Algorithmic Trading Strategies on Equities, Gold and Bitcoin during 2020

Report to the Trading Manager

Introduction

In this report, we discuss trading strategies for 3 tickers, viz. the CSUK.L (an equity ETF), GLD (a Gold ETF) and BTC-USD (bitcoin). We use daily returns recorded for these 3 tickers over 2 time periods following the onset of the Covid-19 crisis, Q2 2020 – Q3 2020 and Q3 2020 – Q4 2020.

Our strategies are based on 6 statistical models from Time Series Econometrics and are as follows:

Parameter	**Single Variable**	**Multiple Variables**
Mean	Auto-regressive (Integrated) Moving Average, or ARMA/ ARIMA	Vector Autoregressive (VAR), Vector Autoregressive Moving Average (VARMA)
Variance	Generalised Autoregressive Conditional Heteroskedasticity (1,1), or GARCH(1,1)	Multivariate GARCH
Cointegration		Vector Error Correction (VECM) Pairs Trading

We start generating trading signals for our Equity ETF's returns as the sole variable, using ARMA and ARMA-GARCH(1,1), and subsequently use multivariate models after introducing GLD and BTC-USD into the analysis. Lastly, wherever we find cointegration, we use a pairs trading strategy and fit a VEC model.

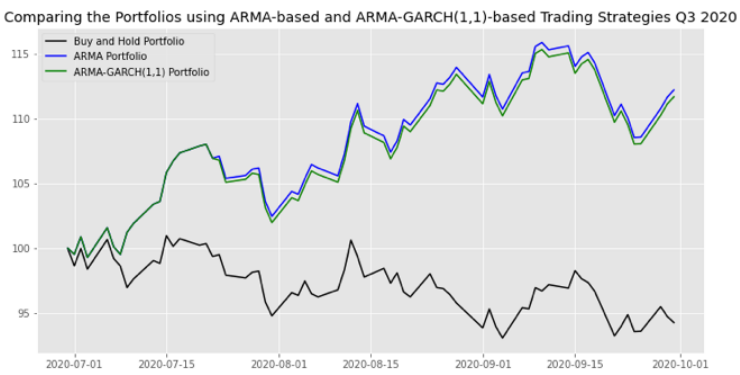
ARMA-based and ARMA-GARCH(1,1)-based Predictive Trading Signals on CSUK.L Returns

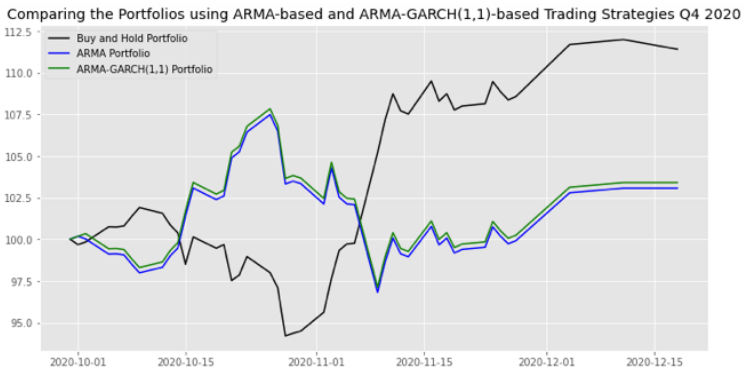
The value of a univariate time series at any given point in time can be thought of as a sum of its mean and the deviations around this mean value, captured by the time series' volatility. In simple terms, ARMA models characterise a time series as dependent on its mean, its previous values (AR component) and previous unobserved random shocks (MA component).

Although ARMA models may do a fine job of fitting some time series, they may not do so for ones whose volatility is not constant over time (heteroskedasticity). In such situations, ARMA models are extended by modelling their residuals using a GARCH(1,1) process which incorporates the varying volatility of the time series through a reaction parameter and a volatility persistence parameter.

With this understanding, we modelled CSUK.L returns using the above 2 approaches. To predict the return on a given day starting Q3 2020, we used a rolling dataset of returns over 60 previous trading days (approx. 3 months). This is because ARMA-GARCH models are typically more suitable for predictions over shorter forecast horizons. To derive each forecasted return, we used an algorithm which chose the AIC-minimising order of the ARMA model (subject to the constraints $p < 6$ and $q < 6$).

Our trading strategy was to go long the index for one day whenever our model predicted a positive return and take a one-day short position whenever the predicted return was negative. We compare this strategy to a simple buy and hold strategy and get the following results:





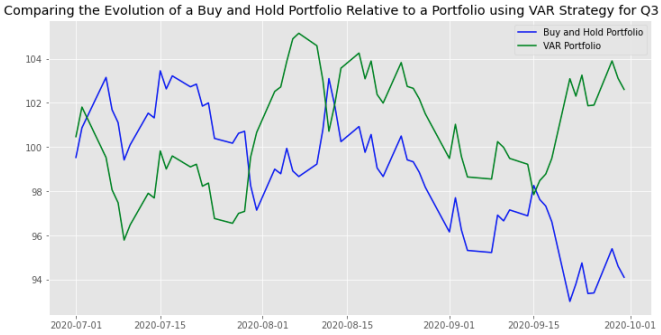
As shown above, the ARMA-based and ARMA-GARCH(1,1)-based portfolios outperformed the buy-and-hold portfolio in Q3 2020 but not in Q4 2020. For the fourth quarter, the underperformance can be explained by the incorrect trading signals generated by our models from October end to the first 2 weeks of November.

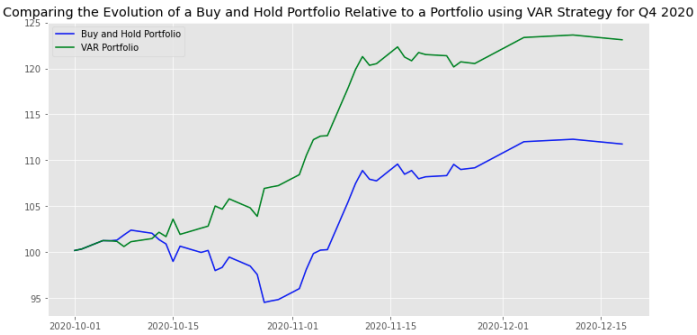
VAR-based, Multivariate GARCH-based and VECM-based Predictive Trading Signals

The rationale behind VAR/ VARMA models and multivariate GARCH is the same as that for AR/ ARMA and univariate GARCH. The only difference is that, in contrast to the latter, the former class of models is used to characterise the evolution of multiple stationary time series which are dependent on their own lagged values and the lagged values of other variables to which they are related.

We modelled CSUK.L returns as the primary variable and GLD returns as the exogeneous variable to improve prediction of the former. In all instances, our trading strategy was the same as the one discussed above, i.e.
If predicted return > 0, execute a one-day long position in the portfolio
If predicted return < 0, execute a one-day short position in the portfolio

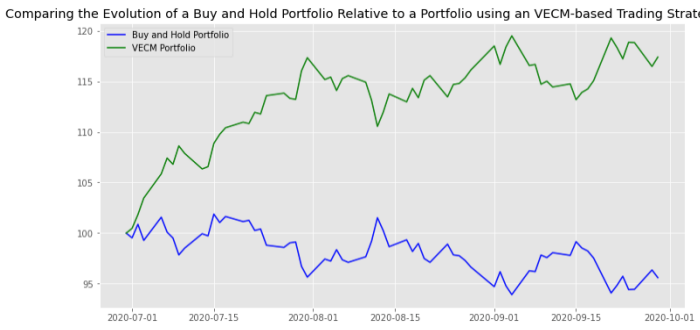
The VAR and multi-variate GARCH models yielded the following results.

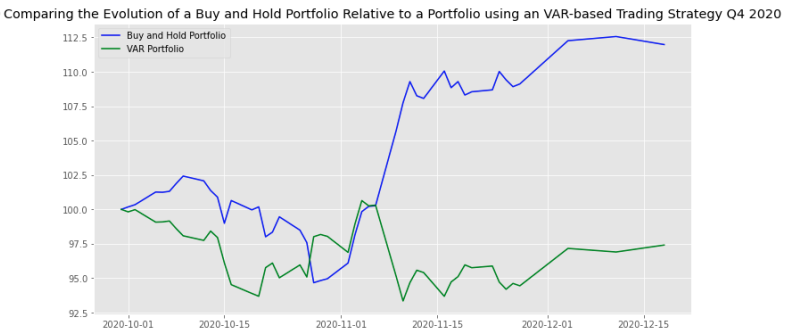


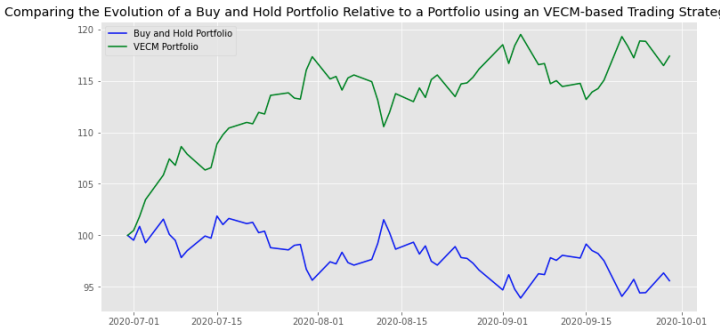


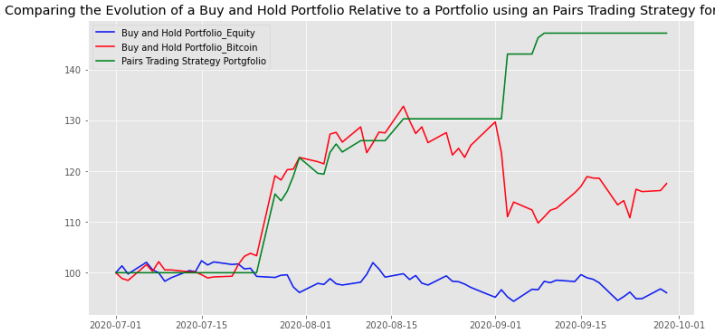
Based on the confusion matrix, the accuracy of the VAR model fitted with CSUK.L and GLD returns comes out to be 49.21% for Q3 2020 and 63.64% for Q4 2020.

After running a VAR model on CSUK.L and GLD returns, we introduced BTC-USD into the analysis and re-ran the model. Further, we noted that CSUK.L and BTC-USD are non-stationary at levels but stationary at (1) and are cointegrated in Q2. Consequently, we also created VECM-based and pairs trading strategies. All these models yield the following results, when compared to a buy-and-hold strategy.







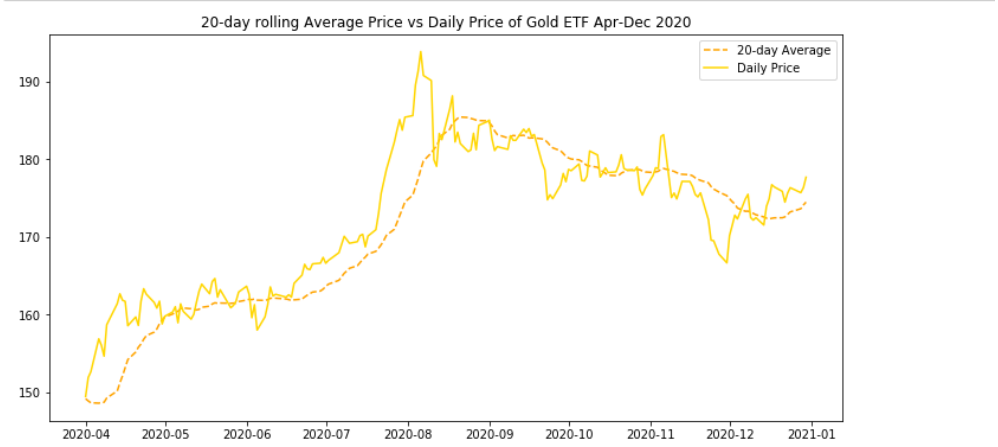


Report to Quant Team Manager

As a Quant team manager, I would study the movements and change in underlying relationship between the various instruments viz. CSUK.L (Equity ETF), BTC-USD (Bitcoin ETF), GLD (Gold ETF) which is quantified using econometrics.

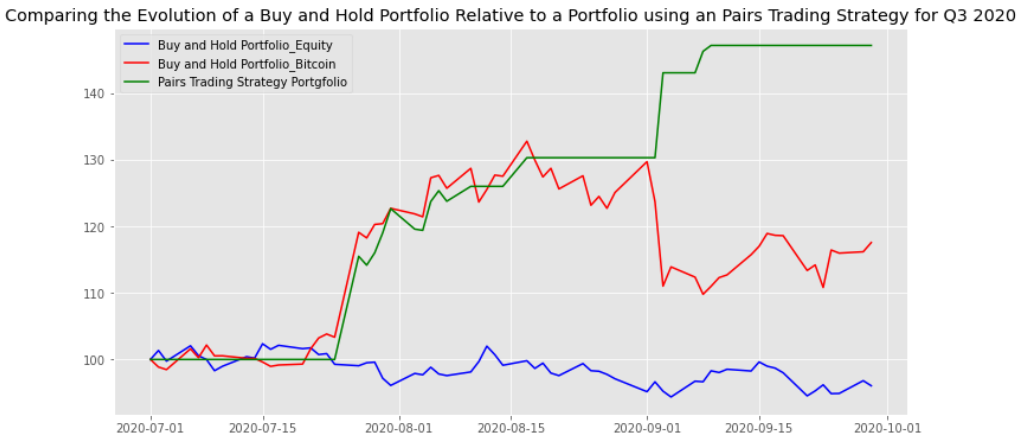
Primary Strategy for Q3

In Q3, I would primarily trade on **Equity using an ARMA-GARCH (1,1) strategy** by studying the equity behavior in Q2 when having a portfolio of multiple instruments would be deterrent from a return's perspective, because BTC-USD has a mean reverting behavior and Gold has a declining trend below the 20 day-MA which can be seen in the chart below. Thus, the 20-day MA would act as a ceiling for the gold prices though it would have added stability to the portfolio by being an equity hedge in usual circumstances but the correlation between Equity and Gold is mere 0.1 during Q2 and Q3. The execution of the **Equity using an ARMA-GARCH (1,1) strategy** would be back tested by actual results and the accuracy of ARMA-GARCH (1,1) in Q3 is great.



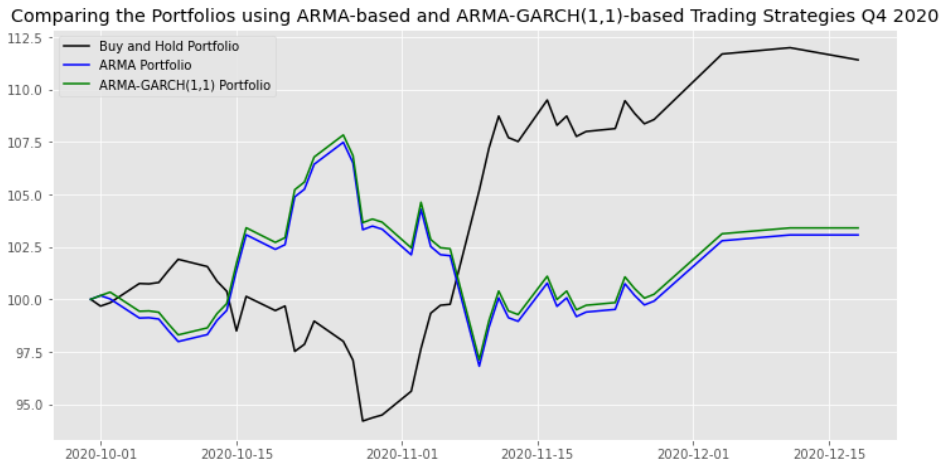
Alternate Strategy for Q3

In Q3, I would primarily use a pair-trading strategy of Equity-Bitcoin as I notice an uptick in correlation between Equity and Bitcoin in Q2 as the correlation rises to 0.81 towards July. The chart below depicts the return in the strategy as compared to a buy-hold strategy. I would prefer the pair strategy as compared to ARMA-GARCH (1,1) due to better risk management which is achieved through diversification in multiple assets.



Primary Strategy for Q4

In Q4, I would trade on the Equity portfolio using an ARMA-GARCH strategy since we notice a strong auto-regressive behaviour.



Report Summarising Distribution of Work in Group 5-H

All 3 members were active and shared the workload. In terms of the distribution, all members, both independently and together, wrote the code and reports for this project

Since each part of the coding assignment was to some extent dependent on other parts (notably with regard to creation of data frames, calculating summary measures etc.), there were many overlaps in the code which each of us individually wrote. Further, the subparts of each part were also shared among the team members

For this reason, it is difficult to provide a precise description of who did each step. Concerning the reports and constructed response essays, all of them contain ideas of all active team members