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Cryptocurrencies as an Example of Innovation in Finance

ABSTRACT

The paper contains theoretical considerations on cryptocurrencies in the context of innovation and specifically focuses on the most popular cryptocurrency – bitcoin (BTC). Based on critical analysis of domestic and foreign writings, bitcoin was classified as a modular innovation despite some of its features suggesting the continuous and breakthrough nature of the solution. The conclusion helped positively validate the research hypothesis proposed in this paper according to which cryptocurrencies, despite their characteristics of an incremental and breakthrough innovation, can be treated as modular innovations.

Keywords: cryptocurrency, bitcoin, innovation

JEL Classification Codes: G, O Introduction

Introduction

For many years the international economy has been witnessing an increasing importance of electronics and telecommunications sector for the growth of national economies. Especially relevant in this case are IT technologies and methods deployed worldwide by consortia, enterprises or individual users. They would not be so important if the computer had not been invented in the mid-20th century or the Internet in the 1980s together with network technologies connected with it. The combination of these two innovations significantly enhanced the importance of the electronics industry worldwide. Nowadays, there are many types of processor-based devices, which use high performance computing without which basic products of the 21st century, such as laptops, PCs, smartphones, tablets, 3D printers or smartwatches possibly could not have emerged. Without these pieces of electronic equipment many organisational improvements and solutions would have never been put in place in the working environment and in everyday life. That would impact individual people and enterprises who use a plethora of processor-based products with high computing potential. Digital technologies ensure the development of new products and new sources of income. Against this background, the continuously increasing popularity of cryptocurrencies, including bitcoin (BIC), both in e-commerce and in financial markets among traditionally operating market entities, seems interesting [Figiel, Popiołek, 2015, p. 1452; *Megatrends...* 2015, pp. 8,10; Sienkiewicz, pp. 172–173].

Digital future in the global market is considered one amongst the main six forces that impact life on Earth. Besides it, the so-called megatrends of the 21st century economy include [*Megatrends...* 2015, p. 3]:

- rising entrepreneurship;
- global marketplace in the context of faster growth rates and favourable demographics;
- urban world – the number and scale of cities continues to grow across the globe driven by rapid urbanisation in the emerging markets and continued urbanisation in mature markets;
- resourceful planet – population growth, economic growth and more middle-class consumers determine the global increasing demand for renewable and non-renewable natural resources;
- health reimagined.

The growth and future of digital economy and enterprises operating in it can become real in the near future based, inter alia, on the following premises [*Megatrends...* 2015, p. 4]:

- increasing demand for real time access to information in any location across the globe;
- enormous opportunities for enterprises to gain advantage as a result of having devices that enable capturing vast amounts of information, entering new markets, transforming existing products, and placing new ones on the market.

Being part of such an economy links also with concerns over new competitors, changing customer engagement, cyber-security and the loss of privacy. For cryptocurrencies this last

aspect does not exist because all transactions are anonymous and you cannot identify the parties involved [Megatrends... 2015, p. 4; Piotrowska, 2014, p. 277].

Proliferation of the Internet and universal access to IT devices are intrinsically linked to digital economy.

Its attributes and increasingly more advanced technological innovations (theoretically) facilitate the introduction of other innovations, which may but do not have to be linked, directly or indirectly, with digitalisation. One of such innovations includes cryptocurrencies and especially the most popular one among them – bitcoin (BTC). Its specificity consists in the fact that it is a digital version of a traditional currency available all over the world. Characteristically, it is resilient to inflation, unlike traditional currencies. It means BTC can be used directly as a means of payment. The currency, together with universal access to the Internet and Internet technologies, ensures fast and efficient servicing of commercial transactions between parties all over the world. Although not approved yet or even regulated in most countries, such forms of payment are available as one of possibilities in Japan or in the USA. In this sense, cryptocurrencies are a response to permanent internationalisation.

In the context of the main problem and presented theoretical considerations, the goal of the paper was to analyse and assess the BTC features, which were used to identify the type of innovation represented by cryptocurrencies. With reference to such a goal, we propose a thesis assuming that despite the characteristics of an incremental¹ and breakthrough innovation,² cryptocurrencies represent the so-called modular innovation (a state in-between the two). The hypothesis was validated using the critical analysis method of domestic and global publications.

Theoretical approach to cryptocurrencies

In accordance with the above-mentioned considerations, digital economy is suggested as one of growth options for developing economies. For almost a decade, digital economy has included a continuously exploring market of cryptocurrencies. Cryptocurrencies are a kind of digital token based on cryptography used to make an encrypted electronic signature when a transaction is made and to monitor the increased supply of tokens. They are based on a decentralised *peer-to-peer* (P2P) network and are electronic equivalents of currencies which enable exchanges in the virtual world. Cryptocurrencies are also carriers of value [Piech, 2016, p. 9].

Electronic market constantly evolves, which is why many people have taken interest in it. One of such people was Satoshi Nakamoto (a nickname), whose real identity in fact has remained unknown until the present. However, we know for sure that he founded the Bitcoin system. The units of measurement used in the system were named bitcoins and were created when the idea of a new form of cryptography-based currency (hence the name of

¹ In the paper we interchangeably use the term continuation innovation.

² In the paper we interchangeably use the term radical innovation.

the cryptocurrency) materialised. Cryptography is used to monitor the currency and make transactions without relying on the central system and monetary authorities. The system is created in a way that enables direct transactions between the users, without the intermediary of the so-called third party (e.g. a bank). Transactions are verified by nodes in the network and registered in a public decentralised register referred to as a blockchain [Nakamoto, 2009, p. 1]. A bitcoin can be divided down to 8 decimal places. The smallest bitcoin amount to be handled in a transaction (i.e. 0.00000001 BTC) is called *satoshi* and can be compared to the Polish grosz or Euro cent. In January 2009 the first bitcoin block, the above-mentioned *blockchain* was created. It is a dispersed and non-systemised database with a continuously increasing body of information (records) grouped in blocks. Data is linked in such a way that each next block contains a timestamp that informs when it was created and a link to the previous block, which is an encrypted “summary” (*hash*) of its content [Piech, 2016, p. 5]. At present, whenever you “mine” 12.5 BTC a new block is created.

In the virtual world, bitcoin, besides ethereum, ripple, NEM, or litecoin, is considered one of the means of payment and investment in the form of an electronic record within the digital space [Wytrębowski, 2017]. According to Piotrowska [2014, p. 276] it bears resemblance to the universally used and approved digital money. In turn, Bradbury [2014] observes that there are significant differences between the terms virtual currency, digital money or cryptocurrency. The first one is a means of payment used among members of a specific virtual community developed around products, such as films or music. Digital money can be associated with loyalty points in traditional retail systems that customers collect to later exchange them for concrete goods. Cryptocurrencies provide a two-way solution, meaning, on the one hand, they are linked with exchange rates, while on the other hand, they can be used to purchase specific goods exactly like traditional money.

What is interesting about BTC is the fact that they are available in limited numbers. That is not observed for standard currencies, where, if a need arises, additional amounts of money can be “printed.” For that reason, there is no inflation in the cryptocurrency market, neither is it linked in any way with the economy of any country. The restricted availability of bitcoin as electronic money results from the fact that it is created in blocks. Subsequent blocks are created with the number of bitcoins changing over time. The reward for each of 210,000 blocks is 50 BTC, then it halves every 210,000 blocks to 25 BTC for the next 210,000, and 12.5 BTC for the third block, etc. The total number of bitcoins in circulation under this schedule is expected to cap at 21 million [Rzeszutnik, 2014, p. 4].

Yermack [2013, p. 35] additionally notes that cryptocurrencies are outside of the impact of the traditional currency market and do not depend on the value of gold. On top of that, Figiel and Popiołek [2015, p. 1454] list other advantages of using BTC. In their opinion, the currency owes its success to universality and reliability resulting, inter alia, from:

- no or little transaction cost – margins for bitcoin transfers are very low, there are no intermediaries unlike in traditional currency schemes;

- simplicity and transparency of the service – customer software must be installed on all operational and equipment platforms;
- transaction anonymity – you must have an account, like an e-mail account, without giving all your data and generate a private identification key;
- transactions are quickly recorded in any location – P2P solution instead of central ones;
- transaction security – to control payments there are cryptographic sets SHA-2 and validation of private and public keys; authorised transactions cannot be cancelled.

These and other advantages are also addressed by Dopierała and Borodo (Tab. 1). Anonymity of users may be the main threat of using BTC as a means of payment. It is particularly relevant in the context of law enforcement and using BTC in illicit transactions. Hackers also pose a serious threat to bitcoin. History has already recorded cases of cyber attacks on bitcoin exchanges and thefts, e.g., Mt.Gox in February 2014. A deterrent that prevents people from having and exchanging cryptocurrencies is the admissibility and way of claiming damages for the loss of BTC [Zacharzewski, 2015, p. 189].

Table 1. SWOT Analysis for Bitcoin transaction system

Opportunities	Threats
<ul style="list-style-type: none"> • internationalisation and globalisation of trade boosts demand for a quick and cheap transaction scheme; The bitcoin system favours particularly entrepreneurs who make payments worldwide; • increasing USD supply administratively and drop in trust in the currency – standard currencies are exposed to inflation because more money is placed on the market, e.g., when trust in a currency decreases; • increased e-commerce turnover – it is estimated that in 2012 the total B2B turnover globally increased by 21.1%. According to forecasts, the increasing trend will continue. 	<ul style="list-style-type: none"> • increasing competition of other electronic means of payment – facilitation in electronic trade in traditional currencies (PayPal system, shortened transaction time in the ELIXIR system) may be more attractive to consumers because they do not require prior purchasing of payment units or additional knowledge about new means of payment; • highly probable hackers' attacks on crucial nodes of the system – if stolen, resources cannot be recovered; • criminals may widely use it so there is a potential of its being banned to prevent trade in illicit goods or terrorism financing.
Strengths	Weaknesses
<ul style="list-style-type: none"> • fast transactions – sending any amount of bitcoins to any location takes 10–60 minutes; • no intermediaries; • low transaction cost – transactions below 0.01 BTC cost 0.0001 BTC, the rest is free of charge; • specified target amount of bitcoins in the system – it should strengthen the currency and protect it against inflation; • division of 1BTC into 10⁸ smaller units (the so called <i>satoshi</i>); • personal data protection of users in the system – each user has got his/her unique public key, meaning he/she is anonymous with unlimited access and insight into all bitcoin transactions globally; • regulation through market-based processes only – there are no other instruments that could cause devaluation of BTC. 	<ul style="list-style-type: none"> • absence of a material form and less credible access to the electronic wallet dependent on electronic devices; • value of the instrument based exclusively on user trust into the system – BTC value depends exclusively on demand, which results from trust, no material coverage; national currencies are also based on trust but trust to the state as an issuing party; • exposure to users' errors mainly due to the lack of a possibility to cancel an operation; on the other hand, this guarantees non-withdrawal; • decreasing reward to those who make the computational power available to the system (miners) – it is estimated that until 2033 the reward will go down to zero; • high volatility of exchange rate.³

Source: the author's own compilation based on: [Dopierała, Borodo, 2014, pp. 5–8, Pickton, Wright, 1988, pp.101–109; Smoręda, 2013, p. 7].

³ Over a longer time perspective it exhibited incremental trends between August 2016 and August 2017 when its value increased 7.5 times from USD 590 to USD 4,416 (calculating at the current exchange rate: from PLN 2, 141.7 to PLN 16, 030.08).

We also mentioned BTC in its investment capacity, which, however, reveals another threat. Since a cryptocurrency is not linked to any economy, you cannot analyse macroeconomic indicators of any concrete economy, such as the GDP, budget deficit, inflation, public debt or unemployment rate. For BTC investment legal and fiscal regulations and views of decision makers who adopt them as well as the openness to financial innovation may be relevant Piotrowska [2015, p. 275].

Before making a decision to invest in a cryptocurrency or to make transactions in it, it is worth considering the SWOT analysis conducted by Dopierała and Borodo [2014, pp. 5–8] for the BTC transaction system. Its major and the most specific weakness is most probably demand based on trust and having no material coverage. Theoretically, we may face a situation where within 24 hrs BTC ceases to exist and its holders will never recover resources deposited in it. Except weaknesses, bitcoin has also strengths, which make people invest in such currencies. They include, first of all: constant amount of BTC that protects against inflation or the absence of intermediaries, which substantially reduces transaction costs and differentiates cryptocurrencies from traditional currencies.

Bitcoins attributes against types of innovation

Our planet has witnessed a large number of innovations which have transformed the way people live and operate. Most of them are associated with major technological breakthroughs and new products. Innovation is crucial for creating the competitive advantage in international markets and offers benefits of the economies of scale to companies [Fernández-Mesa, Alegre, 2015, pp. 148–156]. As argued by Zhou and Bingxin Li [2012, p. 1090] two requirements must be met by a company to develop breakthrough innovations. Firstly, it needs generating breakthrough ideas (which enable to discover nascent technologies and real opportunities hidden in diverse sources of information). Secondly, they must be quantifiable; the number of implemented patents is the most commonly used measure, which, according to Tellis, Prabhu, Chandy [2009, p. 3] is an imperfect but practical tool. Even though a breakthrough (radical) innovation is a relatively rare phenomenon, it often focuses the attention of entrepreneurs and researchers because it changes the competitive environment and creates new market opportunities by substantially changing consumer behaviour patterns [Zhou, Bingxin, Li, 2012, p. 1090]. Breakthrough innovations trigger long waves of economic cycles in the global economy and delineate general global development directions. According to Helpman [2004, p. 51] breakthrough innovations are the so called “general purpose technologies”, ideas which fuelled and enhanced technological and economic development worldwide and marked the beginning of long cycles.

Kondratiev, with the help from Schumpeter, are proponents of long-term cycles linked with 50- to 60-year tendencies that periodically emerge in the global economy. Kondratiev's long wave encompasses two stages: the earlier phase of long-term growth is followed by the

period of economic slump [Burlita et. al. 2011, p. 17]. Cycles are observed in various sectors of the economy and they may overlap. Long-term Kondratiev's cycles are determined by some primary reasons observed also by other researchers, e.g.:

- Schumpeter – technical and technological innovations;
- Akerman – wars (preparation to war and its effects);
- Simiand, Cassel – long-term changes in the supply of gold and other raw materials, changes in the efficiency of agriculture.

Kondratiev's theory of a long-wave economic cycle is still of paramount importance in the perspective of global business cycle and is supported by many researchers worldwide. Since the 17th century until the present times four Kondratiev's cycles have been distinguished whose dates, however, should be treated as approximations (Tab. 2).

Table 2 Kondratiev's long cycles and innovation

Cycle	Growth stage		Slowdown stage		Basic innovation
	beginning	end	beginning	end	
1	1780–1790	1810–1817	1810–1817	1844–1851	steam engine, textile production
2	1844–1855	1870–1875	1870–1875	1890–1899	steel, railway, coal
3	1891–1986	1814–1920	1914–1920	1939–1948	automotive industry, electricity, petrochemical products
4	1949–1952	1967–1973	1973–1982	...	electronics and other hi-tech industries

Source: the author's own compilation based on Bartkowiak [2003, p. 169]; Burlita et. al. [2011, p. 18]; Perez [2005, p. 10].

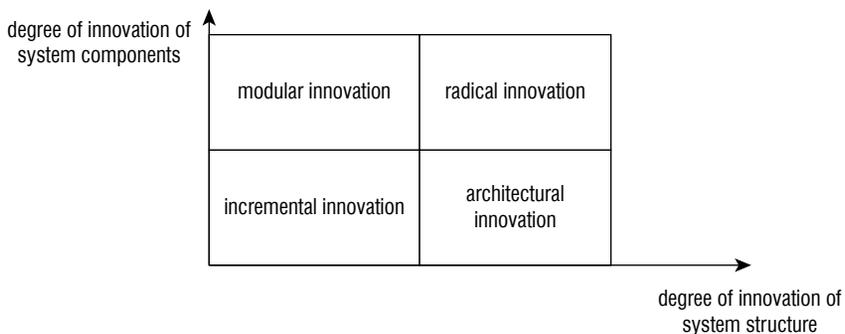
There is no common agreement as to what stage the economy is currently in since the phenomenon is resistant to historical analysis. There are two options: according to the first one the time is specified as half-way, according to the second one as the beginning of the fifth cycle, which theoretically is expected to end around 2025. What is sure, however, the fifth cycle is believed to be characterised with the expansion of cooperating networks of large and small enterprises with computers, electronics and telecommunications industry as the leading themes. These fields rather easily embrace the developing market of cryptocurrencies, including bitcoin. Nevertheless, based on the presented considerations, this market should not be seen as a separate radical innovation. Supposedly, another economic cycle has emerged (or goes on side by side with the previous one) based on biotechnology, bioelectronics, and nanotechnologies [Bartkowiak, 2003, p. 170; Golińska-Pieszyńska, 2010, pp. 58–59].

Summing up, based on the above presented facts, we may say that the market of cryptocurrencies to a large extent links with the development of electronics and telecommunications industry, but so far it has not generated any new cycle or trend in global development, neither has it become innovation that would attract continuation innovation. On top of that, the market does not meet the second requirement proposed by Zhou and Bingxin Li [2012, p. 1090] concerning measuring innovation with patents. Being a cryptocurrency, bitcoin, based on the presented interpretations of a breakthrough innovation, may not be considered one.

As we can read in the literature, breakthrough innovations re-value the market and its expectations drastically transforming its structure, providing users with a completely new value. A breakthrough innovation can also be referred to as a radical, epochal or creative innovation. On the other end there is more evolutionary continuation (incremental) innovation. It consists in modifying the existing solutions already approved by consumers. Such innovations dominate in organisation development strategies [Niklewicz–Pijaczyńska. 2013, p. 335] and improve products or services already available in the marketplace. As observed by Christensen [2010, p. 58], they may be radical, incremental or disruptive by nature and they are predominantly market-triggered.

Comparing the two extreme types of innovation: continuation and breakthrough and trying to match the BTC with one of them, we need to discuss the approach of Niklewicz–Pijaczyńska [2013, pp. 336, 348]. According to the author, depending on the type of innovation we can apply one of the models of innovation. Breakthrough innovations generated in a company are the most appropriately explained by the closed innovation model. Such innovations are introduced in completely new markets, without entering into any dialogue with consumers. What matters here are R&D work and individual creativity of inventors. Moreover, breakthrough innovations usually do not emerge within organised corporate structures but necessitate separate, flexible and often informal internal management and organisational systems. That concurs with the below presented Smith's approach. Niklewicz–Pijaczyńska [2013, p. 348] claims that the open innovation model is the right and effective one to stimulate incremental innovations as it offers direct access and gives up institutional patent protection.

Figure 1. Types of innovation according to Smith



Source: the author's own compilation based on Smith [2006, pp. 28–33].

By differentiating between the types of innovations based only on how they are generated, BTC should be classified as a continuation innovation. However, it is appropriate to discuss a more detailed classification of innovation proposed by Smith [2006, pp. 28–33] – Fig. 1. He proposed an original approach to the depth and scope of changes (innovation) going clearly beyond processes and products. By the same token, innovations embrace the entire structure of the organisational system. The author distinguished four types of innovation based on two

criteria: the impact of an innovation upon the system (does it produce changes or not) and the type of the applied knowledge.

The most revolutionary changes are involved in breakthrough innovations because they trigger putting new elements in place into the system and their re-configuration. The smallest changes in the global economy are produced by incremental innovations, which improve elements of the system without changing the whole structure. Modular innovations represent an indirect form with new or sometimes significantly different elements being introduced into an already existing system and innovations connected with system architecture, which improve the performance of its elements and then re-configure the system (by changing the relationship/links between its existing elements).

Making reference to the above discussed classification of innovation, a cryptocurrency, such as BTC, may not be unambiguously labelled as either a breakthrough or incremental innovation. Yet, bitcoin can be allocated to modular innovations, more directed towards continuation rather than breakthrough novelties. Such reasoning is due to the fact that BTC does not change the structure of the system as nowadays there are network-based clearing schemes, such as PayPal or ELIXIR for faster payments. It is just a new technology used to clear transactions in the virtual reality. The components of the clearing system have changed considerably with BTC emerging as an alternative for the present non-material form of money. This is a tangible reflection of doing away with cash transactions.

Dahlin & Behrens' [2005, p. 717] position is similar to that of Smith. They, however, identify an intermediary stage between breakthrough and incremental innovations, which could accommodate the BTC cryptocurrency. Such conclusions are justified by the way in which these authors interpret radical innovation. According to them, radical innovation meets three mandatory requirements: it is innovative (novel, ground-breaking), unique, and, first and foremost, it exerts significant impact upon future technologies by delineating their development paths (and indirectly stimulating imitation efforts). The latter characteristics leads us to concluding that bitcoin is closer to breakthrough innovation rather than to the incremental one (in contrast with the interpretation of Smith's views). Yet, BTC is not unambiguously associated with breakthrough innovation. Table 3 summarises our considerations on the types of innovation involved in cryptocurrencies.

Table 3 Type of innovation represented by BTC as a cryptocurrency

	Breakthrough (radical) innovation	Intermediary stage	Continuation (incremental) innovation
Kondratiev, Bartkowiak, Golińska–Pieszyńska	-	+	-
Niklewicz–Pijaczyńska	-	-	+
Smith	-	+ (modular innovation)	-/+
Dahlin and Bahrenes	-/+	+	-

Source: the author's own compilation based on the subject-matter literature.

Summing up the information contained in the above table, we need to realise that bitcoin as a cryptocurrency, despite its traits of incremental innovation (highlighted by Niklewicz-Pijaczyńska [2013, p. 348]) and some signs of a breakthrough innovation (as interpreted by Dahlin and Bahrenes), in most instances is labelled as something in-between these two types of novelties. Surely, in the context of innovation, in the future cryptocurrencies will be considered innovations with a broader scope of impact. It should be accompanied with enhancing much wider social approval and regulating the activities promoting the role of BTC (as a “representative” of cryptocurrencies) in the international financial system.

Summary

Considerations included in this paper and the subject-matter literature have led us to concluding that cryptocurrencies, including bitcoin, can become breakthrough innovations in the future. Nowadays, the currency is closer to incremental or continuation innovations. Cryptocurrencies are still too young to unambiguously classify them as continuation or radical innovations. The subject-matter literature provides the classification of types of innovation based on the criterion of the impact a given innovation exerts upon the system and type of applied knowledge. Innovations identified by Smith include: incremental innovations, innovations concerning the architecture of the system, modular and radical innovations. In this classification cryptocurrencies, bitcoin included, are classified as modular innovations. Such novelties are components of an already existing system and they do not change its configuration. Bitcoin, as a “representative” of cryptocurrencies, does not change the system since the Internet clearing platforms, such as PayPal or PayU already exist. In this case innovation consists in the use of new technology to clear transactions. Thus, cryptocurrencies should be interpreted as continuation rather than breakthrough innovations. There are also foreign sources which distinguish an intermediary type of innovations between breakthrough and incremental ones but classify BTC as closer to a breakthrough rather than continuation innovation. This conclusion is based on the conviction that potentially cryptocurrencies may impact future technologies and delineate directions of their future development (which is typical of breakthrough innovations). Critical analysis of the available literature helped us positively validate the hypothesis put forward in this paper that cryptocurrencies, including BTC, represent a modular innovation despite some features suggesting the continuation and breakthrough nature of innovation.

Another issue, at least equally interesting as an innovative cryptocurrency, is investing in the cryptocurrency and approaching it as a way to multiply your capital similarly to traditional stock, bonds or more popular bank deposits. Making transactions in bitcoins and investing in them or in other cryptocurrencies may, over time, turn out to be a good choice. Surely, at this very moment it is hard to firmly decide whether cryptocurrencies become a global breakthrough innovation or they will remain at the borders of modular, continuation,

and breakthrough innovations. Undoubtedly, legal regulations would help together with the approval of this form of money in transactions and settlements in individual countries. However, it would strengthen the supervision over the market of cryptocurrencies paradoxically reducing its attractiveness.

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