Bitcoin: Main Trends and Perspectives

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Authors' contributions

This work was carried out in collaboration between both authors. Author NEE conceived and designed methodology of study. Author KAT formalized main equations and performed problem analysis in trends to BTC development. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Methodological ground for Bitcoin (BTC) as a variation of private money was settled by F. von Hayek (Denationalization of Money: An Analysis of the Theory and Practice of Concurrent Currencies - London Institute of Economic Affairs, 1976). Article takes a point of view on BTC as a modern example of private money based on IT - technology and principles of cryptocurrency exchange.
Aims: We aimed to define BTC specifics as a competitive alternative currency and to establish its main trends and perspectives.
Study Design: Analytical review.
Place and Duration of Study: CEMI Russian Academy of Sciences, 2013-2015.
Methodology: Methodology is based on complex approach which includes retrospective analysis of historical events, predating the appearance of BTC, formally logical look on main problems for BTC user likely to encounter; and an IT-leading exert evaluation method to forecast its main trends and perspectives.
Results: We have established a set of mathematical equations to reflect main source of income for

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BTC-user; covered potential perspectives of BTC (based on this set), in case of different development scenarios (different types of government regulations on BTC) including low purchasing capacities during imposed restriction.

Conclusion: BTC is an important innovation in a financial exchange. Very fact of it emergence reflects todays main modern trend towards "information society". Exchange systems like BTC (improved, revised, upgraded) should take it rightful place in everyday life.

1. INTRODUCTION

BTC functioning aspects were widely discussed for nearby last decade by scientific community, alternative (and even sometimes mainstream) media, with different opinions presented. Gavin Andresen, BTC upgrade and development coordinator is among a camp of supporters. His work is planned to take place under umbrella of MIT (US) involving leading experts in a field - known cryptographer Ron Rivert, ex IMF chief economist Simon Jones and others [1]. Other specialists in IT (Rick Falkvinge (Sweden), Cameron and Tyler Winklevoss (US)) expect high potential of BTC considering this cryptocurrency to be one of the main modern trends, yet to be fairly estimated by general public [2,3].

There is also a number of prominent financial experts opposing BTC like Alan Greenspan, ex-chairman of US Fed Reserve [4].

German Gref, former head of Russian Economics and Trade department (now head at Sberbank) considers BTC as an "interesting international experiment to shift a paradigm of currency emission". As a person having broad opinion he believes that the system should be better given study and regulation instead of restrictions [5].

At the moment, there is a limited number of publications highlighting BTC development problems. The first Russian-language-book was issued in 2014 [6].

Tense discussion and lack of analytical research on a subject confirms topicality of study for currency itself, theoretical preconditions for occurrence and development perspectives.

Bitcoin (BTC) – modern electronic currency exchanged on financial markets since 2009. Due to its economic origins it is considered a variation of alternate private currency and one of the crypto currencies presented.

Cryptocurrency is a type of digital currency which emission and accounting is based on cryptographic methods (for example, proof of work method for information protection and asymmetric cryptography), and system works decentralised in a computer branched (so called peering) network [7]. Principle of anonymous is used in crypto currencies - all transactions are public, but there is no link to particular user within the system (but his/her identity can be found out in case of additional information presented).

Modern times, crypto currencies are considered alternate fiduciary (based on trust) money, emitted and used by private institutional investors. In many countries emission of private (alternate) money is prohibited, in others it's legal but strictly regulated. Thus, in US during so-called "Free Banking Era" (1837–1866) there was issued around 8000 of different kinds of private currency; issuers were particular states, cities, banks, shops, individuals, etc. And up to this day, private money in US are officially legal, but subjected to tax each time transaction is occurred and its nominal value has to be more than 1 USD. In 2009 market of alternative private money blossomed due to world financial crisis.

Last year due to markets' uncertainty and high volatility of some currencies alternative private money looked more and more attractive.

Idea of alternative private currency was proposed almost simultaneously and independently from each other in 1974 by B. Klein [8], and in 1975 - by Friedrich von Hayek [9].

F. von Hayek, well known Austrian economist, in his book 'Denationalization of money: An analysis of the Theory and Practice of Concurrent Currencies' criticized current money system itself, and proposed fundamentally new plan for achieving its stability based on free

competition of alternative private currencies. Likewise, a competition between common goods increases its qualities for consumers and sort a low quality product out, free competition between private currencies should have the same impact, leaving only the most friendly ones to consumers. Decentralization of currency supply would increase its efficiency, since federal monopoly on currency emission inevitably destroys its value and comes to be extremely dangerous to society [9].

Von Hayek's ideas were supported by economy Nobel Prize winner Milton Friedman in 1986 article "Has Government Any Role in Money?" [10]. It was found out that money systems which existed before central banks era and which were based on a principle of free competition, appeared to be effective enough.

Thus, the idea of alternative private currency has a solid methodological base behind and has a history of its implementation in real life.

2. BASE DEFINITIONS AND RELATIONS

Current variations of electronic private money are crypto currencies presented by different electronic money exchange and transaction systems: Bitcoin, PPCoin, Novacoin, Namecoin, Sifcoin, Litecoin, Quark and others.

Bitcoin is considered to be the most common, capitalized and effective crypto currency with main exchange and transfer protocol well built in. All other crypto currencies are in one way or another some variations of Bitcoin, and they use similar algorithms.

Comparative analysis for some examples of crypto currencies is presented in Table 1, which reflects a currently dominating position of Bitcoin.

From this point of view, Bitcoin can be examined for basic principles and patterns of crypto currency as a broad sense idea.

Table 1. Comparative analysis of different crypto currencies [11-13]

Currency name	Ticker	Year of emerge	Inventor	Site	Market cap.[*]	Hash[**]	Note
Bitcoin	BTC	2009	Satoshi Nakamoto	bitcoin.org	3.8 bln. USD[***]	SHA-256	First and most popular cryptocurrency; proof of work
Litecoin	LTC	2011	Coblee	litecoin.org	133 mln. USD	Scrypt	Proof of work
Namecoin	NMC	2011	Vinced	dot-bit.org	4.6 mln. USD	SHA-256	Created resistant for internet censorship;
PPCoin	PPC	2012	Sunny King	ppcoin.org	8 mln. USD	SHA-256	Has no limit for overall emission, hybrid mechanism proof of work / proof of stake
Quark	QRK	2013	Max Guevara	qrk.cc	0.47 mln. USD	Blake, Bmw, JH, Keccak, Skein	Takes 30 seconds to confirm a transaction; hybrid mechanism proof of work / proof of stake

*) Market capitalization at 18 October, 2015
**) hash (hash – code, message digest) – result of hashing operation – compressing a databases via predetermined algorithm; used for control of transfer, storage, and search of data; widely used for information encryption;
***) market capitalization of Bitcoin is comparative to a volume of relatively small country (for example, Belorussia)

Bitcoin was created in 2009 by Japanese programmer (Satoshi Nakamoto), or by a group of people under this nickname. Now, Gavin Andresen is responsible for development and coordination of BTC system.

Many analysts claim BTC to be an ideal currency for electronic transactions due to the following factors:

1) Transaction speed (operation is confirmed almost instantly);
2) It's cost (currently, transaction fee is 0.0005 BTC for small volume);
3) Exact cryptographically identification of each transaction for particular address, (available to everyone and undeniable);
4) Liquidity and convertionability.

Exchange and reconvention of BTC into rubles, dollars, euro and other currencies (also – electronic) takes place in different electronic exchange sites (for example, BTC-e.com, metabank.ru, Bitfinex, BitStamp, BTC China) and it takes minutes to execute [12].

Emission of BTC is totally decentralized (performed by users of the system themselves) and limited by time and volume. Expected amount of issued BTC is presented in picture 1 in dynamics (2009–2033) [7,13].

Chart reflects dependency of exponential type with asymptote in point A, equals 21 million BTC, which marks systems emission limit. Graphically function looks like:

$$Q(BTC) = A\left[1 - exp^{-at}\right] \qquad (1)$$

where:

A = 21 million BTC, t – timeframe, a – function parameter which defines its growth acceleration.

According to displayed chart it is suggested that curve would reach it asymptote point in 2030–2033, which would be an end of BTC emission.

User's production is stimulated by an opportunity of reward in a form of newly issued BTC (for a data processing operation), later this was called a 'data mining' (like mining of raw minerals). Emission is conducted randomly and depends on creation of the information blocks developed by overall user's transactions.

Speed of block creation is regulated. It is planned that all network would spend approximately 10 minutes on each block to create, so it will take about two weeks to create 2016 blocks. After every set of 2016 blocks a correction is performed – if blocks were created faster then in two weeks then speed is reduced and vice a versa. It is done in order to maintain a constant speed of block generation independently of overall network capacity.
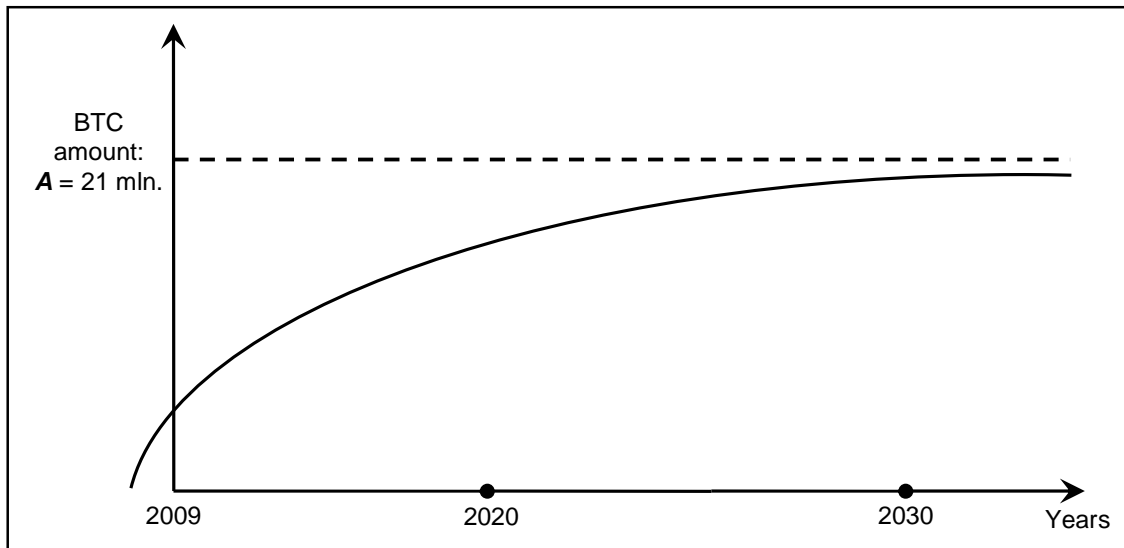

Fig. 1. Chart of mathematical dependence: Expected amount of issued BTC

Random emission event is occurred each time transaction legitimacy is confirmed. Any transaction is not considered legitimate (confirmed) until corresponding data is structured accordingly into blocks, those then form specific links which can form different branches. It has been established that each branch is equally legitimate until one becomes longer; when branches are equaling length, the one which has its last block created earlier is confirmed legitimate. Transactions went into less longer link loose its value along with an opportunity of reward.

Probability of this event is likely to decline as link grows its length. Thus, mining income of i-indexed user is based on (Fig. 2):

1) math expectation of reward for creation of blocks;
2) commission value, which is reflected by following:

$$D_i^M = S_i^C(t) \cdot P_i + K_i \qquad (2)$$

where:

D_i^M – Income from mining;

$S_i^C(t)$ – Discrete (stepwise) reward functions by a factor 0,5, which determines the amount of compensation by i-indexed user, as decreasing geometric progression dependent on time;

K_i – Discrete function reflecting commission value accordingly to step of probability of mining reward for i-indexed user; $0 \le P \le 1$;

P_i – Discrete (stepwise) function, reflecting reward value of i-indexed user, as a declining geometric progression, dependent on time;

S_i^T – Transaction value for i-indexed user.

Probability of reward P_i during 10 minute timeframe (approximate time for a block creation during an established network performance) is defined by equation:

$$P_i = \frac{M_i}{M_{overall}} \qquad (3)$$

where:

M_i – Calculating capacity of i-indexed user;

$M_{overall}$ – Capacity of whole system.

During the time $M_{overall}$ usually grows significantly faster then M_i, therefore probability P_i becomes less. Reward value declines also (Fig. 3).

Function $S_i^C(t)$ is defined on a timeframes set by points $t_0, t_1, t_2...$, during which a set of 270000 information blocks created each (which takes approximately four year in average). First cut on a value of emission (point t_1) occurred at 28 November, 2012, less then in 4 years [7].
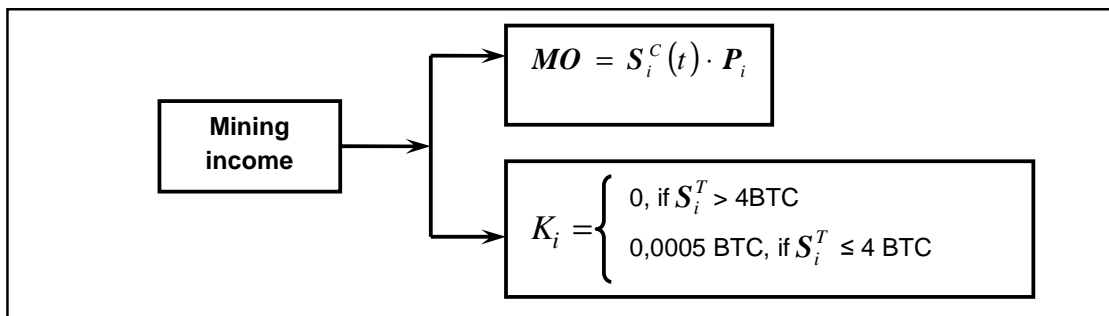

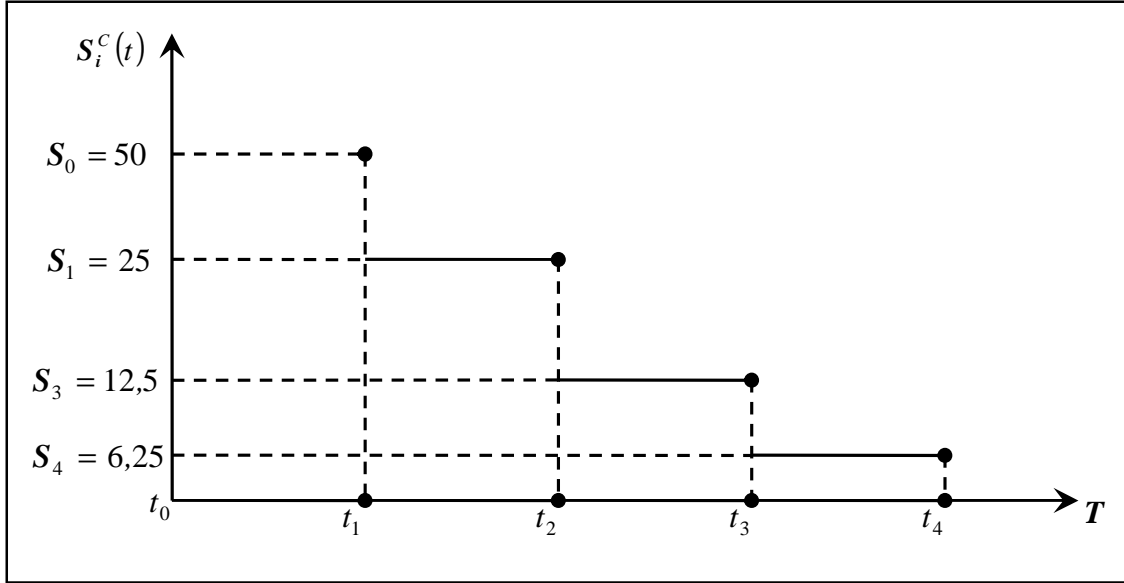**Fig. 2. Income for i-indexed user in BTC network**

Fig. 3. Discrete (stepwise) function: Reward value

Therefore:

$$S_i^C(j) = \begin{cases} S_0, t_0 \leq j < t_0 + 1 \\ \\ S_i^C(j-1) \cdot q, t_0 + j - 1 \leq j \leq t_0 + 1 \end{cases} \quad (4)$$

where:

$t_0 = 0$ – First time period;

j – Correction number for emission reward;

q – Correction coefficient; $q = 0,5 < 1$;

S_0 – First time reward ($S_0 = 50$ BTC);

$t \in [0, T]$ – Interval time of the system.

Accordingly to formula (4) emission reward value declines geometrically: $S_i^C(t) \to 0$ while $t \to \infty$, and after emission ends, mining income D_i^M would consist only of commission.

Already this time it takes significant calculating capacities and expenses for electricity. Thus, net income from mining should be corrected by taking into account occurred expenses Z_i :

$$\tilde{D}_i^M = D_i^M - Z_i \quad (5)$$

where: Z_i – expenses, growing along with network expansion, at a first time frame were not significant to take into account.

By 2013 the necessary computing power to create a single block increased half a million fold than that required for initial operation of the system before. Since that users have started to join so-called mining pools to combine their effort and increase a probability of emission reward comparatively to solo mining.

Rules of emission provided privilege for "mining pioneers" as in relatively simple and effective conditions (each 10 minutes – 1 block and 50 BTC out of thin air) they managed to mine significant amounts.

Thus, experts estimated more than 1 million BTC in Satoshi Nakamoto virtual wallet, an equivalent of several hundred million dollars (at the rate of April, 2014) [14].Later period presumes a change in user's activities, from mining to investment, (Fig. 4) and online shopping. Speculative income depends on BTC rate forecast and development of crypto currencies in general.
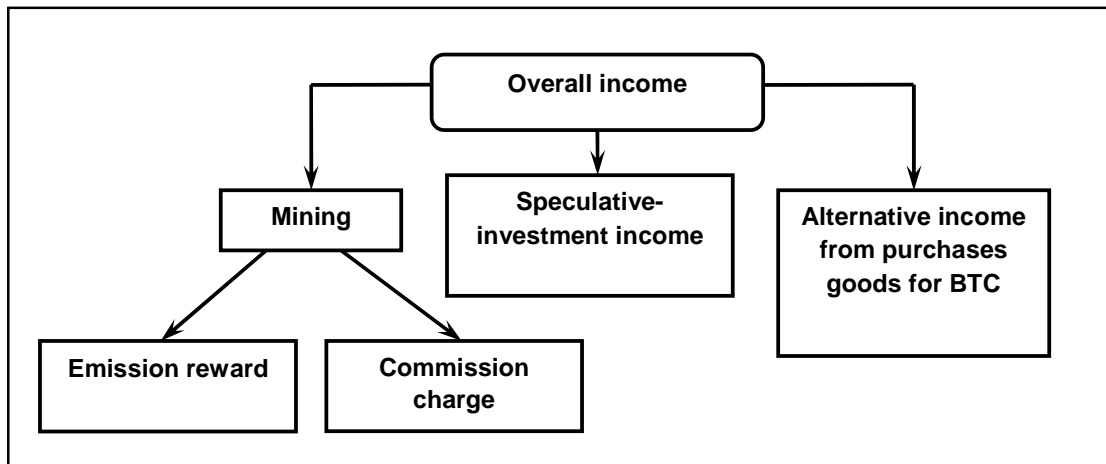
Fig. 4. Income of BTC network user

Overall income for BTC user ($D^{overall}$) is defined as a summation of 1) mining revenue $\widetilde{D}^{M}$, 2) speculative – investment profit D^{inv}, based on exchange rate difference, 3) indirect income D^{A} as a cheaper value of goods purchased for BTC.

$$D^{overall} = \widetilde{D}^{M} + D^{inv} + D^{A} \qquad (6)$$

Indirect income D^{inv} is strongly influenced by BTC infrastructure (ATM machines, shops, goods available online) Thus, user efficiency is defined by BTC rate forecast and general development perspectives [15].

3. ESTIMATION OF PERSPECTIVES: AVALIABLE SCEENES

Forecasts are mainly contradictive. Some experts expect further growth of BTC rate and reduction of its volatility, giving such arguments as limited emission and accretion of demand. Optimists evaluate future BTC rate as 40 000 USD and higher. For example venture capitalist Cris Dixon considers, that BTC rate will reach 100000 USD. Thus he compares BTC to Internet and speculates, that in 1993 it was absurd to imagine some domain names to cost 10 million dollars, nevertheless it has become its price in 20 years period [3,16].

Other experts predict BTC rate to decline 100 times over and after that it is supposed to blow like another financial bubble [17].

Such a variety of opinions come out due to volatility of current BTC market that reflects instability of any emerging and rapidly expanding system. During a relatively short period of time BTC rate grew with incredibly high speed: from 0,3 cents (25.04.2010) up to 1000 USD (28.11.2013) in 2014 it remained in range of 400-500 USD (Table 2).

Crypto currency (BTC in particular) has its supporters and opponents who diversely estimate its role and place in financial system in general.

In case of favorable scenario for development and practical implications it can seriously affect both financial markets and social life. Taking into account rapid capitalization growth in crypto currencies markets and relatively low growth of world's financial markets, in some period of time crypto currencies sector can claim a significant share.

Returning to discussions about BTC challenges it is necessary to point out that its supporters consider it as a major breakthrough in computer science, same way as worldwide web in 1993 and personal computers in 1975. Marc Andreessen invested into his BTC startup venture over 50 million USD [18,19].

They also indicate sophisticated protocol and flawless logic utilized in the system. Dan Kaminsky, known cyber security specialist, confessed that he tried to hack into network in 2011 but failed to find any weak point [20].

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Table 1. Main tipping points in BTC dynamics [7]

Date	BTC exchange rate	Event
25.04.2010	0,3 cent	System start
10.02.2011	1 USD	BTC equal to USD
30.05.2011	8,89 USD	Growth after Forbes «Crypto Currency» article
09.06.2011	29,57 USD	Growth after article about underground resource «Silk Road»
19.06.2011	5 USD	Decline after a news about MT. Gox exchange
28.11.2012	20 USD	First cut down of emission (2 times)
22.02.2013	30 USD	New historic high
01.04.2013	100 USD	Period of fast growth (end of February-March)
10.04.2013	266 USD	Period of extra fast growth
16.11.2013	900 USD	Different rate at different exchanges
28.11.2013	1100 USD	maximum for period
05.12.2013	500 USD	Panic sales after China's central bank's ban on BTC operations current
2014–2015	400-500 USD 200-300 USD	Period of relative stabilization

Crypto currencies skeptics doubt its benefits as a financial instrument and perspectives for long-term existence [17]. Three major arguments are pointed out:

1. Network has a conflict of interests with a state as an institution management: state loses its control over financial streams which means it loses power over economic situation in general. Therefore, sate would naturally reject out-of-control alternative currency exchange network between individuals. Of course, direct restriction is not possible as it is not possible to restrict individuals to communicate with each other over internet. Alex Fork, an author of popular book "BTC: more than just money", claims that government is not fully able to control BTC. By law, electronic currencies can be banned but there is no means of its practical [21]. Nevertheless, government has massive leverage in crypto currencies' functioning process. As an example there is a restriction to exchange BTC into Yuan or into major currencies adopted in China in 2013 and this very restriction brings into discredit the idea of international alternative currency itself. If such a sanctions would be implied by biggest economies cooperatively, BTC would turn into a kind of penny stock. And this scenario is quite possible as more and more countries gradually introduce such a restrictions.

2. Network is also in a relative conflict with society in general. It is hard to say what Satoshi Nakamoto aimed at when he presented his network with a principle of anonymity. Maybe it was "golden rule" of business: big money does not like any public exposure. Maybe he wanted to make BTC attractive for most users, including businessmen, entrepreneurs, who are into legitimate business but would prefer privacy as a protection from possible competitors. But his privacy model (Fig. 5) has opened a wide area of opportunity for so-called "shady business". One of famous examples - internet-shop "Silk Road" which traded various types of drugs, pornography, etc. for BTC. It was shut down in October 2013 by FBI with a turnover of 30000 BTC or approximately 25 million USD. Other Example was in same autumn of 2013; assassination market was found in Tor network that was dedicated to raising BTC for funding political and social assassinations [22], etc. All those facts discredited the network itself and provided an excuse for control and restrictions.

3. Cryptocurrency and BTC delivers significant economic damage first of all – to financial sector and national currencies, as a serious competitor; reduces income from emission and transactions. Many experts point at undisputed link between BTC and flow of capital abroad as due to its cryptographic qualities BTC: it is a useful system for money transfer concealment. And this leads to decrease of investment activities, reduced tax income, utilization of illegitimate financial schemes, etc.

4. In methodological view BTC as an instrument of exchange is criticized by many experts. One of the important points

is the issue of BTC backing. Former head of Federal Reserve System, Alan Greenspan, during his interview to Bloomberg news agency said: ""You really have to stretch your imagination to infer what the intrinsic value of Bitcoin is. I haven't been able to do it." [4]. And BTC supporters answer was: "Maybe he can tell what is the intrinsic value of US dollar?".

The irony of the BTC adepts contained in their counter-question to Alan Greenspan has compelling reasons. At the present time (as opposed to the period of the gold exchange standard and Bretton Woods agreement, 1944), the dollar does not fully has backing of currency neither by the United States gold reserves nor by the volume of real goods and services produced in the country. According to expert estimation in 2006 only about 25% of the dollar value is covered by real goods, when the remaining 75% is a fabrication of unsecured liabilities generated by government printing press [23].

The situation has deteriorated dramatically by 2015 due to growing pyramid of government debt amounted to 17 trillion dollars or 106% of US GDP (total debt, including debt of states and the financial sector - 250% of US GDP, consolidated debt, taking into account social obligations exceeds the GDP 11.6 times) [24,25].

As for the US gold reserves ($\approx$ 8133,5 tons in October 2015, by approximate estimates (authors' calculations), taking into account the average gold price in 2015, equal to $ 1186.62 per Troy ounce [26], it is about 414 billion dollars. Thus, it is 41 times less than the US public debt.

The content of gold in $ 1 is roughly estimated by the ratio of gold reserves and the money supply, which is a negligible amount. As of 2006, M2 money supply amounted to 12 trillion dollars; at the same period the gold reserve was equal to 8196 tons at an average price of 603,46 for 1 Troy once [26]. Accordingly, there comes the ratio:

$$(32170,1 \times 603,46 \times 8196) : 12 \text{ trillion} = 0.013. \quad (7)$$

Despite the proximity of the calculation, the essence of the existing order of things is quite clear: the issue of the gold covering of the dollar loses its meaning.

Nevertheless, the dollar remains the leading currency of international settlements and the creation of reserves. As majority of modern currencies (including BTC and other crypto currencies), the dollar is a fiduciary monetary unit *) it means such a payment facilities denominational value of which is set (adjusted) by the appropriate state or public structure and does not depend on the value of the material (gold) it is made of, or the value of reserves of this material [27]. There is no hard link between the fiduciary unit and marketable coating. These facts are highlighted by the supporters BTC which defend its right to exist.
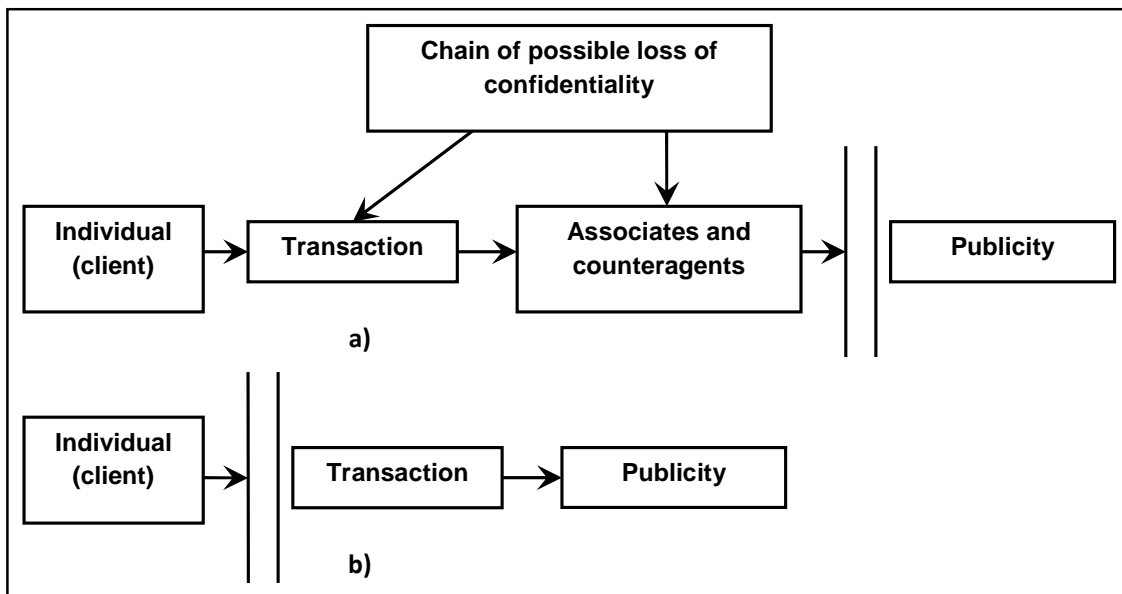

Fig. 5. Comparison of confidentiality models: a) traditional; b) in BTC system

In other words, goodwill and intangible assets play the main role in modern money cover, which importance to the switch to the information society (knowledge society) will increase as a result of objective developments.

The fact that cover of dollar at the moment is not US GDP is widely known, and its reputation component is goodwill, including: 1) its leading role in the international arena for more than one decade, participation in major military-political alliances; 2) prevailing US dollars assets in the world community for payment and savings systems (60.7% of total); 3) the principle "it's too big to burst" because all countries will suffer losses, etc. [24].

These features of modern monetary circulation should be as well considered, according to the authors, at assessing BTC and other crypto currency sufficiency.

BTC backing of currency is composed of two components:

- material one - is a network of powerful pooling computers which is the primary means of storing and processing information as the main product in the knowledge society;
- nonmaterial one, including: 1) the unique IT-technology (blokchain, fork, etc.) - the main advantages of the BTC, which allow us to call it digital gold [28], 2) a special method of decentralized emission and the free market money circulation which excludes "spoiling of money" (by F. von Hayek); 3) a set of specific properties of BTC as a currency, making it attractive for the user (supranational character and independence from local and foreign banks, free trade with the possibility to avoid the prohibitions and sanctions, financial intermediaries elimination, safety and security, zero or low commission, the principle 24/7/365, speed of transactions, etc.) [29].

Analyzing the integration of BTC into the world monetary system, the authoritative magazine "The Economist" points out that the blokchain technology used in the BTC can be successfully used in a wide range of socio-economic activities [30], which, in turn, on the basis of the feedback, will contribute to the growth of BTC due to the impact of IT- technologies generality. According to Samee Zafar, Director of the London office of Edger Dunn & Company Consultancy, demand for BTC is also provided due to the fact that the currency is the epitome of personal freedom and the right to privacy. Therefore, currencies like BTC, based on scientific principles and protected from volatility of central banks policies and the impact of irresponsible governments, will become widespread [31].

4. CONCLUSIONS

Regardless on which scenario would take place in future, whether BTC network continues or cease to exist, its role and impact on society and financial sector cannot be underestimated. The very fact of its existence modern times is not by a random chance.

Financial sector and stock markets has reflecting qualities and one way or other display most important events for society [32]. One of the most significant world's trends is a change into information society and economics of knowledge [33]. If IT-technologies and calculating computer power can be considered one of the most important way of applying current knowledge and intellect, then, methodological base for BTC is totally aligned to this trend. And appearance of this cryptocurrency is a reaction of financial markets on innovations that take place in a society, according to which; holders of knowledge have an advantage over others. Very same thing happens within BTC, when income from mining is likely to be shared between users with most calculating powers. And it's not by a chance, that in US (one of the most advanced countries on it's way to information society), there is no direct restrictions for BTC; instead, there is a motion towards its legislation.

That shows that in future, systems of that kind, based on a conception of knowledge (if not BTC, then some of its analogues), and would take its rightful place in a society.

GRANT SUPPORT

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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