Could Bitcoin Be A Financial Solution For Developing Economies?

Applying Austrian economics to currency network models and evaluating Bitcoin as a financial solution for low-tech environments

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***Abstract*— Developing economies tend to have unstable currencies which are centrally manipulated through rapid increases in money supply and inflation. Using Austrian economic theory, this paper analyses different models of currency networks and shows that Bitcoin is a superior model against centralised manipulation. Some e-payment systems such as M-Pesa in Kenya, which became viral, have made vast improvements in various aspects of finance. Bitcoin could provide some of the improvements that M-Pesa brought to Kenya. In addition, this paper argues that in some instances Bitcoin is also superior to M-Pesa. However, a barrier to its adoption has been problems of internet connectivity.**

Keywords— Bitcoin, developing economies, Austrian economics, kenya, m-pesa, mobile, money)

I. INTRODUCTION

Bitcoin came into 2014 by winning the 'Best Technology Achievement' Tech Crunch award in California.[1] It has been claimed to be an innovate virtual currency which will change financial interaction and behaviour on the internet.[2] At least, this has been the mainstream narrative, however this paper argues that the most significant result of Bitcoin will be the transformation of financial behaviour in developing economies. The hypothesis that will be tested is *could Bitcoin theoretically transform developing economies as a result of its superior infrastructure and utility*? This paper will compare different currency infrastructure models to asses what characteristics Bitcoin has that are superior, and to relate the utility of e-payment systems in developing economies and why Bitcoin could bring further utility. The analysis concludes that Bitcoin could theoretically transform developing economies by its superior infrastructure and utility. However, internet adoption is a primary barrier.

II. RESISTANCE TO CENTRALISED MANIPULABILITY

A. Centralised Currency Networks

A characteristic which Bitcoin excels at is its resistance from being centralised manipulated. Centralised manipulability will be defined as *the amount to which certain nodes (often B nodes, see Figure 1.) are able to control the overall network by using their special permissions* (for example, increasing money supply, facilitating transaction ledger/history, mediating individual transactions.) This section will address three different currency network models; centralised, decentralised and distributed. Although centralised currency network models are most prominent in the contemporary economic environment, the decentralised model is also addressed since it has often been propounded as a solution by the Austrian school.[3]

The need for protection from centralised manipulability in developing economies continues to be a fundamental requirement for their advancement. History has shown the disastrous effects that rapid inflation and currency instability has had on developing economies.[4] For example, in 2008, Zimbabwe's official inflation rate hit 231,000,000% causing consumers to lose their savings and investments which led to the informal switch to the United States Dollar due to its greater stability.[5] The ability of a government or central bank to have control over a currency in developing economies is particularly dangerous, since corruption tends to be more prevalent and parasitic on enterprise.[6] Often the response by the international community has been providing foreign aid which has led to mixed results.[7] However, this paper suggests that Bitcoin and other alternative crypto-currencies could provide the solution to the problem of centralised manipulability since isolation from political volatility is essential. Not only that, but Bitcoin could bring an entire financial infrastructure for developing economies to use.

In modern history, it is common for governments (in general) to issue paper currency to populations and for these currencies to be widely adopted. A primitive form of paper currency was first recorded with the issuance of paper notes in the 11th Century by the Song Dynasty, China.[8] Six centuries later paper currency became adopted all over the world when global maritime trade made it impractical to transport large amounts of commodity based money (e.g. precious metals) or goods for barter.[9] Traders were using promissory notes, which preceded the prominence of banknotes in 17th Century Europe.[10] Governments soon claimed monopoly on the issuance of banknotes with the introduction of central banks

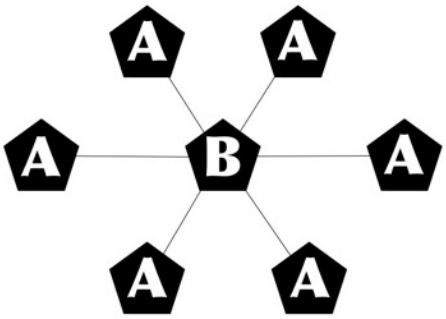

Figure 1. Centralised Network Model

(England in 1694 and United States of America in 1913). The advancements to paper currency have caused greater efficiency in transactions, however, the increase of efficiency has run parallel to an increase in susceptibility to centralised manipulation.

The vast majority of paper currencies today are 'fiat'[11] currencies. The Austrian school claims that 'fiat' currency is only possible if governments monopolise the issuance of a fiat currency (establishing centralised manipulability). Furthermore, that when central banks increase the supply of fiat currency, it causes inflation, thus centralising the value of the currency to central banks or governments.[12] Fergusson denotes where this value actually comes from:"Whatever the reason for a country's deficit… it is alarming that some respected bankers and economists today… are still able to commend 'the printing press' as a fail-safe, a last resort. A country's budget can indeed be balanced in that way, but at the cost… of its citizens' savings and pensions, their confidence and trust, their morals and their morale."[13] Thus, a weakness of fiat currency is that an institution with special permissions to increase the money supply can redistribute value to itself. In the case of governments, this can be used to balance their budgets. Relating this to the theoretical currency network model, the increase of money supply is redistributing value from all A nodes to the central B node. This is a flaw in a centralised currency network.

In addition to the negative effect that Fergusson suggests, Mises indicates that a negative effect is price distortion and malinvestment.[14] Malinvestment is the notion (originally coined by Ludwig von Mises)[15] which relies on the economic understanding that the Austrian school business cycle provides (which Hayek received the Nobel Prize in economics for in 1974).[16] The Austrian business cycle propounds that during an economic boom, the expansion of credit causes malinvestment which is inevitably followed by a market correction (bust). This occurs by the creation of inexpensive credit by fractional reserve banking and central banks which, in turn, causes distortion in market price signals.[17] This suggests that malinvestment causes the propagation of incorrect information from price signals, which in a highly liquid currency would cause an inefficient allocation of resources. Historically, this has shown to be the case since malinvestment has caused economic havoc for networks which used fiat currency.[18] Therefore, two notably weaknesses of centralised fiat currency are its susceptibility to centralised manipulation and the propagation of distorted price signals.

B. Gold Standard

When dealing with currencies which have intrinsic value such as gold or silver coins, the increase in the currency supply can still occur. Historically, coins made from precious metals have been debased by B nodes (governments), reducing their purity (which can be difficult to detect or inefficient for A nodes). Examples can be found throughout the history of coinage and a particularly indicative case, is the steady reduction of silver content in ancient Roman currency.[19] Alternatively, the Austrian School predominately claims tying paper currency to gold in the form of bank notes is a solution to the problems of debasement and increases in the money supply.[20] In particular, Austrians suggest it is a solution to the fiat centralised currency model.[21] Alan Greenspan, who later became chairman of the Board of Governors of the Federal Reserve stated:

"Under a gold standard, the amount of credit an economy can support is determined by the economy's tangible assets, since every credit instrument is ultimately a claim on a tangible asset… In the absence of the gold standard, there is no way to protect savings from confiscation through inflation. There is no safe store of value. If there were, the government would have to make its holding illegal, as was done in the case of gold."[22]

In the modern era, governments have tended to take their currency off the gold standard due to the difficulty of balancing budgets. By analysing institution incentives, Rothbard suggests that governments are incentivised to do so since they do not resource their revenue as payment for services. Therefore, among other methods, they need to manipulate national currencies to generate revenue.[23] Indeed, in 1971, when the United States Federal Reserve could not afford to pay European central banks the amount of gold tied to their United States Dollars, President Nixon issued Executive Order 11615, removing the dollar from the Gold Standard.[24]

C. Decentralised Currency Networks

Hayek proposes a change in the infrastructure of networks, by enabling private institutions to issue their own paper currencies. This would be achieved by ending the government monopoly on the issuance of currency and rather, to have privately issued *competing currencies*. Hayek, a leader in Austrian school economics, claimed it would be desirable for currency users to use currency created by private institutions (mostly banks) over public ones, since competition would cause the institutions to try and align their interests with their customers.[3] The network of currency issuance which Hayek described would be illustrated by having several centralised

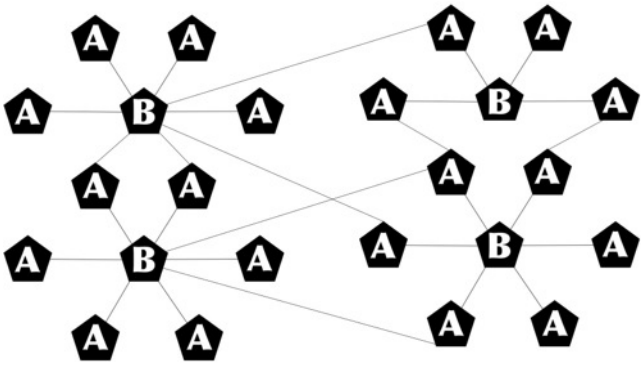

Figure 2. An example of a Decentralised Network Model

networks, in which B nodes could centrally manipulate their currencies, but A nodes would exist in one or more B networks at the same time. Thus, B nodes would be incentivised to not centrally manipulate (since B nodes would want as many A nodes as possible to increase the value of their currency). Hayek describes this as a 'check'.

"There could be no more effective check against the abuse of money by the government than if people were free to refuse any money they distributed and to prefer money in which they had confidence. Nor could there be a stronger inducement to governments to ensure the stability of their money than the knowledge that, so long as they kept the supply below the demand for it, that demand would tend to grow."[3]

The problems with the Hayekian model is that although competition would indeed be a check on currencies between institutions, the currencies could still be centrally manipulated to a degree. Although, comparatively, it would be much less centrally manipulated than a single centralised network, in which, central banks will almost inevitably centrally manipulate. Furthermore, the contemporary context demonstrates that governments are unlikely to allow competing private institutions to issue their own currency, as Rothbard points out.[23]

On the other hand, decentralised electronic currencies have had greater success, since they do not require the issuance of physical banknotes or paper currency. For example, DigiCash Inc., the most notable of the early digital currencies, founded in 1990, created a digital currency which could be used over the internet with partial anonymity.[25] It was controlled and regulated by DigiCash and came to an end in 1998 when the company went bankrupt while competing with Mastercard and Visa. Notably, governments and central banks (e.g Bank of England) have become interested in issuing their own crypto-currencies since they recognise the advantages of a currency being digital.[26] Although these are more efficient than paper currencies in most transactions they are still susceptible to centralised manipulability that the decentralised Hayekian models have. In addition, Rothbard's criticism could still hold true that the government wouldn't allow these without a monopoly, because none of these electronic currencies received the wide adoption rates that physical currencies would.

D. Distributed Currency Networks

Bitcoin marked an incremental advance in cryptography and computer science, but a significant advance in practicality and utility of the internet. Distributed currency networks as advanced as Bitcoin have never existed before the unofficial release of Satoshi Nakamoto's paper in 2008.[27] From Nakamoto's paper, came a peer-to-peer (P2P) electronic cash system which because of the youth of the currency, has had a limited amount of economic theory applied to its architecture. Particularly, because this has often required an inter-disciplinary understanding of computer science and economics. This paper will not only apply theoretical economics, but it will be implicit in the analysis that theories of computer science will be applied to the economics.

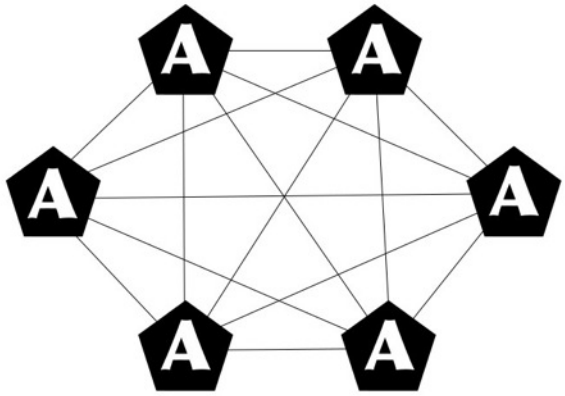

Figure 3. Distributed Network Model

The infrastructure of a distributed currency network arguably solves the problems caused by centralised manipulability. Other digital currencies before Bitcoin would have a central node (B node) that would contain a full transaction history, which would be the master ledger. For A nodes to use the currency, they would need to send the required information to the B node so the ledger could be updated. Centralised manipulability is possible in this model since the B node could alter the master ledger. Indeed, A nodes would be required to trust the B node that it would not alter the ledger in its own favour or as a result of a security breach. Conversely, all nodes in the Bitcoin network contain full transaction histories using a Timestamp Server system. The Timestamp Server takes a "hash of a block of times to be timestamped and widely publishing the hash"[27] into a public ledger or blockchain. [28]

Within the distributed Bitcoin network, the following takes place with a new transaction; 1) new transactions are broadcast to all nodes, 2) each node collects new transactions into a block, 3) each node works on finding a difficult proof-

of-work for its block, 4) when a node finds a proof-of-work, it broadcasts the block to all nodes, 5) nodes accept the block only if all transactions in it are valid and not already spent, 6) nodes express their acceptance of the block by working on creating the next block in the chain, using the hash of the accepted block as the previous hash.[27] Thus, Bitcoin works on a model of *distributed consensus*.[29]

A distributed consensus is a model which could not conceivably operate with the use of physical currency. A distributed consensus is a consensus structure which requires several nodes to agree if they wish to cause changes in the rules of the system. In the Bitcoin protocol, this occurs when 51% of miners agree on a change.[27] As Kroll et. al. point out, this actually occurs fairly frequently when miners change the transaction fees of transfers.[29] Thus, it would not be correct to claim that Bitcoin could not be centrally manipulated. However, the incentives to do so are the inverse of those for governments, central banks and private institutions in centralised networks. The incentive to acquire sufficient computational power to centrally manipulate Bitcoin is not as rewarding as if that computational power was used for mining. Kroll et. al. denote this by pointing out that it would require a user or group of users not to be incentivised by the value which Bitcoin mining would provide to undertake the 51% attack.[29] Also, since miners are exchanging their computation power for Bitcoin, to devalue the currency would not be in their interest. In summary, centralised manipulation is not a major concern for Bitcoin as a result of the distributed consensus model.

Furthermore, the proliferation of the Bitcoin model has caused several other alternative (or alt) currencies to be created (See Fig. 4).[30] These currencies vary in the amount of similarities they share with Bitcoin and some have various functions. For example, Namecoin is a crypto-currency, which when redeemed enables the user to generate a ".bit domain name".[31] Since so many currencies have been created and adopted since Nakamoto's paper in 2008 it is clear that the Hayekian model of competing currencies has been produced from Bitcoin. However, what Hayek was unlikely to anticipate, is that these currencies would exist in distributed networks. This is significant, since distributed crypto-currencies have the benefits of difficult centralised manipulability but also are checked by the competition between them.

Name	Market Capitalisation ($)	Total Supply
Bitcoin	7,994,904,330	12,511,000
Ripple	1,439,187,264	99,999,996,303
Litecoin	450,619,814	26,531,904
Auroracoin	236,872,342	10,618,226
Peercoin	70,520,578	21,221,971

Name	Market Capitalisation ($)	Total Supply
Dogecoin	52,958,892	59,776,798,066
Nxt	41,511,265	999,997,096
Mastercoin	41,402,116	563,162
Namecoin	28,167,228	8,252,442
Counterparty	12,116,977	2,648,651
Quark	9,652,342	247,658,422
ProtoShares	9,371,591	1,561,881
Feathercoin	7,645,453	36,274,150
Primecoin	6,740,964	4,782,877
Infinitecoin	5,676,857	90,353,023,401

Figure 4. Top 15 Alternative Crypto-Currencies by Market Capitalisation

If distributed network currency models are the most resistant to centralised manipulation, how can we know this would be of value to users in developing economies? As previously mentioned, it is intuitive to presume this would be of value as a result of political volatility and corruption, but there is another social level to centralised manipulation resistance. Social structures which exist in all nations are relevant as to whether technological adoption can occur. In Kenya, Morzwczynski documents that customers trust Safaricom (the owner of M-Pesa) a great deal because of its president Michael Joseph, who was born a South African and therefore had no tribal affiliations.[32] On the other hand, banks in the area did have tribal affiliations and therefore had the interests of the tribe above those of their business meaning they would take their money at anytime. Specifically, Michael Joseph and the Safaricom institution is trusted because it is "politically neutral." This could indicate that if indeed political neutrality attracts custom in Kenya Bitcoin would be a highly desirable solution.

III. Dependability

Dependability refers to *the delicacy of the network as a result of the distribution of its foundational infrastructure.* The components which make up the foundational infrastructure are the elements which enable the network to continue trading (for example, the continuation of intermediary parties). When analysing dependability, attention is drawn primarily to all B nodes (or lack of) within a network. To test the delicacy of a network model, it is necessary to ask the question, how many

B nodes need to be removed to stop the network from operating? In the case of centralised networks, this would be a single B node. With a physical fiat currency, if a central bank or government was removed from the currency system, the currency would no longer hold value.[30]

With the Hayekian decentralised model of competing currencies, the removal of a B node stops a single currency network from operating. However, this would not stop A nodes from using currencies since they could continue to do transactions on other competing networks. Conversely, distributed networks such as Bitcoin do not have any single nodes which are required to be online for the network to facilitate transactions. In addition to this effective infrastructure of distribution, Bitcoin competes with other alternative currencies which many A nodes can posses. Thus, in the unlikely event that the Bitcoin network can no longer operate, A nodes can continue undertaking transactions by moving to alternative currency networks.

Dependability is essential for currency networks in developing nations due to the volatility of governments and private enterprises. It has been identified, that unstable banks and financial institutions are significant barriers for nations to overcome poverty.[34] This is due to consumers being unable to maintain their savings accounts which they rely upon to hold their wealth and small firms can find it difficult to access investment to grow their business. Not being able to use these established financial methods has led to innovative alternative methods of continuing economic activity, however, on a macroeconomic level this has led to a lack of broader growth. [35]

IV. Electronic Payments and Internet Currencies

Mobile money "is the provision of financial services through a mobile device box" and has been widely studied in developing economies.[34] One of the best known success stories of mobile money has been the viral adoption of M-Pesa in Kenya. Owned by Safaricom, M-PESA, reported mobile money revenues for first half of 2011 of K Sh 7.9 billion ($90 billion).[34] M-PESA is a small-value electronic payment with a store-of-value functionality that is accessible from ordinary mobile phones in Kenya. The word Pesa comes from Swahili for money. It was first introduced in March 2007 and as of 2011 has 9 million customers (40 percent of Kenya's adult population). It's rapid adoption it likely to do with the greater utility it has brought Kenyians in their daily financial interactions. Indeed, M-Pesa has become so embedded within the infrastructure that M-Pesa handles a greater number of transactions in Kenya than Western Union does globally.[36] This is significant, since for technological advances to be adopted by any societies or communities, it is necessary for them to be open to innovations. The rapid adoption rates of M-Pesa could indicate that Kenya would be a suitable incubator for the proliferation of Bitcoin.

Shifting to electronic payment methods brings benefits in itself to developing economies. In Kenya, data suggests that households with access to mobile money were better able to manage negative shocks (job loss, death of livestock, harvest problems). Whereas, households that did not use M-Pesa saw consumption fall by 6-10 percent on average. M-Pesa users could fully absorb the shocks because they received more remittances and lost less to transaction costs.[37] This instance in Kenya demonstrates the value of e-payment systems which bring utility to users in volatile environments. In addition to the efficiency, the adoption of non-physical currency has had an unexpected effect on violence. Using electronic rather than real cash has shown to be advantageous because it isn't clear how much currency people are carrying so pickpocketing and theft often reduces. Further, a study has shown that it also allows women in traditional cultures to establish savings without seeking permission from their husbands.[32]

An attractive characteristic of M-Pesa is how easy it is for users to register on their mobile phones. For users to register, they must first register at an authorised M-Pesa retail outlet. They're then assigned an individual electronic money account linked to their phone number and can access it through an application stored on their subscriber identification module (SIM) cards of their mobile phones.[36] However, a challenge for some users which has caused them to rely less on M-Pesa has been the requirement to physically travel to an M-Pesa retail outlet.[32] This is an instance where Bitcoin would be superior, since Bitcoin would not require any registration. Rather, Bitcoin wallets (similar to a bank account) can be opened by downloading a program or application. Furthermore, M-Pesa requires users to deposit cash to and withdraw cash from their accounts by exchanging cash for electronic value at retail stores.[36] Thus requiring travel to these retail stores frequently and often costly.

V. Transaction Fees

Transferring funds in developing economies is notoriously expensive or impossible due to the lack of financial infrastructure. Yet, M-Pesa has proved to be particularly useful in this instance since it enables users to transfer funds from one peer to another (P2P) and this occurs regularly when users pay bills or purchase airtime credit.[36] Customers pay a flat fee of approximately $0.40 for person-to-person (P2P) transfers, $0.33 for withdrawals (under $33) and $0.013 for balance inquiries.[36] In comparison to Bitcoin, these are very high transaction fees. Bitcoin developers respond to fluctuations in the Bitcoin price to make sure transactions fees are very low. For example, in March 2014, they became approximately $0.005, which is less than a single United States cent.[38] Low transaction fees are essential for a developing economy and a poor population.

In the case of M-Pesa, Safaricom generates revenue through liquidity and transactions in the market, since users to do not pay for their phones to be set up with M-Pesa. This incentivises Safaricom to cause users to spend their M-Pesa credit and disincentivises using M-PESA as a mechanism for savings. Particularly since transactions are limited at $500, meaning any meaningful savings accounts would be too large to transfer.[36] Conversely, Bitcoin miners do receive a small transaction cost, but when mining is at a low difficulty, the

majority of their payment is received from the creation of new Bitcoin. Transaction amounts are not limited and the amount of Bitcoin that you transfer does not effect the transaction fee that you pay significantly, because transaction fees are calculated on the amount of information you send. Therefore, vast amounts of Bitcoin (perhaps $1,000,000) could be transferred for less than $0.005.

VI. Financial Inclusion

Financial inclusion is "the delivery of banking services at an affordable cost to the vast sections of disadvantaged and low-income groups."[39] The lack of financial inclusion is a widespread problem in developing economies and Chaia's research demonstrates the urgency of the issue.

"*2.5 billion adults, just over half of the world's adult population, do not use formal financial services to save or borrow. 2.2 billion of these unserved adults live in Africa, Asia, Latin America, and the Middle East. Of the 1.2 billion adults who use formal financial services in Africa, Asia, and the Middle east, at least two-thirds, a little more than 800 million, live on less than $5 per day."[40]*

Mobile banking which enables users so save and transfer currency is essential for the financial inclusion of the world's population. Indeed, not being able to use these established financial methods has led to innovative alternative methods of continuing economic activity, however, on a macroeconomic level this has led to a lack of broader growth.[35] Mobile payment systems would be a significant step in the correct direction since, one billion people have a mobile phone but no bank account.[41] Bitcoin requires only a connection to the internet for anyone to set up a Bitcoin wallet or bank account. It is evidently easier to establish points of internet access in some areas than to create entire financial infrastructures.

It is clear that users in developing nations such as Kenya also wish to be financially included. Users of M-Pesa tend to make large deposits and small withdrawals[42] which indicates they use M-Pesa as a system for savings. Bitcoin excels in this area, the increase in mining difficulty and the limit to the number of Bitcoins which can exists makes Bitcoin increase in value over time (deflationary). Although rapid price fluctuations have occurred during Bitcoin's infancy, as it becomes more widely adopted its value will stabilise. In addition to savings, users in developing economics are interested in financial services such as insurance. Mobile money has been successful at providing limited micro-insurance products. For example, Kilimo Salama, a micro-insurance product used M-PESA to provide payouts to small farming businesses who's crops would fail. In its second year of business, 12,000 farmers were insured and 10 percent of those received up to 50% of their insured inputs.[43] Bitcoin services such as insurance, will be even easier to provide since creditors will not be required to change currencies or geographic location to offer these services.

VII. Adoption Problems

Donovan proposes that a significant difficulty for financial inclusion is there are two opposing business models which need to work together to enable adoption of mobile money. Telecommunications and payment businesses are transaction-based, with fees collected on transactions, alternatively, banking business is float-based, meaning money is earned through holding deposits. Consequently, telecoms are interested in incentivising liquidity in mobile money where banks are interested in savings. A big challenge for mobile money is that telecom agents find it a constant difficulty to maintain liquidity to make their business viable. Also, it is difficult to get agents (supply) and customers (demand) to sign up for these programs to a sufficient scale. The difficult is the trade-off between higher costs to recoup their investments or lower costs to reach scale and build a mass market.[36] This has been a significant barrier for the adoption of mobile money across developing economies.

Bitcoin could overcome this problem, since it is actually in the interest of Bitcoin users to increase the number of Bitcoin adopters. Bitcoin users gain from increased adoption because the value of their Bitcoin's increases and they can be used in a greater number of instances. As a result of this, internet connectivity needs to be considered as this would be the greatest barrier to the use of Bitcoin. Fig. 5 shows that internet connectivity has not reached the point where Bitcoin or other digital currencies could be adopted continent wide. Thus, Bitcoin adoption is likely to occur in small pockets of geographical areas. Fig. 6 shows that if the internet is the most significant barrier to Bitcoin adoption, we'd expect to see Asia as one of the leading markets of Bitcoin. This is difficult to test since Bitcoin wallets a psuedonomous. However, the Bitcoin community is taking steps to collect data on adoption rates by geographical location.[44]

It would be conceivable to see crowd-funding campaigns which would try to bring better internet connectivity to developing economies. Indeed, this paper recommends that greater steps be taken by the Bitcoin community to increase internet connectivity across developing economies. This would increase financial inclusion and benefit the broader Bitcoin community.

VIII. Conclusion

Bitcoin has a significant potential to provide a stable financial infrastructure that cannot be centrally manipulated, which is essential in volatile environments that historically have been stricken with currency collapses and hyperinflation. Austrian economic theory has provided a clear understanding of why Bitcoin, as a financial infrastructure, can solve this. The delicacy of financial networks is another outcome of a volatile environment which Bitcoin excels at since there are no central or intermediary institutions required. In addition, the benefits of electronic payments are significant bringing greater financial inclusion and social benefits to developing nations.

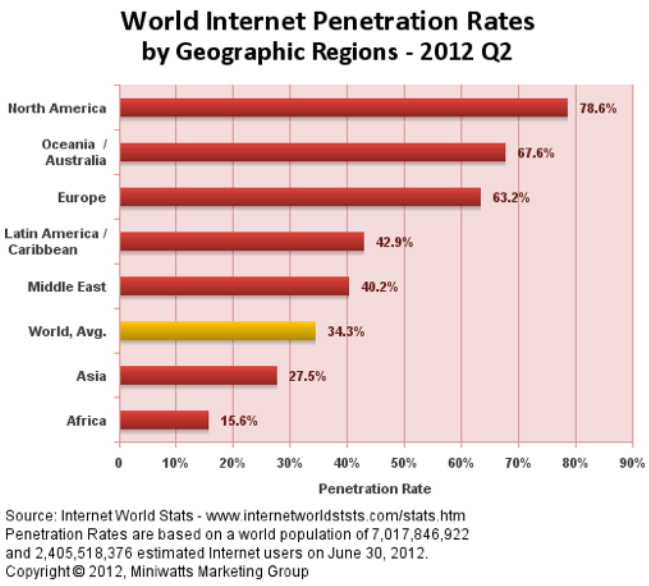

Figure 5. Internet Penetration Rates

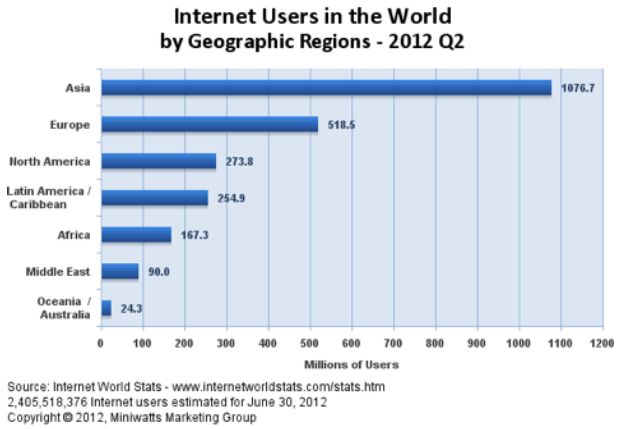

Figure 6. Internet Users in the World

Bitcoin in particular, has such low transaction fees that this is highly affordable. The challenges which Bitcoin faces are access to the internet in low-tech environments, however, this is a challenge which is in the interest of Bitcoin users and the wider community to solve.

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