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The New Darwinism of the Payment System: Will Bitcoin Replace our Cash-based Society?

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ABSTRACT

This paper is concerned with the new Darwinism of the payment system. The researcher discusses the payment system to understand if Bitcoin would replace our cash-based society. The analysis is based on the technology S-curve and Schumpeter's model of economic development. At present, there are problems hindering Bitcoin innovation to achieve a wide adoption as the innovation is not well received by the government central banks around the world. It is interesting to see that the swing of S-curves is not strong enough to cause a paradigm shift according to the Schumpeterian concept of creative destruction. The results have shown parallel S-curve trajectories of electronic money innovations signifying a move from a cash-based economy towards a less cash society. The study provides useful implications to support the diffusion of Bitcoin innovation.

KEYWORDS: Darwinism; Bitcoin; Cashless; Digital money; Payment system

INTRODUCTION

For many decades, new electronic money innovations have been launched in the payment system with the attempts to shift the global economics from a cash-based economy to a cashless society. The payment system has witnessed the development of physical money like cash, notes and cheques to electronic money or digital money like ATM/Cash cards, Credit cards, electronic fund transfer at the point-of-sale (EFTPOS)/Debit cards, Smart cards and Bitcoin, the latest development of electronic money or digital money. Bitcoin is a type of digital money whereby the

financial transactions can take place by electronic means. It is a peer-to-peer mining network using open source software that has been adopted by many countries in the world now. The challenging question arises whether the innovation of Bitcoin would replace our cash-based society.

To date, only limited research has been carried out in respect of the service innovation [1-4] and in particular the financial innovation has received little attention. This study thus attempts to fill this research gap with a focus on Bitcoin innovation in the payment system. The aim of this paper is to explore whether Bitcoin would be the new Darwinism (Charles Darwin's theory of evolutionary change) of the payment system to bring about a paradigm shift from a cash-based economy to a cashless society.

The paper is organized as follows. Section 2 reviews the theoretical framework on technology S-curve and innovation diffusion, and Schumpeter's model of economic development. Section 3 describes the research design, methodology and explores the landscape of the payment system. Section 4 presents the analysis of findings with regard to whether Bitcoin would be the new Darwinism of the payment system. The analysis of the payment system is based on the technology S-curve and Schumpeter's model of economic development. Section 5 concludes the paper and provides useful implications on the adoption and diffusion of Bitcoin innovation – a challenging step towards a cashless society.

Theoretical Framework

Technology S-Curve and Innovation Diffusion

The innovation diffusion theory often deals with the innovation process. The innovation process characteristically exhibits an S-pattern. The review of various scholars' studies on the process of innovation diffusion is shown in Table 1. Utterback and Abernathy [5] articulate the innovation process as S pattern. Vernon [6] Product Life Cycle (PLC) is a classical model explaining the development as a pattern of product substitution (the S-curve pattern).

Table 1: Principal concepts of innovation diffusion

Scholars	Principal concepts of innovation diffusion
Utterback and Abernathy [5]	The life cycle explains sources and directions of technological change. The life cycle explains the development of technology-related products and processes.
Fisher and Pry [7]	Fisher and Pry offer a classical model for forecasting innovation diffusion. Their study is focused on the diffusion process of product innovations as well as the substitution rate of technological change.
Gort and Klepper [28]	The study measures and analyses the diffusion of product innovations. Their study divides the life cycle of the new product industries into five stages. The study provides a basis

Scholars	Principal concepts of innovation diffusion
	for the development of a theory of the evolution of industries.
Abernathy, Clark and Kantrow [8]	They view the innovation process as a process of industrial de-maturity. They argue, from the perspective of evolutionary theory on economic development, that technological change may alter the character of innovation and competition and over time affect the structure of the industry.
Rogers [9-11]	The innovation development process comprises six stages: • problem definition • research (basic and applied) • development • commercialization • adoption and diffusion • consequences
Cooper and Kleinschmidt [29]	The innovation development process of the manufacturing industry comprises: • preliminary assessment • detailed investigation (problem definition) • development • testing and validation • commercialization
Peres, Muller and Mahajan [30]	They study the diffusion processes of new products and services. They view the innovation diffusion as a process of market penetration whereby the launch of new products and services is driven by social influences.
Guseo and Guidolin [31]	Their study is focused on the innovation diffusion – the new product life cycle. They propose a multimodal model to the life cycle of the compact cassette format for pre-recorded music in Italy.

The phases along the PLC reflect innovation diffusion-the progress of product/process innovations along the stages of introduction, growth, maturity and decline. Given the competitive environment of the innovation/diffusion process in the industry, Utterback and Abernathy [5] developed a model of the dynamics of innovation - the innovation life cycle model to describe the process of innovation and the degree of technological change. The innovation life cycle also provides a basis for technological forecasting. According to the study of the innovation process by Fisher and Pry [7], they argued that when a new innovation reaches about 5% penetration of the potential application market, it provides a reasonable base for forecasting the speed and ultimate penetration achievable.

In the theories of economic growth and technological change, Abernathy [8] argued for the process of industrial de-maturity as the driving force of the industry evolution. They considered the nature of the innovation process as well as the competitive environment in which technology evolves to explain the progress of the industry. With respect to evolutionary theorizing on economic growth, they argued that technological change may alter the character of innovation and competition and over time affect the structure of the industry.

Among the different approaches regarding the dynamics of innovation, Rogers [9-11] offers one of the most important models of innovation diffusion based on the well-established theories in social science, psychology, and communications. In this study, the analysis of S-curves in the payment system and the discussions on the process of innovation will be based on the concept of innovation life cycle since the model provides a basis to understand innovation diffusion a process of commercialization and market acceptance.

Schumpeter's Economic Development Cycle

In Schumpeter's theory, the successive industrial revolutions are based on the transformation of the economy by new technologies. According to Schumpeter [12,13] the phenomena of 5 Kondratieff cycles engender waves of technological change. In other words, Schumpeter's long-wave theory explains the waves of economic development whereby the shift from existing business cycle to new one leads to the growth of industrializations. The Schumpeterian view of 'creative destruction' emphasizes discontinuity of economic development. That is to say, the process of creative destruction brings about the economic growth of which the emergence of new product/ process innovations does not grow out of the old ones but eliminates them [12,13].

Schumpeter [12,13] argued that finance and financial institutions are the mainstream of innovation system as well as crucial determinants of the economic performance. It is interesting to see that the Schumpeterian view of economic development has set the stage to develop a new paradigm further [14-20]. The development cycle of industries is represented by revolutionary shifts in which one paradigm displaces another, leading to surges of economic growth [12,13,21].

Tushman and Anderson [22] also describe patterns of technological change as a cumulative process until punctuated by discontinuous innovations. This causes technological shifts, either competence enhancing or competence-destroying. Competence-enhancing discontinuities are order-of-magnitude improvements based on cumulative experience in the use of earlier vintages of technology in contrast to competence-destroying discontinuities which require the mastery of new technology, skills, abilities and knowledge in both the development and the production of the product [8,23]. The argument of Tushman and Anderson [22] is in line with Freeman and Perez's fourth taxonomy of innovation (changes of techno-economic paradigms); and Gallouj and Weinstein's [24] radical innovation, arguing for radical replacement innovations.

Whereas Schumpeter conceptualized a qualitative transformation of the economy, Freeman and Perez [25] made further attempts to define the trajectories as conditions of new waves. Freeman and Perez [25] argued that the process of

economic development is radical and causes a techno-economic paradigm. According to their studies, a techno-economic paradigm is a cluster of interrelated technical, organizational and managerial innovations that affects the whole economy. According to Freeman and Perez [25] the three trajectories characterizing a change in techno-economic paradigm are:

a. The fall in cost
b. Unlimited availability of supply over long-time periods
c. Prevailing use in a large number of products or processes

Taking into account the adoption and diffusion of Bitcoin, the analysis in Section 4 will discuss whether Bitcoin would bring about the shift of economy particularly the payment industry based on the concept of techno-economic paradigm by Freeman and Perez [25].

Research Methodology

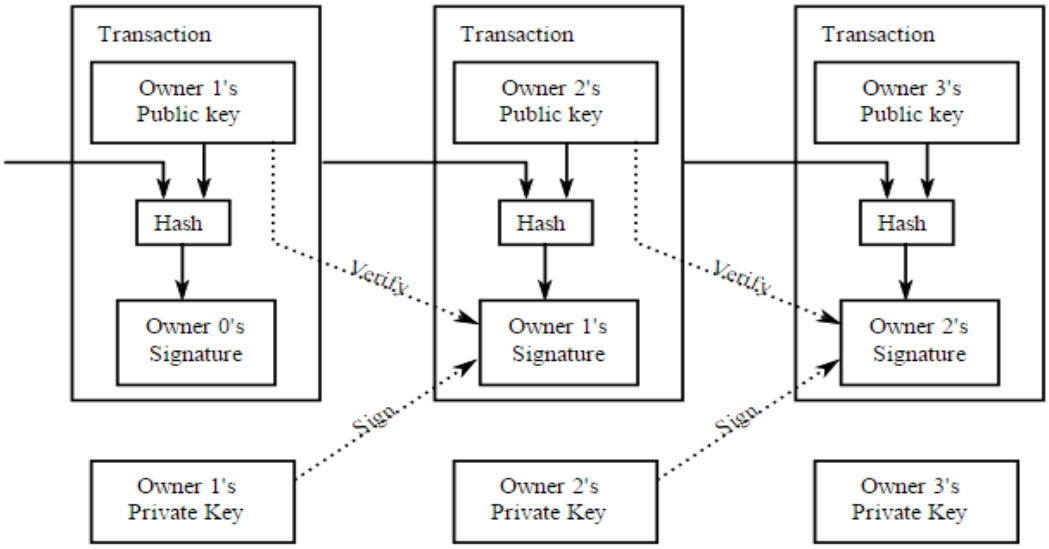
Given a limited research in the financial innovation, this study attempts to fill the research gap by exploring the financial innovation in the payment system. The researcher employs a case study methodology [26,27] and is focused on the case of Bitcoin innovation. The researcher aims to understand the circumstances of Bitcoin's adoption and diffusion. The researcher attempts to explore whether Bitcoin would be the new Darwinism (Charles Darwin's theory of evolutionary change) of the payment system to bring about a paradigm towards a cashless society.

This study has applied the S-curve model of technology adoption and diffusion by Utterback and Abernathy [5], Fisher and Pry [7] and Schumpeter's model of economic development [12,13] to analyze the process of technological change with regard to the new Darwinism of the payment system. The research also analyses the challenges as well as major problems hindering Bitcoin adoption and diffusion.

Bitcoin -The New Darwinism of the Payment System?

The innovation of Bitcoin was introduced in 2009 by Satoshi Nakamoto. Bitcoin is an open-source, peer-to-peer digital currency. It is based on the decentralized digital-payment system providing online payment solutions. Figure 1 outlines the functions of Bitcoin transfer using cryptographic hashing and digital signature technologies. The Bitcoin system allows users to transact directly without needing any payment intermediaries. Interestingly, the Bitcoin wallet enables online access to virtual banking. At present, Bitcoin is gaining popularity where there is hope that the society would shun physical cash and adopt digital money with the aim of progressing towards a cashless society.

Figure 1: Functions of Bitcoin using digital signature technology



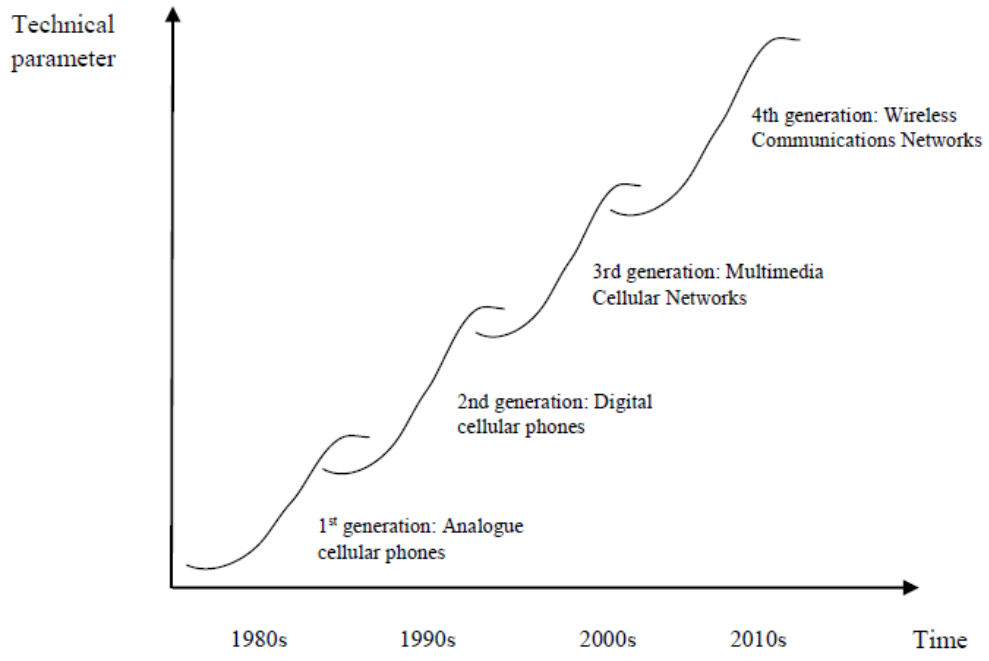
Source: wikipedia.org

Before analyzing the technology S-curves in the payment system, it would be useful to understand the process of technological change in other industries as a basis for comparative analysis. Figures 2 and 3 show the process of technological change in the computer industry and the mobile telephony industry respectively. In the computer industry (Figure 2), the technological change based on the theory of innovation life cycle represents a succession of S-curves. The technological improvement follows the S-curve to reflect technology progression from mainframe, minicomputer, PC, client services, broadband, mobile web/WAP technology. The envelope of S-curves underlying the innovation process also shows technology substitutes to extend the life cycle of the operating system. In the mobile telephony industry, the innovation process, based on the theory of innovation life cycle, represents the generations of mobile system from 1G to 4G (Figure 3). A succession of S-curves signifies versions of mobile communication services with improving frequency limits.

Taking into account the process of technological change of these industries, it can be seen that the overlapping S-curves represent generations of new or improved technology (for product/process innovation). The analysis of technology S-curves in various industries could provide a basis to understand the potential adoption of Bitcoin innovation. Figure 4 analyses the process of technological change of technology S-curves in the payment system. It can be seen that the technological evolution progresses from physical cash and cheques to electronic cash of ATM/Cash card, Credit card, EFTPOS/Debit card, mobile money (or electronic money transfer through cellular networks) and the latest digital money innovation of Bitcoin.

Figure 2: Technological change in the computer industry [5,7]

Figure 3: Technological change in the mobile telephony industry [5,7]



Unlike technological innovations in other industries (the computer industry as shown in Figure 2 and the mobile telephony industry shown in Figure 3) whereby the process of technological change portrays an envelope of S-curves which mean that

the new technologies take up existing technologies; the process of technological change of the payment innovations shows a parallel of S-curves.

Concerning the process of technological change in the payment system, it shows parallel S-curve trajectories of electronic money innovations. The form of S-curves signifies a move from a cash-based economy towards a less cash society. To understand if the trend of technology S-curve for Bitcoin innovation would be a parallel shift or swing upwards to cause a paradigm shift, Table 2 provides the analysis of technological development based on the three factors causing paradigmatic shift argued by Freeman and Perez [25].

Table 2: Analysis on the process of technological change in the payment industry

	Factors	**Description**
(i)	The fall in cost	The transaction cost is 0.045 BTC[1] (or USD 17). The cost to the network is 0.03 BTC per BTC transferred. The Bitcoin innovation has low transaction fee of 0.0005 BTC per 1 transaction compared to other financial transactions (compared to credit card transaction fee of 3-5% per transaction value) which would help achieve widespread usage.
(ii)	Unlimited availability of supply over long-time periods	Bitcoin is a virtual currency created by software for exchanging value without the use of intermediary banks. Given its characteristics as an open source software, this provides unlimited supply since the software developers can use the open-source code to develop Bitcoin applications.
(iii)	Prevailing use in a large number of products or processes	Given that the innovation is not backed by any government and the innovation is vulnerable to manipulation as well as speculation, many countries are reluctant to accept Bitcoin. The major problem concerning lack of secure infrastructure has hindered Bitcoin innovation to achieve widespread use.

[1] BTC stands for Bitcoin. It is the unit of digital currency of the Bitcoin system.

The analyses based on the technology S-curve and Schumpeter's model of economic development [12,13] have shown that at present the swing of S-curves is not strong enough to cause a paradigm shift (Figure 4) due to major implementation problems (Table 3). Currently, the Bitcoin innovation is not backed by any

government and there are problems of insecure payment infrastructure. These are major problems that have caused the slowness of Bitcoin adoption. As can be seen from Table 2, the analysis points out the problem of not achieving prevailing use in a large number of products or processes according to the theory of techno-economic paradigm shifts [25]. The parallel S-curves underlying the process of technological change in the payment system have shown that the innovation process is still evolutionary. The innovation economics is progressing towards the less cash economy (not a process of revolution nor creative destruction) and thus the cashless society seems unlikely in the near future.

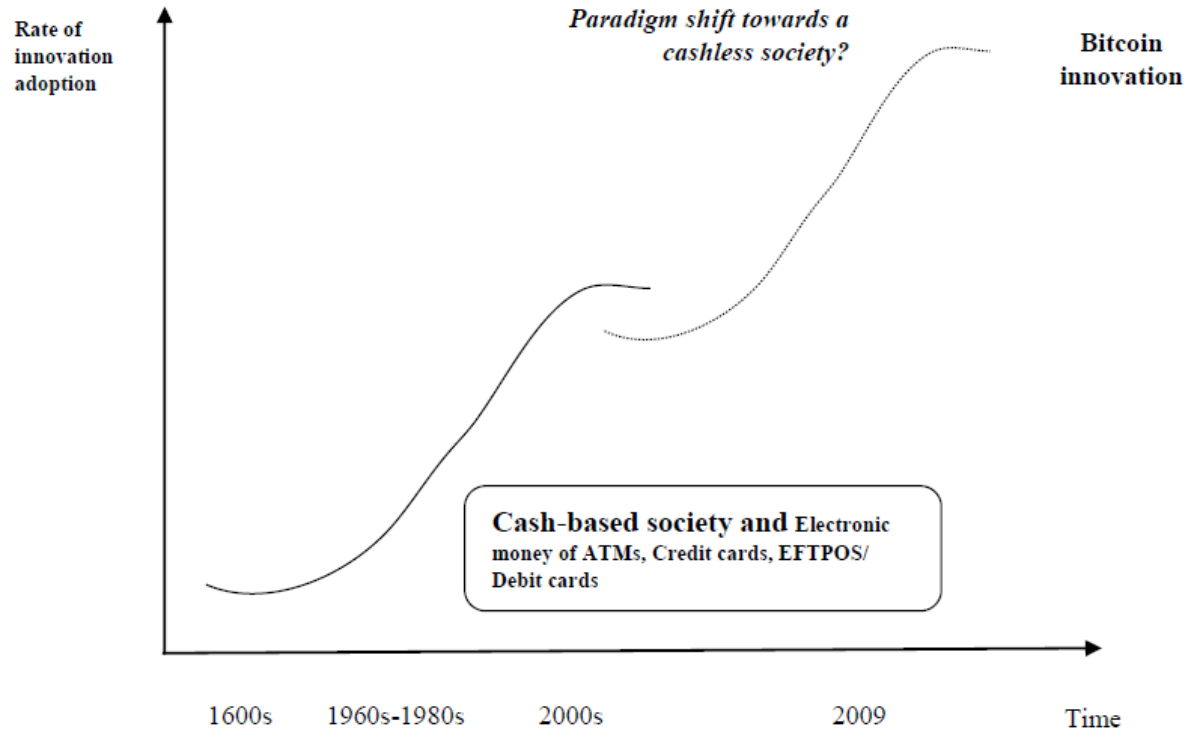


Figure 4: Technological change in the payment system and potential adoption of Bitcoin [5,7]

Table 3: Major problems hindering Bitcoin adoption and diffusion

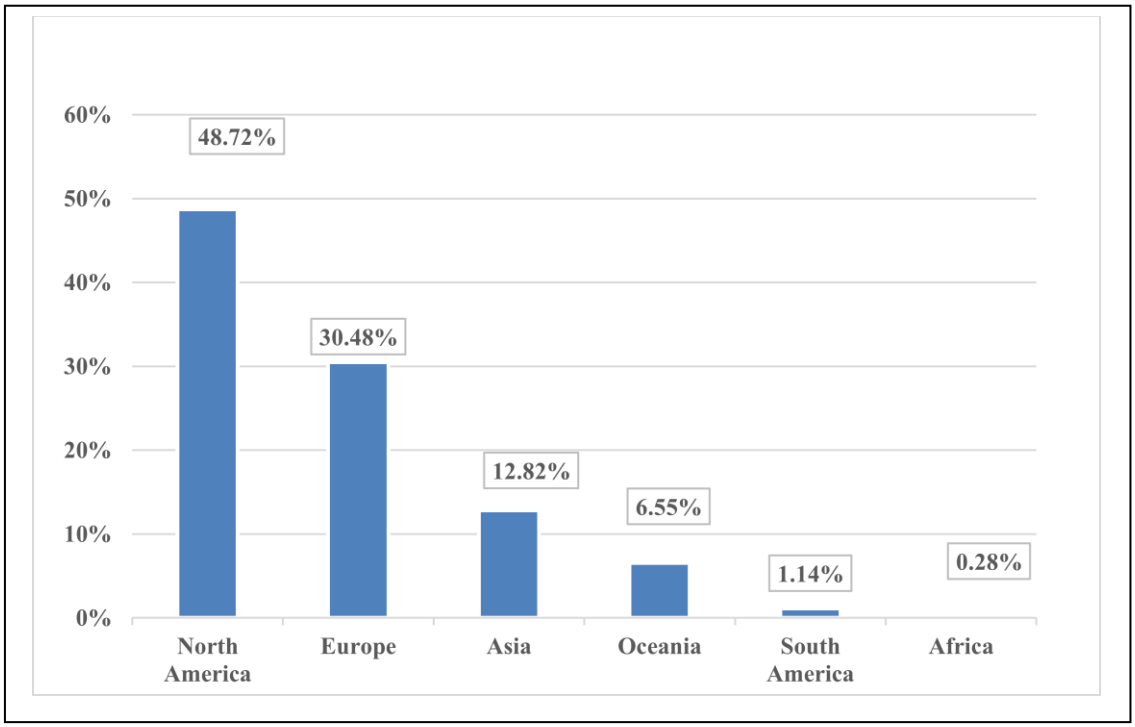
Major issues	Particulars
Competing mining protocol standards	• There are problems of competing mining

Major issues	Particulars
	protocol standards and payment networks which hinder interoperable system of Bitcoin.
Insecure Bitcoin infrastructure	• The problems of account hacking, criminality and insecure Bitcoin payment infrastructure • There are security issues with Bitcoin wallet. The concerns over security increase after Mt. Gox, one of the largest exchanges, had lost its customers' Bitcoins from hacking incidents.
Legality of Bitcoin activities	• As the currency is not issued or backed by the government, there are concerns over legality of Bitcoin activities. • There are problems of illegal tender where Bitcoin needs the government's legislation to improve the legitimacy of this new currency.
Risks of money laundering	• As Bitcoin can be used anonymously, there is a risk of money laundering since the persons performing transactions are unidentified.
Risk of trust and Bitcoin exchanges	• Given that Bitcoin is not issued by banks, the banks cannot control the exchange rates. Thus, the value of Bitcoin is prone to swings as it depends on the credibility of users. • Since Bitcoin is not regulated by the central bank, this affects the credibility of Bitcoin (particularly the problems of trust and transparency of this new digital currency). • The exchange rate of Bitcoin transactions is highly volatile and its value is prone to depreciation. Such volatility affects the stability of the payment system.
Risks on the effectiveness and stability of monetary policies	• There are risks on the effectiveness and stability of monetary policies since the central banks cannot control the supply of Bitcoin. • There are risks of speculating on Bitcoin value which would affect financial stability.

At present, Bitcoin ATMs are installed in many countries to promote wider use of this new digital currency for buying and selling bids (the adoption and diffusion of Bitcoin innovation). To understand the new Darwinism of Bitcoin, Figures 5 and 6 present

the share of Bitcoin adoption worldwide. It can be seen that Bitcoin ATMs are installed in every continent. They are widely adopted in the North American countries (48.72% share as shown in Figure 5) particularly the United States and Canada (Figure 6).

Figure 5: Share of Bitcoin ATMs by continent



Source: Coin ATM Radar

Figure 6: The adoption of Bitcoin worldwide

Source: Cossa.ru

While being widely adopted in the North American and European countries, Bitcoin is struggling to gain acceptance in other continents including Asian countries. That is to

say, the innovation of Bitcoin is struggling to be the new Darwinism in the global payment system. Figures 5 and 6 also reflect the situation where there are many issues hindering Bitcoin adoption (discussed further in Table 3). For example, in China, the central bank has barred financial institutions from handling Bitcoin transactions and restricted the transfer of Bitcoins. In Thailand, Bitcoin is not authorized to operate as the Bank of Thailand argues that Bitcoin exchange operations do not fall under the scope of the Ministry of Finance regulation. In Malaysia, Bitcoin is not recognized as a legal tender where the central bank advises the users to be aware of the risks associated with Bitcoin usage. In South Korea, there are no laws regulating the use of Bitcoin at present. In Indonesia, the central bank of Indonesia sees Bitcoin as money laundering threat and cybercrime2. It can be seen that as Bitcoin is not regulated by banks, many countries have yet decided in terms of planning to issue regulations on Bitcoin innovation.

The views of the Bank of Thailand provide reflection example of the Asian situation where Bitcoin is not accepted as a currency. According to views of the Bank of Thailand, it states: "…Bitcoin is not recognized as legal tender. It is not accepted as a means for debt settlement. Bitcoin has no intrinsic value in itself. Its value varies with the demand and supply of traders who purchase or sell Bitcoins. Therefore, the price or value of Bitcoin can change rapidly and Bitcoin may eventually have no value when nobody wants it. We (the Bank of Thailand) therefore have announced that Bitcoin is illegal. It is a breach of monetary law and we ban buying and selling of Bitcoin. We forbid the use of Bitcoin in exchange of goods or services as well as the exchanges between Bitcoin and other currencies in Thailand…"

Concerning the slow adoption of Bitcoin innovation, the major problems are the competing mining protocol standards which hinder interoperable payment systems and the insecure operation which make Bitcoin digital wallets vulnerable to theft and loss. Furthermore, the issue of unidentified persons performing transactions has raised concerns over financial crime. At present, there are insurmountable problems of insecure computer and internet infrastructure as happened in the case of Mt. Gox where Bitcoins totaling USD 370 million have been stolen3. As the currency is not issued or backed by the government, the central banks of countries around the world hesitate to accept Bitcoin, hindering the progress of Bitcoin adoption. Table 3 summarizes major problems hindering the adoption and diffusion of Bitcoin innovation.

The analyses of findings in this paper have shown the development of payment system whereby many financial innovations are launched in attempts to move from a cash-based economy towards a less cash society (the technological change does not reflect a process of revolution nor creative destruction). To improve the adoption rate of Bitcoin innovation, it needs secure payment platform and information and communications technology (ICT) infrastructure.

CONCLUSIONS

This paper is concerned with the new Darwinism of the payment system. In particular, the researcher conducts the study in attempts to understand if the innovation of Bitcoin would replace our cash-based society. The analyses of the payment system have shown an evolutionary path towards a less cash economy (not a revolutionary technological innovation nor creative destruction according to Schumpeter's model of economic development [12,13]. Further, the analysis of technology S-curve has shown that the swing of S-curves is not strong enough to cause a paradigm shift due to major problems of not being backed by the government and insecure infrastructure. The third factor of not achieving prevailing use in a large number of products or processes according to the theory of techno-economic paradigm shifts by Freeman and Perez [25]. Therefore, the cashless society may not happen in the near future.

The research makes a theoretical and empirical contribution to the studies of financial innovation in attempts to fill the gap of research in service innovation. The analyses in this study have shown the problems hindering the widespread adoption of Bitcoin. The results signify the direction towards a less cash economy rather than the cashless society. It is interesting to see that Bitcoin currency may change the future of banking in developing countries as Bitcoin allows access to a payment system in areas where the banking infrastructure is not developed. In this respect, Bitcoin might be a new Darwinism to change the payment system in the future.

[2]See further information from: The Law Library of Congress (2014), Regulation of Bitcoin in Selected Jurisdictions Report, Global Legal Research Center.

[3]Mt. Gox was the major Bitcoin exchange in Shibuya, Tokyo, Japan. After the operation fraud, the trading was suspended. The exchange was later shut down and filed for bankruptcy (The Guardian News, 21 March 2014).

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