Granger Causality test for weekly prices between

Crude Oil Prices, Bitcoin, MARA and BLCN

Advanced Microeconometrics

University of North Carolina at Charlotte

INTRODUCTION

Over the years there has been vast improvements in modeling and understanding the effects of different variables and how they cause the movement of other macroeconomic variables. Many people are keen on knowing how a variable's movement causes the change in value of other macroeconomic variables. There are many methods that can be used to calculate this movement. The method of capturing this movement of variables has drastically changed from what it was used in the earlier times, out of these methods the Vector AutoRegression (VAR) and Granger Causality Test is widely used specifically for this purpose in recent times.

Thus, this paper checks the predictive power of Crude Oil Price movements to the cryptocurrency Bitcoin, Marathon Digital Holdings Inc ETF and Siren Nasdaq NexGen Economy ETF. In order to do this, this paper uses these 4 variables to get the Vector AutoRegression results for Non-Stationary & Stationary Data. After comparing these results with the Granger Causality Test for the Non-Stationary & Stationary Data, this paper determines if any of the 4 listed variables has a predictive ability for the other variables.

REVIEW OF LITERATURE

Economic theory suggests that there are many factors that need to be analyzed to understand what makes the movement in one variable cause the change in another variable. In recent times there has been much research regarding understanding the movements of Cryptocurrencies and does it cause or does any other variable cause the change in Cryptocurrency.

Hence, Corbet et al. (2019) performs a detailed review of studies in the financial field, suggesting that since cryptocurrencies are considered as an asset class in recent times, it is important to understand the performance of this asset in times of stress. Yousaf and Ali tries to

understand the volatility of the Cryptocurrencies before and after Covid-19 period and they found that volatility transmission in Cryptocurrency was not significant in the pre Covid-19 era, suggesting that investors had the upper hand with respect to diversification. But in the Covid-19 era it was found that the correlation between the Cryptocurrencies were higher compared to pre Covid-19 era, suggesting that hedging was more effective during the Covid-19 period.

This paper totally relies on the work of Granger, who was the first to introduce a method of statistical Hypothesis Test to check for a time series Causality effect. The Granger Causality Test tries to find if a time series variable has a predictive power of predicting another variable with its lagged values. The main motive of this Test is if a variable causes another variable, then the variable has a better forecasting ability of the other variable. Granger Causality is often used after the Vector AutoRegression (VAR) model.

Since VAR is an Autoregressive process, it helps check if the future values of a particular variable can be predicted with the help of past values of another variable.

ECONOMETRIC MODEL & DATA

The variables that I include for this Granger Causality test are weekly prices of Crude Oil, Bitcoin (USD), Marathon Digital Holdings Inc ETF (MARA) and Siren Nasdaq NexGen Economy ETF (BLCN). The weekly data prices for Crude Oil came from the U.S. Energy Information Administration website, Bitcoin USD weekly prices came from FRED website and the 2 ETF's Marathon Digital Holdings Inc and Siren Nasdaq NexGen Economy came from Google Finance. All of these data are downloaded and then combined into one excel file and that file is used to run the Granger Causality Test. The weekly prices for these variables are taken over a time span from 2nd February, 2018 to 15th April, 2022.

My Null Hypothesis is that one variable does not cause the other variable. If we reject the Null then we can say that the value of the latter variable can be predicted with the lagged values of the former variable. And the Alternative Hypothesis for this is that one variable causes the other variable.

I am using weekly prices to test for granger cause because when we look at the daily prices of the variable Crude Oil, there is no data for the weekends i.e. Saturday and Sunday. Whereas, when we look at the daily prices for the Cryptocurrency (Bitcoin) we see that the variable is continuous, in which we have 7 days a week prices for Bitcoin and 5 days a week prices for Crude Oil. Thus conducting a granger causality test for such a time series variable was not possible, so I switched to running the Granger Causality Test at weekly prices.

I will run the Vector Autoregression for all the variables with 1 lag and then do the Granger Causality Test to derive the desired result.

RESULTS

Through the AIC/BIC criterion, it was derived that the optimal number of lags that should be used for the Non-Stationary data is 1. After that I checked if the variables are Stationary with the help of Augmented Dickey-Fuller (ADF) Test, since a Non-Stationary time series gives inaccurate and misleading Granger Causality results. The results indicate that all the variables are Non-Stationary, so in order to make the dataset Stationary, I took the First Difference of all the variables. Now, the results indicate that the optimal number of lags that should be used for Stationary data is 0, but I use 1 lag to run the Vector AutoRegression followed by the Granger Causality Test.

After running the Granger Causality, the results from Non-Stationary data indicate that Siren Nasdaq NexGen Economy ETF (BLCN) causes Bitcoin prices at 5% significance level. We

reject the Null Hypothesis that 1 lagged value of BLCN does not cause Bitcoin prices at 5% significance level since the p-value is less than 0.05. Similarly, we also reject the null that 1 lagged value of Crude Oil and Marathon Digital Holdings Inc ETF does not cause BLCN at 5% significance level because the p-value is less than 0.05. We fail to reject all of the other Null Hypothesis that a variable does not cause the other, indicating that none of the other variables have a predictability power with respect to the remaining variables. But since these results are from Non-Stationary data and relying on these results is not an ideal choice we look at the results of Stationary data.

The Granger Causality results for the Stationary data indicates that the Siren Nasdaq NexGen Economy ETF (BLCN) causes Crude Oil prices at 5% significance level. We reject the Null Hypothesis that 1 lagged value of BLCN does not cause Crude Oil prices at 5% significance level since the p-value is less than 0.05. We fail to reject all of the other Null Hypothesis that a variable does not cause the other, indicating that none of the other variables have a predictability power with respect to the remaining variables.

CONCLUSION

To conclude, this paper has tried to find a relationship between Crude Oil Prices, Bitcoin Prices, Marathon Digital Holdings Inc ETF and Siren Nasdaq NexGen Economy ETF with the help of Granger causality Test. This paper has tried to assess if any of the above 4 listed variables have a predictability power relating to other variables.

The results from the Granger Causality Test for Stationary Data suggests that BLCN ETF prices cause the Oil Prices, but it is reasonable to gather further information regarding this result mainly because Vector AutoRegression is very sensitive with the number of lags used. This paper uses the lowest AIC/BIC criterion to derive the number of lags, but since the result

for that has not been that indicative with respect to the Stationary Data it maynot be in the best of interest to say that BLCN ETF has the predictability power to that of the Crude Oil Prices.

TABULAR RESULTS

Table1: Vector Autoregression for Non-Stationary Data

var OilPrices Bitcoin MARA BLCN, lags(1)

Vector autoregression

Sample: 2018w3 - 2022w15   Number of obs   =   221
Log likelihood   = -3447.924   AIC   = 31.38393
FPE   = 5.01e+08   HQIC   = 31.5081
Det(Sigma_ml) = 4.18e+08   SBIC   = 31.69145

Equation	Parms	RMSE	R-sq	chi2	P>chi2
OilPrices	5	3.36955	0.9642	5950.707	0.0000
Bitcoin	5	2692.95	0.9787	10134.71	0.0000
MARA	5	3.46369	0.9506	4250.135	0.0000
BLCN	5	1.16067	0.9872	17079.86	0.0000

Table 2: Granger Causality Test for Non-Stationary Data

vargranger

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
OilPrices	Bitcoin	.74173	1	0.389
OilPrices	MARA	1.1214	1	0.290
OilPrices	BLCN	.25586	1	0.613
OilPrices	ALL	4.9218	3	0.178
Bitcoin	OilPrices	.63888	1	0.424
Bitcoin	MARA	.2902	1	0.590
Bitcoin	BLCN	8.6017	1	0.003
Bitcoin	ALL	9.6851	3	0.021

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|    MARA    OilPrices  |  1.3606   1   0.243   |
|    MARA    Bitcoin    |  3.4446   1   0.063   |
|    MARA    BLCN       |  2.3906   1   0.122   |
|    MARA    ALL        |  17.643   3   0.001   |
|----------------------------------+----------------------------------|
|    BLCN    OilPrices  |  3.9951   1   0.046   |
|    BLCN    Bitcoin    |  2.7746   1   0.096   |
|    BLCN    MARA       |  4.7446   1   0.029   |
|    BLCN    ALL        |  13.53    3   0.004   |
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Table 3: Vector Autoregression for Stationary Data

var d_OilPrices d_Bitcoin d_MARA d_BLCN, lags(1)

Vector autoregression

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Sample: 2018w4 - 2022w15              Number of obs    =       220
Log likelihood   = -3447.292          AIC              =  31.52084
FPE              = 5.75e+08            HQIC             =  31.64542
Det(Sigma_ml)  = 4.79e+08             SBIC             =  31.82935
```

Equation	Parms	RMSE	R-sq	chi2	P>chi2
d_OilPrices	5	3.33591	0.0466	10.75603	0.0294
d_Bitcoin	5	2723.71	0.0277	6.270565	0.1798
d_MARA	5	3.61048	0.0110	2.447027	0.6541
d_BLCN	5	1.19088	0.0158	3.530027	0.4733

Table 4: Granger Causality Test for Stationary Data

vargranger

Granger causality Wald tests

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|     Equation        Excluded |  chi2    df Prob > chi2 |
|------------------------------+--------------------------------------|
|   d_OilPrices      d_Bitcoin | .00089    1    0.976   |
|   d_OilPrices      d_MARA    | .55857    1    0.455   |
|   d_OilPrices      d_BLCN    | 6.6665    1    0.010   |
|   d_OilPrices      ALL       | 7.4819    3    0.058   |
|------------------------------+--------------------------------------|
|   d_Bitcoin      d_OilPrices | .07692    1    0.782   |
|   d_Bitcoin      d_MARA      | 2.9717    1    0.085   |
|   d_Bitcoin      d_BLCN      | .60906    1    0.435   |
|   d_Bitcoin      ALL         | 5.3929    3    0.145   |
|------------------------------+--------------------------------------|
|   d_MARA         d_OilPrices | .02535    1    0.873   |
|   d_MARA         d_Bitcoin   | .18855    1    0.664   |
|   d_MARA         d_BLCN      | 1.6456    1    0.200   |
|   d_MARA         ALL         | 2.1009    3    0.552   |
|------------------------------+--------------------------------------|
|   d_BLCN         d_OilPrices | .00453    1    0.946   |
|   d_BLCN         d_Bitcoin   | .79846    1    0.372   |
|   d_BLCN         d_MARA      | .55143    1    0.458   |
|   d_BLCN         ALL         | 2.8886    3    0.409   |
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FIGURES

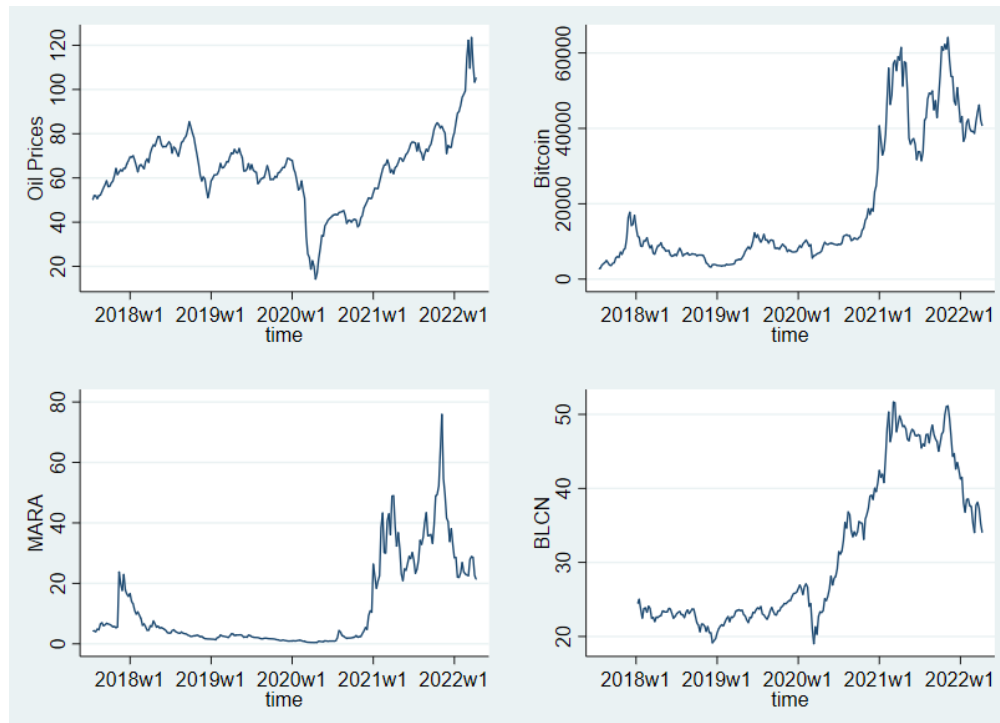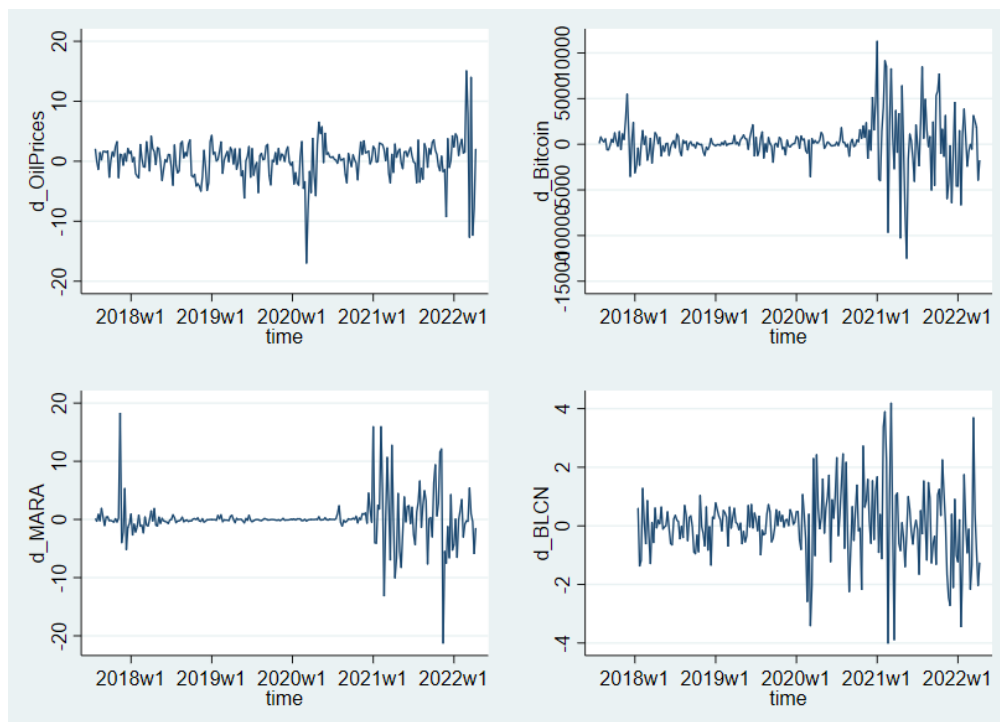### Figure 1: Graph for Non-Stationary Data

Figure 2: Graph for Stationary Data

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https://www.eia.gov/dnav/pet/pet_pri_spt_s1_w.htm : Crude Oil Weekly Prices

https://fred.stlouisfed.org/series/CBBTCUSD : Bitcoin Weekly Prices

https://www.google.com/finance/quote/MARA:NASDAQ?hl=en MARA Weekly Prices

https://www.google.com/finance/quote/BLCN:NASDAQ?hl=en BLCN Weekly Prices