

Cointegrated Cryptocurrencies?

An Exploration of Price Movements

Overview

The original Bitcoin whitepaper was released in 2008 under the pseudonym Satoshi Nakamoto. Since then, other projects have modified the original Bitcoin protocol to create new blockchains, each with their own coins. Colloquially referred to as “cryptocurrencies”, these projects have captured the imagination of many. As of February 23, 2019, the three largest cryptocurrencies by market capitalization are Bitcoin (\$72.6 Billion), Ether (\$16.6 Billion), and Ripple (\$13.6 Billion), I explore price movements in the cryptocurrency market by looking for cointegrating relationships between the various coins. Results suggest that none of the cryptocurrency prices appear to change independently of the others. Further, I find that investors seem to respond to negative price changes with an increase in volatility. As per Leung and Nguyen 2018, these results have implications for constructing a cryptocurrency portfolio that statistically arbitrages the market.

Data

Analyze four major cryptocurrencies.

- Bitcoin
- Ethereum
- Litecoin
- Ripple

Transaction level data for each coin.

- Timestamp
- Quantity Traded
- Price in USD

Final Series.

- Hourly Price Data

Source.

- Bitstamp, a major European exchange

Results

Independent Series

We can model Bitcoin, Ether, and Ripple as threshold generalized autoregressive processes with conditional heteroskedastic error terms (TGARCH). Mathematically we can represent Bitcoin as follows:

$$\Delta BTC_t = 0.20 \Delta BTC_{t-1} - 0.12 \Delta BTC_{t-2} + 0.03 \Delta BTC_{t-3} + \epsilon_t$$

where,

$$E_{t-1}(\epsilon_t^2) = 23.25 + 0.068\epsilon_{t-1}^2 + 0.02D_{t-1}\epsilon_{t-1}^2 + 0.926h_{t-1}$$

Note that $D_{t-1} = 1$ whenever ϵ_{t-1} is negative, and that h_{t-1} is the previous period’s forecasted variance. In English, this says the hourly change in the price of Bitcoin depends on the previous three hours, and also that “bad news” affects the conditional variance more than “good news”. We see similar results for the other three coins.

Cointegrated Series

When we consider the coins together, we find the following correlation table:

BTC	-	-	-
0.70	ETH	-	-
0.89	0.81	LTC	-
0.68	0.86	0.77	XRP

After performing both Johansen and Engle-Granger cointegration tests, we arrive at the following relationship with tradable implications as per Leung and Nguyen 2018.

$$BTC_t = 2996 - 0.77 ETH + 44.78 LTC + 145.66 XRP$$

This suggests that there may exist a trading strategy that allows for building a portfolio such that if any coin changes “too much” relative to the other coins, you can buy or sell with the belief that the price will return to the long-run relationship given above.

