Which asset classes are an effective and reliable way to hedge against inflation?

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ABSTRACT,

Inflation is one of the main challenges businesses and individual face in the current economic environment. With inflation rates continuing to increase, the purchasing power of investors declines. The main objective of this research is to investigate whether asset classes like gold, indices and cryptocurrencies are effective and reliable when it comes to their inflation hedging properties. Using quantitative methods like the Fisher (1930) methodology, Pearson's correlation and linear regression combined with fundamental analysis, the inflation hedging capabilities of cryptocurrencies, gold and the S&P500 index are analyzed versus the inflation rates of USA and the countries within the EU. The results show that cryptocurrencies are too unreliable to be considered an inflation hedge and S&P500 is the overall best performer.

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Inflation, Cryptocurrencies, Bitcoin, Gold, S&P500, Fundamental analysis, Correlation, Regression

1. SITUATION AND ARGUMENTATION

Inflation is one of the most commonly used terms in economics. It proves to be one of the biggest problems society faces nowadays. Inflation occurs when there is a decline of purchasing power of a given currency over time. It is often called the "invisible tax" simply because it affects people's financial situation in a slow, indirect manner and it remains often unnoticed by ordinary people, at least before its effects on the economy start to get large.

With the current state of money printing by national banks worldwide combined with the large stimulus packages that some countries give (Spierdijk & Zakhum, Stocks, Bonds, T-bills, and Inflation Hedging, 2015) yearly inflation rates are continuing to go up, causing cash to lose its value over time, so holding for an extended period of time would result in financial losses. Historically over the last 100 years money has gradually lost its value and the trend still doesn't look to change in long term perspective. An example for that would be the declining value of the current global reserve currency – the US Dollar. (Bhutada, 2021) Europe is also no exception when it comes to inflation. The annual inflation rate in February 2022 was 5.9 % (Eurostat, 2021), further deepening the crisis caused by Covid-19.

Figure 1 – "Purchasing power of the US dollar"

Overall, inflation is a complicated subject with various aspects. So in order to understand it, the subject is split into three important main aspects: cause, impact, and solution.

Inflation is caused by several factors, mainly increases in production costs (cost-push), fluctuations in supply and demand (demand-pull) (Investopedia, 2021) and monetary policies in different countries. The latter is especially relevant in the last few years, because of the policies of the central banks to print excessive amounts of money in order to delay potential recessions. This process along with increases in production costs leads to devaluation of a currency, therefore given that income doesn't increase at least the same percentage as inflation, the purchasing power of a person/business decreases. This could be very harmful to the economy, especially in a long term perspective.

Considering the economic problems that inflation causes, a suitable solution is needed. A common defense mechanism used by a lot of people is having a savings account, which gives a certain fixed percentage of return per year. However, with interest rates being close to 0 in most of the developed countries (or even negative), having a savings account no longer seems a viable option in the battle against inflation, so an alternative solution is needed. This alternative solution might come in the form of investment in different assets in hope that their value will increase with the same rate of inflation or more. But which assets are worth buying in and is investing a viable option? This paper will discuss just that, testing assets such as cryptocurrencies – namely Bitcoin, Ethereum and XRP, also gold and the US S&P500 stock index.

2. RESEARCH OBJECTIVE

The research objective of this paper is to properly understand inflation, where it comes from and why, and to find out whether investing in emerging assets could be an effective way to deal with it. An important goal is to present the subject of inflation in a concise, but informative and non-biased way. The main focus of the thesis will be to present cryptocurrencies, gold and indices as possible ways to battle inflation. Another goal of the paper is to discuss both qualitative (fundamental analysis) and quantitative (historical price data and past performance) aspects of these assets in order to know not only their past effectiveness, but to also bring some insights about their future potential in the economic system we are in. This paper also aims to inform readers about inflation, and possibly provide some new knowledge and insight about inflation. Some information about the potential role of cryptocurrencies will also be provided as a way to combat this global issue, as this aspect of crypto is rarely discussed in the academic field.

Another goal of the research is to also address how the findings may be useful in practice. It is relevant to the current economic situation, because menu prices are going up and common utilities like gas and electricity are going up, while wages are mostly stagnant. A lot of people see these changes and feel the effect that they have on their wallet. For this reason, both ordinary people and business entities who want to hedge their investments could have an interest in inflation related research. Furthermore the information about the assets that is discussed could be beneficial for some investors.

This thesis also aims to contribute academically to the subject of inflation. The existing academic literature such as Bampinas & Panagiotidis (2015) is mostly focused on assets like gold and silver as a way to combat inflation. My thesis will test these gold as an inflation hedge asset, but also includes other asset classes such as indices and cryptocurrencies. The latter is a new asset class with a lot of potential but also with a lot of uncertainty around it, so for these reasons there is not much academic literature that tries to explore its possibilities as an inflation hedge. This is where this paper aims to build on the existing inflation literature and possibly provide some new insights and findings.

3. RESEARCH QUESTIONS

Because the common measures' effectiveness against inflation is either inconsistent or not big enough in the present days, an alternative solution has to be found. The alternative that this paper wants to discuss are emerging assets. Businesses and individuals can invest in various assets like stocks/indices, cryptocurrencies and gold. As previously explained the goal of this paper is to assess whether these assets can be an effective hedge against inflation over time and by what extent. So the main research question that will be addressed is: **Are emerging assets an effective and reliable hedge against inflation?**

To be "effective" against inflation means that an asset's return are higher overall higher than the inflation rate of the research period and it has a statistically significant correlation with the inflation rates subject to this research. To be "reliable" means that the asset can preserve capital and avoid monetary losses. Assets which have high volatility (40% daily/monthly + returns with low correlation with inflation rates for the same period) are not very reliable when it comes just to inflation hedging due to their unpredictability.

Other important aspects will be discussed in various research subquestions:

- What exactly is inflation and what are its causes and consequences from it?
- Which of the assets that are subject to this research have the potential to be a hedge against inflation?
- How reliable are cryptocurrencies as an asset class overall?

4. RESEARCH DESIGN AND METHODOLOGY

In this section the overall research methodology is explained, and how the research will be conducted. My research design is broken down into the following steps:

1) Locating and defining issues/problems.

2) Designing the research project:
   - Historical data about inflation development and discussion of future implications
   - Selection of emerging assets.

3) Collecting data – retrieving data from research and business articles, historical price data of inflation and the asset being subject to research

4) Interpreting and analyzing data – Quantitative and fundamental analysis

5) Reporting results and findings - Evaluation of the assets, are they an effective way to hedge inflation? If yes, why, by what extent, and which ones?

Figure 2 – Steps of performing the research

During the first step, the subject of inflation would be researched. This includes general understanding of the inflation, understanding what it really is, what its impact on economics and society is and are there possible solutions to the problem.

In the second step of the research is where the overall structure and design of the research is made. It is important to select relevant assets, which at least have the potential to be a good way to hedge inflation compared to existing methods like opening a savings account or investing in government bonds. The three main asset classes that are subject to research are cryptocurrencies, precious metals and stock indices. To represent cryptocurrencies, three of the most popular coins – Bitcoin, Ethereum and XRP have been selected. For the precious metals asset class gold was selected, because is one of the most valuable commodities and is often used by businesses and even countries as a way to hedge against inflation. And finally, to represent indices, the S&P500 index has been selected, because of its popularity and inclusion of big US companies.

In the third step, the collection of the data needed for the research will be conducted. This consists mainly of numerical data about historic prices gathered from websites like Fred database and Coingecko. Quantitative data about inflation rates will be gathered from Organisation for Economic Co-operation and Development (OECD). There is also qualitative data about both inflation and the assets that are subject to research. This data gives insights about the intrinsic value of the assets, what they are and why they are valuable. It will be gathered from various scientific and non-scientific articles about inflation, gold cryptocurrencies, white papers, etc.

The fourth step of this research will be to conduct the actual analysis of the data that has been collected. In order to do this, this paper will utilize the Fisher hypothesis, Pearson's correlation and linear regression as a way to measure an asset's returns against the inflation rate for a given period to see whether or not it has a positive correlation with inflation rates. The inflation rates that will be taken into account are the average inflation rates in Europe and in the USA (more relevant for S&P 500 index). Tables with returns and nominal interest rate of gold, S&P500, Bitcoin, Ethereum and XRP over relevant periods will be made in order to see which asset performed best. But we cannot only rely on past data, so in order to provide some information about the intrinsic value of these assets and what will be their potential in the future fundamental analysis is also conducted. This is be done by assessing what the asset brings to investors in terms of utility, usability and potential financial returns and also assessing the role that the asset plays for society in order to be valued in the current

economic system. Degree of uniqueness of the assets will also be noted in the fundamental analysis, as well as different factors that influence the return rates like cyclical forces, current state of the economy, new laws and regulations, pandemics and national disasters and of course price entry point.

The fifth and final step of the research is to report the data, make conclusions about the analysis and answer the research question "Which asset classes are an effective and reliable way to hedge against inflation?" The report of the quantitative and financial data are done via Excel. The report of the fundamental analysis will be in the form of a short text about each asset, discussing the main points mentioned in step 4. Based on this data a conclusion about each asset will be made in terms of its effectiveness against inflation and their potential to be one in the future.

5. DATA

In this section of the paper it will be discussed how the data for this thesis was collected, sampled, validated and analyzed. The data that would be considered mainly consists of quantitative aspects of inflation such as yearly inflation rates in the European Union and USA. The reason for this selection is that both the USA and the EU have very large GDP and the US dollar and the euro are the most used currencies around the world. Furthermore the US dollar is still the world reserve currency to this date. The reasons behind these numbers (which are not always expressed in numbers) would also be investigated. Data about inflation rates measured by CPI (Customer price index) is gathered from the Organisation for Economic Co-operation and Development (OECD, 2022). It contains yearly inflation rates that are compounded every month (e.g. January 2021-January 2022) in the range of 2013 to 2022, since that will be the main period of investigation.

Furthermore the historical price data about different asset classes for the same timeframe (excluding the cryptocurrencies, because some of them didn't exist at this time yet) will be used in order to assess their potential to be a hedge against inflation. Using sampling, particular assets are selected to represent an asset class. For cryptocurrencies, these are Bitcoin, Ethereum and XRP – three of the most popular cryptocurrencies. These were my selections, because they are one of the coins with the largest market cap (1st, 2nd and 5th respectively at the time of writing[1]) and the legitimacy behind their technology and/or team is high compared to most other crypto projects. Furthermore they are all different types of cryptocurrencies. Bitcoin is the biggest one, originally designed to replace the current financial system, but now most often used as a store of value. Ethereum on the other hand aims to create a whole architecture network utilizing its blockchain and smart contract capabilities, and XRP is typically used by the banks as a bridge asset between fiats currencies and it represents the "green" cryptocurrencies designed for payments. The historical price data about cryptocurrencies contains daily and monthly returns percentages and is retrieved from Coingecko.com. The data period will begin from April 2013 for Bitcoin, September 2016 for Ethereum and April 2017 for XRP. The reason behind this is the fact that these cryptocurrencies were created in different years and including the periods of very early stage development where these currencies were unknown for 99.99% of the investors would be unrealistic. So the historical price data was sampled to start from the day the currencies hit a minimum market cap of 1 billion USD in order to keep the data bias free and to keep it relevant. The data period ends at May 2022.

To represent precious metals, gold is selected, because of its importance for the economy and the fact that it is generally regarded as a way to hedge inflation. And for indices, the S&P500 is selected. This index tracks the performance of 500 large companies listed on stock exchanges in the United States. The reason for this selection is that it is one of the most followed indices and represents the performance of some of the biggest companies not only in the US, but in the whole world. The historical price data for both assets starts from January 2013 and ends in May 2022.

The historical price data about this assets includes daily as well as monthly return percentages. The numbers will be expressed in US dollars.

However, some qualitative data is also included and used for the fundamental analysis of the assets in order to assess their intrinsic value and give some foresight for their future and their potential to be a hedge against inflation. This data will be collected from various sources. For cryptocurrencies this would be Bitcoin, Ethereum and XRP white papers, official sites and blog posts from the teams behind the cryptocurrencies (only relevant for Ethereum and XRP). The white papers provide essential information about the intrinsic value of a cryptocurrency as well as explaining how exactly it works. Other qualitative data such as external economic factors like ongoing pandemics, national disasters, new business regulations, tax laws, political factors, and others are also taken into account in the fundamental analysis.

6. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

6.1 Inflation

Various theories are used for the creation of the paper. An important piece of literature that is relevant for my thesis are the demand pull, cost push and built-in theories of inflation (Fernando, 2022). This theory is very relevant for the first part of the thesis, especially for understanding inflation and its initial causes. As Fernando discusses in his article, cost-push inflation is when product/services prices rise, because of an increase in the price of raw materials or means of production. Demand-pull inflation on the other hand is when the demand for a product or service exceeds its supply, so these products/services become scarcer and producers increase their prices (for example increase

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[1] Coingecko - Cryptocurrency ranking by market cap
https://www.coingecko.com/

in gas prices after the war in Ukraine). And lastly we have the built-in inflation, where wages rise in order to keep up with the rise of price, so the living standard is maintained. This literature won't be used in the analysis of the assets, but it is important for general understanding of the topic and the driving forces related to it.

6.2 Regression model & Fisher effect

The second and most important theory for this paper is a regression model for inflation based on the Fisher hypothesis (Fisher, 1930), which is a tool to assess the real interest/return rate of assets when inflation rates are taken into account. Usually when there is a high percentage of inflation, asset prices and wages increase, but so do products and services. That gives people a false sense of improvement regarding their financial situation. Both papers of Fama & Schwert (1977) and Guletkin (1983) use a regression model in order to take inflation into account and see if a return of an asset is correlated and caused by inflation. While both papers use a two-part model which includes both expected and unexpected inflation, due to the small scale of the research and the limited public data that can be retrieved combined with the fact that we rely on past data, a simple regression model is used in order to avoid biases when conducting the research. The formula below is used in the paper in order to see whether or not inflation is a predictor for the returns of these assets and therefore quantify their performance as an inflation defense mechanism.

$$r_{it} = \alpha_i + \beta\pi_{it} + \varepsilon_{it},$$

Where:
r_{it} – Nominal return of asset **i** for time period **t**
π_t – Inflation rate in period t
α_i – Constant/Intercept
β – Slope
ε – Error term

The nominal interest rate will represent the return rate of an asset over a given period of time and inflation rate represents the inflation % over the same period of time. Based on this model, we make null and alternative hypothesis:

H_0: $\beta\,(\pi_{it}) = 0$
H_A: $\beta\,(\pi_{it}) \neq 0$

6.3 Pearson's correlation

Pearson's correlation coefficient (noted with r) is also used for the making of this paper. It gives information about the degree of correlation of the returns of asset i in a timeframe t with the rate of inflation in the same timeframe. Relevant formulas are:

r = Correlation [π_t; R_{it}]

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\,n\Sigma x^2 - (\Sigma x)^2\,][\,n\Sigma y^2 - (\Sigma y)^2\,]}}$$

Where:

- r is correlation (-1 ;1)
- x/ π is inflation
- R/y is asset return percentage

6.4 Fundamental analysis

The theory that will support the Fisher hypothesis by providing some insights about the assets, mainly in the form of qualitative data, is the fundamental analysis. In his book Thomsett gives some fundamental analysis research methods, especially for stocks, such as finding relevant information about a stock/index online, the importance of P/E (price to earnings ratio), but most importantly about indicators that go beyond statements and reports – market sectors, cyclical forces, current economic situation, factual analysis and importance of price entry points. These indicators can be applied to all the assets that are subject to research, and will be used for conducting the fundamental analysis. Furthermore, the Liu and Zhang article provides information about the valuation of cryptocurrencies specifically, discussing aspects like price/utility ratio and the roles of cryptocurrencies as a medium of exchange and store of value.

6.5 Asset specific literature

Last but not least, specific literature about every asset class is included in the thesis, used and taken into account. For cryptocurrencies such literature is the paper of Choi and Shin "Bitcoin: An inflation hedge but not a safe haven", where it is discussed the increasing attractiveness of the currency as an inflation hedge and store of value, but it is also noted that the volatility of Bitcoin as well as its reaction to different types of crises is very big compared to other asset classes. Furthermore the white paper of Bitcoin (Nakamoto, 2009) also explains the fundamentals behind blockchain technology and what it brings to the table for society in the form of alternative and decentralized finance and store of value.

There are also numerous articles focused on both gold and inflation. Most researchers agree that gold is the "safe haven" when it comes to inflation hedging and Panagiotidis and Bampinas also support that statement. Gold is usually always in demand, no matter if the market finds itself in a boom or in a recession. Furthermore during times of crisis, most investors tend to stay away from stocks and indices and turn their attention into commodities such as gold and silver that have intrinsic value no matter the circumstances. But on the other hand, the article of Harris and Shen "The intrinsic value of gold: An exchange rate-free price index" argues that gold intrinsic value is to a certain degree dependent on the dollar, because its price is quoted in USD, therefore changes in USD price will reflect the global price

of gold. It is important to see all perspectives and keep in mind all potential risks with no bias when conducting the analysis.

And for the S&P500 index we take a look at the Kim and Ryo article from 2011 "Common stocks as a hedge against inflation: Evidence from century-long US data", which concludes that strong evidence that US common stocks have been a long-run hedge against inflation from 1950. This article discussed the S&P500 in particular, so this research will try to find out whether or not this is still the case and assess the future potential of S&P500 taking into account quantitative research data along with fundamental factors such as changes in the economic environment like Covid-19, excessive money printing by the Federal Reserve System, new laws, etc.

7. RESULTS AND FINDINGS

After discussing the methodology, data sampling methods and literature review, it is time to present the analysis and its results and findings. For the sake of simplicity, there are some abbreviations used in the tables presented – BTC stand for Bitcoin, and ETH stands for Ethereum.

7.1 Quantitative analysis

Firstly, the quantitative analysis is conducted using past historical data about both inflation and the 5 assets that are subject to the research.
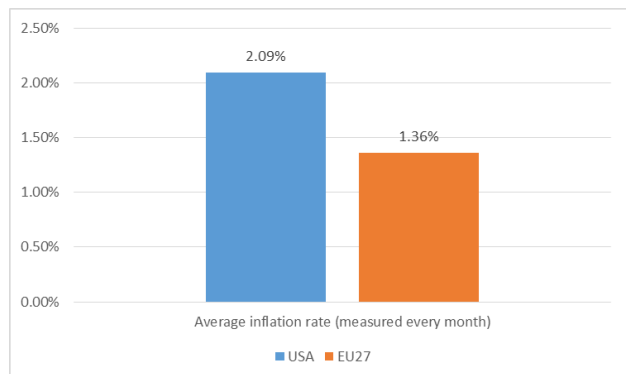
Figure 3 – Average inflation rates.

On Figure 3 we can see a comparison between the USA and the European Union regarding inflation rates in the period between 2013 and 2022. The graph shows that the average inflation in the USA is over 1.5 times bigger compared to the European Union. This significant difference is mainly due to different monetary policies of the respective central banks. While both the FED and the ECB (European Central bank) printed money in order to combat crisis, especially during the Covid-19 pandemic, the FED has been more aggressive with its anti-crisis policies. Furthermore an overall increase in the disposable income which is the amount individuals have left to spend or save after paying taxes and receiving government transfer payments, is also a contributing factor to inflation rate. (Federal reserve bank of San Francisco, 2022)
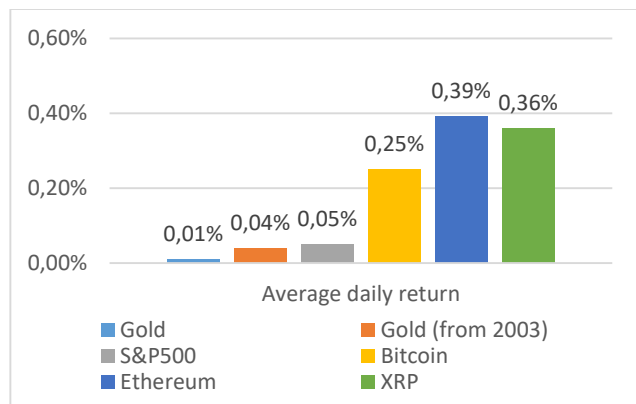
Figure 4 – Average daily return %

The second chart presents the average daily return percentages of the 5 assets during their specified historical data sample periods (see data). The 3 cryptocurrencies produced by far the biggest average daily return, with Ethereum being the highest with an average of 0.39%. The reason behind these big numbers are the favorable run that the crypto market had in both 2017 and 2021, producing record highs and getting the attention of more investors leading to higher amount of adoption. However these average return rates can also be somewhat misleading, because a lot of the price rises in crypto market not only are very big (+30% to 150% in a day), but also happen very quickly in a short period of time. Furthermore the majority of investors tend to buy when the prices are high, because this is the time when they learn about the asset's existence and potential intrinsic value because of publicity. This potential volatility makes the purchase price as well as time in the market in which the investor finds vital for the overall return on investment.

Looking at the S&P500 index, it has a decent average daily return rate of 0.05% and gold has the lowest amount with 0.01%. However the gold data is from 2013 to 2022, in which period the world economy experienced a significant increase and relative stability (excluding 2020 Covid-19 crisis). So to test whether gold thrives during recessions a new data set with average daily returns between 2003 and 2022 was also included, and it shows that average daily return of 0.04%, which is around 4 times higher. This suggests that gold not only saves its value during market crashes, but its value also increases during such times.
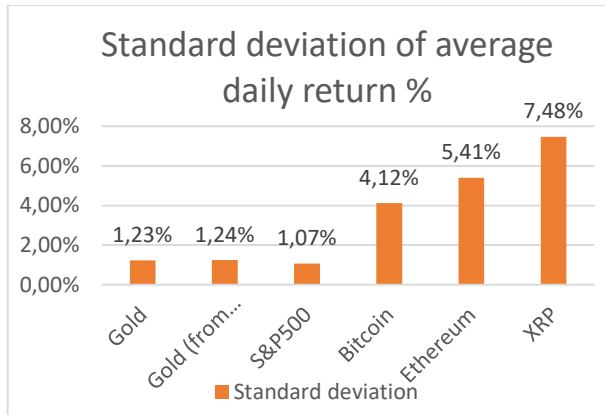
Figure 5 – Standard deviation of average daily return %

On figure 5 the standard deviation of the average daily return percentage is presented in order to show the degree of variability of the returns of each asset. It can be seen that the 3 cryptocurrencies are by far the more volatile assets. Both gold and S&P500 showed much lower levels of price volatility making them more stable and reliable when it comes to holding capital and retaining value despite their lower return rates compared to the cryptocurrencies. On the other side of the spectrum, XRP is the most volatile asset, with 7.48% standard deviation of daily returns, best daily return of 141.40 % and worst daily return rate of – 59.88%. This unusually seen level of volatility makes the cryptocurrency somewhat unattractive to investors whose main goal is to preserve capital and avoid risk rather than to make big return percentages. Bitcoin is the most stable of the 3 cryptocurrencies with 4.12% standard deviation, so it can be perceived as a more "safe" option, but despite that its daily return variability level is still a lot higher compared to gold and the S&P500 index.

	USA	EU
USA	1.000	
EU	0.926	1.000
Gold	0.017	-0.004
S&P500	0.427	0.285
BTC	0.133	0.037
XRP	0.274	0.100
ETH	-0.056	-0.093

Figure 6 – Correlation heatmap

Dependent/independent variable	USA	EU
Gold	0.195	0.965
S&P500	0.000	0.002
BTC	0.195	0.720
XRP	0.057	0.496
ETH	0.680	0.490

Figure 7 – Table with P-values of the Beta

US			EU		
Asset	Constant	Slope	Asset	Constant	Slope
Gold	1.66%	0.13	Gold	1.99%	-0.04
S&P500	8.25%	2.65	S&P500	10.91%	2.11
BTC	143.30%	19.58	BTC	177.06%	6.47
XRP	139.05%	27.54	XRP	70.85%	12.13
ETH	1037.33%	-54.25	ETH	1106.82%	-110.21

Figure 8 – the constant (α) and the slope coefficient (β) of the regression of the assets against both US and EU inflation

Figures 6, 7 and 8 give information about the relationship between inflation rates and asset returns. Figure 6 is a correlation heatmap table, which presents the Pearson's coefficient, which shows the degree of correlation between inflation rates and asset returns. It can be seen that all asset returns are more correlated to US inflation rates compared to EU inflation. S&P500 is by far the best performer when it comes to being tied to inflation with 0.43 and 0.28 correlation values, followed by XRP with 0.27 and 0.1 respectively. The other assets show weak or no/negative correlation.

Looking at figure 7 we can see the P-values of the slope (beta), which show whether or not there is a statistically significant relationship between independent (inflation rate) and dependent (asset return rate) variable. With the significance level being at P-value = 0.05, the only asset whose returns have statistically significant relationship with both EU and US inflation rates. With all other asset, we can't reject the null hypothesis, especially in the case when EU inflation rate is the predictor.

Figure 8 is a table which presents the constant value and the slope coefficient of the regression of the five assets against US and EU inflation rates. It can be seen that cryptocurrencies have much larger constant values, because of their higher returns. In case of Ethereum, this is even more extreme due to it having multiple yearly returns over 1000%, with one of them being around +10 000%

On figures 9, 10 and 11 we can see dot diagram describing the relationship between US inflation rate and gold, S&P500 index and Bitcoin respectively. These diagrams complement the fact that the S&P500 has much stronger positive relationship with US inflation compared to gold and Bitcoin.
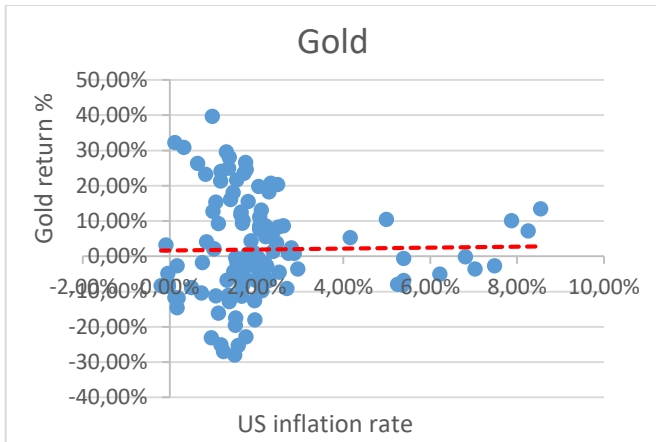
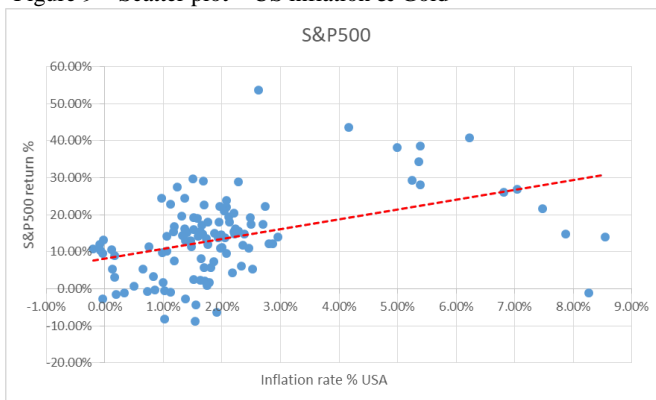Figure 9 – Scatter plot – US inflation & Gold
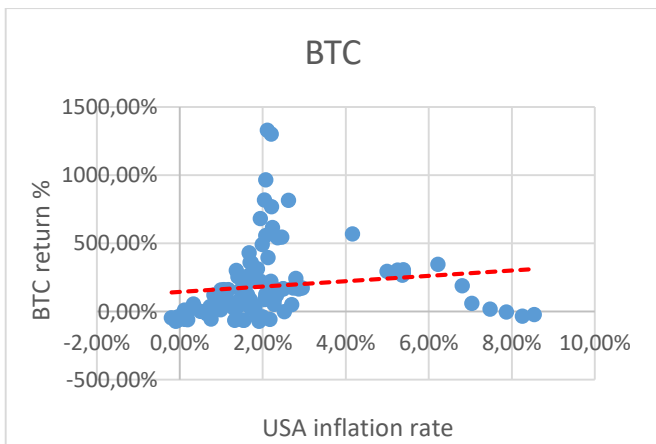

Figure 10 – Scatter plot – US inflation & S&P500

Figure 11 – Scatter plot – US inflation & BTC

Overall, we accept the null hypothesis for all assets, except S&P500. Despite not having as high returns compared to the three cryptocurrencies, the S&P500 index returns have fairly good correlation with the inflation rates of both the United States and the European Union. Combined with its moderately good returns and relatively low level of volatility it's clearly the best performer in the quantitative analysis. Gold, however, did not perform as good in this timeframe, offering the lowest returns on average and little to no correlation at all. And finally, the 3 cryptocurrencies

showed high returns, exceeding inflation rates and generating the highest real returns among the assets that are subject to this research. However, their subpar correlation levels (especially Ethereum), high volatility, combined with their low level of maturity as an asset class and the low sample of the data makes them somewhat unreliable as an inflation hedge.

7.2 Fundamental analysis

This section will discuss the important non-quantitative characteristics of these assets and provide some future insights based on both quantitative and qualitative data using fundamental analysis. It is important to rely not only on pure number, but also on qualitative data that explains the reasons behind those numbers, in order to understand the inflation hedging abilities of the assets better. This form of analysis is based on external events and influences, as well as financial statements and industry trends. Because we have three completely different asset classes, the fundamental analysis will discuss different (only relevant for this specific asset) aspects for each asset class.

7.2.1 Gold

Gold has historically been very important for the economy throughout history (O'Connor, Lucey, Batten, & Baur, 2015). One of its most important uses nowadays is its use in electronics - connectors, switch and relay contacts, semiconductors. It is a highly efficient conductor of electricity which can carry tiny currents and remain corrosion-free, which makes it stand out from other metals. It is also used by for making replacement teeth and to manufacture jewelry. Furthermore Gold has historically been used as a currency or mean to make coins.

However, some analysts argue that gold by itself possesses no intrinsic value, and does not hold the monetary power it held decades and centuries ago. This way of thinking implies that in a modern economic environment, fiat currency is the money of choice and that the primary use of gold is as a material to make jewelry, which does not provide intrinsic value to society. Furthermore the price of gold is quoted in USD (Harris & Shen, 2017), despite not being an US exclusive asset, so if the price of the dollar moves, the price of gold is affected accordingly.

So does gold have an intrinsic value and what is its role when it comes to inflation? Firstly, gold possesses some intrinsic value simply because it is a physical asset which can directly be used in manufacturing of different goods. Despite it losing its role as a currency and medium of exchange, the new technological era has opened new niches for the use of gold in the form of electronics. The efficiency and the uniqueness of gold, unmatched by other precious metals, combined with and the stable, but limited supply solidifies its role as a raw material for semiconductors, which are an essential part of computers.

When it comes to inflation, gold is usually referred to "safe haven", because of its relative stability in both economic boom and recession. Its main role is to preserve capital and avoid losses, but it also can at least fully hedge headline, expected and core CPI in the long-run (Bampinas & Panagiotidis, 2015).

7.2.2 S&P500

The S&P 500 index serves as a way to measure the movement of the U.S. equity market. It is an index, which tracks the price movements of 500 leading US companies, capturing the activity of approximately 80% of the market capitalization of all US stocks[2]. The fact that this index is tied specifically to US economy, means that the economic environment in the country is one of the main things to consider when conducting fundamental analysis. So having a good economic environment with stable supply chain facilitates economic development and growth within the country in various sectors. Another important factor are laws and regulation by the government and the SEC (Securities and Exchange Commission). Companies, including those listed in S&P500, should comply with regulations from various governments in countries they operate in, meaning that any new law adopted by a country could change the way these companies operate. Furthermore these companies are greatly affected by various types of crises such as the Covid-19 crisis during 2020, which greatly affected supply chain networks around the world and made the overall work process more complicated resulting in greater losses for most companies. The price of S&P500 decreased by around 30% in less than a month in the period between February and March 2020.

However, during times of relative economic stability such as the period between 2009 and 2019, where the operation processes of companies are efficient and not as hindered by force majeure circumstances, they almost always thrive, which increases their stock prices and consequently drives the price of S&P500 higher. Furthermore, because of the inflationary nature of the current financial system, there is constant money printing by various central authorities, which result in more money in circulation, creating built-in inflation (Investopedia, 2021) and increasing the raw number of economic returns, wages, prices of goods, as well as stocks, which also results in increase of the S&P500 index.

7.2.3 Cryptocurrencies

Cryptocurrencies are virtual currencies that are secured by cryptography, which makes it almost impossible to counterfeit or double-spend. Most cryptocurrencies are decentralized networks based on blockchain or DLT (distributed ledger technology) enforced by a decentralized network of computers. A defining feature of cryptocurrencies who use DLT is that they are not issued by any central authority, which makes them theoretically immune to government or third party interference. Furthermore with cryptocurrencies there are no intermediary parties who handle deposits and transactions unlike banks. This by itself gives them advantage when compared to fiat currencies

Bitcoin is a decentralized digital currency that can be transferred on the peer-to-peer Bitcoin network. Bitcoin transactions are verified by network nodes through cryptography and recorded in a public distributed ledger called a blockchain (Nakamoto, 2009). It is the first cryptocurrency and the origin of distributed ledger technology, originally made as an alternative to the current

financial system, which mainly relies on banks. Having the first mover advantage, combined with the fact that it is 100 % independent from traditional finance, make it very attractive for people who want to invest or just to use the blockchain technology. Some analysts claim that its best use is as store of value and inflation hedge. These claims were confirmed by some research papers (Blau, Griffith, & Whitby, 2021), however, the different quantitative researches contradict a lot – some say that Bitcoin is an inflation hedge, others dismiss these properties. This is likely due to the low amount data of Bitcoin vs inflation available, the volatile returns and different scopes of research.

The other important cryptocurrencies are Ethereum and XRP. Ethereum is a decentralized, open-source blockchain with smart contract functionality (Buterin, 2014). Despite being created by the Vitalik Buterin and the Ethereum Foundation, the cryptocurrency is still decentralized and independent from third parties, meaning that the cryptocurrency can continue to operate even without the Ethereum Foundation. Its main utility is to create a blockchain architecture network with smart contract capabilities and enabling the creation of decentralized apps through its own program language. However, its high gas fees (transaction costs) make it unattractive to a lot of retail investors. XRP on the other hand is a cryptocurrency designed for payments, and to be a bridge between different currencies. It has much lower transaction costs, and transaction time than both Ethereum and Bitcoin, which makes it very efficient for international payments. Currently it is mainly used by banks as an intermediary between different currencies, so there is some institutional adoption. Both of these assets are considered to have a superior technology than Bitcoin, and some analysts label them as "Bitcoin killers". There is more upside potential for them, because of their lower market cap, but they are also still not as decentralized and trustworthy as Bitcoin. Furthermore issuers of both Ethereum and XRP have been sued by the Security and Exchange Commission (SEC), with Ripple, the company that originally created XRP still being sued[3].

Overall, all three cryptocurrencies have a clear purpose and things they exceed at, with Bitcoin being the first-mover having the highest level of decentralization and trust among investors. On the other hand XRP and Ethereum offer superior technology and more energy efficient operation, but have higher level of uncertainty, because of regulation.

8. LIMITATIONS AND FURTHER RESEARCH

This research also has some limitations. The main one is the data – the timeframe is restricted, because cryptocurrencies are very new asset class. For that reason its returns are very volatile. Despite using sampling in order to avoid bias and therefore excluding the early stages of the cryptocurrencies where very people were able to invest, the returns of the cryptocurrencies are still all over the place. Further sampling was not done, because it would reduce the sample size too much, excluding a lot of years,

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[2] S&P500 https://www.spglobal.com/spdji/en/indices/equity/sp-500/#overview

[3] https://www.sec.gov/news/press-release/2020-338

therefore making comparisons with gold and S&P500 less relevant.

Another problem resulting of this is the limitation of the statistical data. Inflation itself is a complicated subject with various aspects and a simple regression analysis could not provide a complete information to make a definitive conclusion whether an asset is in fact a good inflation hedge. Increases and decreases in prices can occur because of external factors (e.g. Covid-19), so this can influence the validity of the quantitative research. There are different types of inflation, and different assets have the ability to hedge different types of inflation.

A further research should take this into account and differentiate between different types of inflation (e.g. cost-push, demand pull and built-in inflation) and see what asset is best to hedge inflation during economic boom and what is best when there is a recession. For example gold is shown to have much higher returns when timeframes with primarily cost-push inflation are included, but performs poorly in the timeframe which is subject to this research (which mainly has inflation that is built-in).

Furthermore cryptocurrencies can be discussed in a more elaborate way and since there are so many different types of them, more can be included in a research. The Proof-of-stake[4] (or staking) technology should also be discussed as a mechanism to hedge inflation. Staking a cryptocurrency means that the owner delegates it to a validator in order to contribute to the consensus mechanism and receive some passive returns (usually between 2 and 12 %). Staking could be a safer and more reliable alternative to savings accounts, so further research is relevant when it comes to inflation.

9. CONCLUSION

To summarize, the quantitative analysis suggests that only S&P500 is both an effective and reliable hedge against inflation, particularly against US inflation. It is the only asset which showed statistically significant correlation with inflation rates and had moderately positive daily returns combined with relatively low degree of volatility. The other assets showed weak or not statistically significant levels of correlation with inflation rates, with P-values above the significance level of 0.05, which means that the null hypothesis is not rejected. The rates of return of the assets varied – cryptocurrencies had by far the biggest average daily returns. However, they were also the most volatile, which makes them very unpredictable and unreliable when it comes to inflation hedging and avoiding monetary losses. Gold performed rather poorly compared to the rest of the assets, producing low returns and had a statistically insignificant correlation with inflation rates, and contradicting Panagiotidis and Bampinas statement that it is "safe haven".

However, as already stated, quantitative research of cryptocurrencies is not very reliable, because of how new this asset class is (low sample size) combined with its extreme volatility compared to other investments. The fundamental analysis concludes that all of these assets have a potential to be an effective inflation hedge, nevertheless their effectiveness is dependent on external factors and the overall state of the market. Cryptocurrencies specifically may have an intrinsic value and niche in world economics, but presently the current data is not reliable enough to support this statement when it comes to inflation hedging.

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