International Journal of Business & Economic Studies
Year: 2022, Vol: 4, No:1, pp.45-52
https://doi.org/10.54821/uiecd.1122493

Analysis of the Relationship Between Bitcoin Electricity Consumption and the Global Economic and Political Uncertainty Index (GEPU)

Bitcoin Elektrik Tüketimi ile Küresel Ekonomik Politik Belirsizlik Endeksi (GEPU) Arasındaki İlişkinin Analizi

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Received : 27.05.2022
Revised : 07.06.2022
Accepted : 27.06.2022
Type of Article : Research

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Keywords:

Bitcoin,

GEPU Index,

Todo-Yamamoto

Jel Codes:
B23, E63, F43

ABSTRACT

It is possible to define uncertainty as the variability of conditions, the ambiguity and obscurity of statements and events. Uncertainty, for whatever reason, affects the economy in different ways. Uncertainty causes people to be more concerned about their future income. Various estimation and methods have been developed in recent years to calculate the uncertainty, which is equivalent to the concept of uncertainty. These indices, in which economic and political uncertainties are calculated, appear as a form of calculation that also includes political discourses along with financial risk. The aim of this study is to examine the causality relationship between the Global economic political uncertainty index and Bitcoin electricity consumption. For this purpose, the Toda-Yamamoto causality test was applied using data from the period 2011:M7-2022:M1. According to the obtained Toda-Yamamoto causality test findings, Granger causality relationship has been determined both from the global economic-political uncertainty index to Bitcoin electricity consumption and from Bitcoin electricity consumption to the global economic-political uncertainty index.

Anahtar Kelimeler:

Bitcoin,

GEPU Endeksi,

Todo-Yamamoto

Jel Kodları:
B23, E63, F43

ÖZET

Belirsizlik, şartların değişkenliği, ifade ve olayların muğlaklığı ve bilinmezliği olarak tanımlamak mümkündür. Hangi sebeple ortaya çıkarsa çıksın belirsizlik, ekonomiyi farklı yönlerden etkilemektedir. Belirsizlik, insanların gelecekte elde edecekleri gelirleri ile ilgili daha yüksek bir endişeye girmelerine yol açar. Bilinmezlik kavramıyla eşdeğer olan belirsizliği hesaplayabilmek için son yıllarda çeşitli tahminleme ve yöntemler geliştirilmiştir. Ekonomik politik belirsizliklerin hesaplandığı bu endeksler, finansal risk ile birlikte politik söylemlerin de yer aldığı bir hesaplama şekli olarak karşımıza çıkmaktadır. Bu çalışmanın amacı Küresel ekonomik politik belirsizlik endeksi ile Bitcoin elektrik tüketimi arasındaki nedensellik ilişkisini incelemektir. Bu amaçla çalışmada 2011:M7-2022:M1 dönemine ait veriler kullanılarak Toda-Yamamoto nedensellik testi uygulanmıştır. Elde edilen Toda-Yamamoto nedensellik testi bulgularına göre hem küresel ekonomik politik belirsizlik endeksinden Bitcoin elektrik tüketimine doğru hem de Bitcoin elektrik tüketiminden küresel ekonomik politik belirsizlik endeksine doğru Granger nedensellik ilişkisi tespit edilmiştir.

Suggested Citation: Sizer, L. & Yılmaz, Y. (2022). Analysis of the Relationship Between Bitcoin Electricity Consumption and the Global Economic and Political Uncertainty Index (GEPU). *International Journal of Business and Economic Studies*, 4(1), 45-52, Doi: https://doi.org/10.54821/uiecd.1122493

1. INTRODUCTION

Uncertainty is expressed as the variability of conditions and the ambiguity and obscurity of events. In the finance literature, the concept of uncertainty refers to the unknown about how the future of the economy can be affected as a result of sudden changes, such as political or economic crises, in which decision units such as companies or countries are not capable of knowing the possibility of their occurrence in the economic structure (Al-Thaqeb and Algharabali, 2019). In other words, uncertainty; political reasons, internal conflicts, wars or crises in different fields (Bloom, Kose and Terrones, 2013).

Regardless of the reason it arises, uncertainty affects the economy in different ways. Uncertainty causes people to be more concerned about their future income. In order to take precautions against the possible risk of shrinkage in income, people tend to save more instead of consumption (Mody, Ohnsorge and Sandri, 2012). Investors' "wait and see" approach can negatively affect both production and employment. In addition, the increased risk premium in an environment of uncertainty may increase the financing cost of companies' investments (Güney, 2020). In addition, dismissals due to loss of income increase the risk of non-repayment of debts, and accordingly, risk premiums tend to increase and bank loans tend to contract (Schaal, 2017).

Termination estimation and applications can be made to make it possible to measure the obscurity. These indicators are indicators calculated from the point of view of risks and gains information about the global Economic Political education as a basis in the study. GEPU, Baker et al. (2013) It is rescued from economic policy for the USA. This index; applications of references to economics, politics and education are considered to be older than relative aid credit. Later, Baker et al. (2016) article improvement is the policies of economic policies for the USA 11 Europe for the country and the system policies in the newspaper. The authors reported that panel VAR analyzes increased the firm's overall share price volatility in the rating valuation. Later, Davis (2016) makes a global economic policy target.

The GEPU Index consists of the national EPU index based on the GDP weighted average of 21 countries. These countries; Australia, Brazil, Canada, Chile, China, Colombia, France, Germany, Greece, India, Ireland, Italy, Japan, Mexico, Netherlands, Russia, South Korea, Spain, Sweden, the United Kingdom, and the United States. Each national EPU index reflects the proportional frequency of its country newspaper articles (www.policyuncertainty.com) containing terms related to economics, policy and uncertainty.

Bitcoin differs from all other coins since the first coin, as it is decentralized and has a structure such as excluding third parties from the system. Bringing technological infrastructures such as Blockchain has made it a system that is spoken all over the world and that affects not only its investors but all parties. Along with being a revolutionary development in the financial world, cryptocurrencies also show themselves as an indispensable innovation in terms of technology (Çağlar and Yavuz, 2021). However, the electrical energy it consumes causes serious discussions.

One way to obtain Bitcoin is to mine crypto with the help of specially manufactured computers. Bitcoin, which has a volatile price, has an increasing momentum in electricity consumption. Electricity consumption depends on the energy efficiency of the equipment used, the bitcoin price trend, and requirements such as cooling-lighting (Kamiya, 2019). All transactions made in the Bitcoin system are recorded on all computers connected to the Bitcoin system (www.dunyaenerji.org). Miners need to verify transactions on the blockchain for bitcoin production and reveal this proof of work. Due to the fact that they have to do these operations with a large number of advanced computers, they consume serious electricity.

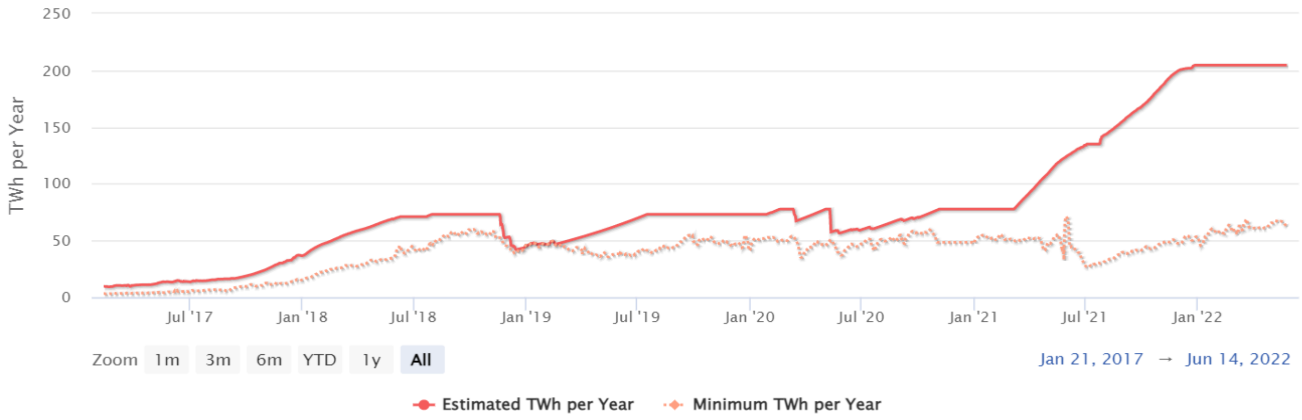

Figure 1. Estimated Bitcoin Electricity Consumption (1 Twh = 1 Billion kWh)

Sources: https://digiconomist.net/bitcoin-energy-consumption

The aim of this study is to analyze the relationship between the GEPU index and Bitcoin electricity consumption. It is aimed to reveal the effect of the GEPU index on the amount of electricity consumed for Bitcoin production. As a result of the literature review, many variables such as GEPU index, stock market indices, exchange rates, inflation, bitcoin price have been the subject of research. However, studies on bitcoin electricity consumption and the GEPU index were limited. In this respect, it is thought that the study will contribute to the literature. After the introduction of the study, a summary of the literature is given in the second part. In the third chapter, the method, data set and analysis results of the study are given. In the conclusion part, the evaluation and interpretation of the findings are given.

2. LITERATURE

Within the scope of this study, many studies related to the global economic political uncertainty index and bitcoin have been examined. It has been observed that studies dealing with the GEPU index, exchange rates, stock market indices, confidence indices and other macro variables have gained intensity. On the other hand, it is noteworthy that studies on energy markets, commodity investments, miner profitability, carbon emissions, bitcoin price and prices of other investment instruments are frequently conducted. This study differs from the literature in order to reveal the relationship between the GEPU index and bitcoin electricity consumption.

Gürsoy, Akkuş, and Doğan (2022) applied a causality test between Bitcoin energy consumption and crypto money price uncertainty index and crypto money policy uncertainty indices in the periods 19.02.2017 and 07.02.2021. According to the findings the uncertainty in the crypto money markets has a causality on Bitcoin energy consumption. Moreover, bitcoin energy consumption is not only linked to crypto markets, but also It was interpreted as being under the influence of government interventions, prohibitions, ill-recognition and developments and movements in other financial markets.

Kılıç, Gürsoy and Ergüney (2021) investigated the relationship between bitcoin electricity consumption and the energy markets of selected countries that lead in bitcoin production. According to the findings, they concluded that there is a bidirectional volatility spread between the CBECI index and the MOEX energy index, and a unidirectional volatility spread between the S&P 500 and SSE energy indices. Jingming et al. (2019), on the other hand, compared the effects of nine types of cryptocurrencies and ten algorithms on mining efficiency and their comparison with Monero mining. According to the results, they stated that the hash algorithm basically determines the mining efficiency.

Çağlar and Yavuz (2021) aimed to reveal the effects of news in newspapers on bitcoin. As a result of the study, they stated that the related news did not have a strong effect on the prediction of bitcoin prices in the artificial neural network. However, among the selected newspapers, they stated that The Wall Street newspaper had a relatively effective effect on the prediction of bitcoin price compared to other newspapers in the same group. Huynh et al., (2022) conducted a study analyzing the relationship between bitcoin energy consumption and market price. They determined that there is a relationship between Bitcoin energy consumption and return and volume.

Sadeghzadeh Emsen & Aksu (2020) tested whether there is a symmetrical and asymmetrical relationship between the BIST100 index and the uncertainty index in their study. While a symmetrical relationship could not be determined as a result of the analyzes, they revealed that there were asymmetrical relationships between the two variables. Gürsoy and Kılıç (2021), on the other hand, investigated the effect of economic and political uncertainty in global markets on financial markets in Turkey. GEPU index, Turkey 5-year CDS premiums and BIST banking index variables were tested with DCC-GARCH model. It has been found that there is a strong two-way volatility interaction between the GEPU index, the CDS premium, and the BIST banking index. Gürsoy (2021) tested the relationship between the GEPU index and exchange rate, inflation and BIST100 variables with the Hatemi-J Asymmetric Causality test. A positive causality effect was obtained from the GEPU index to the exchange rates. Korkmaz and Güngör (2018) aimed to reveal the effect of the GEPU index on the returns of companies traded in the Turkish stock market by analyzing them with volatility models. As a result of the analyzes, they concluded that the GEPU index had a significant and positive effect on the volatility of company stock returns in the 1997-2018 period.

Güney (2020) used the boundary test approach to analyze the existence of the effect of the GEPU index on the volatility of selected exchange rates. They found that the EPU index calculated for the USA had an effect on the dollar exchange rate volatility in the long run, but the EPU index calculated for Europe had no effect on the Euro exchange rate volatility.

3. DATA

The Global Economic-Political Uncertainty (www.policyuncertainty.com) and Bitcoin electricity consumption (BTCTWH) variables used in the analysis were obtained from (https://digiconomist.net). Data belonging to the period 2011:M7-2022:M1 were used in the study. In addition, the natural logarithms of the variables used were taken and included in the analysis.

4. ECONOMETRIC METHODOLOGY

VAR (Vector Autoregressive Models) analysis is an analysis frequently used by researchers and practitioners to present econometric results and to offer policy recommendations. If the variables have a unit root or if there is cointegration between the variables, hypothesis tests are not valid in these models. The series that are stationary are normally analyzed with VAR, and then the F statistic in the Granger test is used. However, Toda-Yamamoto (TY, 1995) showed that if there is a cointegration relationship between the variables, the F-statistic may lose its validity by not complying with the standard distribution. TY (1995) stated that when examining an economic theory or establishing an econometric model, even if the relevant variables contain unit roots, VAR analysis can be done by using the level values of these variables, and the Wald test can be used here. TY (1995) states in his study that if there is a cointegration relationship between the variables, there will be an error correction system (ECM). However, in most applications, the degree of integration of the variables, whether they are cointegrated and their stationarity properties are not known beforehand. As a result, unit root analysis is performed first for Granger causality, and then the cointegration relationship is investigated. Then, it examines the causal relationships with the help of VAR analysis. TY (1995) states that these preliminary tests can give difficult and misleading results. In order to overcome all these problems, TY(1995), (k+dmax). It proposes the creation of a first-order VAR model. Here, k indicates the optimal lag length that meets the stability conditions, and dmax indicates the maximum integration degree of the relevant series in the model (Mert & Çağlar, 2019: 344-345). The TY(1995) test exhibits χ^2 asymptotic distribution with lag length k. For the TY(1995) test, k and dmax must be determined first. The success of causality analysis depends on the correct determination of these two indicators. TY(1995) causality test equations for BTCTWH and GEPU variables are given below:

$$BTCTWH_t = a_0 + \sum_{i=1}^{k+dmax} \varphi_i BTCTWH_{t-i} + \sum_{i=1}^{k+dmax} \gamma_i GEPU_{t-i} + \varepsilon_{1t} \tag{1}$$

$$GEPU_t = b_0 + \sum_{i=1}^{k+dmax} \psi_i GEPU_{t-i} + \sum_{i=1}^{k+dmax} \gamma_i BTCTWH_{t-i} + \varepsilon_{2t} \tag{2}$$

In equations (1) and (2); It is assumed that the error terms ε_{1t} ve ε_{2t} exhibit clean sequence processes and there is no autocorrelation.

$$\begin{aligned} &H_0: \gamma_i = 0 \\ &H_1: \gamma_i \neq 0 \end{aligned} \tag{3}$$

The hypothesis (3) established for the causality relationship of the model numbered (1) above is given in the equation. The rejection of the null hypothesis indicates that there is a Granger causality relationship from the $GEPU_t$ variable to the $BTCTWH_t$ variable. These hypotheses are tested with the help of the Wald test, which fits the χ^2 distribution with k degrees of freedom (Toda & Yamamoto, 1995: 228-229).

5. FINDINGS

Before proceeding to the Toda-Yamamoto causality results, it is necessary to determine to what degree the variables are integrated. For this, ADF and PP unit root tests, which are traditional unit root tests frequently used in the literature, were used. The unit root test results obtained are given in Tables 1 and 2.

Table 1. ADF Unit Root Test Results

	Intercept		**Intercept and Trend**	
Variables	**(T)Statistic**	**5% Critical Value**	**(T)Statistic**	**5% Critical Value**
BTCTWH	-1.347 (1)	-2.884	-1.371 (2)	-3.446
GEPU	-2.166 (1)	-2.884	-4.070** (0)	-3.445
ΔBTCTWH	-4.788** (0)	-2.884	-4.891** (0)	-3.446
ΔGEPU	-14.675** (0)	-2.884	-14.640** (0)	-3.446

Note: ** indicates significant at the 5% significance level. Values in parentheses represent the appropriate lag length determined according to Schwarz (SIC) information criteria.

Table 2. PP Unit Root Test Results

	Intercept		**Intercept and Trend**	
	(T)Statistic	**5% Critical Value**	**(T)Statistic**	**5% Critical Value**
BTCTWH	-2.222 (8)	-2.884	-1.202 (8)	-3.445
GEPU	-2,437 (3)	-2.884	-3.855** (1)	-3.445
ΔBTCTWH	-4.988** (3)	-2.884	-5.152 **(3)	-3.446
ΔGEPU	-18.880** (28)	-2.884	-19.795** (30)	-3.446

Note: :** indicates significant at the 5% significance level. Values in parentheses represent the appropriate Bandwidth delay length determined according to the Newey-West Bandwidth criteria.

According to the results obtained in Table 1, 2, BTCTWH variable was not stationary at the level in both fixed and fixed and trended model according to ADF and PP unit root tests. However, it is seen that the series becomes stationary after taking the 1st difference. According to both ADF and PP unit root tests, while the GEPU variable is not stationary in the fixed model, it appears to be stationary in the level values in the fixed and trend model. Therefore, the maximum lag length for the VAR model is calculated as $d_{max} = 1$

In addition, the appropriate lag length for the VAR model was decided by looking at the Likelihood Ratio (LR), Akaike (AIC), Schwarz (SC) Hannan-Quin (HQ) information criteria. The results obtained according to these information criteria are given in the table below.

Table 3. Determining the Appropriate Lag Length for the VAR Model

Lag	LR	AIC	SC	HQ
1	NA	4.790207	4.836915	4.809174
2	993.0281	-3.703153	-3.563029	-3.646253
3	99.78086*	-4.511197*	-4.277657*	-4.416363*
4	4.153352	-4.481053	-4.154097	-4.348287
5	6.207994	-4.470263	-4.049891	-4.299563

* Indicates the optimum lag length.

In Table 3, the lowest value according to all information criteria shows that the model with 3 lags is suitable. In other words, the lag length to be used in the model was determined as k=3. After determining the lag length, the Autocorrelation LM test was performed in order to decide whether there is an autocorrelation problem according to the determined lag length. As can be seen from Table 4, there is no autocorrelation problem.

Table 4. Autocorrelation LM Test Results

Lag	LM-Statistic	Prob.
1	4.820478	0.3062
2	7.815813	0.0986
3	4.087377	0.3943
4	1.164642	0.8839
5	2.469323	0.6501

In addition, considering the selected lag length, it should be tested whether the error terms of the VAR model contain autocorrelation problems. The autocorrelation problem may lead to deviations in the estimated parameters, resulting in erroneous findings. For this purpose, the inverse roots of the error term of the predicted model can be examined. If the error term is not autocorrelated, its inverse roots must be less than 1. The results for the inverse roots of the error terms are given in the table below.

Table 5. Inverse Roots of Error Terms

Root	Modulus
0.992473	0.992473
0.852633	0.852633
0.702922	0.702922
-0.216035	0.216035
0.992473	0.992473

Table 5 indicate that the inverse roots of the error terms were less than 1, so it was concluded that the model was dynamically consistent. Therefore, to perform the Toda-Yamamoto causality test, causality analysis can be performed since no problems were detected in the pre-tests.

Then, according to the unit root test and VAR lag length results, the $p + d_{max}$ value required for the Toda-Yamamoto causality test is 4. The results of the Toda-Yamamoto causality test obtained by considering these situations are given in Table 6 below.

Table 6. Toda-Yamamoto Causality Results

Direction of Causality	Lag Lenght	χ^2	Prob.
GEPU → BTCTWH	(k=3)+($d_{max} = 1$) = 4	8.243	0.040
BTCTWH → GEPU	(k=3)+($d_{max} = 1$) = 4	8.240	0.041

Table 6 shows that since the probability value of the calculated χ^2test statistical value is 0.04, the null hypothesis is rejected. In other words, there is a Granger causality relationship from global economic policy uncertainty to Bitcoin electricity consumption at the 5% significance level. Similarly, since the probability value of the χ^2test statistical value calculated from Bitcoin electricity consumption to global economic policy uncertainty is 0.04, the null hypothesis is rejected. In other words, there is a Granger causality relationship from Bitcoin electricity consumption to global economic policy uncertainty at the 5% significance level. Therefore, there is a two-way relationship between the variables.

6. RESULTS

Cryptocurrencies have become an investment tool that is frequently mentioned all over the world in the last ten years. Being the first crypto money to emerge and having the power to dominate the market has brought bitcoin to a very different position. Although bitcoin prices are the main talk among investors, bitcoin electricity consumption has a dimension that cannot be ignored. Uncertainty, on the other hand, causes investors to delay their investment decisions due to unpredictable conditions about the future, causing people to suffer higher future anxiety. Some indices have been developed to estimate uncertainty and make it relatively known. One of the most common of these indices is the global economic and political uncertainty index.

In this study, which examines the causal relationship between global economic political uncertainty and Bitcoin electricity consumption, data from the period 2011:M7-2022:M1 are used. Toda-Yamamoto causality analysis was applied to investigate the causal relationship between the variables, as it allows both the variables to be integrated to different degrees and to perform the analysis without the need for any cointegration analysis. According to the Toda-Yamamoto causality result made after obtaining the appropriate lag length, a Granger causality relationship was determined both from the global economic political uncertainty index to bitcoin electricity consumption and from bitcoin electricity consumption to the global economic political uncertainty index at the 5% significance level.

The determination of both variables as the cause of each other clearly shows that one global market affects another market. This situation supports that investors have to follow the financial markets on a global basis, not just the financial instrument they will invest in, while making their investment decisions.

AUTHORS' DECLARATION
This paper complies with Research and Publication Ethics, has no conflict of interest to declare, and has received no financial support.

AUTHORS' CONTRIBUTIONS

Conceptualization, writing-original draft, data collection, editing – LS, methodology, formal analysis – YY, Final Approval and Accountability – LS and YY

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