**Ripple Project**

**Extrapolating the correlation between crypto and non-crypto assets**

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**Abstract**

Institutions and investors in traditional finance are looking for exposure to cryptocurrencies, however they are wary of including a highly volatile asset class in their portfolios without comprehensive knowledge of the downside risk. As such, there has been a significant amount of research in the field of portfolio optimisation, the topic of concern for this project, that looks at applying common techniques to cryptocurrencies. The focus of this study is the change in correlation between crypto and non-crypto assets and utilisation of predictive methods to estimate the effects of this change on the portfolio optimisation process.

**Short Literature Review**

**Portfolio Optimisation**

**Common Risk Factors in Cryptocurrency** - Yukun Liu, Aleh Tsyvinski & Xi Wu

This paper took the 25 of the risk factors proposed by Feng et al. (2017) and Chen and Zimmerman (2018) in *Taming the factor zoo* and *Publication bias and the cross-section of stock returns* respectively applied them to cryptocurrency. These factors fell into four groups: size; momentum; volume; and volatility. They were examined across 1,707 cryptocurrencies from 2014-2018 with particular attention paid to the excess returns of market-neutral strategies with weekly rebalancing.

The authors found nine factors of significance that could be mostly represented a three factor model which combines market, size and momentum; noting ‘*both size and momentum are important in explaining the cross-section of expected returns of cryptocurrencies*’.

**Modelling Crypto Asset Price Dynamics, Optimal Crypto Portfolio, and Crypto Option Valuation** – Yuan Hu, Svetlozar T. Rachev & Frank J. Fabozzi

This paper focussed on minimising portfolio tail risk through two different measures of market risk methods; Value at Risk (VaR) and Conditional Value at Risk (CVaR). Crypto portfolios were optimised using the mean-variance and the CVaR methods where variance and CVaR were minimised at the 99% confidence level. They did this by first calibrating an ARMA(1,1)-GARCH(1,1) model to the log returns of seven cryptocurrencies with several multivariate distributions, then generating 10,000 one-step scenarios, found the efficient frontier and chose the portfolio with the minimum risk as the optimal portfolio.

The authors found the CVaR portfolio had the highest risk-adjusted return. The portfolios they developed were able to outperform the S&P 500 out-of-sample, however the test period only lasted approximately fourteen months which is a much shorter period of time than a supposed Bitcoin ‘cycle’; this means findings cannot likely be wholly relied upon.

The paper also derived a fair valuation model for cryptocurrency options from a dynamic pricing model for the underlying assets.

**CRIX an Index for cryptocurrencies** – Simon Trimborn & Wolfgang Karl Hardle

This paper looked to propose a dynamic index that best represented the cryptocurrency markets with a methodology based on the CRSP U.S. Equity Indexes Methodology Guide and chose the index with the lowest AIC. The study found Bitcoin does not solely for all the variance in the cryptocurrency market and therefore there is a need to include altcoins to improve tracking performance; a solution to this was then successfully implemented by the authors. They concluded their paper by stating ‘the CRIX technology enhances the construction of an index if the goal is to find a sparse, investable and accurate benchmark’.

For the study they only looked at market cap (CRIX) and a liquidity weighting (LCRIX), which gave preference to cryptocurrencies that were more relatively actively traded, and not any other factors that could build a smart beta index such as low volatility or momentum.

In their study the index was rebalanced monthly with a quarterly rebalancing of the number of constituents; these rebalancings were more an intuitive translation from non-crypto indices, however no effort was made to optimise these intervals.

**Balancing Cryptoassets and Gold: A Weighted-Risk-Contribution Index for the Alternative Asset Space** – Aikaterini Koutsouri, Francesco Poli, Elise Alfieri, Michael Petch, Walter Distaso & William J. Knottenbelt

This paper proposes an index comprising five major cryptocurrencies and gold in order ‘*to improve the risk profile of the resulting portfolio while preserving its independence from mainstream financial asset classes such as stocks, bonds and fiat currencies*’. The paper uses Shannon’s Demon as a starting point and ‘*extends the theory of Equal Risk Contribution to Weighted Risk Contribution’*. It was Intuitively noted that constructing a diversified portfolio of two uncorrelated asset classes ‘*reduces price instability while raising the average return per unit of volatility’*.

It was found that their portfolio, when subjected Weighted Risk Contribution, had the highest Sharpe Ratio among several other strategies; while ‘*an Equal Weighting scheme to be more effective in terms of the same metric than a market capitalisation weighting’*. A contributing factor in the success of this paper’s investigation was likely the low transaction costs as the index turnover was ‘*moderate*’.

**Should investors include Bitcoin in their portfolios? A portfolio theory approach** – Emmanouil Platanakis & Andrew Urquhart

This paper investigated the benefits of the inclusion of Bitcoin in a traditional portfolio by focussing on eight common asset allocation strategies in several scenarios and under a number of different constraints. Unlike the relatively short sample periods observed in other papers this work utilises more than half a decade of Bitcoin data which captures full ‘cycles’.

A major strength of this paper is its use of ‘robust’ testing methods through ‘*the inclusion of a commodity portfolio, alternative indices, short-selling as well as two additional optimization techniques including higher moments with (and without) variance-based constraints (VBCs)*’; this serves to support the empirical results.

They found a considerable increase in risk-adjusted returns when Bitcoin is included in a portfolio across all strategies and that it ‘*adds substantially to a stock-bond portfolio in terms of the Sharpe, Omega and Sortino ratios’*. Interestingly, ‘i*n each model a large proportion of the capital is allocated to Bitcoin’*.

**Notes**

Current cryptocurrency portfolio optimisation research tends to concentrate on applying knowledge from traditional finance such as Modern portfolio theory and factor models. This research tends not to stretch to less conventional models like Post-modern portfolio theory. A further indication of this are the weighting metrics used for asset allocation which tend to focus on equal weighting or by market cap.

Much of the research looking to integrate cryptocurrency into a traditional portfolio has concentrated on Bitcoin without looking at the potential benefits of including major altcoins or a cryptocurrency sub-portfolio.

**Common Portfolio Optimisation theories and models:**

* Modern portfolio theory
* Post modern portfolio theory
* Fama-French three-factor model
* Fama-French five-factor model
* Carhart four-factor model
* Black-Littermen model
* Hierachical risk parity
* Critical line algorithm
* Treynor-black model
* Universal portfolio algorithm

**Common methods for time series prediction**

* ARMA
* ARIMA
* GARCH
* LSTM
* XGBoost
* Exponential Smoothing
* Linear/Nonlinear Regression