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Global Financial Inclusion and Human Development: The Bitcoin Effect

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ABSTRACT

The rapid rise of cryptocurrency adoption appears to effect the ability of people to improve their lives. In this paper, the most ubiquitous cryptocurrency, Bitcoin is used to investigate effects on financial inclusion and human development. The findings in this paper show a strong positive correlation between bitcoin transactions and human development, between bitcoin transactions and financial inclusion and between financial inclusion and human development. The Bitcoin effect is identified as having a cyclical relationship on financial inclusion and human development. While the Bitcoin effect has a very positive effect on the global economy, this paper uses these results to investigate what business models are enabled through the Bitcoin effect. Cluster analysis is carried out to identify business models that are relevant to the country categories they represent. Three business models are identified from the Bitcoin effect that relate to the country categories they represent. These are miners, innovators and wallets. This paper's contribution is in discovering and describing the key characteristics of the Bitcoin effect and the business models it generates globally.

Keywords: Blockchain, Bitcoin, Development, Cluster Analysis, Regression

INTRODUCTION

The digital economy has been fueled by the rapid rise of blockchain, which is at the heart of cryptocurrencies, to support financial transactions. According to the University of Cambridge Global Cryptocurrency Benchmarking study of 2017, the combined market value of all cryptocurrencies was \$27 billion with Bitcoin's market capitalization of about 86% of the total cryptocurrency market. They estimate that there are between 2.9 million and 5.8 million unique users actively using a cryptocurrency wallet (Hileman & Rauchs, 2017). At the time of writing this paper, the total market capitalization of cryptocurrencies is \$299,438,553,037. Bitcoin had a total market capitalization of \$116,847,055,832 with 17,086,600 bitcoins (BTC) circulating ("Cryptocurrency Market Capitalizations | CoinMarketCap," 2018).

This rapid rise of cryptocurrencies can be attributed to Bitcoin being seen to challenge the global economic order. It was created in 2008 during a global banking crisis when confidence in the traditional banking system was plummeting. By enabling people with internet access to earn money stored in digital wallets, those who were previously excluded from the financial system could earn and control their own money using Bitcoins (Vigna & Casey, 2016). The use of Bitcoin wallets has the potential to empower people through asset ownership and financial inclusion. With the fall of their banking systems and currencies in countries such as Zimbabwe and Argentina, the use of Bitcoins and cryptocurrencies have become prevalent.

The use of blockchain to power crypto currencies is disrupting the global payment system by cutting out the middleman in payment processing. With the use of cryptocurrencies, it becomes harder to trace transactions and ascertain the identities of participants as such transactions take

place outside of the banking system. While most authors suggest that blockchain is disrupting global finance, Iansiti and Lakhani (2017) suggest that Blockchain is a foundational technology in that it has the potential to create new foundations for our economic and social systems. In terms of socioeconomic development, Roztocki and Weistroffer (2016) suggest that Information and Communication technologies enable business activities and services, which in turn impact the individual, organizational, and country-level socioeconomic achievements. Their conceptual model suggests that the rapid uptake of cryptocurrencies can enable business activities and services to provide the means that enable socioeconomic development. By making business activities more effective and efficient, the innovative uses of cryptocurrencies in new business models impacts the socioeconomic standing of individuals, organizations, and countries.

At the heart of bitcoin and other cryptocurrencies is a distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way. Contracts are the digital code and stored in transparent, shared databases, where they are protected from deletion, tampering, and revision (Iansiti & Lakhani, 2017). Contracts are bits of code that are stored in the ledger and then executed in an "engine" that is part of the blockchain platform. Not all blockchain platforms have the possibility of sorting and running smart contracts.

In order to evaluate the value of bitcoin in a geographically distributed marketplace, the effects of bitcoin transactions on financial inclusion and human development is investigated. In doing so, we discover the bitcoin effect. Since the effects of cryptocurrency adoption are global, spanning continents in a single transaction, this paper first investigates the bitcoin effect on a global level based on data from 45 countries that report bitcoin transactions. The first research question is investigated to identify the bitcoin effect: *How do bitcoin transactions effect financial inclusion and human development?* Then a more specific question is investigated that helps us get at the

unique challenges that the bitcoin effect is addressing. The second question investigated is: *of the business models identified, which ones does the bitcoin effect enable?* The research follows the conceptual framework on ICT supported socioeconomic development framework proposed by Roztocki and Weistroffer (2016).

In the following sections, a theoretical background is offered for the concepts in this study. The methodology describes the data and analysis techniques. The results and analysis section illustrates statistical regression through three models that uncover the details of the Bitcoin effect. Through cluster analysis three business models are identified that are generated through the bitcoin effect. In the final section the key contribution of this study is offered in terms of a definition of the Bitcoin effect and a cyclical model that explains how the bitcoin effect generates the three business models identified in this paper.

THEORETICAL BACKGROUND

The digital economy has brought about improvements in people's lives by offering opportunities for businesses to participate in the global economy. At the same time those who are unable to access the internet are left out of the digital economy and the opportunities it presents. In principle, the technology and infrastructure underlying cryptocurrencies has made smart contracts between organizations economically efficient and distributed autonomous organizations increasingly prevalent. (Christidis, K., & Devetsikiotis 2016) Cryptocurrencies operate on a decentralized distributed ledger technology in the form of a distributed transactional database, secured by cryptography, and governed by a consensus mechanism (Avital, Beck, King, Rossi, & Teigland, 2016; Beck, Avital, Rossi, & Thatcher, 2017). Some suggest that cryptocurrencies may reduce transaction costs by removing third party intermediaries, and reduce risk as trust becomes more process-based than characteristic or institutional-based (Avital et al., 2016). At the same time the

volatility of the cryptocurrency and not being able to identify the people involved in using the currencies make them risky and open to use in illicit transactions.

Bitcoin is an innovation with the largest cryptocurrency uptake in terms of transaction volume and value. Its widespread use has brought about new business models. Some of the emerging business models identified by Daniel Cawrey from CoinDesk include: “1) Bitcoin’s public ledger has the ability to enable trusted recordkeeping on the internet while increasing overall transparency [see notary.bitcon.com], 2) [At the time this paper was written] Bitcoins had a strong market value which meant that people saw it as an asset that can be used to back the value of anything that has value, 3) Wallet technologies are being developed that offer multiple signatures and can be used in large inter-organizational transactions [see bitpesa.co is a wallet and exchange], 4) Bitcoin’s emergence has fueled the development of smart contracts in the bitcoin blockchain to enforce contractual price agreements and reduce volatility, 5) Bitcoin mining is the process by which computers confirm transactions on the network is turning into big business with advanced tools being developed to manage these systems and 6) Bitcoin support businesses are updating existing business models with bitcoin payment options” (“Daniel Cawrey - CoinDesk,” 2018).

The rapid adoption of Bitcoins in payment systems is bringing about globally distributed businesses with unique models of value creation (Holotiuk, Pisani, and Moormann (2017) (Nguyen, 2016). Holotiuk et al. (2017) indicate that blockchain allows new services to be offered while rendering current ones obsolete especially in the payments industry. For example, the ease of international transactions based on digital currencies can make currency exchanges obsolete and cryptocurrency wallets enable individuals to transfer money a very low cost eliminating the need for bank transfers. Cryptocurrency blockchain technology can enable contracts and transactions to be connected. This means that the technology can be used to keep records of contracts of purchase

and passing of property and well as a record of the actual transaction. In this way, a contract of purchase can be directly linked to its payment transactions – this is referred to as a smart contract (Holotiuk et al 2017, Koshba et al 2016, Cawrey 2018).

Holotiuk et al (2017) conducted a cluster analysis of data collected through a Delphi study and found that “(1) Blockchain-enabled services in the first cluster indicate how new services around peer-to-peer (P2P) and direct transactions, cross-border and cross-currency transactions, as well as the connection between contracts and transactions are being introduced. (2) This change in services causes a change in the financial structure of firms in the payments industry. (3) As a consequence, there is a great potential for new business models in the market. (4) A strong impulse to new business models is given by new players like fintechs, which are better able to leverage the potential of block-chain technology” (Holotiuk et al. (2017).

There is a sense that the role of cryptocurrencies as a financial tool can potentially play an important role in the sustainable development of the global economy (Nguyen, 2016). By enabling greater transparency, accountability and business opportunity, cryptocurrencies bring those at the bottom of the pyramid to borderless economic opportunities. The concept of development is conceptualized in terms of improvement in the lives of people (Qureshi, 2013) where innovations the capability to lead the lives they choose to (Kleine, 2013; Sen, 1990). The innovative ways in which bitcoin technology is applied can bring about improvements in people’s lives.

The World Bank estimates that more than 2 billion people around the world lack adequate access to financial services (World Bank 2018). It suggests that financial exclusion is seriously hindering world economic development. In countries, such as Zimbabwe, where inflation and corruption are rampant, Bitcoin use is rising (Chandler 2018). As Bitcoin is not overseen by a central authority that has the monopoly of issuing a national currency, its value is based on market forces making it

very volatile in terms of regular currencies such as the US dollar. Bitcoin exchanges can be hacked making them a very risky investment.

Economic development is defined as “the interruption of the business cycle” according to Schumpeter (1942) and is often used to describe growth in organizations and the regions in which they reside. Bitcoin transactions enable economic development through financial inclusion of those who would otherwise not have access to the payment systems they need to carry out financial transactions. Bitcoin usage has made financial inclusion possible through this decentralized infrastructure because it operates on a peer-to-peer ledger system in which transactions can be completed without a bank or financial institution.

Economic development perspectives measure growth in terms of income generation, job creation, and/or reduction in poverty (Abraham, 2006; Roller & Waverman, 2001; Waverman, Meschi, & Fuss, 2005). Economic development from the use of Bitcoins is difficult to measure as they are often not part of the formal economy. They cannot measure as yet the extent to which actual development (or the lack thereof) is taking place within countries or regions.

The concept of Human Development is about enlarging individual people’s choices so that they may have the freedom to pursue the lives they value (Sen, 1990). In this, income is seen to be an instrument of this freedom to pursue their wellbeing. Sen argues that there need to be a broad set of conditions that include access to food, shelter, health and education that together constitute wellbeing (Sen, 1990).

Human development is seen to be a key determinant of successful ICT adoption (Heeks, 2016). It is also seen as an outcome of successful ICT adoption (Qureshi, 2015; Walsham, 2017). This concept according to Sen (1990) suggests that people need to be in control of their lives in order

to take the opportunities presented to them. Financial freedom seems to be enabled by the use of bitcoins.

In this paper, development is measured in terms of the United Nations Human Development Index (HDI). In order to assess the effect of bitcoin transactions on development, data on the Human Development Index (HDI) is used. The HDI is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living is measured in terms of GNI. A long healthy life is measured by the life expectancy and birth variable that comprises the life expectancy index. Knowledge is measured in terms of year of schooling within an education index, A decent standard of living measured as a Gross national income (GNI) Index which is per capita GNI based on purchasing power parity (PPP) which is the is the sum of value added by all resident producers plus any product taxes (less subsidies) converted to international dollars using purchasing power parity rates. The HDI is the geometric mean of normalized indices for each of the three dimensions ("Human Development Index (HDI) | Human Development Reports," 2018).

Since the frequency and volume of bitcoin transactions depend on the level and quality of Internet penetration in a country or region, it appears that the type of business models that emerge will vary depending upon where these transactions are taking place.

METHODOLOGY

Our sample size is limited to 45 countries due to the availability of bitcoin transaction data. Data was collected in 2018 about the transactions of bitcoin in 2017. Data for the variables in this study for the 45 countries was gathered as follows: 1) Data for the Independent Variable (IV). Bitcoin Transactions per Million Population was gathered from CoinDance (2018), 2) Data for the Independent Variable (IV) Internet Penetration Rate was gathered for the countries in our Bitcoin

sample from International Telecommunication Union (ITU), measured by Percentage of Individuals using the Internet. 3) Data for the dependent variable (DV) the Human Development Index was gathered for the countries in our Bitcoin sample from the United Nations Development Program (UNDP).

Global Financial Inclusion is a dataset of over 800 country-level indicators of financial inclusion summarized for all adults and disaggregated by key demographic characteristics: gender, age, education, income, and rural residence. Covering more than 150 economies, the indicators of financial inclusion measure how people save, borrow, make payments and manage risk. (World Bank 2017).

For our independent variable, we use the data which represents opportunities for expanding financial inclusion through digital technology. Thus, we change the variable to Financial Inclusion through Digital Technology. We use “Made or received digital payments in the past year (% age 15+)” for each representative country/region in 2017.

The first step was to carry our simple linear regression to find out if there is a relationship between Internet Penetration Rate with Bitcoin transactions per million population. The second step was to test our model to see if there is a relationship between bitcoin transactions per million population and human development using Multiple Regression Analysis. Finally, cluster analysis was carried out to see if there are types of globally distributed business models connected to cluster categories of countries.

REGRESSION RESULTS AND ANALYSIS

This section identifies a bitcoin effect on financial inclusion and human development. In order to investigate the first research question: *How do bitcoin transactions effect financial inclusion and*

human development? We conducted a simple regression of all the countries in our sample of Bitcoin Transactions per Million Population and Human Development. There is a significant relationship between with Bitcoin Transactions per Million Population and HDI. For 1 unit of increase in Bitcoin Transactions per Million Population, HDI will increase by 0.007 unit. There is a positive relationship between the two variables. Bitcoin use clearly affects the ability of people to bring about improvements in their lives. This is illustrated in figure 1 below:

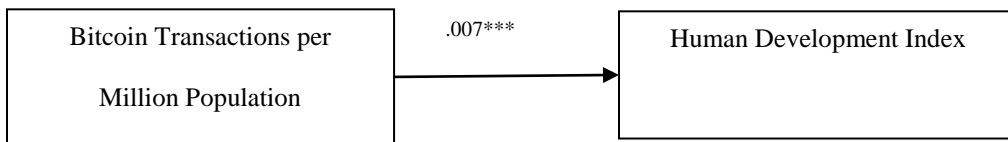


Figure 1. Model of Bitcoin transactions on the Human Development Index

ANOVA table for the first research model can be found below.

Table 1. ANOVA table for research model 1

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	.153	1	.153	12.780	.001 ^b
Residual	.504	42	.012		
Total	.657	43			

a. Dependent Variable: Human Development Index (HDI)

b. Predictors: (Constant), Bitcoin Transaction per Million Population

Based on the regression results, R Square is 0.233. This suggests that the model is explaining 23.3% of the variance from the sample. We have the first research model that illustrates the relationship between Bitcoin Transaction per Million Population for Each Country and the Human Development Index:

Model 1: $HDI = .007 * Bitcoin + 0.718$

Based on the model, for every unit increase in bitcoin transaction per million population, the Human Development Index will increase by 0.007 unit. This suggests that there is a positive relationship between the bitcoin transactions with the Human Development Index.

In order to find out if financial inclusion through digital technology and internet penetrations bring about improvements in people’s lives, we carried out a Multiple Regression Analysis and found a positive correlation between the Internet Penetration and Financial Inclusion through Digital Technology with the Human Development Index. This is illustrated in figure 2 below:

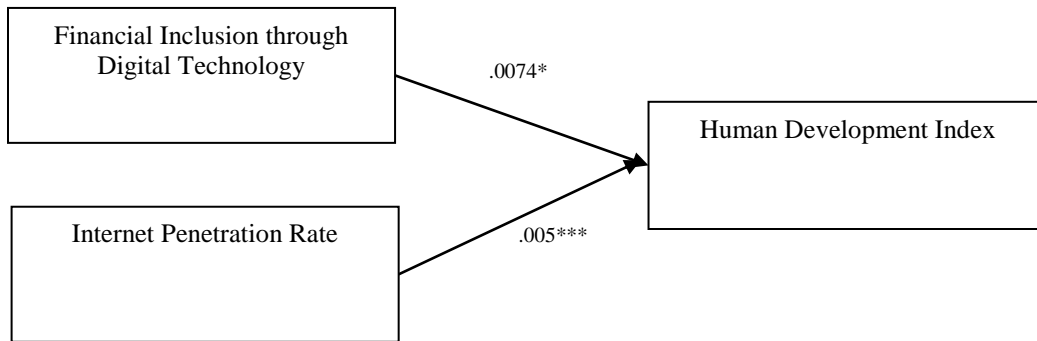


Figure 2. Model of Financial Inclusion through Digital Technology and Internet Penetration Rate on the Human Development Index

ANOVA table for the first research model can be found below.

Table 2. ANOVA table for research model 2

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.583	2	.291	159.782	.000 ^b
	Residual	.075	41	.002		
	Total	.657	43			

a. Dependent Variable: : Human Development Index (HDI)

b. Predictors: (Constant), Internet Penetration , FinancialInclusionviaDigitalTechnology

Based on the regression results, adjusted R Square is 0.881. This suggests that the model is explaining 88.1% of the variance from the sample. We have the second research model that

illustrates the relationship between Financial Inclusion through Digital Technology and Internet Penetration Rate on Human Development Index:

$$\text{Model 2. HDI} = 0.0074 * \text{Financial Inclusion through Digital technology} + 0.005 * \text{Internet Penetration} + 0.42.$$

This indicates that there is a positive relationship between Financial Inclusion through Digital Technology, Internet Penetration Rate and HDI. For each percentage increase of Financial Inclusion through Digital Technology, HDI will increase by 0.0074 unit, while Internet Penetration Rate stays constant. On the other hand, for each percentage increase of Internet Penetration Rate, HDI will increase by 0.005 unit, while Financial Inclusion through Digital Technology stays constant. The positive relationship between the three variables also highlight the importance of using digital technology, including Bitcoin.

In order to find out if there is a connection between bitcoin transactions and Internet penetration on financial inclusion, we conducted a Multiple Regression Analysis of all the countries in our sample. This gave us our third model that is also significant as illustrated in figure 3 below:

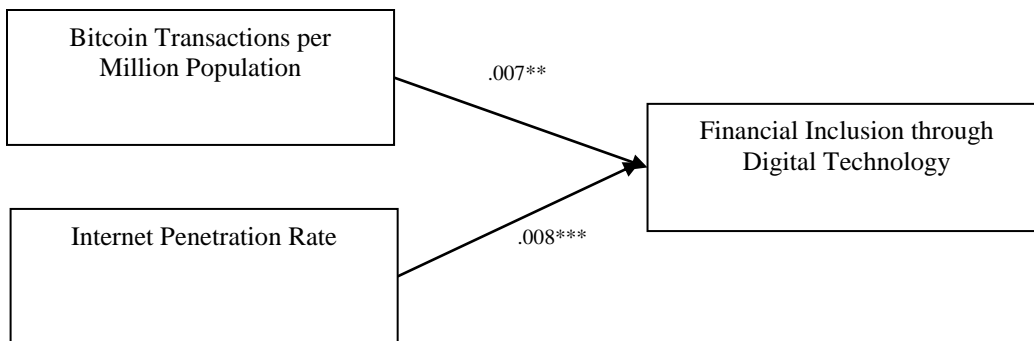


Figure 3. Model of Bitcoin Transactions per Million Population and Internet Penetration Rate on Financial Inclusion through Digital Technology

Table 3: ANOVA Table for research model 3

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.903	2	.952	34.064	.000 ^b
	Residual	1.173	42	.028		
	Total	3.077	44			

a. Dependent Variable: FinancialInclusionviaDigitalTechnology

b. Predictors: (Constant), Internet Penetration, Bitcoin Transaction per Million Population

Based on the regression results, adjusted R Square is 0.60. This suggests that the model explains 60% of the variance. The second research model illustrates the relationship between Bitcoin Transaction per Million Population and Internet Penetration Rate on Financial Inclusion through Digital Technology:

Model 3. Financial Inclusion through Digital technology =0.007*Bitcoin Transactions per Million Population +0.008*Internet Penetration+0.095.

This indicates that there is a positive relationship between, Bitcoin Transactions per Million Population, Internet Penetration Rate and Financial Inclusion through Digital Technology. For each percentage increase in Bitcoin Transactions per Million Population, Financial Inclusion through Digital Technology will increase by 0.007 percent, while Internet Penetration Rate stays constant. On the other hand, for each percentage increase of Internet Penetration Rate, Financial Inclusion through Digital technology will increase by 0.008 percent, while Bitcoin Transactions per Million Population stays constant.

The above analysis has shown that there is a significant positive relationship between bitcoin transactions and human development where human development is measured through HDI and seen to bring about improvements in people's lives. We also found a positive relationship between financial inclusion, internet penetration and human development. Finally there is a positive

correlation between bitcoin transactions, internet penetration and financial inclusion. These results paint a very rosy picture of the effect of bitcoin usage for the global economy. We conduct a cluster analysis to discover the categories of countries with bitcoin adoption and their unique characteristics.

CLUSTER ANALYSIS

In order to find the categories of countries and discover the key characteristics that differentiate them, we conduct a cluster analysis. In doing so, the following question is investigated: *Of the business models identified, which ones does the bitcoin effect enable?* The indicators used in our k-means cluster analysis were Financial Inclusion through Digital Technology, Internet Penetration Rate, and Bitcoin Transaction per Million Population for Each Country in the research model. Three different types of clusters are identified with their unique characteristics. While the users in all countries have some characteristics identified in these business models, the cluster analysis helps differentiate which groups of countries share certain characteristics and thus the business models that support these characteristics. The following table illustrates the characteristics for each cluster.

Table 4: Final Cluster Centers

	Cluster Median	High	Low
FinancialInclusionviaDigitalTechnology	.50	.89	.39
Bitcoin Transactions per Million Population	1.918	11.743	1.098
Internet Penetration	59.78	86.43	22.51
Human Development Index	.73	.87	.54

The characteristics that make each cluster unique are illustrated as follows:

The Miners: Medium Bitcoin adoption, Internet Penetration, Financial Inclusion and Human Development Index. The majority of countries (22) in our sample fell into the first cluster. Compared to the other country clusters in our sample they have medium levels of bitcoin adoption (an average of 1.9 million transactions), and internet penetration (average of 60%). These countries also illustrate medium levels of Financial Inclusion (average of 0.50) and HDI (average of 0.75).

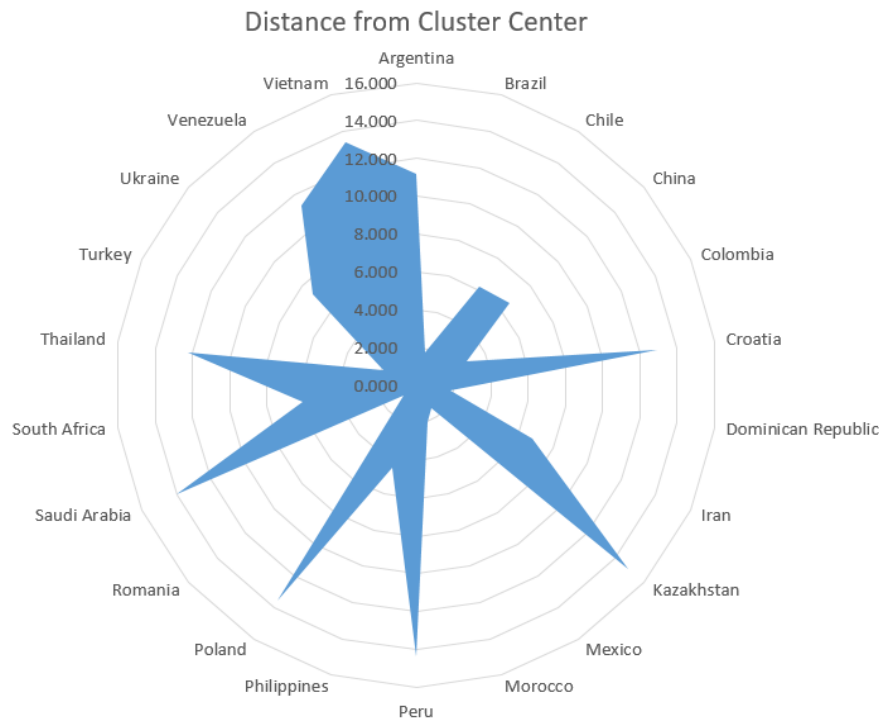


Figure 4. Miners

These are Argentina, Brazil, Chile, China, Colombia, Croatia, Dominican Republic, Iran, Kazakhstan, Mexico, Morocco, Peru, Philippines, Poland, Romania, Saudi Arabia, South Africa, Thailand, Turkey, Ukraine, Venezuela and Vietnam. These countries represent variations to the bitcoin mining business model, which is the process by which computers confirm transactions on the network is turning into big business with advanced tools being developed to manage these systems. Other business models that are emerging use bitcoin’s public ledger which has the ability

to enable trusted recordkeeping on the internet while increasing overall transparency. These countries are illustrated in Figure 4 in relation to each other.

Economic problems that lead corrupt governments to print money have accelerated the adoption of bitcoin in Argentina, Venezuela, Colombia and Brazil. While it is clearly used as an emerging currency, these countries are also supporting mining business models that offer variations to the traditional model of exchanges.

China, which appears at the center of this cluster, is leading blockchain based patent applications (Noonan, 2018). In 2017, more than 50 percent of blockchain related patent applications were originated in China (Noonan, 2018). Due to the relatively low energy cost and facility cost, there are many large bitcoin mines in western part of rural China (Chow & Peck, 2017).

One of the countries in the cluster, South Africa has received attentions in investment in cryptocurrencies such as Bitcoin and Ethereum on offshore exchanges. South Africans are able to utilize their offshore annual investment allowance up to R 1 million ("Life after Bitcoin," 2018). More recently, blockchain is considered as an enabler for public mobile health (mHealth) solutions in South Africa (Weiss, Botha, & Herselman..., 2017). It is argued that the integrity of healthcare related data can be protected by Blockchain, thanks to its decentralized nature. Another innovative adoption of Blockchain in South Africa is to use blockchain's s exposed ledger as a tool to fight corruption (Dinham, 2018). For example, it enables a more transparent funding mechanism for South Africa's public education system (Dinham, 2018).

Innovators: High Bitcoin adoption, Internet Penetration, Financial Inclusion and Human Development Index. The second cluster revealed 16 countries: Australia, Canada, Czech Republic, Denmark, Hungary, Japan, Malaysia, New Zealand, Norway, Russia, Singapore, Sweden, Switzerland, United Arab Emirates, United Kingdom and the USA. Compared to the

other country clusters in our sample they have highest levels of bitcoin adoption at an average of 11.74 million transactions per million population and internet penetration (86.4%) as well as financial inclusion (0.89) and Human Development Index (0.87). These countries are illustrated in Figure 5 in relation to each other.

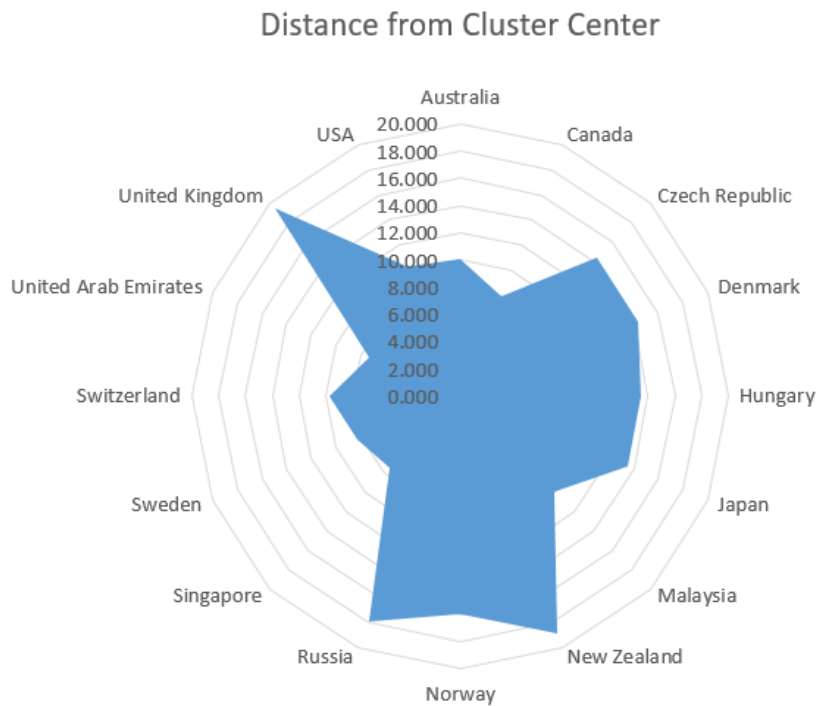


Figure 5. Innovators

The United States is leading the development and adoptions of blockchain related innovations. The awareness of blockchain related technology is relatively high in the United States. It is suggested that the majority of the US states have some levels of regulatory stance related to blockchain and bitcoin. Even blockchain has the potentials to disrupt US based companies like Apple, Amazon, and Facebook (Ward, 2018), blockchain in the US is also believed to have the ability of help fight corruption (Aldaz-Carroll, 2018) .

The other country from the cluster, the United Kingdom, is also supporting the development of blockchain related technology (De, 2018). Innovate UK is investing a total of \$26.6 million in new projects that are related to the distributed ledgers technologies. On the other hand, the UK government is planning to tighter regulation of bitcoin (McLean, 2018). Based on the report by the UK Government Chief Scientific, it is identified by the UK government that distributed ledger technology, including blockchain, has the potential to help government reduce fraud, corruption, and errors (Adviser, 2018).

The business models that are emerging in these countries offer innovations that reflect bitcoins strong market value and people see it as an asset that can be used to back the value of anything that has value. Regulatory frameworks are supporting the use of bitcoin for smart contracts in the bitcoin block chain to enforce contractual price agreements and reduce volatility.

Wallets: Low Bitcoin adoption, low Internet Penetration, low Financial Inclusion and Human Development Index Only 6 countries fell into the third cluster: India, Indonesia, Kenya, Nigeria, Pakistan, and Tanzania. Compared to the others, these countries represent low levels of bitcoin transaction per million population averaged at 1 million, an average internet penetration off 22.5%, financial inclusion index at .39 and human development index of 0.54. These countries are illustrated in Figure 6 in relation to each other.

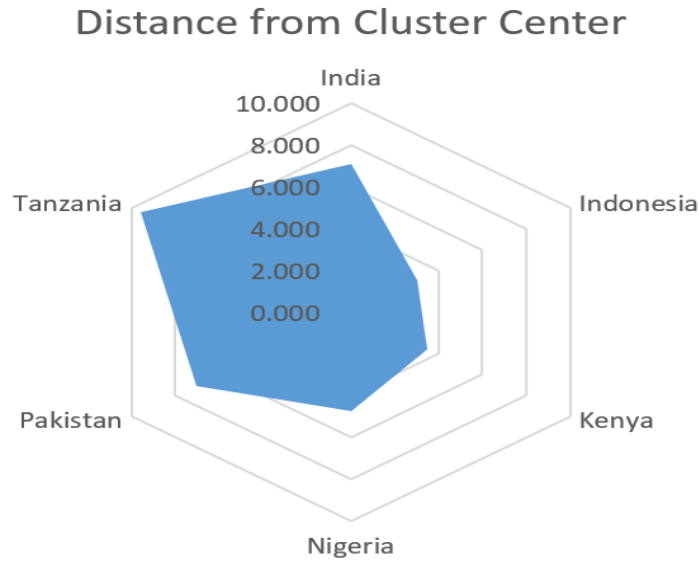


Figure 6. Wallets

Despite their low adoption, these countries are seeing rapid uptake of bitcoins for payment transactions and to facilitate trade with other countries. Exchanges and the development of wallet technologies that offer multiple signatures and can be used in large inter-organizational transactions and business models that are updating existing business models with bitcoin payment options are the business models emerging from this cluster.

Kenya is the home of Bitcoin startup, BitPesa, a digital wallet which enables users to send and receive payments in multiple currencies. The payment systems offered by BitPesa have been credited with increasing trade between China and African countries. Kenyan companies are also trying to utilize blockchain technology to save its water catchment areas (Bwana, 2018). Given the rapid uptake of cryptocurrencies, this last group consists of countries that have limited or low bitcoin adoption largely due to regulation prohibiting crypto-related transactions. For example, the Indian government signals its discomfort and is trying to make trading virtual currencies more difficult in the future (Anand, 2018).

Based on a study from Deloitte conducted in 2017, adoptions of blockchain technology in India are facing several challenges, including lack of awareness from the business, lack of suitable platform, vendor, and partners, and data security challenges (Deloitte, 2017). Kenya, on the other hand, is trying to utilize blockchain technology to save its water catchment areas (Bwana, 2018).

BITCOIN EFFECT

The above analysis has discovered a *bitcoin effect* on financial inclusion and on human development which the ability of people to bring about improvements in their lives. Our results show that there is a strong positive correlation between bitcoin transactions and financial inclusion and on human development. There is also a strong positive correlation between financial inclusion and human development as there is a strong correlation between these two factors and internet penetration. This suggests that the bitcoin effect is an interdependent, cyclical relationship between bitcoin transactions and these indexes.

Given these findings, we *define the Bitcoin effect as the enablement of global transactions for financial inclusion and human development*. This means that higher rates of bitcoin transaction will increase prosperity in the global economy and lower rates of bitcoin transactions will have the opposite effect. The positive cycle will continue to bring about development and economic growth as long as they key elements of development are present. These are: rule of law, property rights, human rights and access to basic services such as healthcare and education. This effect of bitcoin transactions on the global economy is illustrated in Figure 7 as follows:

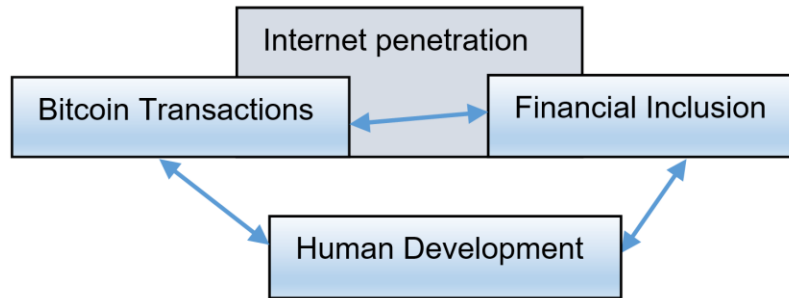


Figure 7: The Bitcoin Effect

The Bitcoin effect identified in this paper reflects growth in the global economy. This is because bitcoin transactions are decentralized, transparent and not restricted by national borders. Three business models are also identified from the bitcoin effect. The effect of these bitcoin business models is summarized as follows:

Miners from the bitcoin effect are prevalent in countries with medium Bitcoin adoption, internet penetration, financial inclusion and human development. Since bitcoin transactions are decentralized, the bitcoin mining business model involves the use of graphic cards in servers that transactions on the network for a small fee for the miner. This is turning into big business, especially in countries such as China and Kenya where electricity can be generated relatively cheap. The effect of this bitcoin business model is that server farms and advanced tools are being developed to manage these systems

Innovators from the bitcoin effect are in countries with high levels of Bitcoin adoption, internet penetration, financial inclusion and human development. These advanced countries are leading the way in the development of smart contracts in the bitcoin block chain to enforce contractual price agreements and reduce volatility. Bitcoins strong market value and public ledger enables trusted recordkeeping on the internet while increasing overall transparency in virtual

markets. This means that bitcoins can be used to back the value of anything that has value while enabling trusted transactions between organizations and industries.

Wallets for bitcoin transactions are growing in countries with comparatively low bitcoin adoption, internet penetration, financial inclusion and human development. Through wallet technologies such as BitPesa, bitcoin is offering a low cost, high volume means of making payments within and across geographic borders. For example, when the Chinese government decreed the use of bitcoins illegal in its country, vast amounts of bitcoins were transacted from China using BitPesa to purchase property and other assets in Africa. While bitcoins are more readily accepted than they used to be, wallets such as BitPesa enable transactions to be converted in almost any currency of the world. Thus greasing the wheels of the global economy. Bitcoin wallet technologies are being developed that offer multiple signatures and can be used in multiple, distributed, inter-organizational transactions.

CONCLUSION, LIMITATIONS, AND FUTURE RESEARCH

Given the rapid rise bitcoin as the cryptocurrency with the largest volume and number of transactions in the world, this paper investigated the effect of bitcoin transaction on two key concepts enable people to bring about improvements in their lives: financial inclusion and human development where internet penetration is an important enabler. This research discovered a *bitcoin effect* on financial inclusion and on human development which the ability of people to bring about improvements in their lives. Our results show that there is a strong positive correlation between bitcoin transactions and financial inclusion and on human development, and a strong positive correlation between financial inclusion and human development. There is a strong correlation between these two factors and internet penetration. We offer a model which illustrates the bitcoin effect is an interdependent, cyclical relationship between bitcoin transactions and these indexes.

Given these findings, we define the Bitcoin effect as the enablement of global transactions for financial inclusion and human development. Following a cluster analysis to discover the country categories of the bitcoin effect, three types of business models are identified within each of the country categories. They are miners, innovators and wallets.

While the above three business models appear to be most prevalent in the sample of countries studied here, there are many more that are being developed as this paper is being written. Further research will have to carry out an analysis of a broader range of business models being generated through the bitcoin effect.

A limitation of this study is the relatively low sample size due to the limited data availability of geographic bitcoin transaction data. Also, this research only investigates the dominant cryptocurrency-Bitcoin. We plan to include more cryptocurrencies, including Ethereum, Litecoin, Ripple, and Zcash in the future.

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