ARTHAVAAN
Volume 3, Issue 1, December 2019

http://www.bharaticollege.com

Evolution of Cryptocurrency in Light of Network Security Protocol & Regulation Issues

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Abstract: ***In the wake of 2008 financial crisis, alternative financial systems thrived as distrust among private banking institutions and government authorities soared. Bailouts of insolvent banks reached a pinnacle in low interest rates, zero inflation and lack of economic stimuli. Cryptocurrencies born during this time introduced a peer-to-peer financial system without reliance on Banks. As the system operates outside existing regular financial institutions and a lack of consensus on regulation exists between countries, a sound security and regulatory framework is absent. The paper traces the journey of cryptocurrencies through risk, enhanced network security protocols and lack of regulatory mechanism. As the cryptocurrency is young and the operational factor change on daily basis, few comprehensive academic sources exist. Systematic review of 21 cryptocurrencies and theoretical implications of network security protocol mechanisms is presented. The paper concludes that the pathway to success of cryptocurrencies requires three developments – underlying computer algorithm of the currency to stay transparent, robust and protected, usage of it being spread beyond the narrow band of enthusiasts to the global marketplace and sound infrastructure for transporting, securing and saving bitcoin.***

Keywords: Cryptocurrencies, Virtual Currencies, Network Security Mechanisms, Hash Algorithm

1. INTRODUCTION

Relationship between customers, workers and employers has been recast as the outreach of the silicon chip has pervaded all spheres of life. With dramatic improvement of computing power across the world & participation in digital economy, it is imperative to design policies that allow us to make use of digital revolution advantages while minimizing job dislocation.

Digital transformation is referred to as a general purpose technology – its enabled to continuously transform itself, progressively expanding and boosting all industries and sectors. Such transformation rarity was earned by three previous technologies : the steam engine, the electricity generator and the printing press. General purpose technological revolutions are widely disruptive. Payment practices, infrastructures, networked accountancy and their chains of mediators rely on mutual trust to enact, test and validate the transaction of economically coded signs.

Cryptocurrency is a chain of digital signatures where each owner transfers the coin to the next by adding to the end of the coin - digitally signed hash of the previous transaction and a public key of the next owner. Cryptography, an encryption technique is used for securely buying and selling. A "Wallet" stores lines of computer codes on personal hard drives and/or online wallets such as Coinbase. Cryptocurrency, like cash and commodities are subject to being lost, destroyed or stolen. In 2014, Mt. Gox (Bitcoin exchange) had declared USD 350 million worth of bitcoin stolen, forcing the exchange to declare bankruptcy. It highlighted security issues within the world of cryptocurrency. It triggered a wave of information in finance, much as the internet did in online services.

Cryptocurrencies does not guarantee absolute anonymous state. Pseudonymity[1] allows consumers to complete purchase with disclosing identities to merchants. However, from a legal perspective, a transaction can be tracked back to a person or entity. Nevertheless, amid concerns of identity theft and privacy, cryptocurrencies can offer advantages to their users.

As cryptocurrencies do not involve financial intermediaries, the merchants benefit from low transaction costs due to absence of the "middlemen". Cryptocurrencies have challenged the paradigm of state sponsored currencies and the dominant role of central banks and conventional institutions in the international financial system. Twenty years ago, when the internet came of age, a group of prominent economists and central bankers wondered whether advances in information technology would render central banks obsolete (Kings 1999). The debate has been rekindled by the rise of crypto assets.

These assets may in coming times serve as an alternative means of payment and units of account, resulting in reduced demand for fiat currencies or central bank money. Monetary

[1] *Pseudonymity means a near anonymity.*

policy relevance would diminish without central bank money. At present, crypto assets are excessively volatile and risky to pose a threat to widely trusted fiat currencies. Notorious cases of fraud, security breaches, operational failures and affiliation to illicit activities have deterred citizens to trust crypto assets. However, technological advancements may address some of the deficiencies. Effective monetary policies have to be carried by central banks

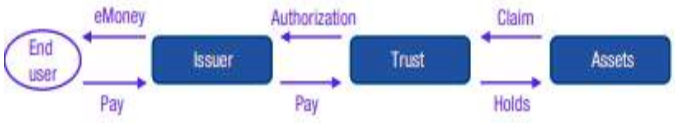
2. LITERATURE REVIEW

Stefan Ingves[2] (2018) points that demand for cash has dropped by more than 50 percent over the past decade as growing number of Swiss people are relying on debit cards and mobile payment applications. The novelty of digital solutions existing earlier for large payments has filtered down to individuals making small payments. In countries such as India, South Korea, Kenya and Tanzania paying through mobile instead of cash or card is commonplace.

If coins and bank notes have had their day, then in future the society cannot have access state guaranteed means of payment. Control accessibility, technological developments and pricing of available payment methods would be vested in private sector. Most likely, there would be limited financial access to the sections of the society that currently lack any means of payment, other than cash. Competition and redundancy in the payments infrastructure would

[2] *Governor, Sveriges Riksbank, Central Bank of Sweden (Oldest central bank in the world). Going Cashless,2018*

Figure : e-Money transformation



Source: IMF Publication: Rise of Digital Money, July 2019

As payments market infrastructure is established, the marginal cost of payments are low and positive externalities are present. Positive externalities mean that the value of being connected to a payments system increases as more people join contrary to when few people use the system.

Payments market can be looked as collective utility, and the state must regulate the infrastructure to ensure robustness and smooth functioning. Firstly, the society must have the service broadly available. Second, the infrastructure must ensure safety and security to sellers and buyers. Third, perceived ease of using the system and efficiency is settling payment fast involving lowest possible cost.

Dong He et al (2016) defines virtual currencies as digital representations of value, issued in their own unit of account. Virtual currencies differ from other digital currencies as e-money, as in the digital payment mechanism for other virtual currencies are fiat currency dominated. Virtual currencies have their own account and are not denominated in the fiat currency.

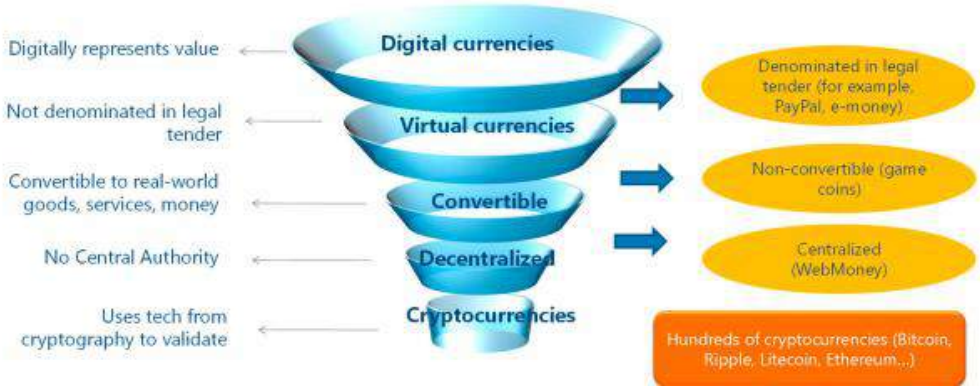


Figure: Taxonomy of Virtual Currencies

Source: Virtual currencies and Beyond, January 2016

Non-convertible Virtual Currency or Closed Schemes exclusively operate within a self-contained virtual environment. Significant restrictions are present for exchange of virtual currencies with other virtual currencies or fiat currency or towards payments for goods and services outside the virtual domain.

Convertible Virtual Currency or Open Schemes allow for exchange with other virtual currencies and with fiat currency.

Payment for goods and services is seamless in the real economy that ensures a better level of contact.

The concept of money is broader than that of currency as different types of assets (Demand draft) exist in addition to coins and banknotes. The value and credibility of a sovereign currency are intrinsically associated with the ability of the state to support the currency.

Damodaran (2014) opines that the final measure of a currency is its strength and durability of easily being converted into other currencies, be abled for storage and saving and its compensation factor for the holder of the currency. Global currencies such as US Dollar or Euro, offer these trading benefits as they are converted into other currencies at minimal cost and when idle, can be invested across banks or securities to generate market determined rate of return. Emerging market currencies are more constrained as conversion restrictions operate and often they cannot be invested beyond their local economies.

Security issues with bitcoin are highlighted through the 2014 collapse of Mt. Gox[1] , where bitcoins worth more than USD 450 million were stolen from supposedly secure servers. These servers are equivalent of banks in the bitcoin economy; and as are unregulated, money of the depositors are neither protected nor insured against bank runs or of bank robberies. While the idea he stated may conflict with cryptocurrency revolutionaries, the bitcoin market would need its own regulation and an insured centralized entity.

[1] *One of Bitcoin's biggest exchange; launched in July 2010. Handled 70% of all Bitcoin transactions worldwide between April 2013 and February 2014.*

Currency	*Issuing Entity*	*Transaction Capability*	*Security, Storage & Convertibility*
US Dollar (Euro)	Issuing Entity: The Federal Reserve (ECB) Trust: Has ebbed & flowed over time, depending upon how independent the Fed (ECB) is perceived to be and how focused it is on protecting the dollar's (Euro's) buying power. It is possible that the shift to protecting the US (EU) economy (with quantitative easing) over the last few years has reduced this trust.	Almost universal acceptance, reflecting the size of the US (EU) economy & the depth of financial markets in the US (Euro Region).	Can be saved relatively securely (in insured bank accounts & treasuries), while earning market-set interest rates.
Chinese Yuan	Issuing Entity: The People's Bank of China Trust: While the Chinese Central Bank gets in the news with its currency interventions, the perception (fair or unfair) is that it is a creature of the Chinese Government and will do its bidding.	Acceptance within Chinese borders but only limited acceptance outside China.	Can be saved in Chinese banks or government securities, but at rates influenced or set by the government.
Argentine Peso	Issuing Entity: Central Bank of Argentina Trust: Controlled by the Argentine government. Any attempt at independence is quickly countered.	Accepted in Argentina, but even Argentines may prefer to be paid in other currencies.	Can be saved, but security can be undercut by government decree.
Gold	Issuing Entity: Nature Trust: Absolute, unless the alchemists finally succeed	Almost universal for big transactions, but	Compact & portable. Can be stored but with a cost to the saver, not a return.
Bitcoin	Issuing Entity: Computer Algorithm Trust: Perhaps higher among tech true believers than the rest of us, but depends ultimately on how impervious the algorithm is to internal manipulation or external assault.	Limited to a small subset of transactions among the technologically adept.	Stored on compute servers, with no return to savers. Unregulated nature of business exposes users to risk.

Source: Ashwath Damodaran[1]

[1] *http://aswathdamodaran.blogspot.com/2014/03/bitcoin-q-bubble-or-breakthrough-both.html*

Damodaran analysed four currencies (US Dollar, euro, Yuan and Peso) along with gold and bitcoin. He concludes favoring US dollar over the yuan, but yuan over the peso. He selects gold over yuan and yuan over Bitcoin.

Bholat (2013) states that central bank's direction of regulation travel towards more granular data may be viewed as a conjectural phenomenon, that is, as a reaction to the global financial crisis. Misreporting was central to the plot of a host of recent financial scandals from Enron to LIBOR. Need for increasingly micro-level data to monitor compliance is a result of increasing volume of regulation in response to the scandals. Recent initiatives at international level like the Financial Stability Board (FSB) has proposed a common reporting

template for globally systemically important banks (GSIBs) that will capture detailed data on their counterparty and instrument exposures. In Europe, new reporting standards such as the common reporting (CoRep) templates issued by the European Banking Authority (EBA) are changing the detail of the data that firms report. It is noteworthy that the EU Solvency II directive mandates insurers report their assets to regulators on a security-by-security basis. In UK, the newly established Financial Policy Committee has signaled it will seek to improve and broaden data collections to better execute macro-prudential policy.

Economic welfare shall rise with positive developments in globalization, digitization and technical improvements. The state cannot withdraw from its responsibility by transferring retail payment infrastructure in private hands. It remains to be seen what role will central banks of the world play in the coming times.

3. FINDINGS BASED ON LITERATURE

Primary method of the review was through white papers, though information relating to several coins were not available, in which case the data was collected from the coins' websites. The figure below shows active participation by the emerging Asia-Pacific region.

(By Region)

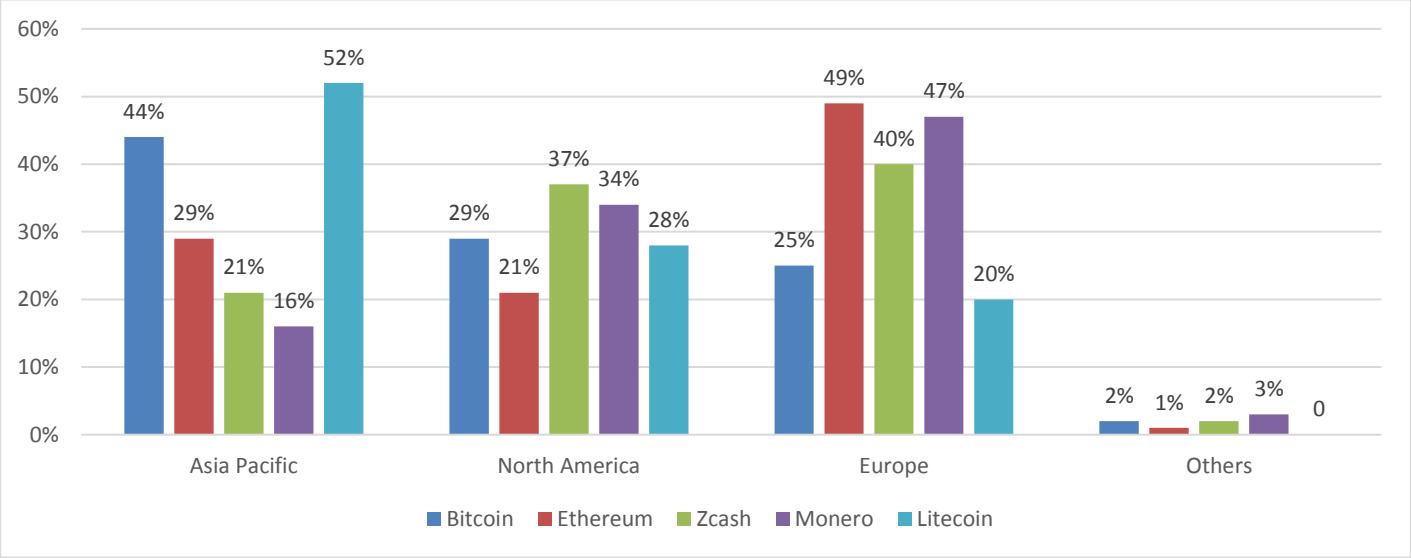


Fig. 1. Distribution of Cryptocurrency Mining Pools Worldwide in 2018

Source : Statista

The table includes the launch date of the crypto currency, market capitalisation (in US Dollars),the consensus algorithm (Hash algorithm), current free floating supply of the crypto currency (in units), the Blockchain mechanism it is operated on and the tendency of the currency to face deflationary scenarios

TABLE 1: Detailed Classification of Crypto currencies

S.N.	Currency	Release	Market Capitalisation (October 2019)	Hash Algorithm	Supply	Blockchain Mechanism	Deflationary
1	Bitcoin	Jan-09	$168,566,822,177	SHA-256	17,782,387	POW	Yes
2	Ethereum	Jul-15	$20,652,057,363	Ethash	106,654,627	POW	Yes
3	Zcash (ReLaunch)	Jul-19	$305,054,476	Equihash	6,840,756	POW & zk-SNARKs	Yes
4	Monero	May-14	$1,105,161,261	CryptoNight	17,064,775	POW	Yes
5	Litecoin	Oct-11	$4,034,512,216	Scrypt	62,404,376	POW	Yes

S.N.	Currency	Release	Market Capitalisation (October 2019)	Hash Algorithm	Supply	Blockchain Mechanism	Deflationary
6	Ripple	Sep-13	$12,989,422,815	ECDSA	42,566,596,173	POW	Yes
7	Binance Coin	Jul-17	$3,185,648,245	ECDSA sign	141,175,490	POS	Yes
8	Dashcoin	Jan-14	$674,438,057	X11	8,885,618	Hybrid POW & POS	Yes
9	Stellar	Aug-14	$1,622,686,812	Undefined	19,412,689,403	Byzantine Consensus	No
10	Bitshares	Jul-14	$80,952,603	Undefined	2,729,930,000	Undefined	-
11	Dogecoin	Dec-13	$317,060,456	Scrypt	120,094,185,233	POW	No
12	Nxt	Nov-13	$14,050,916	SHA-256d & Curve25519	998,999,942	POS	Yes
13	Peercoin	Aug-12	$7,365,127	SHA-256	Unlimited	POW & POS	No
14	Bitcoin SV (Orignal)	Jan-09	$2,519,003,226	SHA-256	17,854,986	POW	Yes
15	Tether	Jul-12	$4,129,108,937	SHA-256	3,574,945,622	POS / Omni	No
16	Namecoin	Apr-11	$7,092,221	SHA-512	14,736,400	POW	Yes
17	Monacoin	Mar-14	$72,356,575	Scrypt	65,729,675	POW	Yes
18	Tron	Jul-17	$1,355,043,273	Lamport	66,682,072,191	dPOS	No
19	Cardano	Sep-17	$1,172,017,710	Ouroboros	25,927,070,538	dPOS	No
20	EOS	Jan-18	$3,385,422,917	EOS.IO	920,765,652	dPOS	No
21	Neo	Jul-14	$794,958,039	SHA256 & RIPEMD160	70,538,831	Byzantine Consensus & POS	No

Although Bitcoin still remains as the dominant cryptocurrency in terms of market capitalization, other cryptocurrencies are increasingly catching up to cut bitcoin's historically dominant market capital share.

While in March 2015, bitcoin's market capitalization was 86%, it dropped to 72% by March 2017 and currently in October 2019 it holds 67.83% of the market capitalization. Ethereum (ETH) has positioned itself as the second largest cryptocurrency. Other currencies have witnessed have witnessed exponential rise in their volumes.

The rise of these cryptocurrencies has led to their increased interest and popularity. At present, more than 1634 different cryptocurrencies (referred as Alt-Coins) and estimated number of active users of cryptocurrency wallets has surged from 3,177,707 in 2015 to 43,052,627 in 2019. The crux of cryptocurrencies however, is that policymakers and financial regulators are lagging behind technological developments and are jeopardized about the way to regulate this novel phenomena in this nascent stage. There has been an evolution in the regulatory mechanisms taking place systematically as shown in Table 2.

TABLE 2: Evolution of Network Security Mechanisms

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
POW	1		1		2	2	1					7
POS/dPOS					1				4			5
Byzantine Consensus						1						1
Hybrid				2		1			1		1	5
Other						1						1

Transaction Network of cryptocurrencies works of cryptographic proof without a central authority. At first, the coin changes ownership that is recorded by combination of digital signatures of transacting parties, transaction date and timestamp. A code is generated that represents a coin and its path in the network. The code is then sent to computers connected to and running the cryptocurrency network softwares' nodes. For completion of the transaction, majority of the nodes are required to agree on the transactions occurred. In the event of non-agreement, integrity of the system is violated and there is a probability of double-spending and denial-of-service attack.

Proof of Work (POW) is a piece of data that is costly to produce so as to satisfy certain requirements but is trivial to verify[1]. Economic cost to perform a function is added by POW.The mechanism was implemented by Bitcoin and many altcoins (other cryptocurrencies) use the protocol. Transactions in this network are not considered verified until a certain amount of energy has been utilized to broadcast transaction. Each node takes a block and begins adding a piece of data to the block called nonce. A hash is created by block + nounce that meets the requirement of the hash algorithm. The new (block+nounce+hash) is added to the blockchain and transmitted to all the nodes.SHA-256 hashing function is used by Bitcoin.

Proof of Stake (POS) is an alternative mechanism of POW, that means a form of proof-of-ownership. In place of computational power being relied as a "scarce resource", the resource that the network security relies on is the ownership of the coin itself. As most POS coins do not have capping on money supply, they are inflationary in nature. The system distributes coins to the miners on the basis of their value addition to the network. This created a host of problems and the coins using the network turned to be fraudulent, as the creators gave themselves the majority of the coins. An improvement of this system was delegated proof-of-stake.

Delegated Proof of Stake (dPoS) is a consensus algorithm that is developed to secure a blockchain by ensuring representation of transactions within it. DPoS is designed to use voting and election process as an way of implementation of technology-based democracy. It protects the blockchain from centralization and malicious usage. dPOS coins are scalable, more democratic and inclusive than their alternatives. DPoS vs PoS offers more governance power to users with small stakes, DPoS vs PoW does not require as much computing power and, therefore, is not so financially demanding on the use.

Byzantine Consensus Protocol created a distributed network infrastructure. Servers in the network are faced with the problem of deciding if other servers in the network are sending accurate messages i.e. transactions.

The system is tolerant to wide array of failures called Byzantine Generals. Byzantine Generals problem, the Byzantine army is divided between multiple lieutenants who receive an order of attack or retreat from a commanding general.

However, there are a number of traitors - potentially the commanding general himself -

yet all loyal generals need to reach consensus despite a small number of traitors working to foil this plan. The problem is that the loyal lieutenants need to reach consensus on which order to obey by sending each other signed messages. Various algorithms have been proposed that provide solutions to the above problem. Summarization of each mechanisms' utility is presented as follows

[1] *Cynthia Dwork and Moni Naor (1993)*

TABLE 3: Main Features of each mechanism

Mechanism	POW	POS	dPOS	Byzantine Consensus
Decentralized Control	✓	✓	✓	✓
Low Latency		maybe	✓	✓
Flexible trust			maybe	✓
Long Run Low Energy Cost		✓	✓	✓

At present, the market capitalization of the 21 currencies analysed are presented in the table before as per their network security protocol. The findings suggest that POW mechanism which is scores less on depositor security is still flourishing

TABLE 4: Market Capitalizations by Mechanism (October 2019)

Mechanism	Combined Market Capitalisation (October 2019)
POW	$ 210,263,488,310
POS/ dPOS	$ 9,098,132,145
Byzantine Consensus	$ 1,622,686,812
Hybrid	$ 5,910,924,636
Other	$ 80,952,603

4. RESULTS

Virtual Currencies being volatile in nature, fail to serve as a reliable store of value. They are neither liabilities of a state and a few are not liabilities even liabilities of the private entities that introduced them. National currency pairs are relatively stable and less volatile than virtual currencies. The findings suggest that POW mechanism which is scores less on depositor security is still flourishing. Though networks that are sound and robust are present, the creators are resilient to adopt mechanisms that ensure better stability and storage value. Volatility ensures that they act as drivers of the market and secure profits at the cost of their beneficiaries.

In this state, where there is a lack of institutional backing or deposit insurance, the environment remains highly risky and unsuitable for the long term depositor or currency holder.

5. CONCLUSION

Cryptocurrency industry has expanded in terms of number of coins and circulation, showing resilience in the face of major thefts, including Mt. Gox. Improvement in network protocols demonstrated creativity in implementation of workable solutions. Bitcoin in the coming future may not dominate the industry, but the industry owes its existence to the pioneering anarchic coin.

In cases of preference divergence, international cooperation would involve exchange of experiences of which strategy works best. There would be a gradual discovery of the best policy for firms to organize themselves around upcoming technology. Inequalities are a result of the widening gap in market value and efficiency between firms and new business models and those firms that have not reorganized themselves. Replacement of old processes closes the gaps. Education policy must provide the coming generations with requisite skills to work in the emerging economy while the competition policy needs to ensure that new techniques do not become the province of select firms that come first in a winner-take-all-lottery.

Disruptions in technological payment space are taking place at lightning speed. Quantum computing, that facilitate calculations beyond capabilities of traditional computers, can enable new products rendering current technologies obsolete. Current standards of cryptocurrency could be obsolete that would affect privacy and communication at a global level. It is one facet to the threat to cyber security, given that all essential public services and private information are now online.

In light of the global reach of digital technology, and risk of the race to the bottom, policy corporation is the need of the hour, on the lines of global financial markets. The amorphous nature and location of Internet makes it difficult to oversee country specific regulation towards personal data and intangible assets. Monitoring of peer-to-peer payments transactions, including those funding crime, is difficult as they are not regulated through financial supervisory systems.

The risks need to be mitigated without stifling further innovation. Amidst paradox of regulation, it can be conveniently concluded that action cannot be put off until the answers become completely clear. The future regulatory framework should be attuned to the rapid pace of change, accounting considering unexpected new opportunities and risks likely to arise. Global international institutions like IMF can provide a platform for dialogue addressing challenges posed by digital revolution, integrating issues, experiences and tailoring advice effectively to cater countries' needs. Another approach, undertaken in Abu Dhabi and Hong Kong SAR is to establish regulatory "sand boxes" in order to test financial technologies under a close supervised environment.

Rather than ignoring or Repressing digital revolution, we need to accept and improve it. At the times of great technological change, sensible policies are required to minimalize disruptions and maximize benefits. With willingness to cooperate across borders and domains of digital data, international taxation, labour policies and inequality, education and competition.

An open mind towards crypto assets and financial technology is required, not just for the risks they pose, but also due to their vast potential to improve lives across the globe. Henceforth, existing technologies will improve well-being without diminishing enthusiasm and energy of the digital age. Value addition can take place with the advent of new technology, but it is imperative for central banks to communicate that cryptocurrencies are not currencies rather

high risk investments and assets. A review of the supervision and regulatory framework of digital currency is required, as causality unnecessary bubbles arising in future from this relatively new phenomenon are high. Even with short term dislocations, reorganizing the economy around revolutionary technologies generates tremendous long term advantages. Success of cryptocurrencies can be ensured when the larger population buy the idea of holding cryptocurrencies, and it is not just restricted to technology enthusiasts.

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