at various time frames included (daily, weekly, monthly), and all of the prices are the Adjusted Close Price. The functions used for calculating the markov regime switching model is the python statsmodels API (see documentation here). The method used for finding the smoothed probability of the variance of returns for each regime is also built upon sample code from the statsmodels API (see 2nd example of the Kim, Nelson, and Startz (1998) Three-State Variance Switching link here). All of the code is accessible on the GitHub and all of the results are replicable using the Streamlit app.

Background:

Please read the first writeup that I published about this topic (see link). To sum it up I'm looking at the creating Markov regime switching models that look at the variance of returns.

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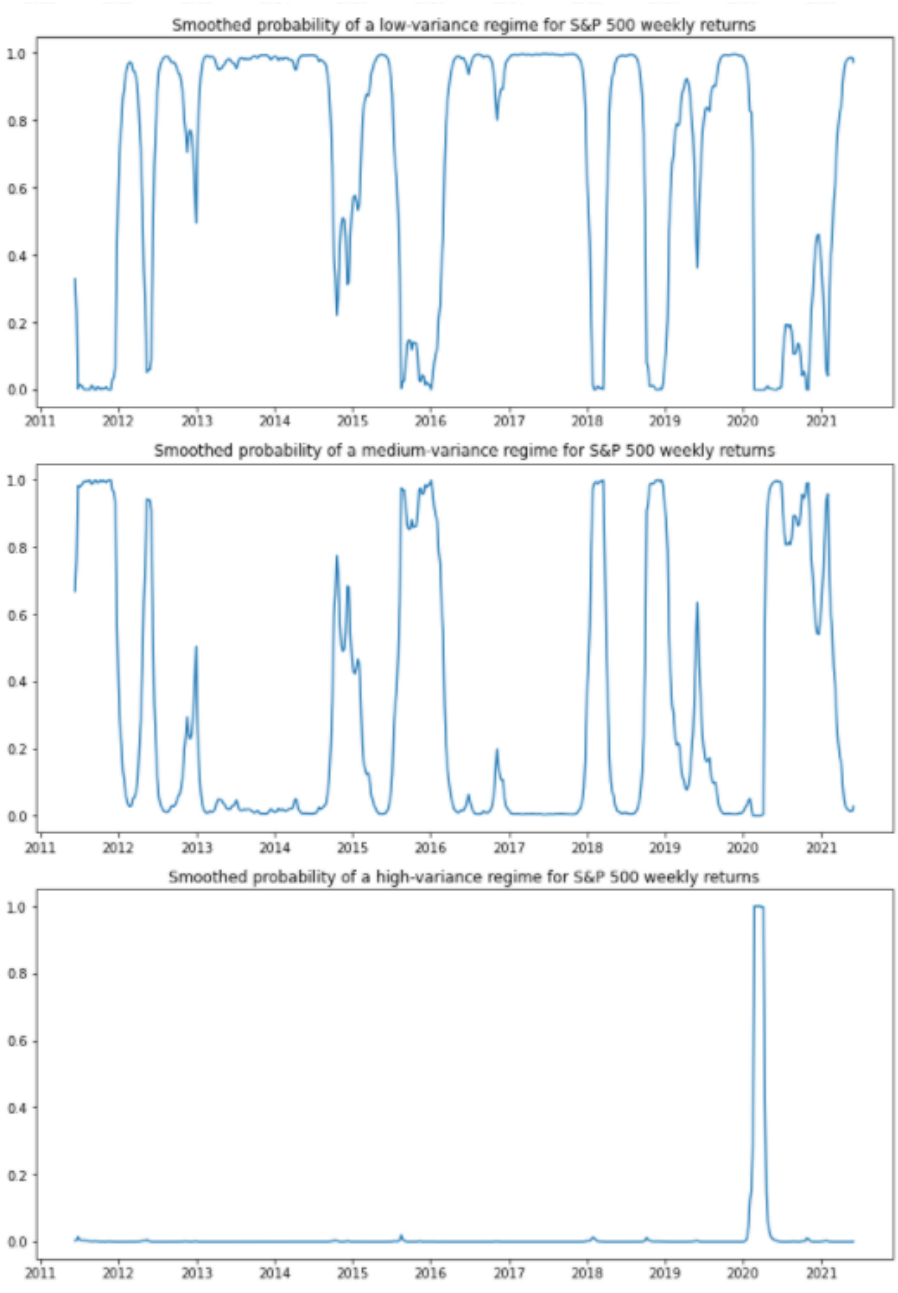
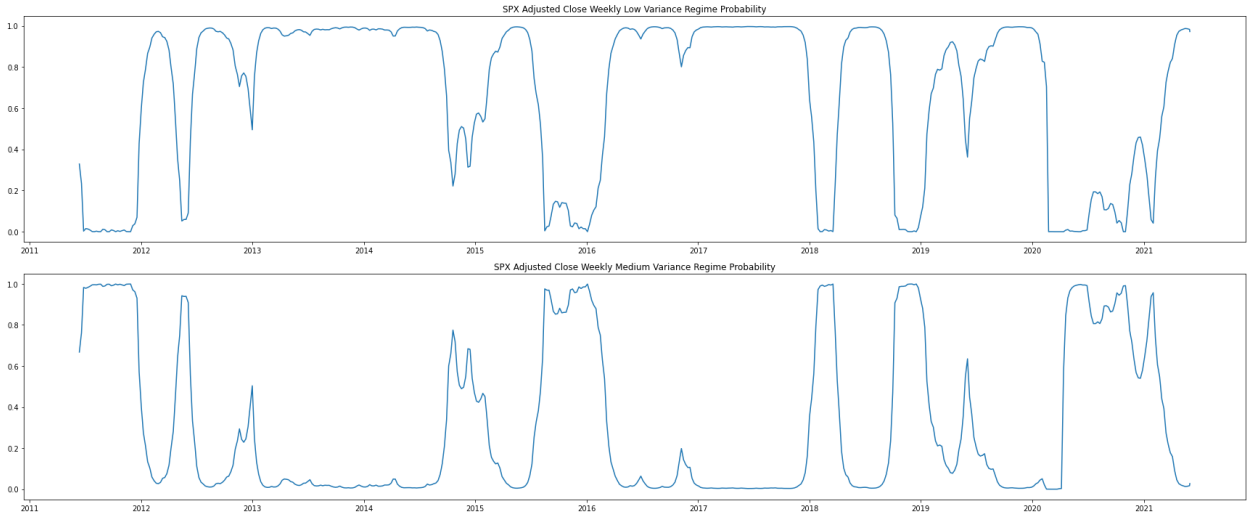
Findings:

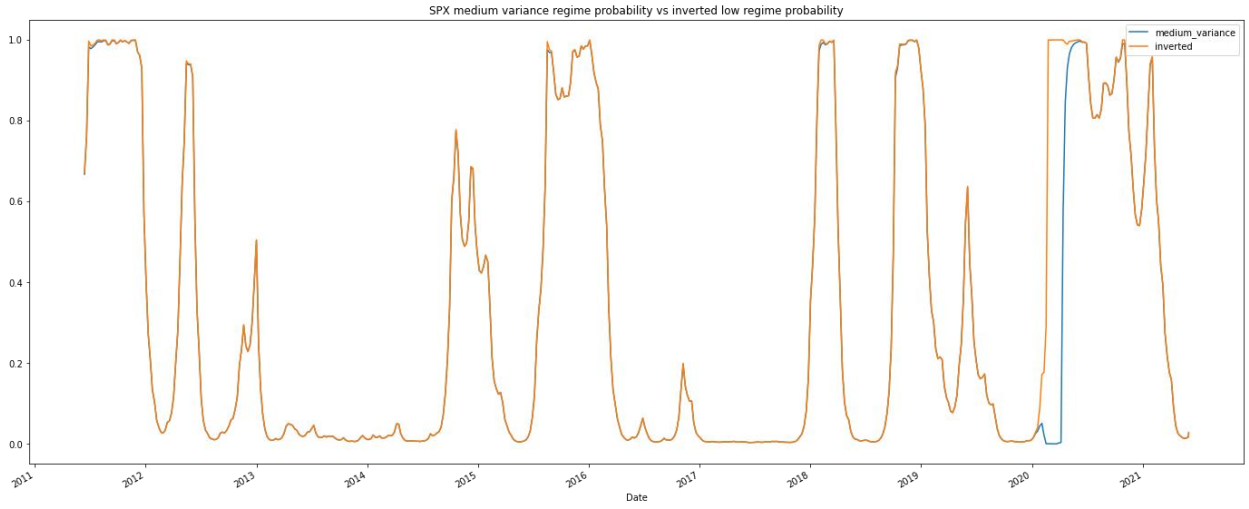
For this example, I pulled the S&P 500 weekly Adjusted Close price. I plotted the probability of Markov regimes. The regimes are determined by the variance of the returns.



Something that I noticed was that the medium and low regimes are almost the same time series but reflected across the x-axis.



The first thing that I did was then invert one time series over the other.



Then to make it into an indicator function I measured the correlation between the two-time series.

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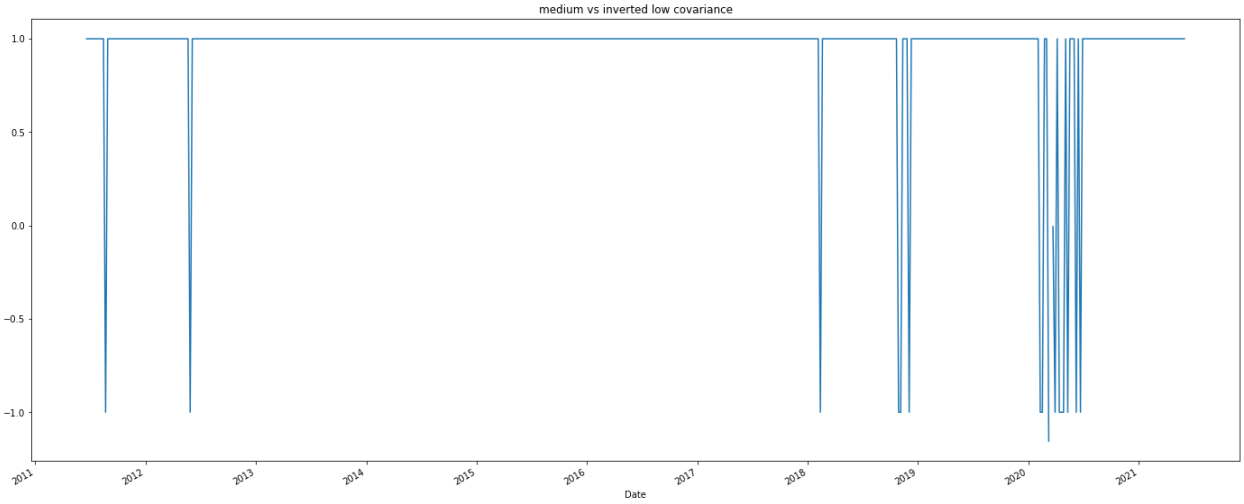
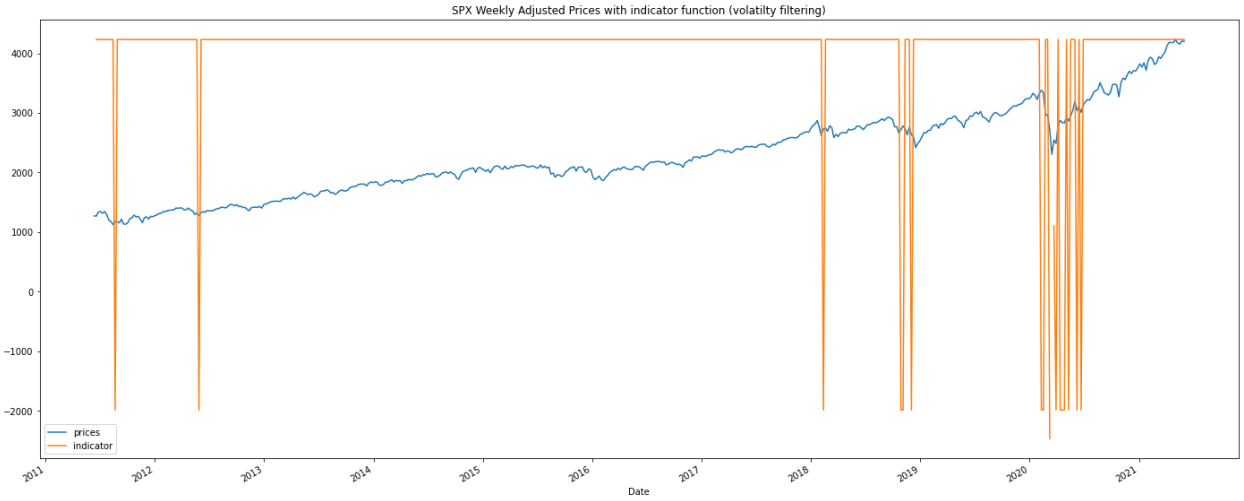
They will have almost perfect correlation until they break which will result in a spike in correlation. The correlation plot looks like.



Then if normalize the plot to the prices of the security and overlay this indicator function over the prices we get.



The streamlit app can output this graph for any security (left hand sidebar -> experiment, beta version is out there are still some bugs that need to be worked out)

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Predictive Power:

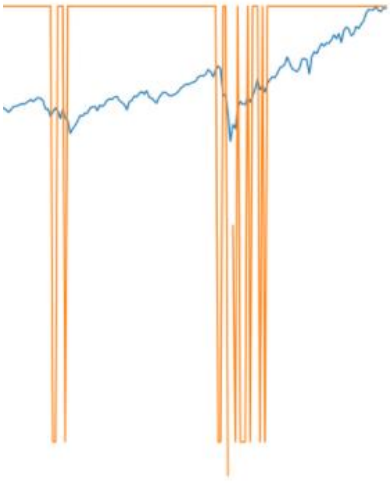
As seen, it looks like there is some applicability for trying to predict volatility. Although there needs to be more research into other time frames, different quoting frequencies, and with different types of securities. It may have some predictive power, but it may not be able to "predict" fast enough.

Using it as a risk measure:

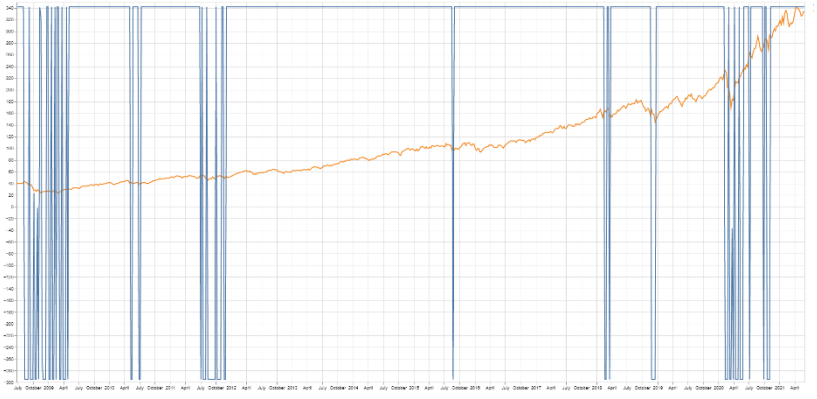
The application may be to run this and then "count" how many times the indicator function has shown signs. This could lead to a new risk measure of for these securities.

Looking into frequency of the indicators:

Another research vector would be to look into the how the frequency affects the price. We can see that with indicators that are closely packed together the price is volatile.



SPX example



QQQ Example

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Inverting to different regimes.

Essentially, we are inverting the medium regime to low regime to get an indicator function for the high regime. In theory we should be able invert any to two regimes and measure correlation to get indicator functions for the third regime.

Areas of Concerns:

There is a large room for error. I break those areas into these categories.

- Programming errors – this could be errors within the statsmodels or within my code.
- Data errors – errors within the data that is getting pulled.
- Knowledge gaps – I do not fully understand markov chains, processes, or regime switching models to be fully confident in implementing a model. I also fully don't understand how to apply them in the python programming language let alone the statsmodels API.
- Statistical errors – this would be errors when drawing and making statistical inferences from the time series.

Another area of concern is the performing future analysis on this model. Markov regime switching models are a form of time series analysis. Now we are trying to analyze the time series of model that analyzes a time series. Possible next steps could be implementing more statsmodels tools or using another regime switching model, or continuous wavelet transform. But applying a second form of analysis may be overkill.

Diego Alvarez
Diego.alvarez@colorado.edu
LinkedIn | GitHub | Medium

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