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## Blockchain effect on the New Connect Stock Exchange

Accepted by Editor Ewa Ziemba | Received: June 7, 2019 | Revised: October 30, 2019 ; January 22, 2020 | Accepted: February 3, 2020.

### Abstract

**Aim/purpose** – Blockchain is a distributed database system widely popular in social and business spheres. As a result, interest in blockchain technology is utilised by listed companies, who, thanks to the announcement of blockchain application, record a significant increase in the share value. The aim of this publication is to analyse the situation with regard to companies listed on the New Connect market, who over the last two years, expressed an interest in blockchain technology in their communication with investors.

**Design/methodology/approach** – Observing the range of applications of this technology in business, a study was conducted to check if and how the information on using the blockchain technology affects the quotations of the New Connect market listed companies that applied it. Qualitative comparative analysis (QCA), a method developed by Ragin was chosen as a complementary research method. An underlying assumption of QCA is that social phenomena involve complex causality.

**Findings** – In most cases, companies releasing blockchain application announcements counted on fast and high growth of the quotations. In most of the analysed cases, blockchain technology utilisation announcements were not fulfilled. This could be a result of conscious tactics towards investors, a rapid increase in quotations and/or a lack of competence and resources to implement blockchain technology. Investors should analyse the business activity of a company before investing.

**Research implications/limitations** – Research is conducted with a small sample of 11 companies from the New Connect market in Poland. Consequently, to obtain more general results, it is recommended for future research to use a larger sample such as other stock exchanges in Europe and USA.

**Originality/value/contribution** – The research revealed that new blockchain technology is used by some listed companies on the New Connect market for short-term share growth. Investors are becoming increasingly more attracted to the fashion for the new blockchain technology without understanding its mechanism. Accordingly, this study will also attempt to explain such a mechanism.

**Keywords:** blockchain, distributed ledger technology (DLT), QCA, New Connect.

**JEL Classification:** G10, G41, G19, L17.

## 1. Introduction

Blockchain is a type of groundbreaking information technology, which is supported by cryptography. It is a distributed digital recording system, functioning due to a consensus mechanism. It is a distributed public book, in other words, a decentralised database. This technology has grown out of an older, more established technology – centralised accounting books (Swan, 2015; Wright & De Filippi, 2015).

This is a technology that can have a significant impact on today's economy and its future development. The first sector using blockchain in the economy was the financial sector (Wass, 2018). The process had already started in 2008 thanks to bitcoin cryptocurrency, but in the following years many companies appeared, developing the cryptocurrency market based on blockchain technology (Nakamoto, 2008; Swan, 2015). Recently a new FinTech industry has emerged that includes both companies providing financial services using modern information technology, such as blockchain, as well as new technology companies that help create new financial services for entrepreneurs and provide them with the necessary technology infrastructure (Guo & Liang, 2016). The FinTech sector includes a number of banks, insurance companies, payment institutions, lending institutions, investment platforms, crowdfunding platforms, and other groups using blockchain.

Another application of this technology is visible in the energy, construction and transport sectors, but the potential of blockchain is also seen by many governments in the world (United States, United Arab Emirates, Sweden, Ukraine, Estonia, United Kingdom and others), which are testing and applying such solutions, for example, for electronic voting, tax collection, identity management, property and land registries (Hughes, Park, Kietzman, & Archer-Brown, 2019; Syeed, 2018).

Blockchain is a distributed database system, which is widely popular in the social and business spheres and also greatly appeals to both entrepreneurs and investors (Belleflamme, Lambert, & Schwienbacher, 2014; Morkunas, Paschen, & Boon, 2019). Interest in blockchain technology is exploited by listed companies,

who, thanks to the announcement of their blockchain application, record a significant increase in the share value. This phenomenon appeared first on world stock exchanges, and a similar effect has also been observed in Poland since 2017.

Recognising the potential of the technology, companies used it willingly to encourage investors' interest (Lee, 2016). The goals of companies using the blockchain slogan are diverse. Some of the companies started implementing this technology in their own systems, while others counted on the blockchain effect, i.e. a short-term but intensive increase in the share value.

The existing literature about blockchain on the stock exchange focuses on presenting the range of possible applications of this technology (Lee, 2016; Pop et al., 2018). Much attention is paid to cryptocurrency trading, their market organisation, and legal regulations (Vasek & Moore, 2015; Zheng, Xie, Dai, Chen, & Wang, 2017). There are no publications directly related to the content of the paper. The aim of this publication is to investigate this phenomenon.

The selection of companies from the New Connect market was due to the fact that it was supposed to be a market facilitating fund sourcing for innovative small and medium-sized companies that specialise in modern technology. For New Connect companies, use of the blockchain technology is strategic and often becomes the primary direction in their operations. For this reason, information about blockchain application may have a significant impact on the investors' decisions and increase the company's quotations.

To confirm the hypothesis that the announced message on the use of blockchain by the companies listed on New Connect triggered an increase in share prices, case studies and qualitative comparative analysis (QCA) were carried out. The purpose of QCA method is to examine the causality of a particular effect (increase in quotations).

In order to present and discuss the defined aim of the publication, the following work design has been adopted. The main assumptions behind blockchain technology are described; first, a literature review concerning the problem of blockchain on the stock exchange is carried out, second, the research methodology is discussed, and finally, research results and conclusions are presented.

## **2. Blockchain – related works**

### **2.1. Blockchain technology**

Blockchain is a distributed database system that records each transaction. In the literature, blockchain is most often defined not only as a distributed public book (Feng, He, Zeadally, Khan, & Kumar, 2019; Zhao, Fan, & Yan, 2016) but

also as a meta-technology (Mougayar, 2016). It is a decentralised book that digitally records transactions by merging them into data blocks (chains). In other words, it is a method of digital recording of information and it consists of a cryptographically linked chain of data blocks. The information is combined into blocks with a specified number of transactions. When a block of information is full, another block of data is created, which then takes the form of a chain of blocks. The basic structure of the block chain can consist of a P2P network, databases and various applications (Kim & Laskowski, 2018).

Blockchain technology, based on a P2P network, functions without a central server to store data, and has no management and transaction verification systems. Each P2P network node, i.e. the user's computer, takes part in sending the transaction and its authentication. A key element of blockchain technology is the protocol that guarantees that databases, i.e. chains of blocks, although created by different people and in different places, will be identical (Min, 2019). There are two types of blockchains: public and private. Public technology allows anyone to interact with another transacting party. Private blockchain allows only pre-validated individuals or groups of individuals to access the ledger to enter and view data (Morkunas et al., 2019, p. 297).

Blockchain is often synonymous with distributed ledger technology (DLT). While this is correct, blockchain also has a special feature; it can distinguish between DLT and this is precisely the way the data of P2P are recorded. In blockchain networks, as in DLT networks, data are recorded by all participants of the network. What distinguishes blockchain from DLT is the registration of data, which in Blockchain, is carried out with the help of blocks forming an inseparable chain and in DLT, the data are maintained in a continuous form, without division into blocks (Devey, 2019).

The origins of this modern technology date back to the recent financial crisis. In 2008, this technology was introduced and used to operate cryptocurrencies (Nakamoto, 2008). Bitcoin is an example of the first protocol in blockchain technology, whose mechanism is based on a consensus among network participants. Bitcoin technology has eliminated intermediaries in concluding transactions, i.e. trusted third parties. Blockchain is a registry for all bitcoin transactions and copies of these registries are kept worldwide. Bitcoin works based on a distributed accounting book, a copy of which is on every device connected to the network. Each transaction is digitally signed, and this signature is verified based on cryptographic techniques. After positive verification of the transaction, it is saved in the block chain using the so-called mining process, also based on cryptography, which increases the level of transaction security. Miners with high

computing power are involved in mining cryptocurrencies (Jayachandran, 2017). The calculations, which a hardware miner performs, allow an investor to add a new unit to an existing chain. For the network to operate in a decentralized manner, the process of maintaining a common ledger must generate an incentive to attract miners. A miner who encrypts an earlier transaction block receives a cryptocurrency reward (Vranken, 2017). The goal of transaction confirmations is to reach a consensus as to which transactions are correct and which should ultimately be attached to blockchain registers. Due to the lack of one trusted website, which miners represent in blockchain cryptocurrencies, they must reach a consensus in the form of, for example, *proof of work* (Zheng et al., 2017). As a result, much effort is devoted to blockchain system security in publications. Due to the increasing use of this technology in cryptocurrency trading, the risk of fraud is also increasing (Luu, Teutsch, Kulkarni, & Saxena, 2015; Vasek & Moore, 2015).

In addition to the widespread Bitcoin, other blockchain-based applications, such as ethereum, have emerged over time (Vasek & Moore, 2015; Wohrer & Zdun, 2018). It is a platform that allows each participant of the network to create any business relationship using a computer code.

In order to develop applications such as bitcoin or ethereum, it was necessary to raise funds. A very interesting method that allows one to do this for the development of projects (applications) based on the blockchain technology is Initial Coin Offerings (ICO), also referred to as Coin or Token Crowdsales (Catalini & Gans, 2019). This method is based on emitting and selling a token in a blockchain (e.g. ethereum) (Belleflamme et al., 2014; Mollick, 2014). The means of payment for the tokens are cryptocurrencies, most often bitcoins or ethers. Tokens are records in the database and can be traded on cryptocurrency exchanges. This way of raising funds for projects may be easier and cheaper than traditional solutions. A token purchased by investors does not have to be in a monetary form. The buyer may receive certain rights, such as voting rights on projects, which translates into co-ownership. Tokens can be equipped with functions similar to traditional financial instruments which can be both proprietary or connected to debt. As mentioned earlier in the publication, transactions based on the blockchain technology receive an assigned computer code. This code regulates the rules and the mode of token trading and is known to all the parties concerned in the network. However, it requires the necessary IT and technical knowledge to correctly read and understand the programming code.

## **2.2. Blockchain on the Stock Market**

The company's goal in the long term is to maximise goodwill for shareholders. Achieving this goal means building positive relationships with the environment. An important role in shaping these positive relationships is played by ethical principles and values that guide the enterprise and Corporate Social Responsibility (CSR). Adopted legal regulations will not ensure adequate protection of stakeholders if the company does not comply with business ethics and if the values it follows hamper the building of positive relations with the environment. The importance of ethics and business values was highlighted by the 2008 financial crisis.

Trading in securities, their purchase or sale at the best price for parties raises ethical problems. Previous studies confirm the benefits that result from the behavioural standards of ethics. Companies applying the code of ethics achieved higher efficiency than those which did not (Vershoor & Murphy, 2002; Webley & More, 2003; Weiser & Zadek, 2000).

Blockchain is an innovative technology that attracts many investors, but it can also be easily exploited by some companies. This is the case with any new technology. In the dot.com period, many companies around the world and in Poland decided to use this abbreviation in order to increase the share price. There were even several publications analysing the situation of companies that added specific keywords to their names and how their stock prices behaved as a result of such an activity (Cooper, Dimitrov, & Raghavendra Rau, 2001; Cooper, Khorana, Osobov, Patel, & Raghavendra Rau, 2005; Jain & Jain, 2019; Josev, Chan, & Faff, 2004; Karim, 2011; Lee, 2001).

The existing literature about blockchain on the stock exchange focuses on presenting the range of possible applications of this technology. Blockchain gives the opportunity to decentralise the stock exchange system, reduce transaction costs, limit the participation of intermediaries in stock auctions (Lee, 2016; Pop et al., 2018). Much attention is paid to cryptocurrency trading, market organisation for cryptocurrencies, and legal regulations for cryptocurrencies. Many stock exchanges around the world carry out tests on stock exchange transactions based on blockchain (Guo & Liang, 2016). There are no publications directly related to the content of the paper.

A number of listed companies world-wide took advantage of the interest in blockchain and their success encouraged others to apply this solution on the Polish stock exchange as well. However, a serious problem is the lack of

knowledge about this technology from the companies using blockchain and potential investors. Reading several interviews with CEOs of companies announcing the use of blockchain, one may have an impression that the companies are not ready and do not have the resources (specialists) necessary to successfully implement the new technology. The studies presented so far in the literature indicate a problem with understanding the blockchain mechanism. Research conducted among supply chain specialists confirms a strong interest in this technology, but shows that the vast majority of them are unable to explain blockchain to their customers (Annalect, 2017).

### **3. Research methodology**

Work on blockchain and its implementation has been announced by companies from both the main market and New Connect. However, only companies from the New Connect market have been included in the study. This is because, for the main market companies, blockchain is a certain complement to the existing strategy, while for the New Connect market companies, it is primarily the main activity. Observing the range of applications of this technology in business, a study was conducted to check if and how the information on using the blockchain technology affects the quotations of the New Connect market listed companies that applied it. The New Connect market has the status of an organised market but is operated by the Stock Exchange outside the regulated market. It is an offer for small and medium companies from various industries that are developing in the area of new technology.

The research covered companies from the New Connect market, which announced plans to implement blockchain technology in 2017-2019.

The research began with a search for specialised websites related to investing in the stock exchange using the keywords: 'blockchain', 'blockchain trend', 'introduction of blockchain technology by companies', 'use of blockchain by listed companies'. The information collected has been verified. The Stock Exchange website analysed the announcements of selected companies on the use of blockchain and, using the website [www.bankier.pl](http://www.bankier.pl), checked the quotations of a given company after the announcement was published.

Selected issues were analysed:

- whether the information about blockchain leads to changes in these companies' quotations; what increases were recorded by the company within a week from the publication of the announcement;

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- what is the nature of the change in the quotations – short-term or long-term; whether the company's current quotations (May 2019) have changed compared to the growth after the blockchain application announcement.

To confirm the hypothesis that announced message on the use of blockchain by the companies listed on New Connect triggered an increase in share prices, QCA were carried out.

QCA, a method developed by Ragin (1987, 2000, 2008) was chosen as a complementary research method. This method combines a quantitative and qualitative approach and is primarily used in the disciplines of social sciences, but also in management sciences. It is used for a medium-sized research sample (between 5 and 50 cases). QCA formalises and systematises case comparison.

An underlying assumption of QCA is that social phenomena involve complex causality. Complex causality has many meanings:

- causal factors combine with each other to lead to the occurrence of an event or phenomenon,
- different combinations of causal factors can lead to the occurrence of a given type of event or phenomenon,
- causal factors can have opposing effects depending on the combinations with other factors in which they are situated (Mahoney & Goertz, 2006, p. 236; Schneider & Wagemann, 2010, p. 382).

The basic assumption of QCA is causality based on the coexistence of many factors. These factors may or may not be necessary or sufficient conditions to trigger specific effects (Kocór & Worek, p. 41).

As part of the procedure, several stages can be identified:

- selection of the research area,
- data calibration,
- construction of the truth table,
- truth table minimisation (Ragin, 1987, 2000, 2008).

### **Data calibration**

At this stage of the analysis, all variables are converted into sets. Variables in the set can take values from 0 to 1. Uniquely calibrated variables in the set take values from 0 (no membership) to 1 (membership). Variables can also be calibrated with undefined values, where three limit values are most often used.

### **Construction of the truth table**

The purpose of building a truth table is to identify random combinations of variables. The truth table has a number of rows equal to  $2^k$ , where  $k$  is the number of conditions selected for analysis. The truth table shows all possible combinations of variables with the result.

The function determining the truth table searches for every observed combination (input data) and sets the value of the result after a very simple decision-making process:

- if all observed combinations match the value of the result (0 or 1), then the result will be set to this value,
- if any cases with the same combination of conditions present both 0 and 1, then the result is contradictory and marked with the letter ‘C’,
- for any combination of conditions that is not in the data, the result is set as missing and coded with a question mark ‘?’.

### **Truth table minimisation**

Using the primitive expressions that were identified as sufficient in the truth table, Boolean minimisation serves to identify more and more general combinations of conditions sufficient for the outcome that remain logically true. One way this process works is by focusing on pairs of configurations that differ in only one combination but agree in displaying the outcome.

## **4. Research findings and discussion**

### **4.1. Blockchain on the New Connect – initial research findings**

Over the last two years, information on blockchain technology has emerged for 11 companies listed on the New Connect market. The companies that announced the use of the blockchain technology are:

- companies producing computer games (Prime Bit Games, Playway),
- IT companies (BitEvil, MakoLab, Blockchain Lab),
- companies conducting investment activities (Synerga, Novina, Erne Ventures, Devoran, Telehorse),
- others: e-commerce (Merlin Group).

Two companies operating in the computer game industry decided to combine their previous experience with the new blockchain technology. The information published in February 2019 about advanced works in implementing

blockchain technology in the games of Prime Bit Games brought a 6% increase in the company's quotation but only for a short time. For Playway, however, the announcement of investment in the blockchain technology only reinforced the positive trend. The quotations are rising and are a result of the successful launch of many more games on the market.

IT companies recorded an increase in share quotations, but the results they achieved in comparison with other companies can be considered average results. The highest growth was recorded by BitEvil, whose shares are at a low level today, and, compared to the two other IT companies such as Makolab, it is now classified as a penny company.

In comparison to all other companies, investment companies recorded much higher price increases in the first period after the publication of information on blockchain use (Devoran, Novina).

Merlin Group is an e-commerce company. Prior to the publication of the press release, this company was a penny company. The increase in quotations was significant but short-lived.

The completed analysis was intended to provide answers to research questions: What was the impact of blockchain technology messages on the company's quotations?

Almost all companies made an announcement about planned implementation of blockchain technology. Only one company, Damenomania.pl, changed its name to Blockchain Lab.

The observation of the companies' quotations following the blockchain application announcement is included in Table 1.

**Table 1.** Companies' quotations after the blockchain application announcement and present quotations (May 2019)

Branch	Company name	Date of the announcement	Increases in quotes within 1 week of the announcement	Quotations in relation to the announcement (May 2019)
Computer games companies	Prime Bit Games	15.02.2019	6%	falling
	Playway	12.02.2018	4%	soaring
IT companies	BitEvil	12.07.2017	48%	falling
	Makolab	30.06.2017	2%	soaring
	Blockchain	01.04.2019	17%	soaring
Investment companies	Synerga	14.03.2018	25%	unchanged
	Novina	18.01.2018	88%	unchanged
	Erne Ventures	11.01.2018	3%	falling
	Telehorse	28.06.2018	26%	soaring
	Devoran	19.01.2018	123%	falling
Others	Merlin Group	06.07.2018	70%	falling

All companies recorded a share price increase following the publication of the blockchain application announcement. The largest increases could be seen for Devoran, Novina, Merlin Group and BitEvil. Thanks to blockchain, all these companies, except for BitEvil, left the group of penny companies. The blockchain announcement gave these companies an increase in the share value and, looking at the current quotations, it can be assumed that blockchain was only a short-term bait for investors.

Slight increases were recorded by companies from the computer games industry. Playway is enjoying significant success and it is well received by the computer games market, while blockchain gave only a temporary increase in quotations for Prime Bit Games.

In the case of Erne Ventures and Novina, these companies' quotations were suspended immediately after publication of the blockchain announcements, due to the exceeded range of permitted fluctuations. Novina achieved an increase of 88% in quotations after the blockchain announcement, and the investors expressed no concern about the company's previous weak performance (penny company). For Erne Ventures, the initial enthusiasm (suspended quotations) almost certainly faded and the growth slowed down during the following days.

Almost all the analysed companies are penny companies, the price per share does not exceed 1 Polish zloty. The exception in this group are two companies – Playway and MakoLab. It can therefore be deduced that, for many companies, blockchain was only a slogan, a novelty, which was to cause a rapid increase in these companies' short-term quotations.

The analysis of stock exchange quotations of companies in the first week after the announcement regarding the use of the blockchain, and over a longer period of time following the announcement, is insufficient to formulate final conclusions.

## **4.2. Qualitative comparative analysis**

To conclude on the causality of the increase in share prices of companies announcing blockchain use, an additional qualitative comparative QCA analysis was conducted. It was assumed that success in the form of an increase in share prices may depend on many factors. Investor's decisions on the stock exchange should be based on the financial data presented in the financial statements. Therefore, in addition to the blockchain message, financial information, such as:

- net profit (loss),
- cash flow from operating activities,

- total cash flows,
- rate of return,

obtained by companies:

- in the quarter before the announcement,
- in the year preceding the announcement.

Additionally, the nature of the companies was determined by dividing them into: penny and non- penny companies.

### **Data calibration**

The study identified 10 factors that may affect investor's behaviour. These variables have been converted into sets. The sets range from 0 (no membership) to 1 (membership). The factors examined are:

- BC: blockchain message (1) or not (0),
- SNGR: nature of the company: non-penny (1) or penny (0) companies – a penny company is one whose share value does not exceed 1 PLN),
- WFR: net profit of companies (1) in the year preceding the issue of the announcement on the use of blockchain, or loss (0),
- WFK: net profit of companies (1) at the end of the quarter preceding the announcement or loss (0),
- POR: positive operational cash flow (1) in the year preceding the issuing of the blockchain message or not (0),
- POK: positive operational cash flows (1) at the end of the quarter preceding the announcement or not (0),
- PRR: total positive cash flows (1) in the year preceding the issuing of the blockchain message or not (0),
- PRK: total positive cash flows (1) and at the end of the quarter preceding the announcement or not (0),
- SZWR: positive rate of return (1) for the year preceding the issuing of the message on the use of blockchain or not (0),
- SZWK: positive rate of return (1) at the end of the quarter preceding the announcement or not (0).

The "0" factor is in lowercase, e.g. pok, prk, sng. Data for analysis were taken from the financial statements of companies and from the New Connect website.

In the analysis presented, the procedure for calibrating the result in the form of an increase in quotations in the first week of the announcement, was carried out using the direct method (Ragin, 2008). The following limit values were adopted: 0,1 (no affiliation); 0,5 (the turning point of the maximum ambiguity) and 0,9 (the threshold of full belonging to the set).

Over half (55%) of companies belong to the so-called penny companies whose value does not exceed PLN 1. Therefore, the threshold of 0.4 share price increase was adopted for analysis.

After selecting the factors and measures of results, the variables were coded into sets. For this, the R-project with QCA package was used (Dusa, 2019; R Core Team, 2019).

QCA formalises and systematises case comparison. The main construction of QCA is based on necessity and sufficiency.

Table 2 contains the necessity conditions. It means that the condition (combination of conditions) has to be present for the outcome to occur. When testing conditions for their necessity, remember that the threshold for consistency should be high ( $> .9$ ) and its coverage should not be too low ( $> .5$ ). For this reason in our function we assume that  $incl.cut = 1$ ,  $cov.cut = 0.52$ .

**Table 2.** Analysis of necessity

No.	Combination of conditions	inclN	RoN	covN
1	pok	1.000	0.714	0.667
2	wfk*pok	1.000	0.857	0.800
3	wfk*PRR	1.000	0.714	0.667
4	pok*PRR	1.000	0.857	0.800
5	pok*BC	1.000	0.714	0.667
6	wfk*pok*PRR	1.000	1.000	1.000
7	wfk*pok*BC	1.000	0.857	0.800
8	wfk*PRR*BC	1.000	0.714	0.667
9	pok*PRR*BC	1.000	0.857	0.800
10	wfk*pok*PRR*BC	1.000	1.000	1.000

Source: Data analysis QCA in R (Generated by QCA package for R-project).

If the companies had negative operating cash flows in the quarter, for 33% of the companies surveyed this was a prerequisite for obtaining increases in quotations above 40%. For 20% of the companies surveyed, a negative quarterly financial result and negative quarterly operating cash flow is a prerequisite for achieving growth. Positive annual cash flow and negative financial results are a prerequisite for 33% increases in this sample. Negative operating cash flows in the previous quarter and, providing the blockchain message are a necessary conditions for price, increases above 40% for 33% of the companies surveyed. For 33% of the companies surveyed a negative quarterly financial result, positive annual cash flow and blockchain message is a prerequisite for achieving growth above 40%. If the companies had negative operating cash flows in the quarter,

negative operating cash flows in the quarter, positive annual cash flow and blockchain message, for 33% of the companies surveyed this was a prerequisite for obtaining increases in quotations above 40%.

### Truth table

The purpose of the truth table (Table 3) is to identify random combinations of variables with the result. The number of rows in the truth table is calculated as  $2^k$  (where  $k$  is the number of variables). In the case of the test conducted, the number of possible combinations is 512.

**Table 3.** Truth table

Number of combinations	SNGR	WFR	WFK	POR	POK	PRR	PRK	SZWR	BC	OUT	n	incl	PRI	Cases
4	0	0	0	0	0	0	0	1	1	0	1	0.000	0.000	6
10	0	0	0	0	0	1	0	0	1	1	1	1.000	1.000	7
12	0	0	0	0	0	1	0	1	1	1	1	1.000	1.000	10
32	0	0	0	0	1	1	1	1	1	0	1	0.000	0.000	5
44	0	0	0	1	0	1	0	1	1	1	1	1.000	1.000	11
236	0	1	1	1	0	1	0	1	1	0	1	0.000	0.000	9
286	1	0	0	0	1	1	1	0	1	0	1	0.000	0.000	1
310	1	0	0	1	1	0	1	0	1	0	1	0.000	0.000	8
400	1	1	0	0	0	1	1	1	1	1	1	1.000	1.000	3
502	1	1	1	1	1	0	1	0	1	0	1	0.000	0.000	4
512	1	1	1	1	1	1	1	1	1	0	1	0.000	0.000	2

Note:

OUT – output value.

n – number of cases in configuration.

incl – sufficiency inclusion score.

PRI – proportional reduction in inconsistency.

Source: Generated by QCA package for R-project.

A level of consistency of 1 was identified in rows 10, 12, 44 and 400 (Table 3; the bold values in column OUT). These configurations are positive because they support the hypothesis (the result is 1.0). Company BitEvil, Novina Devoran and MerlinGroup (cases: 7, 10, 11, 3 in the truth table are shading) recorded increases within 1 week of the announcement about Blockchain above 40%. These companies belong to the group of penny companies and have recorded a permanent decline in the value of their shares in the longer term (May 2019).

A sufficient condition for an increase in quotations above 40% with the use of blockchain, was a positive cash flow, and a negative financial result achieved in the quarter preceding the release of the message.

### Truth table minimisation

The truth table can be minimised to produce a solution formula (Table 4). The basic solution is the pair-wise comparison of configurations that have the same outcome but differ in one other condition, as in the example below on columns SZWR.

**Table 4.** Pair-wise comparison

SNGR	WFR	WFK	POR	POK	PRR	PRK	SZWR	BC	OUT
0	0	0	0	0	1	0	0	1	1
0	0	0	0	0	1	0	1	1	1
$(PRR)(\sim SZWR)(BC) \leq OUT + (PRR)(SZWR)(BC) \leq OUT \Leftrightarrow (PRR)(BC) \leq OUT$									

Source: Generated by QCA package for R-project.

The highlighted configuration pairs indicate that positive annual cash flows (PRR) and blockchain (BC) message have an impact on the quotations of companies above 40%. A positive annual rate of return (SZWR) does not affect the quotations of companies above 40%.

Using the minimalisation can derive complex, parsimonious (M1) and intermediate solutions from a truth table, such as presented in Table 5.

The discovered parsimonious solution can take the following form:

$$M1: \text{sng}r * \text{wfr} * \text{wfk} * \text{por} * \text{pok} * \text{PRR} * \text{prk} * \text{BC} + \text{sng}r * \text{wfr} * \text{wfk} * \text{por} * \text{pok} * \text{PRR} * \text{prk} * \text{SZWR} * \text{BC} + \text{SNGR} * \text{WFR} * \text{WFK} * \text{POR} * \text{POK} * \text{PRR} * \text{PRK} * \text{SZWR} * \text{BC} \Leftrightarrow \text{OUT}$$

**Table 5.** Solution of minimalisation truth table

No.	Combination of conditions	inclS	PRI	covS	covU
1	$\text{sng}r * \text{wfr} * \text{wfk} * \text{por} * \text{pok} * \text{PRR} * \text{prk} * \text{BC}$	1.000	1.000	0.500	0.250
2	$\text{sng}r * \text{wfr} * \text{wfk} * \text{por} * \text{pok} * \text{PRR} * \text{prk} * \text{SZWR} * \text{BC}$	1.000	1.000	0.500	0.250
3	$\text{SNGR} * \text{WFR} * \text{WFK} * \text{POR} * \text{POK} * \text{PRR} * \text{PRK} * \text{SZWR} * \text{BC}$	1.000	1.000	0.250	0.250
	M1	1.000	1.000	1.000	

Note:

inclS – inclusion for the solution.

PRI – proportional reduction in inconsistency.

covS – coverage scores for the solution(s).

covU – unique coverage.

Solution(s)  $M1: \text{sng}r * \text{wfr} * \text{wfk} * \text{por} * \text{pok} * \text{PRR} * \text{prk} * \text{BC} + \text{sng}r * \text{wfr} * \text{wfk} * \text{por} * \text{pok} * \text{PRR} * \text{prk} * \text{SZWR} * \text{BC} + \text{SNGR} * \text{WFR} * \text{WFK} * \text{POR} * \text{POK} * \text{PRR} * \text{PRK} * \text{SZWR} * \text{BC} \Leftrightarrow \text{OUT}$

Source: Generated by QCA package for R-project.

The intermediate solution that has been derived from the parsimonious solution can then be inspected in a prime implicant chart as it is shown in Table 6.

**Table 6.** Prime implicants chart

Combination of conditions	10	12	44	400
sng <sup>r</sup> *wfr* <sup>w</sup> fk*por* <sup>p</sup> ok* <sup>p</sup> RR* <sup>p</sup> rk*BC	x	x	-	-
sng <sup>r</sup> *wfr* <sup>w</sup> fk* <sup>p</sup> ok* <sup>p</sup> RR* <sup>p</sup> rk*SZWR*BC	-	x	x	-
SNGR*WFR* <sup>w</sup> fk*por* <sup>p</sup> ok* <sup>p</sup> RR* <sup>p</sup> RK*SZWR*BC	-	-	-	x

Source: Generated by QCA package for R-project.

Recorded increases above 40% were identified in four cases of the sample. In the situation where the company belonged to penny companies, it recorded a financial loss and a negative cash flow from operating activities both in the year and in the quarter preceding the announcement of the blockchain message. It also obtained positive annual flows and issued the blockchain message in two cases (*case: 10 and 12*).

In addition, two companies issued a blockchain message and recorded a positive rate of the return and recorded increases above 40% (cases 12 and 40).

However, in only one case (case 400), did the company (which did not belong to penny companies) record an annual profit, positive cash flow (both annual and quarterly), a positive rate of return, and announce a blockchain message with negative annual and quarterly operating flows and a financial loss in the quarter preceding the announcement. In this case, the company's listings increased by over 40%.

Reported positive results (i.e. an increase in the listings of companies above 40%) are covered by 3 combinations of variables (Table 5 and 6). For two cases, (10 and 12), the first combination covers 50% positive results, for two cases, (12 and 44), the second combination covers 50% positive results, and for case 400, the third combination covers 25%.

A necessary condition for the growth of quotations above 40% for 33% of the surveyed companies were negative operating cash flows and also a combination of several factors, where apart from the blockchain message and positive cash flow, financial information was unfavourable for investors.

The truth table identified four cases where companies' quotations increased above 40% when a blockchain message and positive annual cash flow were present (sufficient conditions). The presented case study of companies listed on the New Connect market confirmed the hypothesis that the announcement of blockchain use caused an increase in their listing in the first week after the blockchain.

The preliminary conclusions resulting from the case study indicate that some companies expected a rapid and high increase in quotations when announcing the blockchain message. Despite unpromising financial data, these companies attracted investors. It means that investors should analyse the business activity of a company before investing. This partly confirms the observation of the surveyed companies' quotations after the announcement in the long run. The listings of these companies were checked in May 2019. Two companies of the sample, PlayWay and Makolab, generated financial gains, positive operating cash flows, and positive total cash flow before the publication of the annual statement. Their listings for May 2019 showed growth and they were the only non-penny companies, and Playway had just entered the Main Market of Stock Exchange.

A qualitative comparative QCA analysis was conducted to investigate whether, apart from the blockchain message, other factors had an impact on company's listings. However, the results obtained through formalised QCA analyses do not prove causal relations.

A necessary condition for an increase in quotations above 40% for 33% of all surveyed companies were negative operating cash flows but also combinations of several factors, where, apart from the blockchain message and positive cash flow, there was also financial information that should discourage the investor from buying shares (net loss, negative operating flow, etc.).

This may mean that:

- The investor was aware of the company's poor financial condition, but saw an opportunity for quick profits (up to date with stock market experience).
- The investor's decision was based only on the blockchain message, without the analysis of necessary financial information about the company.

The prepared truth table identified four cases where companies' quotations increased above 40% when the blockchain message and positive annual cash flow and negative operating cash flow appeared in the quarter (sufficient conditions). This is confirmed by minimising the truth table. Despite the negative financial results, negative cash flows from operating activities, and the lack of a positive return rate, the company's shares still grew over 40% during the week. All companies that achieved stock growth above 40% in the first week after the blockchain announcement, recorded a sustained downward trend later (BitEvil, Novina, MerlinGroup, Devoran). The share prices of these companies in May 2019 were clearly at a lower level than before the announcement. It can be assumed that in these cases the blockchain message was to attract investors' attention. Even before the blockchain announcement, these companies generated

financial losses and negative cash flows from their core operating activities (with the exception of Devoran). Despite unpromising financial data, these companies attracted investors.

## **5. Conclusions**

### **5.1. Research contribution**

Blockchain is a type of modern technology that can be applied both in the business and the social spheres. As with any other modern technology, it raises interest among entrepreneurs, investors, governments, but also among researchers.

The research literature does not present similar studies concerning the impact of blockchain messages on the behaviour of listed companies. It is clear that, observation of the behaviour of company listings was used, for example, when the company name changed (Cooper et al., 2001). Seeing the possibility of increasing quotations, companies often contact potential investors and announce, usually enthusiastically, suggested new solutions, such as the use of blockchain technology. As the analysis shows, in many cases, short term interest in the company was the sole purpose of the message. After a rapid increase in listing, most companies report unchanged or even lower results.

The adopted research methodology seems to be appropriate because, in addition to the blockchain message, numerous financial variables that could influence investors' decisions were also included. An additional value of the adopted research methodology is the presentation and observation of the results of quotations both in the short (1 week after the date of the announcement) and long term. QCA is a decisive support for the analysis. This methodology is universal and can be used for companies listed on other stock markets in the world.

### **5.2. Research implications**

The presented methodology and research results may encourage other experts to do similar research, adapting the research apparatus to the analysed phenomenon.

The presented conclusions from the analysis can be a warning for potential investors. It is important not to succumb to the fashion for new, often incomprehensible activities, technology or changes offered by companies. The presented

results of the analysis confirm the irrational behaviour of investors. Investors' decisions should be based on many factors, both financial and non-financial. One notable example is sound knowledge of the industry.

### 5.3. Research limitation and future works

The results of the research require further study. The sample was small, which did not allow the use of quantitative research. In subsequent investigations, it would be worth increasing the sample in order to achieve a fully comprehensive view of the company, particularly, in three main areas:

- various stock markets in a given country (regulated and unregulated stock market),
- various markets and stock exchanges around the world (comparison),
- division of the company: small, medium and large.

It would also be worth considering to extend the scope of the variables subject to analysis of additional data, both financial and non-financial. Expanding the scope of the study, the size of attempted research can be used in studies focusing on quantity and quality. Their application may indicate additional interesting aspects, dependencies, and offer a thorough explanation of the conditions under which investors make decisions.

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