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Bitcoin: Safe haven, hedge or diversifier? Perception of bitcoin in the context of a country's economic situation — A stochastic volatility approach

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HIGHLIGHTS

- We study different properties of bitcoin depending on economic situation of the country and currency of trade.
- Venezuela, Japan, China, Sweden and Estonia are taken into account.
- We utilize multivariate stochastic volatility model with dynamic conditional correlation.
- Bitcoin was treated as a weak hedge in all markets when investment in US dollars is considered.
- Bitcoin was treated as safe haven in Venezuela and investment in bolivars.

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ABSTRACT

The aim of the article is to verify whether bitcoin can act as a hedge, diversifier or safe haven on various stock markets, depending on the economic situation in the countries. To diversify the sample, we include five very different countries in our study: Japan, Venezuela, China, Estonia, and Sweden. Using daily data over the period 2014–2017, we estimate the dynamic conditional correlation model between main stock indices and bitcoin price in local currencies (Bitflyer — in the case of the yen, Kraken — in the case of the euro, Huobi in the case of yuan and LocalBitcoins in all the remaining cases), as well as between main stock indices and the bitcoin price in the US dollar (Bitfinex exchange). We apply the Stochastic Volatility Model with the Dynamic Conditional Correlation. We add binary variables into the dynamic correlation equation, indicating the occurrence of extreme return on the stock-exchange index in the lower 1%, 5% and 10% quantile. The conclusions vary, depending whether we consider trade on the local bitcoin exchanges or in the global one. We conclude that bitcoin was treated as a safe haven asset only in the case of Venezuela and investments in bolivars. In the case of local investments in Japan and China bitcoin behaved as a diversifier. In the bitcoin-friendly economies of Sweden and Estonia it acted as a weak hedge. In the case of the USD trade, the results suggest that bitcoin is a weak hedge with respect to all of the analyzed markets.

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1. Introduction

Bitcoin is a special kind of assets called cryptocurrency. It was designed by Satoshi Nakamoto (allegedly a pseudonym of one person or a group of people) to work as a medium of exchange [1]. Contrary to "traditional" fiat currencies, bitcoin does not rely on any central authority, but uses cryptography to control its creation and management. Some business already began accepting bitcoins in addition to national currencies. However, the legal status of bitcoin varies substantially from country to country. For instance, Japan officially recognizes bitcoin and digital currencies as a means of payments. In Estonia, the use of bitcoins is not regulated or controlled by the government. In Venezuela, in 2016, the mining of bitcoin was declared illegal and in late 2017 the Government started to work on a comprehensive legal framework to tax and regulate cryptocurrency mining in the country (see: [2]). In 2018, together with launching of its own petrocurrency called Petro, Venezuela legalized cryptocurrency [3]. In China, cryptocurrency trade was banned in October 2017.

There are many opinions about the role that bitcoin plays in the economy. It is viewed as an alternative to fiat currencies or even as part of an alternative economy [4]. The role of bitcoin as a currency has been questioned by market experts, especially due to its volatility and the speed of transaction processing (see e.g. [5,6]). Some authors argue that bitcoin should be rather treated as a kind of a physical good, like gold or other precious metals. Dyhrberg [7] claims that bitcoin bears many similarities to both gold and the dollar (e.g. when hedging capabilities are concerned) and therefore its position on the market would be between the two assets. However, as Dorfman [5] notes, usually an asset has a tangible underlying use: e.g. gold can be a pure investment asset or be used to make jewelry. Bitcoin has no fundamental value, but it is similar to gold in the sense that its total amount is limited to a maximum of 21 million [8]. Thus, when people are unaware of the central bank's policy or to the government policy, they *may* choose to locate their savings in bitcoin, as they used to locate them in gold.

Unlike [7], [9] claim that bitcoin is very different from gold and fiat currencies. It has unique risk–return characteristics, follows a different volatility process when compared with other assets, and is uncorrelated with other assets. Therefore, as a highly speculative asset, it differs from gold or the US dollar. This view is endorsed by many researchers, e.g. Glaser et al. [10]; Baek and Elbeck [11] or Williamson [6]. Taking into account all of the above, in this article we assume that bitcoin is perceived by market participants as an asset, not as a currency *sensu stricto*.

This paper was inspired by a series of articles analyzing the role of bitcoin from the perspective of investors: is it a new safe haven asset, a hedge, or a diversifier (see. [4,12–16]). The results presented so far suggest that bitcoin might serve as a hedge against equities and currencies [4,16], a commodity index [13], stock market expectations of near term volatility — measured by VIX [12], as well as a safe haven either against global financial stress [14] or against commodities and energy commodities [13].

All of the papers cited above take global or "averaged" perspective into account. First, they utilize the index price of bitcoin, more often than not the Coindesk Price Index [4,7,9,12,13,16,17]. It lists the average price of bitcoin against the US dollar from leading trading platforms from around the globe. Thus, the movements of the index are driven by the investors from all over the world and we cannot indicate the country of origin. The researchers study the relation of the bitcoin price to stock markets based on FTSE [7,16], global and regional stock indices [14,17–21] or stock indices of the biggest players on the bitcoin market (US and China) (*ibidem*). The papers that relay on the perspective of individual countries are, among others, Chan et al. [15] (who checked the hedging and diversification abilities of bitcoin against the Euro STOXX, Nikkei, Shanghai A-Share, S&P 500, and the TSX Index) and Bouri et al. [4] (who analyzes stock indices of USA, UK, Germany, Japan, and China). In both papers the authors studied the relation between the indices and the averaged bitcoin price index. The reason is that there is no one bitcoin price, as bitcoin is traded in many different platforms or exchanges (see [22] or [23]) and also in different currencies.

Our motivation for the research was to analyze the role of bitcoin in a "micro-perspective", i.e. to concentrate on trade in individual countries, taking into account not only the domestic stock indices, but also domestic investment in bitcoin. Hence, we study bitcoin trade in local currencies and confront it with the trade against bitcoin in the USD. We claim that the motivation to trade bitcoin may vary across the countries (possibly due to different economic conditions) and therefore, the trade in local currencies can shed more light on the role of bitcoin for different traders than the aggregate index prices. Moreover, the relationship between local market dynamics and bitcoin price in foreign currency may be affected by the exchange rate of local currency. To the best of our knowledge this is the first study to analyze the role of bitcoin from the local perspective while taking into consideration different economic background of traders.

To diversify the sample, we include five very different countries in our study: Japan, Venezuela, China, Estonia, and Sweden. Japan and South Korea, where the saving rates were extremely low, had displayed a tendency to apply bitcoins in savings. In 2017, the investors could have gained on average a 17% return on the stock in Asian exchanges, while over the same period the value of cryptocurrencies increased by 124% [24]. Moreover, Japan is a very characteristic country, where bitcoins are now official means of payment, in addition to real money.

Again, mining of bitcoins was very popular in Venezuela, where hyperinflation and lack of confidence in the local government policy forced people to look for other options to earn their living. Chun [25] pointed out that under the socialist regime of President Maduro electricity was heavily subsidized so it became essentially free. Thus, bitcoin mining turned out to be an investment at no cost. However, in 2016 President Maduro announced that mining of bitcoin (and other cryptocurrencies) was unlawful despite the fact that bitcoin trading was perfectly legal. Then, in early 2018, the mining of cryptocurrencies was declared legal because the Government decided to launch the national cryptocurrency — Petro, backed by Venezuela's oil reserves, with one token equaling one barrel (see: [3]).

On the other end of the spectrum, there are countries eagerly adapting new technologies that due to their overall technological development. In 2016, Bitcoin.com listed ten bitcoin-friendly countries: Estonia and Sweden were among them [26]. The Estonian government is deemed to tech-friendly and has jumped on the wagon of blockchain technology supporting its use in healthcare, banking services. The government is also pondering upon the launch of its national currency called estcoin. The national bank of Sweden is also willing to introduce the e-krona, while Avanza — a company that provides a digital platform for Swedes to trade was the first one to offer derivatives for bitcoin (in 2015).

The last country from the sample is still one of the biggest players on the market. It differs significantly from the four countries in question in terms of the volume of trade. As Chan et al. [15] notes: bitcoin trading against the Chinese Yuan accounted for most of bitcoin's trading volume until China started to clamp down on digital currency exchanges in early 2017. Eventually, in September 2017, a ban on the trading of bitcoin was imposed in China. Before the ban, the Chinese market used to attract majority of bitcoin miners, among others, due to low energy prices (similarly to the case of Venezuela). Another reason for such popularity of bitcoin in China could have been the intention of local investors to overcome capital control [17]. Thus, the situation of Chinese investors was somehow similar to the situation of the Venezuelan ones (cheap energy prices, regime, ban on cryptocurrency mining or trade), except for the fact that Venezuela was undergoing a severe economic crisis during the study period.

Given that we wanted to separate the "local" trade in bitcoin from the "global" one, we needed to collect data from various sources. Thus, for each country we checked the trading volume on local bitcoin exchanges (the source of data was bitcoinity.org) and chose those boasting the highest trade volume and deepest order book as the most representative ones. As a result, for the Venezuelan bolivars and the Swedish crown LocalBitcoins was selected, for the yen — Bitflyer, for the yuan — Huobi, and for the euro — Kraken. As a reference, we collected daily bitcoin prices in the US dollar from the most liquid exchange in US dollar, namely Bitfinex.

To summarize: the aim of this article is to verify whether bitcoin can act as a hedge, diversifier or safe haven on different stock markets, depending on the economic situation in the countries. Secondly, we analyze if these roles are related to the decisions made by investors to trade bitcoins in the local currency or the USD. We estimate a set of multivariate stochastic volatility models with a dynamic correlation coefficient to verify the possible role of bitcoin in different economies. The methodology applied in the article is similar to the one applied by Bouri et al. [4,13], but instead of regressing the dynamic conditional correlation obtained from the MGARCH model against binary variables, we include the variables into the dynamic correlation equation directly. In concordance with the results obtained by Dyhrberg [16] and Bouri et al. [12] we conclude that when BTC/USD prices are taken into account, bitcoin can be treated as a hedge in all cases. The results differ, however, when local investment is taken into account. Bitcoin can be treated as a safe haven asset only in the case of Venezuela and investments in bolivars. In the case of local investments in Japan and China before the 2017 ban, the results suggest that bitcoin behaved as a diversifier. In the bitcoin-friendly economies of Sweden and Estonia it acted as a weak hedge.

2. Literature review

When creating a portfolio, an investor tries to minimize its risk by including various assets that are likely to react in a different way to the changing market conditions. An asset that is on average positively correlated with the base one is called a **diversifier**. Diversification aims at smoothing out unsystematic risk events in a portfolio. The idea is that the positive performance of some investments could neutralize the negative performance of others (on condition that the assets are not perfectly correlated). A **hedge** is an asset that is typically uncorrelated or negatively correlated with the base one. An asset that is negatively correlated with the main asset during the economic downturn is called a **safe-haven** asset. Presence of these assets in a portfolio allows for overcoming possible losses under standard market conditions, as well as in the times of turbulences.

Most of the articles published so far concentrate on the safe haven property of gold. For instance, Baur and Lucey [27] verified whether gold can be treated as a safe haven asset, estimating a regression model for the returns of gold, where the explanatory variables were the returns of bonds and stocks, as well as the extreme negative returns of bonds and stocks. The authors concentrated on 1%, 2.5%, 5% lower quantiles. It was also assumed that the error term from the regression model follows an asymmetric GARCH model. The results suggest that gold was a safe haven for stock market but not for the bond market. Anand and Madhogaria [28] verified the hypothesis of safe haven in the context of gold by analyzing causality between gold and stock market returns in six countries and concluded that gold indeed served as a safe haven asset. On the other hand, Joy [29] came to different conclusions. Analyzing the exchange rate of sixteen currencies against the US dollar together with the price of gold over twenty three years and utilizing the multivariate GARCH model with dynamic conditional correlation, he concluded that gold behaved as a hedge against the US dollar and was a poor safe haven.

Together with the development of the market of cryptocurrencies, many researchers started the debate over the possible role of the new asset from the investment perspective. One of the research hypotheses assumed that it can be treated as alternative gold by some investors (see e.g. [7,30,31]. When investors lose confidence in the domestic monetary authorities and/or mainstream currencies, they can switch to bitcoin. While some authors confirmed bitcoin resemblance to gold [7], and confirm its safe-haven properties in some subperiods [18] — others came to very different assumptions. No resemblance to gold nor the ability of bitcoin to serve as a safe-haven asset was proved by Klein et al. [21] or Baur

et al. [9]. Smales [32] claims that with liquidity problems, transaction costs, and time to execute transaction bitcoin should not be considered as a safe-haven asset.

Other researchers emphasize the hedging and diversifying capability of bitcoin. The results vary, depending on the portfolio composition (stock indices, commodities, oil, etc.), data frequency (daily or weekly), and time span. For instance, Dyhrberg [16] provides an analysis of daily data and shows that bitcoin can be a weak hedge against the UK assets. Guesmi et al. [20] compare the risk and return on portfolios with and without cryptocurrencies; they claim that hedging strategies based on gold, oil, emerging stock markets, and bitcoin considerably reduce portfolio risks (variance) when compared to the risk of a portfolio composed of gold, oil, and stocks from emerging market only. They conclude that bitcoin may offer diversification and hedging benefits for investors. Symitsi and Chalvatzis [33] find statistically significant diversification benefits from the inclusion of bitcoin into four asset class portfolios (exchange rates, gold, oil, and a diversified pool of stocks), which are more pronounced for commodities. They note, however, that the decrease in the overall portfolio risk due to the low correlation of bitcoin with other assets, is not offset by its high volatility.

Some authors prove that the properties of bitcoin are subject to change, depending on data frequency. For instance, Bouri et al. [4] show that when daily data is analyzed, bitcoin cannot be regarded as a weak or strong safe haven against extreme movements in any of the assets under study: stock, oil commodities (see also Bouri et al. [19]). However, in the case of Asia Pacific stocks and oil, bitcoin was found to be an effective diversifier, and also a strong hedge against movements in Japanese and Asia Pacific stocks and commodity index. However, when weekly data is used, bitcoin shows strong hedging capabilities against Chinese stocks. In line with this research, Chan et al. [15] show that bitcoin is an effective strong hedge against the Euro STOXX, Nikkei, Shanghai A-Share, S&P 500, and the TSX Index under monthly data frequency. Thus, we can conclude that the hedging ability of bitcoin differs depending on the frequency of the analyzed data.

Special attention is put to the interaction of bitcoin and oil price or energy commodities, as bitcoin mining is an energy-consuming process. Selmi et al. [34] conclude that both bitcoin and gold would serve the roles of a hedge, a safe haven, and a diversifier for oil price movements. They note, however, that this property depends on bitcoin's and gold's different market conditions (bear, normal or bull) and on whether the oil price is in a downside, normal or upside regime. The result is supported by Bouri et al. [13] — at least when the period before December 2013 crash is considered (see also [35] and [36]). The authors claim that since the event bitcoin has been more likely to be deemed a diversifier than a hedge.

To sum up, the opinions on the role that bitcoin plays in the portfolio composition differ among the researchers, depending on the data frequency, periods and markets under study. In most of the research, however, the authors take into account averaged bitcoin price index from the Coindesk Price Index, which lists the average prices of bitcoin against the US dollar from leading trading platforms from around the globe. The reason for such an approach is that there is no one bitcoin price. As noted by Pieters and Vivanco [22], although bitcoin is indeed a homogeneous and identical virtual good across all online markets on which it is traded, its prices behave differently across these markets. Depending on the analyzed platform ([22] covered eleven of them), bitcoin has different price variations and fluctuations. The study is further extended by Matkovskyy [23] who compared the euro, U.S. dollar, and British pound sterling (GBP) with centralized and decentralized bitcoin cryptocurrency markets in terms of return volatility and interdependency. His results demonstrate that the markets differ for instance in terms of volatility which tends to be higher in the decentralized markets. Centralized markets have higher tail dependence regarding returns.

With all the studies presented above, we decided to examine the interdependencies between bitcoin prices and stock indices of very different economies, with focus not only on the aggregate bitcoin price in the US dollar, but its price in local currencies as well. Such an approach offers at least two advantages. First, the analysis is not affected by any modifications of the exchange rate of local currency to the US dollar. Second, we can be sure that there are local investors who (mainly) drive the bitcoin price. With the diversified sample of countries, we can also verify the capabilities of bitcoin with regard to different economic conditions. To the best of our knowledge this is the first study that covers the issue from this perspective.

3. The model

The methodology to test whether an asset should be classified as a safe haven, hedge or diversifier differs among other authors. The approach taken in our study follows Baur and Lucey [27], Ratner and Chiu [37], Bouri et al. [12,13] and Klein et al. [21]. Thus, we estimate volatility between main stock indices and the bitcoin price using the dynamic conditional correlation model (further: DCC). However, to enable more flexible modeling, we utilize the Stochastic Volatility Model with the Dynamic Conditional Correlation proposed by Yu and Meyer [38]. The choice of the model is motivated by the non-standard properties of bitcoin prices behavior (see e.g. [39,40]). In our opinion, the linear GARCH models may be too rigid to describe its full dynamics. Instead of a two-step approach in which, first, the dynamic correlation is estimated and then regressed against binary variables, we apply a one-step approach. Namely, we add binary variables into the dynamic correlation equation, indicating the occurrence of extreme return on the stock-exchange index in the lower 1%, 5% and 10% quantiles. To broaden our analysis we study dependencies between main domestic stock indices and the price of bitcoin expressed in local currencies and on local stock exchanges (Bitflyer — for the yen, Kraken — for the euro, Huobi — for the yuan and LocalBitcoins for all the remaining cases), as well as between local stock indices and the bitcoin price in US dollars (Bitfinex data).

Let us denote the vector of the mean-adjusted instrument prices with $\boldsymbol{y}_t$. In our case, the vector consists of the main stock exchange index of a given country and the price of Bitcoin, so $\boldsymbol{y}_t = (y_{1t}, y_{2t})'$, where $t = 1, \ldots, T$. Let us also assume that it can be modeled as a process of $\boldsymbol{\epsilon_t} = (\epsilon_{1t}, \epsilon_{2t})'$ in the following way:

$$\boldsymbol{y}_t = \boldsymbol{\Omega}_t \boldsymbol{\epsilon_t}, \tag{1}$$

where: $\boldsymbol{\Omega_t} = diag\left(\exp\left(\frac{h_t}{2}\right)\right)$, $\boldsymbol{\epsilon_t}|\boldsymbol{\Omega_t} \sim N\left(0, \boldsymbol{\Sigma}_{\epsilon_t}\right)$, $\boldsymbol{\Sigma}_{\epsilon_t} = \begin{bmatrix} 1 & \rho_t \\ \rho_t & 1 \end{bmatrix}$. The volatility of the instrument prices, $\mathbf{h_t} = (h_{1t}, h_{2t})'$ is modeled as an autoregressive process:

$$\boldsymbol{h}_{t+1} = \boldsymbol{\mu} + diag\left(\phi_{11}, \phi_{22}\right)\left(\boldsymbol{h}_t - \boldsymbol{\mu}\right) + \eta_t, \tag{2}$$

where: $\boldsymbol{\eta_t} = (\eta_{1t}, \eta_{2t})'$ and $\boldsymbol{\mu} = (\mu_1, \mu_2)'$, while: $\boldsymbol{\eta_t} \sim N\left(0, diag\left(\sigma^2_{\eta_1}, \sigma^2_{\eta_2}\right)\right)$. Finally, the conditional correlation of $\boldsymbol{\epsilon_t}$ equals:

$$\rho_t = \frac{\exp\left(q_t\right) - 1}{\exp\left(q_t\right) + 1}, \tag{3}$$

where:

$$q_{t+1} = \psi_0 + \psi\left(q_t - \psi_0\right) + \sigma_\rho v_t,\ v_t \sim N\left(0, 1\right). \tag{4}$$

It is also assumed that $\boldsymbol{h}_0 = \boldsymbol{\mu}$ and $q_0 = \psi_0$. The model was presented in [38] as the multivariate stochastic volatility model with the dynamic conditional correlation (DC-MSV). The model is similar to the multivariate GARCH (generalized autoregressive conditional heteroskedasticity) models with dynamic conditional correlation models. The conditional correlation is also modeled as an autoregressive process q_t and normalized to take values from the $(-1;1)$ interval (ρ_t).

To allow for even more flexible modeling, the model was estimated in WinBUGS using the Bayesian approach. Following the authors, we assumed that the parameters in the variance equation and parameters in the correlation equation are mutually independent. We used the following priors (see: [38]):

$$\begin{aligned}
&\mu_1 \sim N\left(0, 25\right);\\
&\mu_2 \sim N\left(0, 25\right);\\
&\phi^*_{11} \sim Beta\left(20, 1.5\right), where\ \phi^*_{11} = \frac{1}{2}\left(\phi_{11} + 1\right);\\
&\phi^*_{22} \sim Beta\left(20, 1.5\right), where\ \phi^*_{22} = \frac{1}{2}\left(\phi_{22} + 1\right);\\
&\sigma^2_{\eta_1} \sim Inverse - Gamma\left(2.5, 0.025\right);\\
&\sigma^2_{\eta_2} \sim Inverse - Gamma\left(2.5, 0.025\right);\\
&\psi^* \sim Beta\left(20, 1.5\right), where\ \psi^* = \frac{1}{2}\left(\psi + 1\right);\\
&\psi_0 \sim N\left(0.7, 10\right);\\
&\sigma^2_\rho \sim Inverse - Gamma\left(2.5, 0.025\right).
\end{aligned}$$

In order to check the influence of extreme events on the conditional correlation between the stock index and the bitcoin price, we constructed three binary variables in the value of 1 in the case of the extreme return on the **index** in the lower 1%, 5% and 10% quantile; respectively: $D(r_{(stock)}q_1)$, $D(r_{(stock)}q_5)$, $D(r_{(stock)}q_{10})$. The new variables are added to the correlation equation. Unlike other scholars, who first estimate the dynamic correlation, and then match a regression line with it, including the newly-defined variables as explanatory variables, we decided to modify Eq. (4) directly:

$$q_{t+1} = \psi_0 + \psi\left(q_t - \psi_0\right) + a_1 D\left(r_{(stock)}q_1\right) + a_5 D(r_{(stock)}q_5) + a_{10} D(r_{(stock)}q_{10}) + \sigma_\rho v_t \tag{5}$$

Coming back to the definition of hedge, diversifier and safe haven assets:

- A **hedge** is an asset which is, on average, **uncorrelated or negatively correlated** with another asset or portfolio. A hedge does not have the property of reducing losses in times of market distress, as despite being negatively correlated with the base asset in normal times, it can exhibit positive correlation during the period of turmoil. Following Bouri et al. [4]: bitcoin can be perceived as a **weak hedge** if ψ_0 is zero or as a **strong hedge** if it is negative.
- A **diversifier** is an asset that is, on average, **positively correlated** with the base asset. Given that the condition of positive correlation is required to be valid on average only, the diversifier does not have the property of reducing losses during the period of turmoil. Therefore, if ψ_0 is positive, bitcoin can be perceived as a **diversifier**.
- A **safe haven asset** is defined as the one which exhibits **negative or no correlation** with the base asset (or portfolio) over a **period of distress**. The correlation does not have to be negative over the entire period, but only during extreme market conditions and as such compensate the investor for losses in the base asset. If bitcoin is treated as a safe

haven, then in the case of the extreme falls the investors should leave the domestic market and invest in bitcoin, making its price higher. Thus, we should observe a fall in the correlations. Therefore, bitcoin is a **weak safe haven** against movements in other asset if the a_1, a_5 and a_{10} coefficients are not much different from zero, or it is a **strong safe haven** if these coefficients are **negative** (see [4]).

We check significance of the dummy variables by investigating the posterior distribution of the coefficients: a_1, a_5 and a_{10}. If the 95% confidence interval of the parameter covers 0, it is interpreted as insignificantly different from 0. In the case of the respective coefficients, we assumed non-informative Normal priors of low precision, and set their starting values to 0.

4. The data

We collected the daily data on the dynamics of the main stock indices of Venezuela, Japan, China, Sweden and Estonia from respectively: Venezuela Stock Exchange General Index (IBVC), Nikkei 225 (NKX), Shanghai Composite (SHC), OMX Stockholm 30 Index (OMXS 30) and OMX Tallin (OMXT). Next, for each country, we gathered data representing local bitcoin trade, and for the purpose of reference — the international trade in the US dollar.

We wanted to isolate the "local" trade in bitcoin from the "global" one in our study. To this end we needed to include data from various sources. Bitcoin is traded on many exchanges which are different when it comes to liquidity or possibility to trade in local currencies. We decided to choose the exchanges based on criteria of trade volume and the depth of order book.[2] The most liquid exchange currently is **Bitfinex** when one takes into account the volume of trading of bitcoin against the US dollar (see: [41]). According to the statistics from bitcoinity.org., when it comes to the trade volume over last the 5 years, the market share of the Bitfinex exceeded 34% (the next leader was Bitstamp with a market share approaching 15%). Bitfinex was also the frontrunner when it comes to the depth of order book (almost 32% market share — according to bitcoinity.org). The highest volume of bitcoin trade against the euro was observed in **Kraken** (market share of over 47% in the last 5 years, according to the bitcoinity.org). In terms of the depth of the order book in the last 5 years and having excluded MtGox, Kraken was also one of the leaders. However, when it comes to bitcoin trade against local currencies, the Finnish exchange called **LocalBitcoins** was the number one. At LocalBitcoins.com, people from different countries can exchange their local currencies to bitcoins. The site allows users to post advertisements where they state exchange rates and payment methods for buying or selling bitcoins. When it comes to liquidity, the volume of trading of bitcoin against most local currencies is the highest in LocalBitcoins, except for the Japanese yen and the Chinese yuan (according to the statistics published by the bitcoinity.org). The volume of trading of bitcoin against the Japanese yen is the highest on **BitFlyer** – an exchange localized in Japan (market share of 96% in terms of volume in the last 5 years, and once MtGox closed down – over 98% in terms of the order book, according to bitcoinity.org). For the yuan – before the official ban on the trade of bitcoin in China was imposed – it was Huobi and OKcoin. The two exchanges boasted a nearly 40% market share when it comes to the trade volume (*ibidem*). However, according to the ranking based on the depth of the order book (bitcoinity.org data), **Huobi** ranked higher, therefore we decided to use this exchange in our study.

The data on volume trade and order book were gathered from data.bitcoinity.org. The sources of the bitcoin prices were the Quandl and bitcoinity.org databases, while the data on local the indices were collected from the stooq.pl and CEIC databases.

Due to the different lengths of the available data samples, we performed estimations for different subsamples, depending on the analyzed country and the bitcoin exchange. The descriptive statistics are presented in Table 1. Due to the data non-stationarity, the logarithmic rates of returns have been computed. What we can observe is especially high kurtosis in the case of BTCJPY from Bitcoinity. Moreover, the highest standard deviation was observed for BTCBVL from LocalBitcoins. The price of bitcoin in the USD over the 2014–2017 period was slightly left-skewed, similarly to the price of bitcoin in the Swedish Krona (from LocalBitcoins), while the remaining prices were right-skewed (the highest value of the skewness was observed in the case of BTCJPY). Next, we estimated a series of DCC-MSV models with binary variables in the conditional correlation for the pair: local index — bitcoin price in the US dollar as well as for the pair: local index — bitcoin price in local currency. The results are presented in the next section.

5. Results

The results of estimation are presented in Tables 2–6. In each case we present the 95% interval of the parameters a_1, a_5 and a_{10} as well as ψ_0 and ψ. What we can see is that the results differ within each country, depending on whether the price of bitcoin in the local currency or in the US dollars was analyzed. When we compare the results obtained for all the countries and for the bitcoin price in dollars, we can conclude that in each case bitcoin could be perceived as a weak hedge asset (parameter ψ_0 was insignificantly different from 0 in all the cases). Moreover, in all the cases the parameter ψ was positive and significant, indicating that the correlation was changing over time. The more the correlation exceeded the average value (i.e. when the markets were moving in the same direction), the stronger was the tendency for bitcoin

[2] Order book and volume both provide useful information on liquidity of the exchange. They give information about the ability to execute big orders without moving the price too much (see: https://bitcoinity.org/markets/rank_explanation).

Table 1
Descriptive statistics of logarithmic changes of bitcoin prices in USD and local currencies as well as logarithmic changes of local stock indices.

Exchange	Variable	Time-span	Mean	Standard deviation	Skewness	Kurtosis
Returns of bitcoin prices						
Bitfinex	Bitcoin (USD)	(2014–2017)	0.2827	4.2125	−0.1561	5.1946
LocalBitcoin	Bitcoin (BVL)	(2014–2017)	1.3061	**8.8205**	0.4723	5.8370
LocalBitcoin	Bitcoin (SEK)	(2014–2017)	0.3585	7.7293	−0.0147	3.0434
Bitflyer	Bitcoin (JPY)	**(2015–2017)**	0.5322	3.8913	1.5370	**12.7346**
Kraken	Bitcoin (EUR)	(2014–2017)	0.3003	3.4064	0.2434	6.1437
Houbi	Bitcoin (CNY)	(2014–2017)	0.1737	3.5101	0.0100	7.9211
Returns on main stock indices						
Caracas SE	IBVC (Venezuela)	(2014–2017)	0.8005	3.1590	1.9888	9.4644
Tallin SE	OMXT (Estonia)	(2014–2017)	0.0494	0.5635	−0.8351	9.2790
Stockholm SE	OMX30 (Sweden)	(2014–2017)	0.0194	1.1155	−0.6362	6.4406
Tokio SE	NKX (Japan)	(2014–2017)	0.0508	1.3208	−0.1518	5.9428
Shanghai SE	SHC (China)	(2014–2017)	0.0579	1.7453	−1.2684	5.7614

Note: The following databases were sources of data: CEIC, Quandl, Bitcoinity.org, and stooq.pl. The presented statistics were computed for the stationary logarithmic returns of the series. The time span of the research was chosen based on the data availability. So, due to the 2017 ban on bitcoin trade in China, Huobi stopped publishing the bitcoin to the yuan exchange rate, the data availability ends in September 2017. In Japan, the trade had been concentrated primarily on MtGox before it closed down; no investors used other platforms. The informative data sample in Bitflyer starts from 2015 and therefore the data sample is shorter in this case.

Table 2
Estimates of the DCC-MSV model parameters for Venezuela.

Node	Mean	Std. dev.	MC error	2.50%	Median	97.50%
(LocalBitcoins) BTCVEF and IBVC						
a_1	0.0117	0.4976	0.0323	−0.8722	−0.0628	1.1120
a_5	0.2958	0.2947	0.0195	−0.2721	0.2983	0.8518
a_{10}	**−0.7120**	**0.3177**	**0.0222**	**−1.3170**	**−0.7305**	**−0.0729**
ψ_0	**0.4891**	**0.1258**	**0.0082**	**0.2292**	**0.5000**	**0.7070**
ψ	**0.7714**	**0.0895**	**0.0062**	**0.5892**	**0.7830**	**0.9124**
(Bitfinex) BTCUSD and IBVC						
a_1	0.5459	0.3240	0.0193	−0.0576	0.5749	1.1570
a_5	−0.0257	0.2844	0.0174	−0.7107	0.0232	0.4000
a_{10}	−0.0250	0.1766	0.0108	−0.3335	−0.0407	0.3682
ψ_0	0.0117	0.1114	0.0068	−0.2170	0.0247	0.1997
ψ	**0.7967**	**0.0867**	**0.0051**	**0.5929**	**0.8109**	**0.9302**

Note: In the table we present the estimates of the conditional correlation (5) parameters obtained from the DCC-MSV model (1)–(4) for the Venezuelan Stock Exchange General Index (IBVC) and the bitcoin price in bolivars (upper panel) versus the bitcoin price in the USD (lower panel). We present a mean, median, and 95% credibility interval for the estimated parameters. If the interval covers 0, we interpret the coefficient value as insignificantly different from 0. We bolded the parameters that are significantly different from 0.

to behave more like a diversifier. The bigger the drop of the correlation below the average (i.e. when the markets moved in opposite direction) — the stronger the tendency for bitcoin to act like a hedge. Thus, in some shorter sub-periods, the role of bitcoin might have changed.

The results differ – also across the countries – when bitcoin trade in local currencies is analyzed. Bitcoin appeared to be a diversifier in the case of Japan and China, while a safe haven asset in the case of Venezuela. In the bitcoin-friendly European countries – Sweden and Estonia – it acted as a hedge regardless of which bitcoin exchange was analyzed.

In Table 2, we present the estimation results for the MSV-DCC model for Venezuela. When we concentrate on the upper panel, when the results for local trade are presented, a negative value of coefficient a_{10} is observed. This means that in the period of distress, the correlation between the stock exchange assets and bitcoin changes in bolivars became negative. This can indicate that bitcoin could have been perceived as a strong safe haven within the 10% stock quantile in this country. The result was not confirmed in the analysis of the local market relationships with bitcoin trade in the US dollars, which can be explained by the fact that the main investors on the cryptocurrency market are the individuals. LocalBitcoins allow users to use interface in their native languages, which makes the investment process easier. Moreover, the price of bitcoin in the local currency is driven mostly by local rather than international investors. Therefore, the reaction of correlation between the markets to the deteriorating economic conditions – reflected also one the local stock exchange – should be much better reflected on the local exchange.

In Table 3, we present the results of the estimates obtained for the Japanese market. Analyzing the relationship between the local stock market and bitcoin price in dollars, we came to the conclusion that bitcoin is a hedge against movements

Table 3
Estimates of the DCC-MSV model parameters for Japan.

Node	Mean	Std. dev.	MC error	2.50%	Median	97.50%
(Bitflyer) BTCJPY and Nikkei 225, 2015–2017						
a_1	0.0080	3.1510	0.0166	−6.1720	0.0156	6.1880
a_5	−0.0040	3.1720	0.0163	−6.2410	−0.0032	6.2710
a_{10}	−0.0354	3.1640	0.0153	−6.2490	−0.0159	6.1470
ψ_0	**0.4028**	**0.1280**	**0.0056**	**0.1232**	**0.4067**	**0.6453**
ψ	**0.8830**	**0.0584**	**0.0035**	**0.7449**	**0.8925**	**0.9670**
(Bitfinex) BTCUSD and Nikkei 225, 2014–2017						
a_1	0.4452	0.3102	0.0178	−0.1519	0.4436	1.0470
a_5	−0.2481	0.2337	0.0139	−0.6987	−0.2581	0.2300
a_{10}	−0.0684	0.1642	0.0098	−0.4693	−0.0340	0.1847
ψ_0	0.0823	0.1592	0.0090	−0.2012	0.0727	0.4046
ψ	**0.7970**	**0.1471**	**0.0091**	**0.4315**	**0.8310**	**0.9732**

Note: In the table, we present the estimates of the conditional correlation (5) parameters obtained from the DCC-MSV model (1)–(4) for Nikkei 225 (NKX) and bitcoin price in the yens (upper panel) versus bitcoin price in the USD (lower panel). We present a mean, median, and 95% credibility interval for the estimated parameters. If the interval covers 0, we interpret the value of the coefficient as insignificantly different from 0. We bolded the parameters that are significantly different from 0.

Table 4
Estimates of the DCC-MSV model parameters for China.

Node	Mean	sd	MC error	2.50%	Median	97.50%
(Huobi) BTCCNY and SHC index, 2014–2017						
a_1	−0.2028	0.3320	0.0247	−0.8601	−0.1739	0.4032
a_5	−0.2209	0.1957	0.0142	−0.5890	−0.2288	0.2035
$\boldsymbol{a_{10}}$	**0.3058**	**0.1624**	**0.0127**	**0.0032**	**0.2982**	**0.6343**
$\boldsymbol{\psi_0}$	**0.8766**	**0.0707**	**0.0059**	**0.6931**	**0.8918**	**0.9687**
ψ	−0.2728	0.1464	0.0107	−0.5310	−0.2870	0.0514
(Bitfinex) BTCUSD and SHC index, 2014–2017						
a_1	0.2240	0.2668	0.0213	−0.3014	0.2217	0.7215
a_5	0.0053	0.2396	0.0192	−0.4605	0.0050	0.5148
a_{10}	−0.2209	0.2027	0.0165	−0.6365	−0.2121	0.1421
ψ_0	0.0253	0.1534	0.0126	−0.2901	0.0320	0.2748
$\boldsymbol{\psi}$	**0.6604**	**0.1567**	**0.0126**	**0.2672**	**0.6926**	**0.8711**

Note: In the table, we present the estimates of the conditional correlation (5) parameters obtained from the DCC-MSV model (1)–(4) for the Shanghai Composite Index and bitcoin price in Chinese Yuan (upper panel) versus bitcoin price in USD (lower panel). We present mean, median and 95% credibility interval for the estimated parameters. If the interval covers 0, we interpret the value of the coefficient as insignificantly different from 0. We bolded the parameters that are significantly different from 0.

on the Japanese stock — which corroborates the results obtained by, e.g., Bouri et al. [4]. On the other hand, bitcoin appears to be a diversifier when the local exchange is considered. When we take into account that interest rates in Japan were extremely low in the period under study, we can suppose that the investors did not expect bitcoin to have the property to reduce their possible losses, but just to enhance the return on their portfolios.

A very interesting result has been obtained in the case of China (Table 4). When the relationships between the local market and bitcoin price in local currency is analyzed, we observe that both a_{10} and ψ_0 parameters are significant and positive, but the autoregressive parameter ψ is insignificantly different from 0. This suggests that the conditional correlation might have been constant over time, and bitcoin used to be a diversifier for Chinese investors. Note that such a conclusion in some sense is in line with the result obtained by Bouri et al. [17] who observed positive return spillover from China to Bitcoin, regardless of the market condition. Again, when we analyze the relationships between the Shanghai stock exchange and bitcoin price in the US dollars, bitcoin appears to be a weak hedge with respect to the Chinese market. The result obtained for Chinese markets can suggest that the investors who traded bitcoin in local currencies, should have treat it as an additional investment opportunity, having in mind the risk associated with such an investment, rather than as a tool to minimize the risk of their portfolio.

Eventually, in the case of Sweden and Estonia (Tables 5 and 6), the frontiers of money digitalization, no differences were spotted between the results obtained for trade in bitcoin in local money versus the investments made in US dollars. In each case, bitcoin behaved as a weak hedge asset. In the case of Estonia, the lack of differences between the results from different exchanges can be justified by the fact that the euro is the currency of the entire Eurozone, not only in Estonia.

Table 5
Estimates of the parameters of DCC-MSV model for Sweden.

Node	Mean	sd	MC error	2.50%	Median	97.50%
(LocalBitcoins) BTCSEK and OMXS30, 2014–2017						
a_1	0.3831	0.2907	0.0178	−0.1723	0.3878	0.9575
a_5	0.1459	0.2697	0.0173	−0.3911	0.1835	0.6029
a_{10}	−0.1594	0.1653	0.0105	−0.4651	−0.1629	0.1753
ψ_0	0.0230	0.1141	0.0070	−0.1927	0.0222	0.2452
$\boldsymbol{\psi}$	**0.8523**	**0.0898**	**0.0057**	**0.5843**	**0.8795**	**0.9434**
(Bitfinex) BTCUSD and OMXS30, 2014–2017						
a_1	0.1550	0.3220	0.0201	−0.5728	0.1499	0.8336
a_5	0.2313	0.2082	0.0124	−0.2473	0.2369	0.6470
a_{10}	−0.2220	0.1562	0.0096	−0.5546	−0.1934	0.0516
ψ_0	0.0806	0.1277	0.0083	−0.1416	0.0770	0.3159
$\boldsymbol{\psi}$	**0.8292**	**0.1098**	**0.0074**	**0.5745**	**0.8569**	**0.9659**

Note: In the table we present the estimates of the conditional correlation (5) parameters obtained from DCC-MSV model (1)–(4) for OMXS30 and bitcoin price in the Swedish crown (upper panel) versus bitcoin price in the USD (lower panel). We present a mean, median, and 95% credibility interval for the estimated parameters. If the interval covers 0, we interpret the value of the coefficient as insignificantly different from 0. We bolded the parameters that are significantly different from 0.

Table 6
Estimates of the DCC-MSV model parameters for Estonia.

Node	Mean	sd	MC error	2.50%	Median	97.50%
(Kraken) EURBTC and OMXT, 2014–2017						
a_1	0.0147	3.1820	0.0198	−6.3290	0.0155	6.3130
a_5	0.0337	3.1560	0.0209	−6.1840	0.0542	6.2260
a_{10}	0.0281	3.1640	0.0226	−6.1520	0.0332	6.2600
ψ_0	0.0842	0.0919	0.0064	−0.0865	0.0851	0.2494
$\boldsymbol{\psi}$	**0.9030**	**0.0707**	**0.0056**	**0.7128**	**0.9277**	**0.9730**
(Bitfinex) BTCUSD and OMXT, 2014–2017						
a_1	−0.3939	0.3297	0.0188	−1.1720	−0.3575	0.1705
a_5	−0.2232	0.2036	0.0116	−0.5905	−0.2338	0.1672
a_{10}	−0.0264	0.1916	0.0115	−0.4399	−0.0030	0.3087
ψ_0	0.2253	0.1192	0.0070	−0.0024	0.2318	0.4400
$\boldsymbol{\psi}$	**0.7997**	**0.1077**	**0.0065**	**0.5588**	**0.8236**	**0.9342**

Note: In the table, we present the estimates of the conditional correlation (5) parameters obtained from the DCC-MSV model (1)–(4) for the Estonian OMXT and bitcoin price in the euro (upper panel) versus bitcoin price in USD (lower panel). We present a mean, media,n and 95% credibility interval for the estimated parameters. If the interval covers 0, we interpret the value of the coefficient as insignificantly different from 0. We bolded the parameters that are significantly different from 0.

Table 7
The role of bitcoin in different countries depending on the currency of trade — summary of the results.

Region	Country	Role of bitcoin	
		In local currency	Trade in US dollars
Europe	Estonia	Weak hedge	Weak hedge
	Sweden	Weak hedge	Weak hedge
South America	Venezuela	Safe haven	Weak hedge
Asia	China	Diversifier (constant)	Weak hedge
	Japan	Diversifier	Weak hedge

6. Discussion

For the convenience of the reader, we summarized the main results in Table 7. Based on the results, we may suggest that to assess the behavior of local bitcoin investors and the roles of cryptocurrencies on different markets, it may be necessary to take into account the local bitcoin trade. When the prices of the US dollar are taken in consideration, no clear differences may be noticed between different markets — possibly due to the fact that it is difficult to separate the decisions made by national investors from international investors. The global price of bitcoin is driven by the investors from all over the world, while those who trade in local currencies are primarily local investors.

Our results obtained for the relationship between local stock indices and BTCUSD partially corroborate the studies already published. So far it has been found that bitcoin can mainly be used as a hedge against market specific risk [42]. This is consistent with the results of Chan et al. [15], who concluded that bitcoin is a weak hedge for the European indices (STOXX) Nikkei and Shanghai A-Share when daily frequency is analyzed. On the other hand, Bouri et al. [4] concluded that bitcoin is a diversifier with respect to the European indices (MSCI Europe). However, the time span of the research of Bouri et al. [4] was 2011–2015, while Chan et al. [15] analyzed the period of 2010–2017, which may have impacted their conclusions. Similarly to Bouri et al. [4] we notices that bitcoin (in USD) is a hedge with respect to the Japanese and Chinese stock markets.

Yet, contrary to e.g. Klein et al. [21] or Bouoiyour and Selmi [43], who strongly argued against the hypothesis that bitcoin can serve as a safe-haven asset, we managed to obtain such result for Venezuela, when local trade was considered. In fact, all of the researchers who denied the safe-haven properties of bitcoin, formulated their opinions based on aggregated bitcoin price and on stable markets. Venezuela is an exceptional case in our data sample, as it experienced a severe economic crisis, incomparable to the other economies. Therefore, we suspect that the safe-haven properties of bitcoin may reveal themselves only in extreme economic conditions, not in the standard ones or even in mild recession. The length of the data sample, however, does not allow us to verify this finding. It is impossible to extend the analysis backwards and take into account the whole economic cycle. Therefore, the conclusion is based on the cross-country comparison rather than on a one-country analysis over a longer period of time. To support the conclusion with a statistical data analysis, we need to replicate it when a longer data sample is available and verify whether the safe-haven property of bitcoin in Venezuela will hold when "normal" economic conditions would be taken into consideration.

Another possible explanation for the result is that bitcoin may serve as a safe haven asset in the countries with less developed financial markets, with a smaller number and variety of available assets. In such cases bitcoin – or cryptocurrencies in general – is an interesting option. Investors in the countries boasting deep and mature financial systems have a plethora of other opportunities to compensate for their losses during the crisis.

The differences among the countries themselves may stem not only from the economic situation and development of financial markets, but also from the attitude of the citizens to their authorities and regulatory frameworks. The stricter the control over private investments in the country, the more willing the investors are to look for other means of investment. As noticed by Bouri et al. [17], a conceivable reason for such popularity of bitcoin in China could have been the intention of local investors to overcome capital control. Yet, even after bitcoin exchanges were shut down, it is still legal there to own, buy and sell bitcoins individually[3] and bitcoin itself is officially considered as a kind of property [44]. Therefore, bitcoin could have always been considered by the investors as an additional means of investment, used with intention to diversify portfolio, not necessarily to hedge it.

In Japan, the investors did not believe in the possibility to obtain an unusual return by investing in the local exchange due to the very low interest rates. Therefore, bitcoin could have been perceived as an instrument used to make additional savings. Such an argument is in line with the findings of Bouoiyour et al. [45] who argue that bitcoin is not necessarily a purely speculative asset.

7. Summary

The goal of our research was to verify whether the role of bitcoin (a hedge, diversifier or safe haven) is different in particular countries. Then, if the role turned out to be indeed different, we wanted to check whether such difference is related to the fact that investors trade bitcoin in USD or in local currencies. We compared Venezuela, Japan, Sweden, Estonia, and China. We approached the study with the hypothesis that bitcoin may play different roles in the investment portfolio depending on specific market conditions.

We computed the conditional correlations between the bitcoin price in local currencies and the main stock index in a given country, as well as the correlation between the bitcoin price in the US dollar and the main stock index. We used the multivariate stochastic volatility model with the dynamic conditional correlation and explanatory variables — extreme downward changes of the stock indices. The conclusions from our analysis vary, depending whether we consider trade on the local bitcoin exchanges or in the global one. In the case of the USD trade, the results suggest that bitcoin is a weak hedge with respect to all of the analyzed markets.

However, the country-specific analysis (i.e. when the bitcoin price from the local exchanges is studied) shows that bitcoin can be, indeed, perceived differently in different economies. And thus, it appears to be a safe haven asset in crisis-driven Venezuela, a diversifier in Japan and China, and a weak hedge in Sweden and Estonia. We attribute these discrepancies to different economic situations in the countries, as well as different regulatory frameworks imposed there.

The findings are significant and potentially useful to researchers, practitioners, and participants in the bitcoin market when making better investment and risk management decisions. The most important conclusion from the perspective of investing is that it may be advisable to focus attention on local bitcoin exchanges, especially when one considers investing in emerging market stocks.

The results offer policy- and regulatory-related implications for authorities responsible for monetary and financial stability in a given country (especially in the developing or emerging ones), who may be wondering about making

[3] https://www.24hchina.com/how-to-buy-bitcoins-using-alipay-or-wechat/.

cryptocurrencies a monetary policy device or a kind of complementary currency. It should be remembered that not only no institution exists to provide stability of bitcoin, no monetary or exchange policy is in place — but there is no single bitcoin price and its properties vary across trading platforms. The absence of international regulations is conducive to regulatory arbitrage and stimulates bitcoin volatility. Therefore, any concepts of binding the national currency (e.g. on the basis of a currency board system) with bitcoin are at this point very risky and should be treated with caution.

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