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Original Article

A Probe Survey of Bitcoin Transactions Through Analysis of Advertising in an On-Line Discussion Forum

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Abstract

Cryptocurrencies have become a major phenomenon in recent years. For IT, a breakthrough is both the cryptocurrency itself as a commodity and the technology that cryptocurrency development has brought. The article focuses on the bitcoin cryptocurrency as the most important cryptocurrency. A relatively unexplored topic is what goods or services are purchased for bitcoins. To track what bitcoins are spent on, it is necessary to look for places that are dedicated to trading cryptocurrencies. The bitcointalk.org forum was chosen as a source for our data mining. The aim of the article is to find an answer to the research question: What are bitcoins on the discussion forum bitcointalk.org planned to be spent on? As part of the research, an application was developed using a PHP script to gather information from the discussion forum (bitcointalk.org). There is some evidence which suggests what types of products or services people spend cryptocurrencies on. This research has proven that cryptocurrencies are used to buy and sell goods or services in the electronics and computer world segments. Today, these segments are widespread, which may speed up the integration of cryptocurrencies into everyday life. This applies, of course, only if the risks associated with cryptocurrencies do not increase.

Keywords: Cryptocurrency, Bitcoin, On-Line Advertisement, Text Mining, Cybersecurity, Discussion Forum.

1 Introduction

Cryptocurrencies are a new and big subject of contemporary science. Cryptocurrencies are a type of digital currency based on cryptographic principles for transaction validation. They form an alternative to traditional fiat currencies, issued and guaranteed by individual states. Unlike them, cryptocurrencies are decentralized, i.e., independent of central authority. What is important is that cryptocurrencies have a fixed maximum stock and release process.

Bitcoin is the first and also the most widespread cryptocurrency, created quite recently, in 2009. Bitcoin has become a very attractive commodity. The paper focuses on analysing advertisements in which bitcoin features. At present, it is difficult to obtain valuable information about the bitcoins spent. It is not clear what people spend cryptocurrencies on, how much they spend, etc. Bitcoin spending can be defined as signing a bitcoin transaction. Transactions in cryptocurrency systems are pseudo-anonymous but also transparent, non-

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returnable, fast and inexpensive. It is speculated that most of the transactions that are made do not serve to buy target products but only to trade with the given currency (Russo, 2018).

In order to perform a relevant data analysis, it was first necessary to find a source from which as many samples as possible could be obtained. Since no Internet shops yet exist that would sell goods for cryptocurrencies in larger volumes, it was necessary to search for data elsewhere (the term "goods" in this text generally means "things for sale"). Auctions and, above all, forums were among our candidates. There are a number of discussion forums that have been operating from the very beginning of cryptocurrencies and therefore have a large number of visitors.

Our research has shown that it would be best to use the *bitcointalk.org forum* as a source for data mining. The aim of the article is to find an answer to the research question "What are bitcoins on the discussion forum bitcointalk.org planned to be spent on?". Information was collected from primary sources – online advertising. The authors tested the scientific hypothesis that "the incidence of supply advertisements on the bitcointalk.org is just as likely as the incidence of demand advertisements". The goal of the article was achieved by developing an application (software programmed for this purpose) that enabled the collection of information from web pages, and then analysing this information. A vital feature of the application was that it should be able to read real-time data and use a suitable database or data warehouse to store and analyse that data. The results were compared with other research, including studies focusing on fiat currencies and their online spending.

Although an increasingly widespread population is interested in bitcoin, it is still a relatively unknown topic. No one has focused in more detail on the subject examined in this article. This is not surprising, given the fact that in the past it was not necessary to study what bitcoins were spent on because they were not yet a big phenomenon. Thus, the contribution of this article is up to date and completely original. This fact can be approached in different ways. It can be assumed that the results of the article could have the biggest benefits for companies that decide whether or not to invest in providing bitcoin payment options. As far as the scientific contribution to theories is concerned, to the best of the authors' knowledge, this article presents new insights into the fields of marketing, informatics and also finance. However, it is necessary to acknowledge the limits of the generalization of the results of our research. Despite the importance of the bitcointalk.org forum that was examined, analysing a single forum cannot reflect the whole market. The contribution draws on (Ban et al. 2018; Ban 2018; Lansky 2018; Lansky 2017).

It should be mentioned here that this article is an extension of considerations and discussions undertaken within the paper that was presented by the authors at 26th Eurasia Business and Economics Society Conference (EBES) that was held in Prague (Ban et al., 2018).

2 Background

This section provides an introduction to the issue of cryptocurrency, which is crucial in this text. A special emphasis will be placed on bitcoin as the lead player among cryptocurrencies. For the sake of completeness, the fiat currency will be briefly discussed as well. This section will also illustrate online shopping trends and purchase/sale through advertisements, both of which are closely related to our research.

2.1 Bitcoin and other cryptocurrencies

Cryptocurrencies are becoming a part of life for an increasing number of people. They are a digital representation of value that is created by private developers. Cryptocurrencies can be retrieved, stored, transacted and accessed via Internet clients – wallets (Narayanan, 2016). Cryptocurrency is a decentralized payment system without a central authority to perform transaction clearings (Lansky, 2018). Transaction clearings are performed in a computer network of individual peer-to-peer network nodes. Each network node verifies the accuracy of transactions individually. Transactions are lined in blocks, which are then added to the ledger that typically uses the *blockchain* data structure designed by Haber and Stornetta (1991). Blockchain technology is also applicable in other areas, for example Knirsch et al. (2019) analyse the use and safety aspects of blockchain technology in photovoltaic power distribution.
Each network node keeps the same copy of the ledger up-to-date. There are several different methods to verify the validity of the blocks to agree all network nodes on a single version of the ledger. The oldest method to achieve such agreement is the proof of work (*PoW*) developed by Back (1997) and formally described by Back (2002).

Cryptocurrencies create a great deal of turmoil in the world, especially most recently. This is mainly because they have given rise to very interesting investment opportunities. Most cryptocurrencies have the tendency to gain in value, and some of them experience an incredible increase in price for a very short time. As cryptocurrencies gain popularity, more and more companies are expected to provide people with a cryptocurrency payment option (Antonopoulos, 2015). According to *coinmarketcap.com*, there are 3047 cryptocurrencies that are tradable on stock exchanges (Cryptocurrency Market Capitalizations, 2019). And others are still emerging; an attempt to create something unique attracts a lot of programmers. Many authors focus on analysing of the demand for cryptocurrencies and the use of cryptocurrencies as a means of exchange. Chokun (2016) proves that the number of merchants who receive cryptocurrencies as payment for their goods and services is expanding. The other side of the coin is linked to the fact that cryptocurrencies are also becoming a subject of interest for banking regulators (European Banking Authority, 2014).

The beginning of cryptocurrency research can be associated with Chaum (1983), who introduced the first digital monetary system. Another milestone is the emergence of the first bitcoin cryptocurrency introduced by Nakamoto (2008). Most cryptocurrencies are derived from bitcoin. Nakamoto (2008) describes the algorithms used for the operation of bitcoins. Antonopoulos (2014) explains the function of the bitcoin system on practical examples. Bitcoins are called digital gold (Popper, 2015).

Cryptocurrencies are a new issue that is very complex; it brings a lot of opportunities but also problems. Research into cryptocurrencies is carried out in the fields of informatics, finance, economics and law.

The study of economic aspects with a focus on price development is centred on the most widespread cryptocurrency – bitcoin. The market capitalization of the bitcoin currency according to (Cryptocurrency Market Capitalizations, 2019) corresponds to 68% market capitalization of all cryptocurrencies. The degree of similarity between cryptocurrencies and fiat currencies is often addressed in literature and the factors influencing bitcoin price and bitcoin price volatility are discussed.

Dwyer (2015) analysed the demand for cryptocurrencies, the use of cryptocurrencies as means of exchange, and the price and volatility of the bitcoin between 2010 and 2014. Wolfson (2015) summarized the major events in the history of the bitcoin cryptocurrency and

examined their influence on its price. Cheah and Fry (2015) analysed the price of the bitcoin between 2010 and 2014 by econometric tools and proved that the price of the bitcoin cryptocurrency tends to create bubbles. Dyhrberg (2016) analysed the volatility of the bitcoin by means of *GARCH* and ascertained that the bitcoin combines the characteristics of the US dollar and gold. The authors of this article examined the prices of cryptocurrencies in the past (Lansky, 2018), choosing cryptocurrencies which showed the greatest price drops and rises, and analysed the innovation value of those cryptocurrencies. Lansky (2020) is also concerned with the probability of the cryptocurrency surviving a given number of years since its inception.

The effect of various factors on the price of cryptocurrency was examined by Ciaian et al. (2016). The factors were divided into three groups, one of which was the attractiveness of bitcoin for a user. Among other things, they were unable to prove that macroeconomic factors affect bitcoin's price. Bitcoin's attractiveness for users was measured by the number of new posts and the number of new users on *bitcointalk* – the largest online bitcoin forum. They used the same source – the *bitcointalk* forum – for their assertions as our research.

From the view of information and communication technology, the issues most often discussed with respect to cryptocurrency are anonymity, safety, suitability of individual technical parameters and increasing the usability of cryptocurrencies in practice. From a legal point of view, discussions are frequent on how to regulate cryptocurrencies and the misuse of cryptocurrencies for criminal activity. A number of treatises warn against the risks of cryptocurrencies. The European Banking Authority (2014) defined 70 risks that the use of cryptocurrencies may bring. Cryptocurrencies are often referred to as pseudo-anonymous. All transactions that take place in the given system are available to anyone on the Internet. The only information about the user is their public address. It is this anonymity that opens the dark side of the cryptocurrencies. It is speculated that a part of the illegal trade functions on the principle of cryptocurrencies and uses this anonymity (Lee, 2015). Dostov and Shust (2014) dealt with the anonymity of bitcoin transactions and the problems this anonymity poses when applying the rules of "Anti-money laundering and combating financing of terrorism". Finance chiefs from the G-7 issued a stark warning that cryptocurrencies like the Libra digital money recently unveiled by Facebook should not be allowed before "serious regulatory and systemic concerns" are addressed (McHugh, 2019). From the IT point of view, it is necessary to see the development of cryptocurrencies as a part of further digitalization, robotization and automation, which according to (Basl & Doucek, 2019) in manufacturing are associated with the Industry 4.0 concept.

Cryptocurrencies also have downsides. Conrad et al (2018) highlight the high volatility of cryptocurrency prices. Cryptocurrency holders may lose a significant part of their investment within a short period of time. High volatility is one of the reasons why commodity prices are not expressed in cryptocurrency units but in fiat currency units. Demieva (2018) draws attention to the difficult situation in which the ownership of cryptocurrency units is subject to state regulation. Ownership of crypto currency units is, by its nature, a mere knowledge of the private key through which ownership of crypto currency units can be transferred to other holders. This feature of cryptocurrencies raises problems in litigation over their ownership, because a court's judgment is not practically enforceable. Barone and Masciandaro (2019) disclose ways in which cryptocurrencies can be used in money laundering. Due to their anonymity, cryptocurrencies may be a good tool for organized crime. Greenberg and Bugden (2019) deal with electricity consumption in extracting cryptocurrencies using proof of work. This method of electricity consumption has a negative impact on the attractiveness of cryptocurrencies for the ecologically minded part of the population.

The information that gets to the media about cryptocurrencies is not always true. Unfortunately, this is due to the fact that the general public makes different assumptions about cryptocurrencies. The most popular views of cryptocurrencies comprise, for example, the information that cryptocurrencies are used for payment on the black market. People believe that the partial anonymity of cryptocurrencies makes it an ideal currency in this market. Another of the widespread assumptions about cryptocurrencies is that they serve more as an investment tool than as an end-goods/services payment. There are a number of similar assumptions and these most likely greatly inhibit the development of the technology as such.

2.2 Fiat currencies and their spending

As stated above, cryptocurrencies present an alternative to fiat currencies, forced circulation currencies. Users of cryptocurrencies are required to have greater personal responsibility than users of fiat currencies. Cryptocurrency transactions are irreversible and cryptocurrency systems are independent of any state authority (Lansky, 2018). At present, the short-term changes of cryptocurrency rates are so great that cryptocurrencies cannot be used for pricing goods. However, they can be deemed to retain value in the long-term. Historically, significant rises/falls are not typical for cryptocurrencies only, as the fiat currencies are also subject to currency crises (Helisek, 2002).

As this article aims to study current bitcoin spending, we must also notice the context of changes in the manner of spending fiat currencies. The consumer culture has undergone radical changes (Roubal, 2017). The main agents of such changes are the information and communication technologies, social changes and ideologies that surround computerization and informatization (Smutny & Vehovar, 2020). Figure 1 shows the development of internet users who bought or ordered goods or services for private use in the previous decade (by age group within the EU-28).

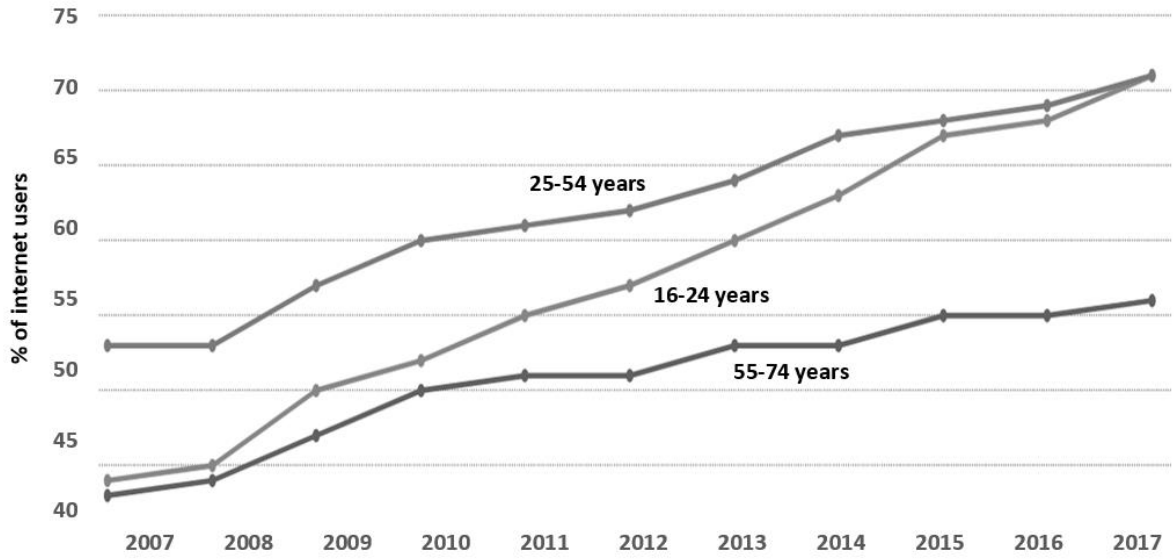

Fig. 1. *Development of internet users selling of shopping for goods (%).*
Source: (Eurostat Statistics Explained, 2018)

The market is changing, looking for low-cost communication channels. Especially SMEs are flexible (see Mares & Dlaskova, 2016). Some goods are sold through advertising, especially online advertising. Advertising can utilize almost any form of media including print, television, radio, cinema or the outdoors. In recent years, digital and mobile advertising have been targeted by advertisers. Online advertising has proven to be extremely profitable for

business, as confirmed by reports (Statista, 2018) showing that around 95% of Google's revenue comes from online advertising (Statista, 2018). The source (Statista, 2018) contains data on worldwide on-line advertising expenditure with a forecast until 2020. This statistic projected the spending would grow to 335.5 billion U.S. dollars by 2020.

3 Data collection and methods

This section will describe how the research examination was carried out, show the issue of searching for relevant data and the theoretical starting point for the development of software applications such as data mining and text-mining. The cryptocurrency market is very young and the cryptocurrencies are not yet sufficiently integrated in the real world to effectively put together statistics about their usage. Similarly, the properties of cryptocurrency itself, such as partial anonymity and the difficult traceability of persons owning cryptocurrencies, make objective statistical surveys impossible. Given these facts, there are not many analyses of what the cryptocurrencies are spent on at the moment. Let us, therefore, at least focus on similar cases.

The first subject we are going to focus on is the *statista.com* website. This website publishes various statistical surveys and provides information on cryptocurrencies. It does not focus strictly on the target products on which people spend their cryptocurrencies but rather on easily traceable indicators related to cryptocurrencies (e.g. price development, development of the number of transactions, etc.). However, this website provides interesting information from which it can be deduced how quickly cryptocurrencies integrate into real life (Number of bitcoin ATMs, 2018). Another application is *bitpay.com*. Its main objective is not to analyse the market with cryptocurrencies but to create a simple platform for cryptocurrency payment, whether one is paying for services, products, or simple transfers (BitPay, 2017).

One can locate any block or blockchain transaction on the *blockchain.info* website. The page also provides information about each of them. For example, information about the addresses of the given transaction, the value of the transaction, the size of the transaction in bytes, the recipient's IP address, or the transaction fee (Antonopoulos, 2015) can be determined. It is clear from the above that it is not possible to determine from this website the purpose for which the transaction was executed. This means that it is not possible to determine whether the transaction was made for the purpose of purchasing an end product, or whether it was a transfer between two accounts. Another application that traces bitcoin transactions is *blockonomics.co*. A bitcoin address is entered in this application and it lists all transactions that were made using this address.

Our other candidates for sources of relevant data included auction sites. For example, the *bitify.com* site allows its users to offer and buy items by auction. Although all prices are converted to dollars, one can pay only with *bitcoin* and *Litecoin*. For the purposes of our analysis, however, this page is not very suitable because the volume of products offered here is not too large or sufficiently varied.

In order to keep track of what bitcoins are spent on, we need to look for places that are designed for trading with cryptocurrencies. There are different websites that serve for advertising goods for cryptocurrencies. The best known at international level include, for example, *glyde.com* or *bitify.com*. These sites are visited by people for the purpose of selling or buying goods. Here, it is possible to obtain the desired information for our research, i.e. what goods are sold for cryptocurrencies at present.

The discussion forum *bitcointalk.org* appeared to be the most suitable candidate for collecting data for analysis. This forum was established in 2009, the same year as bitcoin, and is one of the oldest websites that deal with the issue of cryptocurrencies. At present, this forum has almost 2 million users. The most important fact, with regard to our research question, is that this forum trades products and services for cryptocurrencies. People publish advertisements in which they seek or offer goods of all kinds in exchange for cryptocurrencies. The advantage is that the data appearing in these advertisements is varied, i.e. they do not focus only on several types of products or services, but on their entire spectrum. The analysis should then reveal what kinds of goods people seek and offer most frequently.

This leads to the question of data collection, what type of data is on the examined bitcointalk.org forum and how to obtain information from it. The term *data* is used in the traditional sense in the article – it is an expression of a given fact in a certain form for the purposes of storing, transfer, and processing. Data can be interpreted in a variety of ways, e.g. numerically, as a text, audio, geographically, as multimedia, or image. What they have in common is that they carry certain information (Saltz & Stanton, 2018). In the modern, digitized world, it is logical that the amount of emerging data grows rapidly and contains enormous amounts of information. Social networks produce the largest amount of data. There is a large amount of usable information in this data, but it is relatively difficult to obtain. The sources of this data comprise, for example, blogs that the authors of the article focused on. Their contents are highly unstructured but contain interesting information (Stieglitz et al., 2018).

One of IT disciplines, *Data Mining*, focuses on obtaining data and, subsequently, obtaining information from that data. Data Mining is based on empirical data and detailed analysis of individual cases and relationships between variables. Based on the differences and similarities found in the data, the so-called *patterns*, or more precisely data models are created. Before analysing the data, it is necessary to clear the data of poor data. Subsequently, the data is transformed. Transformation means a change in the view of data, i.e. putting emphasis on some of its aspects. The mining process itself is based on the transformed data. This gives a person the patterns that will be used to interpret the acquired knowledge. Knowledge is the resulting product of an entire algorithm. This algorithm describes a technological view of knowledge mining. But there is a second, managerial perspective. In this view, a problem is first specified. For example, if one deals with the customers of a department store, the problem may be finding out what segment of people buys certain types of goods. It may also be about obtaining information about what goods are traded via the Internet using cryptocurrencies (Witten et al. 2016).

Data mining methods are usually based on the fact that someone has data in a database that is ready for processing. When acquiring knowledge from text, a person usually does not have a pre-defined database available that he/she can directly work with. They often have to work with non-relational databases or data warehouses. A lot of data is stored in the form of text, in the so-called text or document databases. These databases carry data, for example from emails, newspaper articles, books or websites, as is the case of our research. These databases are becoming more and more widespread and popular. That is why a recent trend in Data Mining has been to increasingly promote the so-called *Text Mining* (Han & Kamber, 2006).

In this article, html search and weakly structured data are applied to the information extracted from the *bitcointalk.org* forum. A key-word search is applied, which is a common method for similar investigations. For example, Jansen, Sobel and Zhang (2011) analyse the relationship between performance and use of brand terms in the key phrases that link advertisements to searcher queries. Within the research, human factor was used to classify key words into

categories. Different people can classify certain keywords into different categories, which implies that even the results obtained may vary slightly. Another inaccuracy may arise if the advertiser uses the keyword in a different meaning than is usual.

While retrieving the data we had to overcome the protection mechanisms of the portal, because we were considered a *DoS* attack due to our high data download intensity (Nulicek, 2018). Based on data usage (data that consisted of more than 2.5 million records) there are an evidence, that a focus by key word advertisers on branded terms for search engine ads could be quite beneficial for both the effectiveness and efficiency. The individual advertisements do not contain metadata, therefore more advanced techniques could not be carried out, such as Simek et al. (2013).

As has been said, the goal of developing our software application (see Ban, 2018) is to find out what bitcoins are spent on and in what amounts. Since it is an application that downloads information from websites, it offers the possibility of developing a PHP script. This language is designed for the development of Internet scripts and is suitable for creating real-time applications (Lecky-Thompson & Nowicki, 2010). Data could then be stored in a repository, which is suitable for frequent searches and analyses. For this, a data warehouse is created to store data so that it can work effectively during analysis, as stated by Zhang (2008).

4 Results

The aim of the next part of the article is to answer the research question and examine the issue of cryptocurrencies according to the ways of their spending. It outlines the development and implementation of a data mining application that collects and analyses information from the discussion forum bitcointalk.org.

4.1 The process of obtaining, preparation, and data processing

Once the problem is specified, data needs to be collected. In this step, it is necessary to collect as much relevant data as possible to find a suitable solution to the problem. Coming back to the problem of the merchandise that is being traded for cryptocurrencies, it is necessary to collect all the data from the web pages and choose from it the data that is relevant. Then follows the pre-processing step. If the data is strongly unstructured (as was the data from the blog in our case), it is difficult to prepare the data for analysis. The data pre-processing step is often very demanding and requires many computational operations.

As already mentioned, the *bitcointalk.org* forum was chosen as a source for data mining. To do this, a *script* had to be designed that would be able to go through all advertisements and download relevant data that would then be processed and analysed.

Before developing this script, it was necessary to determine which items would be relevant to the analysis. The advertisements are broken down in a *html* table so that it only shows the title of the given ad, the nickname of the member who wrote the ad, the number of replies, the number of views and the last answer. The user can then click on the title on the ad page itself. It contains a link that shows a specific ad, if it is still possible to get to its text. The newly created database is the result of the data acquisition phase. After several iterations regarding the loading of the data mining script, it was filled with data. The script was able to download all published advertisements.

After downloading 120,000 advertisements, it was necessary to select only the relevant data and prepare it for analysis. As mentioned in Chapter 2, data preparation is one of the most important steps in the process of acquiring knowledge from databases. It often has a direct

impact on what results can be achieve, which is why we often returned to this phase and adjusted the data as needed.

First, it was necessary to focus on the structure of the downloaded data. The key information we wanted to obtain from each unique ad comprises the items *headline* and *text*. They contain information about whether a given product is offered or sought, and also what product it is and what its price is. The problem was that the advertisements we had managed to download did not have a fixed structure. This means that we could not uniquely search for key information based on specific rules. After examining several tens of advertisements, however, it was possible to find a pattern according to which the data could be modified to be ready for analysis. This pattern was that the author's intention, i.e. whether they wanted to buy or offer the product, was often found in the title. Furthermore, in most cases the author mentioned in the title the product they wished to offer or sell.

In the next step, the data was transformed so that it could be effectively searched. Transformation in this case meant converting all capital letters in the spreadsheet advertisements to lowercases. This was to ensure that whenever we searched for a particular keyword, we would always find all of its occurrences. In addition, it was necessary to remove irrelevant data and at the same time make sure that no key data was lost in this step.

When analysing the advertisements, it was also possible to find several keywords that were used in ad headlines and which were suitable for data preparation. The most critical words included expressions *deleted <*, *close <*, *del <*, *end <*. These terms indicated that the ad had either been deleted, closed, or terminated, and therefore there was no relevant data for future analysis because both the text and the title were deleted and replaced with the above terms. Therefore, all ad listings that contained one of the above terms were deleted. Around 12,000 such advertisements were in the database, representing almost 10% of the initial sample. At the next stage of data preparation, all irrelevant words were removed from *title* and *text* attributes. Such words include prepositions, connectors, and pronouns.

In this phase of the process, the data has been downloaded and transformed so that it could be effectively searched and worked with. The main objective of the analysis was the search for the offered or demanded products. However, it was also important to find out if a specific advertisement was of a supply or demand nature. In the first stage of data processing, we tried to divide all advertisements into three different categories: Demand, Supply, Indefinite. While browsing the sample of advertisements, it was obvious that the title of the ad reflected in many cases the intention of the ad writer. There were also different patterns that differentiated the advertisements according to whether the goods were being offered or sought. Examples of such patterns and key terms were: *WTS* (Want to sell), *WTB* (Want to buy), *Looking to buy*, *Looking to sell*. The result was the creation of 43 keywords to determine the nature of the advertisements. Three new tables (WTS, WTB and IND) were created in the database, into which we sorted individual advertisements according to their type. The last of these tables was used for inserting advertisements for which we were not able to determine whether they offered or wanted the product.

To ascertain the character of the advertisements, a feature was designed that went through all the advertisements and sorts them into the tables *WTS*, *WTB* and *IND*. In order to make the feature as effective as possible, it was necessary to find as many terms as possible that appeared in the headlines of the ads and clearly divided the ads into individual groups. Then the filter was run, using the *SQL* query language and the *LIKE* clause, which enabled it to search the table for occurrences of different strings. This process took place in several

iterations. The feature was able to sort 75% of advertisements. This means that only in 25% of advertisements it was possible to determine whether it was a product demand or supply.

At the next stage of the data processing, the goal was to focus on the headline and text of each ad and try to look for patterns to help with the search for the products to which the ad relates. This could have been approached in several ways. One of the first options was to create a feature that would go through the headlines and texts of all advertisements and sort all words according to occurrence thereof. After testing this option, it became clear that this pattern would not be very helpful in finding product information. A much more effective option was to manually go over a smaller sample of advertisements and search for patterns. After this test analysis, it became clear that in many cases the product offered or demanded appeared both in the headline and in the ad text. Having filtered out all unnecessary words from the title in the data preparation phase, it was much more likely that this analysis would yield more accurate results. Therefore, a feature was implemented that went through all advertisements and searched for all the words in the caption attribute that appeared in the *text* attribute in the same ad. New *WTSklic*, *WTBklic*, and *INDklic* tables were created, which were copies of the previous tables with the keywords attribute added. The keywords attribute were words that appeared both in the title and in the ad text.

In the next phase of knowledge acquisition, we performed the analysis itself, in which we tried to find in each ad the name or description of the product that the advertisement was concerned with. This part of data mining is the most important and at the same time involves most work. The ambition was to achieve the best possible product search results, while maximizing accuracy and minimizing the number of errors that occur due to process automation. The goal at this stage was to create several product groups that had similar characteristics and create features that would break individual advertisements into these groups based on the keyword comparison algorithm. First of all, it was necessary to start defining the keywords according to which the advertisements would be categorized into individual groups. This phase was the most labour-intensive of the whole analysis, since it could not be fully automated.

First, it was necessary to manually browse through the *WTSklic*, *WTBklic*, and *INDklic* tables to track the keyword attribute. From this attribute such words had to be chosen that were definitely key words and could serve as classification parameters. It was necessary not to choose words that could not clearly classify the advertisement. To make this process as efficient as possible, iterations need to be performed. First, we found 10 keywords. Then we implemented a feature that again scanned all ads in the *WTSklic*, *WTBklic*, and *INDklic* tables, comparing the keywords attribute in those tables with the keywords we had found manually. If the function found advertisements with these keywords, it sorted them into relevant groups and deleted them from the original tables. This process had to be repeated as long as we were able to find relevant keywords that would help us categorize ads. In order to obtain the final number of keywords, it was necessary to perform over 30 iterations. As a result, twenty product groups and 328 keywords were found. The sorting algorithm reached the accuracy of 85%. The remaining advertisements that were left unspecified were largely absurd, poorly structured, or related to very specific subjects.

The product groups are as follows: *Coupons, Hardware, Mobile, PC Games, Gambling, Grey Zone, Black Zone, Server, Programming, Web, Books, Crypto, Money, Food, Transportation, Software, Sports, Services* and *Goods*. Each product group has its own characteristics and a number of keywords that determine whether or not a particular ad belongs to that group. For example, the characteristics of the *Coupons* group are that they are products for the purchase

of goods. It concerns the majority of gift vouchers, prepaid cards used for purchases on the Internet or in the shops.

The *Hardware* group includes all electronics for computers, televisions, game consoles, etc. However, computer games and mobile phones are not included as they form a separate group. *Gambling* is another large group. This includes all products/services that are related to gambling, i.e. scratch cards, poker chips, cards, etc.

The *Grey Zone* and the *Black Zone* are interesting groups. These include illegal products and services and also those considered unethical or inappropriate in the society. The *Black Zone* includes all products and services that are strictly illegal, others are in the *Grey Zone*.

The *Server* group includes most often offers of virtual servers or VPN. *Software* includes advertisements that concern the provision of software services, software as such, or licenses for individual software products form another major group. The *Programming* group includes all services related to application development. The *Web* table forms another very large group. It consists of advertisements that try to sell accounts in individual web applications, sites, or stores. *Books* includes all audio books, e-books and printed books. The table *Goods* includes other small items that were not represented in the advertisements to a greater extent, such as clothing, collectible artefacts, etc.

Cryptocurrencies form a very large group. All advertisements related to cryptocurrency exchange for fiat currency or vice versa fall here; also all the software and hardware that is used to extract cryptocurrencies. The *Money* group is a relatively similar group. Here we include all banking services, services related to electronic wallets, etc.

The *Food* group includes all advertisements related to restaurants, food sales, etc.; advertisements for other services belong to the *Services* group. An example may be renting real estate. *Transport* and *Sports* form the last two groups. The first includes advertisements related to taxi services, car sales, and other means of transport. Various sports equipment is included in the *Sports* table.

It is logical that collisions can occur after the creation of so many groups. This means that one advertisement may belong to multiple groups. Based on this fact, keyword analysis was performed and collision tables were identified.

4.2 Check and interpretation of results

Several inspections and treatments were required after the advertisements had been sorted out. The assembled test feature progressively went through all the tables where the advertisements were already sorted and performed the keyword test. As mentioned earlier, many advertisements may fall into multiple groups. We maintained the so-called weight of the advertisements in the tables. This weight was to serve us in the data analysis phase and tells us in how many other groups the advertisement occurred.

This part of the paper deals with the interpretation of the results. From the original sample of 120,000 downloaded advertisements, after removing erroneous advertisements, the sample was reduced to the final 101,585 advertisements. Table 2 shows how successful the search algorithm was in distinguishing between supply (WTS) and demand (WTB) ads. The *IND* attribute describes advertisements in which it was not possible to determine whether they are for demand or supply. They were used in further analysis regardless.

PURPOSE/NUMBER	[%]	NUMBER
WTS	52	52 824
WTB	21	21 333
IND	27	27 428
TOTAL	100	101 585

Tab. 1. *The success of determining the purpose of the ad. Source: Authors.*

Table 1 shows the first dominant pattern or, more precisely, knowledge. We found that more than half of the advertisements under review were of a supply nature. On the other hand, we found demand nature only with respect to 21% of the advertisements examined.

By testing the following hypothesis, we will verify whether there are, statistically, significantly more WTS advertisements:

> H0: The incidence of supply advertisements (WTS) is just as likely as the incidence of demand advertisements (WTB).
>
> H1: The incidence of supply advertisements (WTS) is greater than the incidence of demand advertisements (WTB).

All advertisements with the IND attribute are included in the WTB group (this is the best option for the H0 hypothesis). We will assume that, if the H0 is applicable, the number of advertisements with the WTS attribute will be subject to binominal division with the parameter p = 0.5. For test statistics, we will use the value:

$$S1 = \frac{(2\mathrm{WTS} - \mathrm{TOTAL})}{\sqrt{TOTAL}} \tag{1}$$

If the H0 is applicable, the S1 statistics will be asymptotically subject to normal division. In our case, S1 = 12.748 and p-value = 0.000. We reject the H0 hypothesis with 0.01 level of significance. We can therefore assume that there were significantly more supply advertisements than demand advertisements. Because S1 is positive we can accept the alternative hypothesis H1.

Now we will focus on the most important results of the overall analysis. In the course of the analysis, a total of 20 different groups were created, into which advertisements were sorted, as already mentioned. The graph in figure no. 2 below shows the percentage values for each of the twenty groups. The first three groups (*Coupons*, *Crypto*, and *Web*) are around the 20% share limit. The first example we can extract from this information is that all the most numerous groups are in some way connected to the digital world. Thus, the logical reasoning is that cryptocurrencies are most commonly used in the world of computers and electronics. Another pattern that follows from the table is that, in addition to the *Hardware* table, there is no group that would have the nature of goods.

The highest share after the overall analysis is taken by *Web* with 19.14% of the total number of advertisements. In particular, advertisements relating to various Internet applications such as *spotify*, *facebook*, etc., and also domain name provision, the sale of Internet accounts, addresses etc. are included in this table. Again, there is a pattern indicating the frequent use of cryptocurrencies in digital environment. *Crypto* is the second largest group. In this table there are all advertisements regarding cryptocurrencies, their exchange, mining, etc. In the vast majority of cases, it is about trying to exchange the cryptocurrency for fiat currencies. This fact indicates that cryptocurrencies are not currently used too much to buy end products, but rather as an investment. In the third largest group, *Coupons*, there are advertisements related to the supply and demand of gift cards, coupons, etc.

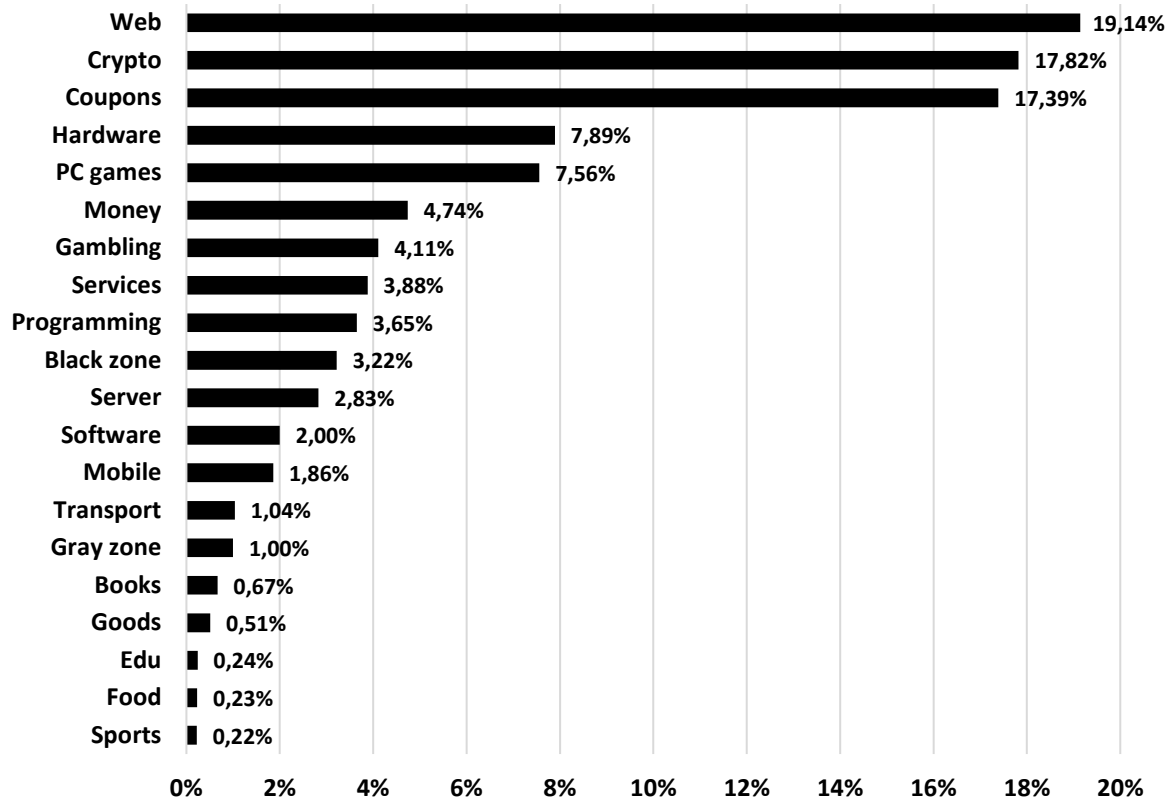

Fig. 2. *Graph of individual group representation (in %). Source: Authors.*

The smaller groups of the original twenty follow one important pattern. Unlike the table of the most numerous groups, this table contains groups that are of the character of material goods. This fact again reinforces the pattern that the population does not currently tend to buy goods for cryptocurrency.

Let us think about the results of the analysis and discuss the patterns and knowledge we have gained through the analysis. We will also reflect on the potential use of the acquired knowledge both now and in the future. We will also attempt to predict the future integration of cryptocurrencies into everyday life. On the basis of the analysis that was conducted, we were able to acquire interesting knowledge. The first piece of knowledge was that people use cryptocurrencies to purchase things related to the digital world. It can be argued that cryptocurrencies as such are in digital form and originated in computer environments. The question is, of course, whether or not the cryptocurrencies will over time be integrated into other spheres. Since digital services and electronics are inherent parts of people's lives nowadays, it is valid to speculate that cryptocurrencies will spread to other segments.

Another significant piece of knowledge gained from the analysis is that cryptocurrencies are very often used as an investment tool. At least that is what advertisements in the *Crypto* group indicate, which was the second most numerous group. In this group, most of the advertisements concerned the exchange of cryptocurrencies for another cryptocurrency or a fiat currency. One of the widespread beliefs in society is that cryptocurrencies are used rather as investment tools and that they do not have a long-term future. This assumption radically contradicts the original purpose of all cryptocurrencies. The aim of most of them is to create a decentralized currency that will gradually replace the classic fiat currencies. Cryptocurrencies' developers greatly support the vision that in future cryptocurrencies will

replace all the known fiat currencies and that they will be used in everyday life. The fact that the *Crypto* table was the second largest group of all, however, strengthens the presumption of their use primarily as an investment. 2017 marked a great media outreach and almost a "crowd madness", which attracted a large number of speculators. However, it can be assumed that these externalities will stabilize over time and with market developments.

Cryptocurrencies are pseudo-anonymous for the public. It is one of the features that people prefer and, therefore, seek to keep it. Nowadays, there are several stock exchanges that deal with cryptocurrency trading. The disadvantage, however, is that stock exchanges are often required to collect data about their users and, in some cases, to provide it to financial institutions. This eliminates one of the main features that people prefer with respect to cryptocurrency. It can be assumed that people search for sites like Internet forums where they can continue to trade their cryptocurrencies relatively anonymously.

Another piece of knowledge revealed by the analysis is that cryptocurrencies are not much used to buy goods. The analysis shows that most groups that have the character of goods or services tend to be in the lower half of all groups. Groups such as *Hardware*, *Software*, and *PC Games* constitute an exception. In these groups, however, it must again be pointed out that they are more of a digital or electronic character.

Section 2.1 above mentioned the assumptions about cryptocurrencies. The most widespread assumption concerns their use for trading on the black and grey markets. It also has a significant share in slowing down the development of cryptocurrencies as such and their integration into normal life. The assumption in our analysis, we focused on the black and grey market separately. The comparison between the grey and black markets suggests that there are roughly three times more black-market advertisements than grey market advertisements. In terms of total representation, the black market accounted for 3% of the total number of advertisements. It concerned approximately 3,000 advertisements. By contrast, the grey market accounted for only 1% of the total.

5 Discussion

Acheson (2018) deals with a question that is similar to this paper. The article introduces a wide range of fields where cryptocurrencies are used for payment. It also mentions a wide range of websites that support pay-as-you-go payments. The most popular sector includes gift vouchers and Internet applications providing multimedia data such as music or videos. The fact that people spend cryptocurrencies on goods is also mentioned by bitpay.com developers in their blog (BitPay, 2018). They also mention the rapid growth in the number of transactions, indicating the ever-increasing integration of cryptocurrencies. The blog developers claim that several business partners have doubled their monthly profits by offering cryptocurrency payments. There are companies engaged in the sale of electronics and precious metals.

Nova (2018) speculates that it is too early to get cryptocurrencies in real life on a larger scale and to replace the classic fiat currencies. The study emphasizes that cryptocurrencies are often used for investment. Mildeova and Brixi (2011) show that people accept technological innovations of a "disruptive" nature (such as the blockchain cryptocurrencies) with a time lag.

The results of the above studies correspond to the outputs of our analysis. The high number of advertisements in the *Coupons* and *Web* groups support Acheson's (2018) claim that gift vouchers and Internet applications are the most popular items for cryptocurrency payments. As for the demand for electronics and valuable metals discussed in the blog (BitPay, 2018),

our research has confirmed the frequency of advertisements for electronics. However, the demand for precious metals has not been proven and these words have not been confirmed as key. What Nova (2018) says, as well as a number of other authors, is that cryptocurrencies are often used for investment; our research unambiguously confirmed that by the placement of *Crypto* in the second place in our ranking.

Foley, Karlsen and Putniņš (2019) state, that cryptocurrencies are among the largest unregulated markets in the world and that cryptocurrencies are transforming the black markets by enabling "black e-commerce". The authors reckon that approximately one quarter of bitcoin users are involved in illegal activity. At the same time, they claim that the illegal share of bitcoin activity declines with mainstream interest in bitcoin and with the emergence of more opaque cryptocurrencies. In contrast, the results of our research did not show cryptocurrencies as a threat that facilitates trafficking in illegal goods. However, it should be remembered that the authors of the article drew information only from the *bitcointalk* forum.

Let us compare our results with studies focusing on fiat currencies and the population tendencies in online spending patterns. The European Statistical Office deals with such queries (Eurostat Statistics Explained, 2017). The groups explored are similar to the groups that were used in this article. In addition, the analysis of the European Statistical Office divides the surveyed segments according to age. This categorization by age structure is advantageous for comparison with the cryptocurrency market. The younger generation uses cryptocurrencies to pay with a higher frequency. Also interesting would be a correlation with other aspects, especially education, which of course also prepares students for new forms of marketing (Svec & Selby, 2019). However, due to the anonymity of *bitcointalk* forum, these analyses are not possible and are not cited even by Eurostat Statistics for fiat currencies.

The graph in Figure 3 shows that clothes, sports goods, travel and household goods are the items most often bought on the Internet through fiat currency. However, by looking at the shopping pattern of young people, a trend can be seen towards purchases of tickets for events, video games and other software, bringing them closer to the results of our research.

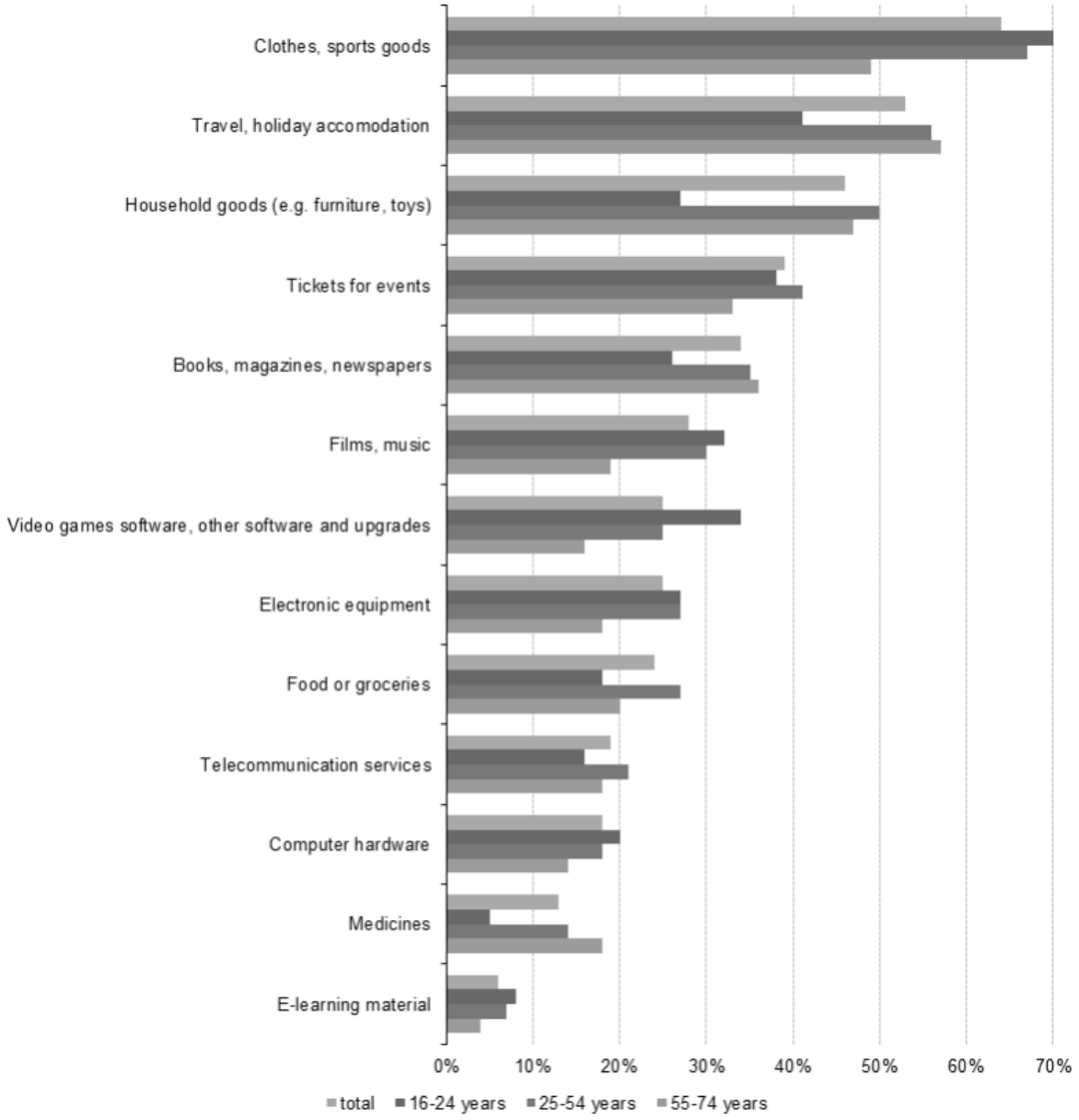

Fig. 3. *Online sales in the EU. Source: (Eurostat Statistics Explained, 2017)*

6 Conclusion

In this research, the authors tried to answer the research question "What are bitcoins on the discussion forum bitcointalk.org planned to be spent on?" The fact that these advertisements do not focus so much on the advertising of goods/services opens up some interesting topics for discussion. If we think again about the mission of cryptocurrencies, we find that it is a rather crucial step in history. The population is used to working in everyday life with fiat currencies. It is, therefore, logical that the emergence of a new concept, such as the cryptocurrencies, that attempts to replace the established trend of the fiat currencies will encounter a relatively high resistance. If they are to be used in everyday life, it is necessary for the population to become accustomed to them over time and to integrate them into further sectors. The fact that cryptocurrencies are currently not much used to buy ordinary goods does not mean that their mission has not been fulfilled. However, this may mean that the integration of cryptocurrencies into everyday life is slowing down. The results of the analysis

suggest that cryptocurrencies are used to buy and sell goods/services in the electronics and computer world segments. And given the fact that in the modern world these segments are widespread, this may help speed up the overall integration of cryptocurrencies into daily life.

At a time when cryptocurrencies are integrated into everyday life, information about what the cryptocurrencies are exchanged for or what people spend them on is very valuable. Increasingly more and more corporations and global companies allow their customers to pay with cryptocurrencies. However, there is not much information in which sectors this option would have the greatest potential. The outcomes of our research could serve as a valuable asset for companies that consider introducing a cryptocurrency payment option.

The scientific hypothesis that "the incidence of supply advertisements on the *bitcointalk* discussion forum is just as likely as the incidence of demand advertisements", as outlined in the introduction to this article, has been rejected. The assumption that there were significantly more supply advertisements than demand advertisements leads to the individual conclusion that supply and demand are not balanced on *bitcointalk* discussion forum.

A limitation of the results, however, is the fact already pointed out in the article, and that is the anonymity of the users of this forum. Although our study analyses 120k advertisements, it is not known how many individuals posted them. Of course, it is not possible to speak of any representativeness with respect to the total population and its tendency to spend. Yet we are convinced that the paper brings many interesting insights from which future research may follow. The analysis would be even more interesting if it was done on a larger sample of data and if the data was obtained from multiple sources.

Cryptocurrencies bring competition to the currency market. While in the past only one fiat currency monopolised the territory of any given state, the users today may choose from hundreds of cryptocurrencies with different characteristics. Only the law of supply and demand determines the value of the individual cryptocurrencies. A state might be tempted to shield its fiat currency from competition by regulating the use of cryptocurrencies. At present, the state partially regulates transactions between fiat currencies and cryptocurrencies. Regulation of cryptocurrency purchases of goods could be next.

Although the cryptocurrency market is still young, its potential is huge. This could motivate other scientists to create similar analyses that would help cryptocurrencies meet their primary goal of integration into real life. In conclusion, it is important to point out that a lot of people are sceptical about cryptocurrencies. In the authors' opinion, they are mostly people who lack sufficient knowledge of digital currencies. Undoubtedly, fears about possible crime and other weaknesses of cryptocurrencies, which have also been highlighted in the text, also play a role. For ordinary consumers, the disadvantage of using cryptocurrencies is also a relatively complicated manipulation with the cryptocurrency, even with the assistance of special software ("crypto wallets"). This can be compared to the aversion to using digital certificate authentication for Internet banking, which has not been adopted even 19 years after the adoption of the Electronic Signature Act.

The article is intended especially for users of modern technologies who critically consider the possibility of using cryptocurrencies in their business, for example e-shop owners. The information gathered by the research and published in the article is probably not going to please these readers. Cryptocurrencies have their benefits as well as risks. We would compare them to fire, which is said to be a good servant but a bad master. One would compare them to live organisms, which all undergo development but only the most successful ones survive. The authors believe that the cryptocurrencies technology will form one of the main pillars of future economic development, just as the Internet after the year 2000. Cryptocurrencies are

accepted by an ever-growing number of businesses, newly for example by the Alza business chain (see, www.alza.cz). Cryptocurrencies could also be used for the purposes of shared economy, such as shared transport by Uber or shared accommodation by Airbnb, and thereby encourage their decentralization. Cryptocurrencies lay the foundation for the development of new applications which will change our life in the future.

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