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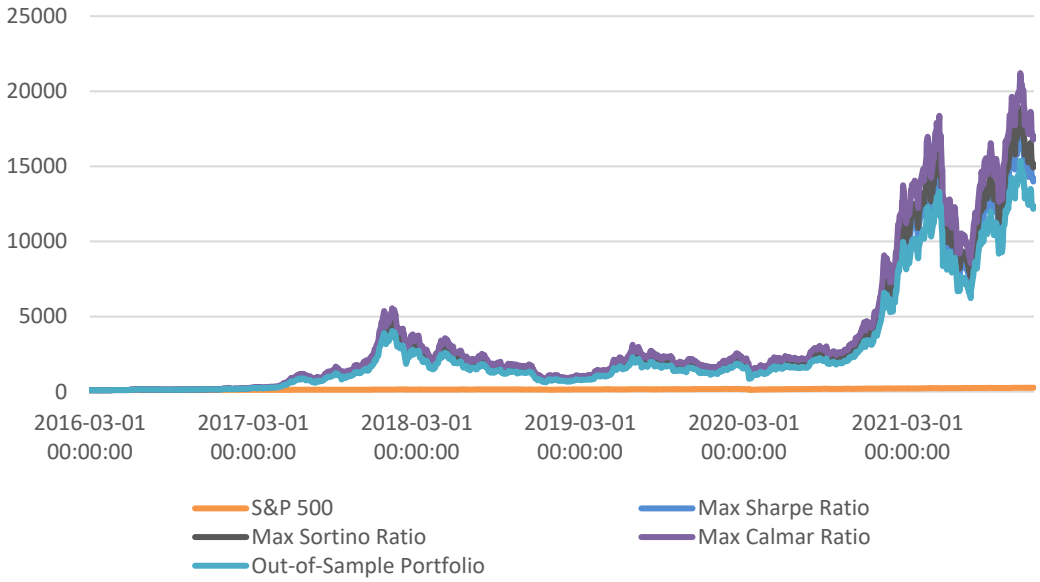
Analyzing Crypto (Part 2) – As An Investment

Abstract

This white paper picks up where the last paper[1] left off. In Part 2, I examine cryptocurrencies as an asset class, where they fit in a conventional portfolio, and then design an optimum portfolio based on three parameters. This paper also contains a section on the hazards of investing in crypto and if this new asset can genuinely deliver utility inside the ordinary portfolio. **Exhibit 1** summarizes and compares all portfolios made during the creation of this paper.

Exhibit 1: Optimized Portfolios with $100 Invested Day 1

5/6/2013 – 12/27/2021



Source: Yahoo Finance and Royalton-CRIX, computed in Python. Link to GitHub. Summary of all optimized portfolio and the S&P 500. Used for comparison on the different methods and strategies of optimizing a portfolio.

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1 Analyzing Crypto (Part 1) – As A Currency. In Part 1 I went over the drawback and future prospects of cryptocurrencies as a product and as a medium of exchange. Different from this paper where I analyze crypto strictly as an investment.

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About Eli Febres Jr

I am a full-time student at UCF, the Co-founder and CEO of BNC Capital Management, LLC, and The Pegasus Group's Lead Portfolio Strategist. Since I was 13 years old, I've concentrated on the PMP (Portfolio Management Process) side of investing. My expertise and passion to put what I love into practice have aided in my ambition to create my own investment fund while still in college and to continue to learn more about the profession on a daily basis. This has prompted me to begin writing research papers, which help me improve all of my talents while also requiring me to concentrate and study in-depth knowledge of a variety of investing disciplines.

Cryptocurrencies As An Asset Class

(Brinson et al., 1986) and their follow-up (1991) studies demonstrated the relevance of asset selection and its effect on portfolio performance. They discovered that asset allocation accounts for 93.6 percent[2] of the variation in overall portfolio return. For decades, people have questioned whether or not this assertion is right, and if so, how accurate it actually is. Regardless of the exact number it should make clear to the reader that asset allocation is an important part of building any successful portfolio.

Investors have a wide range of asset classes to choose from when constructing portfolios. Unfortunately, neither the description of an asset class nor the criteria for defining an asset class have been settled upon. Taking inspiration from (Kinlaw et al., 2017), we set out to create a definition that not only suits multiple existing assets classes, but also allows us to properly distinguish new asset classes as they may materialize.

"An asset class is one that has a relatively stable mix of directly investable assets. An asset class must also be able to distinguish itself from other asset classes that behave differently, indicating that it can be grouped with assets that behave similarly."

Cryptocurrencies, if taken by their definition are "digital asset that use a distributed ledger, or blockchain technology to enable a secure transaction." As a result, cryptocurrencies are a stable asset class. In contrast, momentum could not be considered an asset class since the underlying securities will vary day to day, resulting in unacceptably high trading and tracking costs.

Another requirement is that cryptocurrencies be investable directly, which there are many exchanges[3] that allow the direct purchase of crypto coins. Inflation is an asset class that cannot be directly invested in because it requires investment in replicating securities. Cryptocurrencies should also be able to distinguish themselves from other types of assets. It is relatively easy to distinguish crypto from other currencies and asset classes since there are no other asset classes that are "digital assets" and use blockchain[4] or distributed ledgers to protect their transactions. Using this discriminating criterion, we can also classify other digital properties (NFTs) that use the same technology together, fulfilling the last requirement.

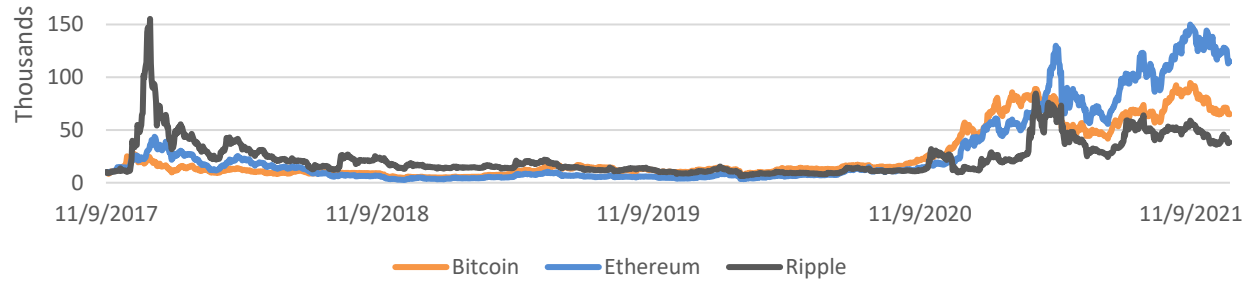
Note: In the future, the price of each type of cryptocurrency will behave differently, just as different stock sectors do. As the market develops, cryptocurrencies will begin to mature as an asset class and sectors separated by use/purpose will begin to develop. Cryptocurrencies can be divided into seven groups or classes (Härdle et al., 2019). We won't address them in this paper since cryptocurrencies haven't yet grown to the point where categorization has a substantial influence on market movement. Nonetheless, as we'll see later, even if they belong to various groupings of cryptocurrencies, most cryptos remain highly correlated with one another.

2 Although (Brinson et al., 1986) discovered a 93.6 percent correlation between asset mix and portfolio performance their research had many flaws. Their methodology, for example, implicitly assumes that monies not allocated to their specified asset mix were not invested at all. Despite its flaws, their study has highlighted the relevance of not just security selection but also asset class mix for portfolio managers.

3 The top 5 most popular exchanges (not in order) are: Coinbase, Gemini, Blockfi, Crypto.com, Binance, and Kraken.

4 The blockchain and how it remains so secure are explained in Part 1of Analyzing Crypto.

Exhibit 2: Bitcoin, Ethereum, & Ripple Initial Investment of $10,000
11/9/2017 – 12/31/2021



Source: Yahoo Finance. $10,000 invested in each asset on 11/9/2017. Values shown in thousands. Ending values for each cryptocurrency on 12/31/2021. Bitcoin: $64,822, Ethereum: $113,079, Ripple: $38,216.

Historical Performance

Crypto exchange markets have existed for 6 years now, starting in 2017. For the past few years, we have seen significant increases in value for all types of cryptocurrencies, summarized in **Exhibit 2**. Bitcoin started in 2009 with an exchange rate of 1309.03 BTC to 1 USD. In 2010 a bitcointalk.org user put 10,000 BTC up for auction with a $50 minimum and got no bids. Today 10,000 BTC is worth well over $450 million dollars.

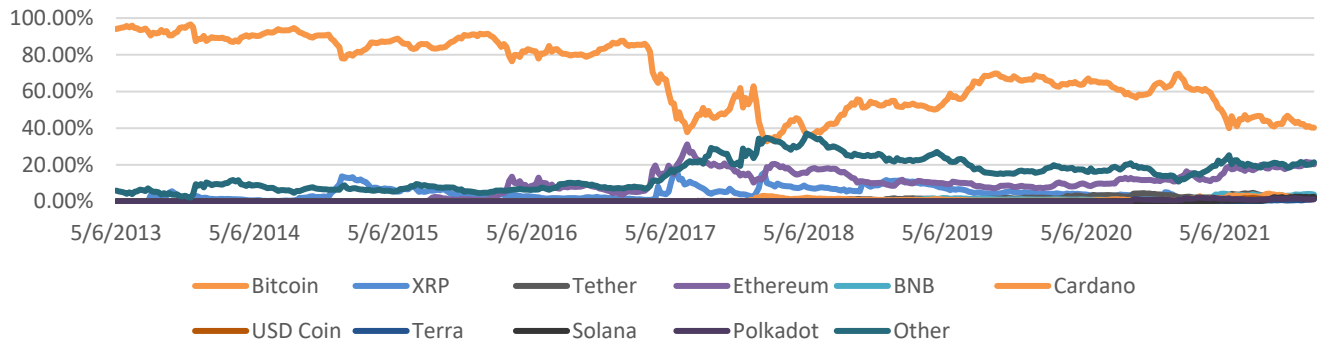
Bitcoin's meteoric rise from anonymity and massive increase in value is well documented (Fiorillo, 2020). As Bitcoin gained traction numerous cryptocurrencies began to take off as well. However, the huge gains were not without their fair share of huge drawdowns. There have been several crashes in Bitcoin's and by correlation[5], the crypto market as a whole. In 2014 a crypto exchange website called MT. Gox had a serious security breach resulting in 850,000 Bitcoins being stolen, which equated to 6% of the total circulation Bitcoin at the time and amounting to 37 billion dollars in today's money. In 2017, there was a boom in the number of cryptocurrencies created by coin offerings (ICOs) raising $4.6 Billion in the process all while the prices of these cryptocurrencies rose at inexplicable rates. Not surprisingly, 80 percent of Bitcoin's and the majority of the blockchain market's worth was wiped out after a series of incidents starting in January of 2018.

It's worth noting that Bitcoin and the cryptocurrency industry as a whole have bounced back from several bear markets. Many institutional investors are put off by the uncertainty, but it should be taken as a symbol of resilience and durability, indicating that cryptocurrencies may be here to stay.

Another indicator of the sustainability of cryptocurrencies is the amount of cryptocurrencies that account for the overall market share of the crypto market. In 2014 the number of altcoins amount to 69 that number today is 16,435 raising exponentially after the creation of crypto market in 2017, according to Coinmarketcap. In 2016 Bitcoin accounted for over 80% of the total market cap. Today it accounts for only 39.4% of the global crypto market cap. This diversifies the risk of the crypto market away from one single crypto. It is also a sign of strength and provides liquidity for institutional and retail investors to build positions across multiple altcoins.

5 See **Exhibit 4** for the correlation of Bitcoin and the crypto market as a whole

Exhibit 3: Major Cryptoassets By Percentage of Total Market Capitalization
5/6/2013 – 12/27/2021



Source: Coinmarket.com. The above graph shows the individual proportions of the largest ten cryptoassets relative to the total market capitalization of all assets.

Can Crypto Increase Portfolio Utility?

Any asset class selected by an investor or portfolio manager to be included in a portfolio should increase portfolio utility. That is, when a portion of the portfolio's capital is allocated to the examined asset class, it should either improve performance or reduce risk. Correlation is commonly used to test this. Each asset class should be heterogenous; otherwise, including an asset class that is substantially connected to another asset class raises risk while often not improving performance.

Is the crypto market isolated from other market driving factors? For instance, is the crypto market influenced by the job market, which tends to influence the stock market? When the stock market goes down does the crypto market tend to also go down? As we can see in **Exhibit 4** the correlation of known asset classes and CRIX (Crypto Index much like the S&P 500 is an index to the stock market) is low. **Indicating that the crypto market is heterogeneous and can provide "safe haven" for investors when market factors may bring down other asset classes.**

This finding has also been reached by other academic papers. According to (Kuo Chuen et al., 2017), integrating this new asset in a portfolio dramatically expands the portfolio's efficient frontier. **That is to say, it significantly improves portfolio utility.**

The next few sections will be able to show exactly how the performance within the traditional portfolio is improved by allocating fund to this new asset class.

Exhibit 4: Asset Class Correlation Matrix
2016 – 2021

	CRIX	SPY	IYR	GLD	BND
CRIX		0.189622	0.139910	0.115755	0.136528
SPY	0.189622		0.759274	0.026513	0.070103
IYR	0.139910	0.759274		0.106214	0.216378
GLD	0.115755	0.026513	0.106214		0.337956
BND	0.136528	0.070103	0.216378	0.337956	

Risk of Investing in Crypto

Many individuals and institutions have been hesitant to invest, or invest extensively, in cryptocurrencies, partially due to the limited market size accessible, but primarily due to its **volatility**. In 2014 China outlawed the use of crypto saying, in a nutshell that cryptocurrencies, because of their volatility "violate" the safety of people's investments and distribute financial chaos (Gura, 2021). However, China's motivation may be for other reasons as they have gone on record stating that they are making their own stable coin.

Market Manipulation: Cryptocurrency prices will be at the mercy of hackers, pump and dump traders, wash traders, and others as long as there is little to no regulation of crypto exchanges. Anyone thinking about investing in cryptocurrencies should be informed of the basic techniques used by hackers and market manipulators and take safeguards to prevent their portfolio from being impacted by these illegal activities.

Regulation risk: Academics and business professionals are divided on the extent to which government institutions regulate and how much such regulation influences the crypto market and individual crypto projects. The potential for cryptocurrencies to be used to fund money laundering and human trafficking has made cryptocurrency regulation a major priority for governments throughout the world. The cryptocurrency market will be influenced by the restriction or requirement of licenses for businesses to transact in cryptocurrencies. Despite the fact that these risks are impossible to quantify, risk-averse investors should stay informed about legal and tax changes in their country.

Speculation and Management Risk: Each cryptocurrency carries some amount of speculative risk because the crypto sector is still relatively young, having only begun trading in 2017, compared to the NYSE, which began trading in 1792. Each project is dependent on its founders, the concept's validity, and the competition. Today, investing in any cryptocurrency carries the same speculative risk as starting a small business. Many of these dangers are tied to management's capacity and willingness to drive their crypto business forward quickly enough and upgrade as needed in order to avoid being deemed obsolete by next-generation currencies.

Exhibit 5: Risk-return profiles of each asset class

2016 – 2021

Risk-return measurements	*CRIX*	*STOCKS*	*Real Estate*	*Gold*
Annualized Returns	2.278	0.202	0.137	0.072
Annualized standard deviation	0.808	0.181	0.215	0.137
Annualized Sortino Ratio	4.138	1.266	0.713	0.520
Maximum DD	-0.853	-0.337	-0.423	-0.188

Source: Yahoo Finance and Royalton-CRIX, computed in Python. Link to GitHub. The risk-return profile of each asset class to later be compared to optimized portfolio using same assets and sample size.

Portfolio Optimization

Portfolio optimization takes into account the constraints and objectives indicated in the investment policy statement (a company's or an individual's investment plan) and builds a portfolio using a variety of approaches to get the greatest potential returns for the risk taken. To put it another way, the purpose of optimization is to design the perfect portfolio given a certain set of rules. However, there isn't a single perfect portfolio. Every portfolio should be tailored to the demands of the individual or organization. There should be as many unique optimized portfolios as there are unique investors.

The most popular method for optimizing portfolios is Markowitz's MPT (Modern Portfolio Theory). MPT uses a mathematical formula where the objective function is to minimize the variance of the portfolio, known as MVO (Mean Variance Optimization). The most prevalent technique among financial advisers for converting MVO into a viable portfolio for clients is to maximize the portfolio's risk-to-performance ratio. This strategy selects the asset allocation that has the highest Sharpe ratio, which is often achieved by selecting the largest ratio of volatility to performance.

$$MVO = \min_{\{w_i\}_{i=1}^{n}} \sigma_p^2 \;\; subject\ to \;\; E\left[\tilde{r}_p\right] = \mu_p$$

$$Sharpe\ Ratio\ Optimization = \frac{E[\tilde{r}_{Max}] - r_f}{\sigma_{Min}}$$

MVO and Sharpe ratio, to be noted, have major flaws that stem from their underlying assumptions. To begin with, taking the **mean variance does not correctly quantify investment risk**. If the variables that impact the price of an asset change, the item's variation may alter permanently, nullifying prior variance. The sample size is another issue with utilizing the mean variance. When the sample size for an asset is changed, the mean variance might change dramatically. Second, **MVO assumes that investment returns are normally distributed, making the model incredibly sensitive to assets with non-normal return distributions, such as cryptocurrency**, which could result in the asset being completely removed or nearly 100% of the portfolio being allocated to cryptocurrency.

To combat some of the flaws of MVO and Sharpe ratio I will be using Sortino ratio and Calmar ratio.

Sortino ratio removes the punishment of positive return volatility. Sharpe ratio divides by the total standard deviation of the portfolio. For example, an asset that only rises 40% is ideal, but it will have a low Sharpe ratio and will most likely be eliminated from a portfolio due to its high upward volatility. Positive returns do not constitute risk for an investor. The Sortino ratio, unlike the Sharpe ratio, solely measures downside volatility. That same asset will have an incredibly high Sortino ratio and will have a higher allocation within the portfolio for it. The formula for optimizing a portfolio using the Sortino ratio is as follows.

$$Sortino\ ratio\ optimization = \frac{E[\tilde{r}_{Max}] \;-\; t}{\sum\left(\left(\sqrt{\frac{\sum(R_i - \bar{R})^2 \;\; where\ R_i < T}{n}}\right)_n * w_n\right)_{Min}}$$

The **Calmar Ratio** (drawdown risk) is similar to the Sharpe and Sortino ratios, only it uses maximum drawdown as a risk indicator instead of volatility. It calculates performance as a percentage of the greatest decrease a portfolio or asset has seen over the course of its sample size, or performance as a ratio to the absolute worst risk possible.

High volatility assets may have large maximum drawdowns, however by combining uncorrelated assets and optimizing the Calmar ratio, one may construct a portfolio that obtains high volatility returns while avoiding high volatility drawdowns, resulting in a "free lunch" portfolio.

$$Calmar\ ratio\ optimization = \frac{E[\tilde{r}_{Max}] \ - \ t}{\max\limits_{\tau \in (0,T)} \left(\min\limits_{t \in (0,\tau)} (P(t) - P(\tau)) \right)}$$

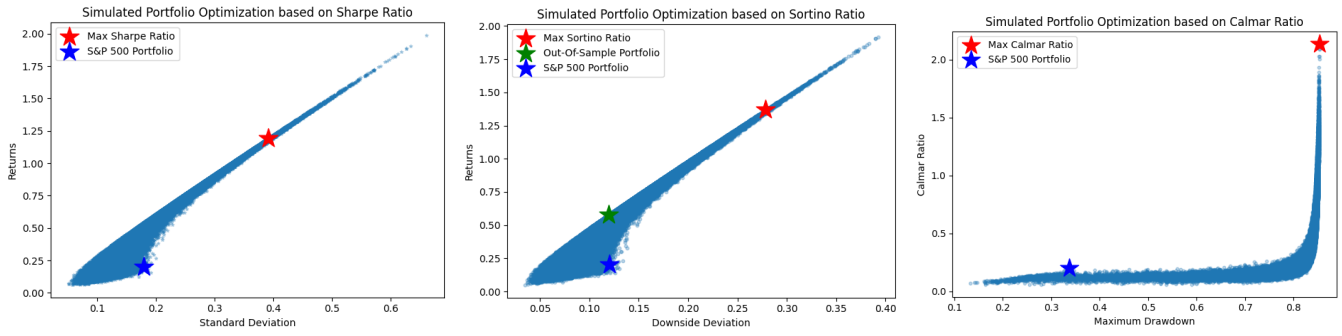
Optimizing the Crypto Portfolio

The portfolio or fund's purpose and risk exposure are undoubtedly the two most important variables for any IPS (investment policy statement). Each investor, client, or firm may place different values on each aspect of an IPS, and each should have a portfolio tailored to their risk tolerances and objectives.

I will be creating four different optimized portfolios. I'll optimize three separate portfolios utilizing three different strategies for comparison. I'll also simulate an out-of-sample portfolio meant to maximize the Sortino Ratio with a maximum downside deviation no greater than that of the S&P 500. This portfolio will be tracked over 1 year and I will release the results at that time.

To keep things simple, I'll utilize the assets in **Exhibit 4**. For investment experts and sophisticated investors, I would recommend a more in-depth research of each asset class, not just cryptocurrency. While adding illiquid assets to a portfolio has been found to increase diversification (Staff, 2021), I will be using liquid benchmarks for the purpose of simplicity, which are unfortunately more connected to the stock market as a consequence. Which explains why IYR (Real Estate) is so closely linked to the S&P 500.

Exhibit 6: Portfolio Simulations
2016 – 2021



Source: Yahoo Finance and Royalton-CRIX, computed in Python. Link to GitHub.

Each simulation summarized in **Exhibit 6** is created based on daily returns from 2016 to end of 2021. By giving each asset different allocations you can derive at different portfolios. My python program runs over 250,000 portfolios in each simulation to find the most optimal portfolio given each of the parameters listed above.

Exhibit 7: Optimized Portfolio Metrics

2016 – 2021

	Returns	Standard Deviation	Downside Deviation	Maximum Drawdown	Sharpe Ratio	Sortino Ratio	Calmar Ratio
S&P 500	0.2020	0.1786	0.1201	0.3372	1.0753	1.5991	0.5696
Max Sharpe	1.1957	0.3914	0.2443	0.8490	3.0292	4.8545	1.3967
Max Sortino	1.3689	0.4507	0.2785	0.8508	3.0149	4.8788	1.5973
Max Calmar	2.1352	0.7119	0.4376	0.8531	2.9853	4.8566	2.4911
Out-of-Sample	0.5802	0.1926	0.1201	0.8468	2.9602	4.7479	0.6733

Source: Yahoo Finance and Royalton-CRIX, computed in Python. Link to GitHub.

Exhibit 7 shows how combining these distinct asset types increases the utility of a portfolio. It's worth noting that these portfolios rely significantly on past assumptions, and their performance can't be relied on to predict future results. The three optimized portfolios are merely to test the utility of each asset class.

With the exception of real estate, every asset type had allocations of more than 5%. As previously stated, REITs are heavily tied to the Stock Market, hence the greatest method to maximize portfolio utility with Real Estate is through illiquid private equity ownership.

To be clear, the "Out-of-Sample" portfolio was designed to equal the S&P 500's downside volatility and it achieved that while also increasing yearly average gains by 187 percent. The target portfolio's allocation is shown below.

Exhibit 8: Allocation of Asset Class in Out-of-Sample Portfolio

	CRIX	SPY	IYR	GLD	BND
Out-of-Sample	0.2288	0.1555	0.0028	0.1366	0.4763

Source: Yahoo Finance and Royalton-CRIX, computed in Python. Link to GitHub.

However, it's worth noting that portfolio optimization is primarily reliant on past data. Any portfolio based exclusively on historical data necessitates such a far-fetched assumption that previous values will continue in the future, which is typically disastrous for a portfolio. Bonds, for example, are significantly weighted in the desired portfolio due to their recent performance. With inflationary pressures and rising interest rates, it's quite improbable that bonds will continue their bull run. I'll swap the allocation between Bonds and Real Estate in the "Out-of-Sample" portfolio since I believe Real Estate will profit tremendously from the same issues that would impair Bonds.

Concluding Thoughts

This study established that cryptocurrency may be viewed as a new asset class and that the asset class as a whole has can drastically increase portfolio. Crypto's historical performance since its inception has been phenomenal. However, it is unreasonable to expect cryptocurrencies to continue their meteoric climb.

Cryptocurrencies, in my opinion, have a place in most portfolios; nevertheless, the danger resides in selecting which cryptocurrencies to invest in. Selecting a cryptocurrency necessitates a level of understanding in the industry that the average investor does not have the time or background knowledge to obtain, and there is currently a lot of misinformation in this market. An index like CRIX, which was utilized in this study, might help to minimize the asymmetry of information and open this new asset class to the larger public.

Thank you for taking the time to read this paper. If you missed Part 1 you can find it here: https://www.linkedin.com/feed/update/urn:li:activity:6884484890881073152

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