

# A Framework for the Development of a National Crypto-Currency

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## Abstract

This paper seeks to provide a conceptual framework as to whether a central bank or a monetary authority should issue a crypto-currency given available technology and what are the consequences of doing so. Under the fiat standard the value and purchasing power of money has experienced an exponential decay, whilst prices have increased exponentially. Typically, a central bank is responsible for monetary and financial stability, including settlement and payment mechanisms. A proposed methodology is provided that involves both quantitative and qualitative analysis to measure the comparative monetary performance, stress testing and impact assessment of a new crypto-currency that includes backing by gold, silver and a basket of commodities. The scope of the proposed framework involves a monetary economic analysis, supported by a technological investigation, under the framework of *Shari'ah* compliance, to explore an impact assessment of the adoption of a national crypto-currency. The significance of this study is that, it provides a framework for the development of a new national crypto-currency, which retains its' store of value in terms of monetary performance and price stability, that would also investigate whether it's implementation is viable.

**Keywords:** central banks, crypto-currencies, monetary policy, Islamic finance, fintech

## 1. Introduction

### 1.1 Background

The emergence of private crypto-currencies, such as Bitcoin, Ethereum and even gold-backed versions such as OneGram, has demonstrated that it is possible to transfer value securely via a peer-to-peer (P2P) network without having a trusted third party in the form of a financial institution. Whilst there are differences of opinion as to the legality of private crypto-currencies from a *Shari'ah* perspective, they also contain economic (*iqtisad*) flaws, in terms of volatility. Nonetheless, the distributed ledger technology (DLT) that crypto-currency payment systems rely on, may have a significant effect on money, payments and financing in a modern economy. Accordingly, should a monetary authority, or central bank, adopt such technology to issue crypto-currencies itself? This central premise involves exploratory impact assessment as to:

- (i) What is the rationale for a central bank to issue a crypto-currency supported by some form of distributed ledger payment system?
- (ii) What are the legal, economic, technological and regulatory challenges of a central bank issuing a crypto-currency?

### 1.2 Problem Statement

Under the fiat standard the value and purchasing power of money has experienced an exponential decay, whilst prices have increased exponentially. This decline in the value of money, as a result of an increase in the supply of money in relation to demand, the effect of which is higher prices, means that society's wealth is being eroded due to inflation, which is a monetary phenomenon. Since money is the common denominator for all economic transactions it must at least maintain its store of value function, if it is to succeed not only as a currency, but conform to the objectives of the *Shari'ah* (*Maqasid al-Shari'ah*) in terms of wealth preservation (*hafiz al-mal*).

Fiat currencies, generally, have experienced a significant decline in their value, for example in Malaysia, one oz

of gold exchanged for MYR 110 in 1970. However, as at 1<sup>st</sup> Dec. 2017, the price of gold was MYR 5,232. Hence, in terms of the value of money, the MYR 1.00 in 1970 is now only worth 2 cents (= 110 / 5,232) – a decline of 98% in only 47 years.

Meanwhile, investors subscribing to initial coin offerings (ICOs) and trading in crypto-currencies are mainly treating them as a commodity, or an asset class for investment purposes, rather than as a currency. In 2010, a single Bitcoin (BTC) was worth a quarter of one U.S. cent (USD 0.0025). At that time, if an investor bought USD 5.00 worth of Bitcoins (2,000 coins), and cashed out in Dec. 2017, when the price was about USD 18,000 / BTC, the investor would be worth USD 36 million. Even now, at USD 6,000/BTC (as of July 2017), the investor would still worth USD 12 million.

Whilst central banks cannot regulate customer behaviour in terms of customer experience (Cx), or user experience (Ux), with regard to crypto-currency technology, members of Bank Negara's own legal team admitted that, "Bitcoin's decentralized payment system...could make central banks obsolete" (Zahudi and Amir, 2016, pp.65-66) and recommended crypto-currency regulation. In that case, given the inherent poor performance of fiat currencies and the over-riding threat of technology, monetary authorities may find it compelling to embrace current block-chain technology and issue their own crypto-currency in line with their policy objectives of price and financial stability. After all, according to the IMF, there have been 425 banking, monetary, and sovereign debt crises since 1970 (Lietner, 2017, p.48).

### 1.3 Proposed Research Questions and Objectives

Proposed research questions (RQ) and objectives (RO) are summarized in table 1, however in terms of RQ3/RO3, further questions arise that would require further analysis.

Table 1. Proposed research questions and objectives

No.	Research Questions (RQ)	Research Objectives (RO)
1.	<b>Why</b> would a central bank consider issuing an alternative medium of exchange to fiat money and <b>how</b> would we establish a framework for monetary performance?	To demonstrate importance of the <i>Maqasid al-Shari'ah</i> , in terms of <i>hafiz al-mal</i> , and the loss of store of value function of money and wealth transfer under the fiat standard.
2.	Should a central bank adopt available technology to issue a crypto-currency and <b>what</b> type of crypto-currency would satisfy the criteria for monetary performance?	To investigate current block-chain solutions and issue a new central bank crypto-currency that adheres to the <i>Maqasid al-Shari'ah</i>
3.	<b>What</b> are the legal, economic, technological and regulatory challenges of a central bank issuing a crypto-currency?	To evaluate the implementation of crypto-currencies from the legal, economic, technological and regulatory aspects.

As mentioned, further questions emerge with regard to RQ3/RO3 in terms of implementation, given the impact on the monetary and financial system (adapted from Bank of England, BoE, 2015), such that an impact assessment will have to also consider the following questions (1 to 7):

- 1) Is it possible for a crypto-currency to be *Shari'ah* compliant, in terms of both legal form (*fiqh*) and economic substance (*iqtisad*)?
- 2) From the perspective of monetary and financial stability, what are the costs and benefits of issuing a new crypto-currency accessible to a wide range of holders? What would be the impact on existing payment and settlement systems?
- 3) What are the implications for government-backed deposit insurance scheme if central bank money is widely accessible by households and businesses? From an Islamic perspective, what would be the legal definition of these deposits (a bailment or a loan)?
- 4) From a conventional perspective should central bank issued crypto-currency balances be remunerated and should remuneration be linked to the official monetary policy interest rate? How would the monetary policy transmission mechanism be affected? However, from an Islamic perspective, how would digital balances and monetary policy be affected?
- 5) If transactions balances could migrate to digital currency, how would banks compete? Would there be any implications for the availability of credit? Would banks have to evolve institutionally and on what basis would be the provision of finance, investment and wealth creation and management?
- 6) What would be the costs and benefits of different central banks using a common platform for issuing crypto-currencies? What type of distributed ledger technology would be most appropriate for a central bank backed system? What are the regional and global implications in terms of governance?

- 7) How could institutions offering access to central bank issued crypto-currencies be regulated? In what way would third party servers integrated into the crypto-currency framework be remunerated and regulated?

## 2. Literature Review

### 2.1 Introduction

The literature review can be expanded to include an analysis of money in Islam, the mechanics of the gold and silver markets, but for the purposes of this study, it primarily concentrates on historical efforts at monetary reform, an analysis of bullion-backed digital savings and payments systems as a hedge against inflation whilst adopting available technology, and specific issues relating to the latest design developments of peer-to-peer (P2P) crypto-currencies.

### 2.2 Monetary Reform

Gold and silver has been empirically tested to hold its value in Egypt, Turkey, England and America over 1,300 years and an Islamic monetary theory of value established that a high value currency meant low and stable prices over the long term (Abdullah, 2016). Alternatives have included a money-of-account or a basket of commodities, which could also include currencies. In fact, a basket of commodities, including gold, is not without precedent from an Islamic perspective, and was anticipated under the Ayyubids, by none other than Saladin in 1171 (Abdullah, 2016). The army *dinar* or *dinar jayshi* (DJ), was an important money-of-account used to determine the present value of agricultural land for land concessions (*iqta'*) granted by the Sultan for military service, in lieu of a stipend.

The *dinar jayshi* (DJ) was valued in cash and in kind, including gold, wheat and barley, which reflected the primary medium of exchange and agricultural output in Egypt. The DJ was also worth the equivalent of  $\frac{2}{3}$  of the Egyptian *dinar* (ED) and its value was mainly influenced by the price of wheat and barley given the composition of the basket of commodities. The gold ED exchanged for 1:20 *dirhams* in circulation, which at that time were debased and contained only  $\frac{2}{3}$ <sup>rd</sup> silver. Thus, the DJ exchanged for  $13 \frac{1}{3}$  Egyptian *dirhams*, given their purity ( $20 \times 0.666 = 13.333$ ). At the time of Saladin, the Egyptian *dinar* weight was based on the wheat grain (*qamhah*) and weighed 4.30g. Similarly, the Egyptian *dirham* weighed 3.01g – these differed from the legal *dinar* (4.25g) and legal *dirham* (2.975g) weights by 1.25%, which were based on the barley grain (*habbah*). The prevailing Ayyubid gold:silver ratio was 9.3 ( $2.01 \times 20 / 4.30$ ), whilst at the time of the Prophet (s.a.w.s) it was 7.0 ( $4.25 \times 10 / 2.975$ ) reflecting the market exchange rate of 10, which was also applicable in the determination of *zakat*. To achieve the same gold:silver ratio of 7.0, it implies the same exchange rate of 10 and an Egyptian *dirham* that was not de-based ( $3.01 \times 10 / 4.30 = 7.0$ ). In that case, a pure *dinar* would exchange for 10 pure *dirhams*, or exchange for 15 debased *dirhams* ( $10 / 0.666 = 15$ ) containing only  $\frac{2}{3}$ <sup>rd</sup> silver (Abdullah, 2016).

However, by monetizing the average agricultural revenue in the form of the *dinar jayshi*, the Egyptian *dirham* exchange rate of 20 was reinforced through an implied money-of-account that consistently under-valued silver. The exchange rate for a coin of  $\frac{2}{3}$  silver should have been 15 not 20 in relation to the legal exchange rate of 10 between a legal *dinar* and *dirham* comprising pure gold and silver, when determining *zakat* ( $10 / 0.666 = 15$ ), and would have been so, had the market decided the intrinsic market exchange rate rather than the rate ascertained by government intervention. By valuing the *dirham* at 20 to the Egyptian *dinar*, the same amount of silver was being valued at 25% less of what it should be as a coin of  $\frac{2}{3}$ <sup>rd</sup> purity. Therefore, the rulers of Egypt under-valued silver in relation to gold. Silver became increasingly cheap and gold increasingly expensive. Through government intervention with money-of-accounts and exchange rate edicts, silver replaced gold as the main standard of value by the end of the Ayyubids. In other words, the design of the basket of commodities is important, since a monetary authority can misprice a basket of commodities that includes gold and silver, in relation to the prevailing market supply and demand for commodities and precious metals in the real economy, serving to undermine the objective of monetary and hence price stability.

Historically, David Ricardo (1722-1823) proposed a scheme that was essentially ahead of its time. In *Proposals for an economical and secure currency* (Ricardo, 1816), the Bank of England (BoE) had suspended the conversion of paper and gold in 1797, and subsequently created substantial debt and credit to finance the wars with Napoleon. The BoE might have been subjected to enormous claims on its depleted gold reserves upon resumption of payments and the restoration of the gold standard. Accordingly, he suggested a means to reinstate a gold standard, which would be 'economical' since it would not rely on gold circulating in the domestic economy. This was to be accomplished by prohibiting the convertibility of bank notes into gold coins, while allowing conversion in gold ingots. Ricardo states that, "a currency may be considered as perfect, of which the standard is invariable, which always conforms to that standard, and in the use of which the utmost economy is practiced" (Ricardo, 1816, p. 8). He argued that it would reduce the amount of gold needed to circulate as money,

so that the BoE's reserves could withstand the demand for redemption due to the obvious inconvenience of receiving ingots in return. This would have the effect of allowing the Bank to maintain a smaller amount of reserves. His proposal anticipated the Bretton Woods gold-exchange system.

More recently, a number of modern scholars have suggested that a new mechanism can be developed, which combines modern technological advances of electronic payments with the stability of a gold standard. With the unprecedented amounts paper money produced by the Bank of England from 1694, eventually a *de-facto* gold standard existed in England from 1717, *de jure* from 1816, and *de facto* in the U.S. with the limping gold standard and the de-monetization of silver in 1873. Soon after, Berkley (1876) proposed that a clearing mechanism be adopted, but this would only later be explored further in the inter-war years. Fisher's *Stabilizing the Dollar: A Plan To Stabilize The General Price Level Without Fixing Individual Prices* (1920), involved a managed currency that implies centralized control and monopoly, by maintaining the gold standard via paper dollars, but withdrawing the circulation of gold dollar coins, for he wished to alter the value of the dollar and "make it conform in purchasing power to the composite or goods-dollar" (Fisher, 1920, p. 89), which was defined as a basket of commodities, whose value could be measured scientifically through an index number, in order to thereby alter the value by adjusting the weight of the nominal gold standard (Fisher, 1920, pp. 85-6, 104-5). Fisher then wrote *The Making of Index Numbers* (1922) in support of his thesis with a detailed exposition on the construction of a suitable price index, and reinforced the whole concept with *The Money Illusion* (1928), which differentiated the illusion of the nominal value and the real value of the dollar: "As I write, your dollar is worth about 70 cents of pre-war buying power. In other words 70 cents would buy as much of all commodities in 1913 as 100 cents will buy at present" (Fisher, 1928, p. 3).

Fisher again blamed the demise of the purchasing power of the dollar on the fixed weight dollar (i.e. the gold standard): "Our fixed weight dollar is as poor a substitute for a really stable dollar as would be a fixed weight of copper, a fixed yardage of carpet, or a fixed number of eggs. If we were to define a dollar as a dozen eggs, thenceforth the price of eggs would necessarily and always be a dollar a dozen. Nevertheless, the supply and demand of eggs would keep on working. For instance, if hens failed to lay, the price of eggs would not rise but the price of almost everything else would fall. One egg would buy more than before. Yet, because of the Money Illusion, we would not even suspect the hens of causing low prices in hard times. In what sense, then, should a dollar be fixed, if not in weight? Evidently in buying power... [since the dollar] cannot at present be used with accuracy, for measuring value. This fact, is hidden from us by the Money Illusion" (Fisher, 1928, pp. 17-18). Following WWI, although prices soared and then fell, technological improvements with improved radio and telephone communication, electrification, improvements in infrastructure with highway construction and mass production in the automobile industry, saw improved earnings and demand for goods during the 'roaring 20s', which ensured that prices were still 30% above pre-war levels, but Fisher blamed the gold standards' stable currency for the demise in purchasing power. Fisher would again blame the monetary system in *100% Money* (1935), by using his equation of exchange from *The Purchasing Power of Money* (1911) in an attempt to show that USD 8 billion reduction in the quantity of current account money was the cause of the Great Depression (Fisher, 1935, p.6) and called for a 100% reserve system.

Milton Friedman in *A Monetary History of the United States 1867-1960* (1963) in chapter seven entitled "The Great Contraction", would also blame the Federal Reserve and the monetary system, and by implication the gold standard. He suggested a reduction in the deposit-currency ratio, initially as a result of the payment of liabilities following the Wall Street Crash of 1929, that saw by 1931 a contraction of deposits necessary to free a demand of currency (gold dollars), by a ratio of 14:1, as banks emptied their reserves, which led to a contraction in current account money (M2), and a spiral of bankruptcies and unemployment (Friedman, 1963, pp. 333-346). Abdullah (2013) established that the demand for increased government intervention and currency management was misplaced: whilst there was a problem with the fractional reserve banking system, there was in fact nothing wrong with the gold standard or the value of the dollar, which remained pegged to gold until 1933, but rather it was trade policy in the form of the Smoot Hawley Trade Tariff Act proposed in 1929 that caused the Wall Street Crash, and was enacted in 1930 causing a slump in agricultural prices, which led to currency withdrawals, a multiple contraction of deposits, and a spiral of bankruptcies that led to widespread unemployment and the Great Depression.

Meanwhile, Keynes described the gold standard in *A Tract on Monetary Reform* (1923) as a "barbarous relic" (Keynes, 1923, p. 172), and in any case, "in the modern world of paper currency and bank credit there is no escape from a 'managed' currency, whether we wish it or not...the value of gold itself depends on the policy of the Central Banks" (Keynes, 1923, p. 170). As with Fisher, Keynes also proceeded to suggest monetary reform in the form a managing the purchasing power of a new commodity standard, "by regulating the supply of currency

and credit with a view to maintaining...the stability of the internal price level...I argue, therefore, that the same policy which is wise for Great Britain is wise for the United States, namely to aim at the stability of the commodity-value of the dollar rather than at stability of the gold-value of the dollar...We have reached a stage in the evolution of money when a 'managed' currency is inevitable" (Keynes, 1923, pp. 190, 203-4). This would soon arrive following the demise of the gold standard, first by Keynes (1942) and then by Hayek (1943) in advance of the Bretton Woods negotiations. Keynes suggested *Proposals for an International Clearing Union* in 1942 for a global clearing union involving the *bancor* or 'bank gold' (Note 1), given that as a unit of account it was to be fixed in terms of gold, although "the purpose of the Credit Union is to supplant gold as a governing factor, but not to dispense with it" (Keynes, 1980, pp. 72, 183).

In terms of governance, Keynes proposed that the Credit Union would "set up a super-national policing body charged with preserving peace and maintaining international order. If any country was to infringe its properly authorized orders, the policing body might be entitled to request the Governors of the Clearing Union to hold the Clearing Account of the delinquent country to its order and permit no further transactions on the account except by its authority. This would provide an excellent machinery for enforcing a financial blockade" (Keynes, 1980, p. 190). The Clearing Union would also provide for various mechanisms to maintain price stability through the finance of stocks of commodities, as well as commodity controls in staple products (Keynes, 1980, pp. 190-191).

Hayek also suggested *A Commodity Reserve Currency* (1943) (Note 2), and in doing betrays a pattern involving the leading economists of the day. Fisher and Friedman (quantity theorists), Keynes (mercantilist/purchasing power theorist) and now Hayek (Austrian school), despite their public differences in economic theory, suddenly all rallied around the demise of gold to suggest a more efficiently managed global monetary architecture based on the management of purchasing power to stabilize prices. As Hayek put it "The gold standard as we knew it undoubtedly had some grave defects. But there is some danger that the sweeping condemnation of it, which is now the fashion, may obscure the fact that it also had some important virtues which most of the alternatives lack. A wisely and impartially controlled system of managed currency for the whole world might, indeed, be superior to it in all respects... The basic idea is that currency should be issued solely in exchange against a fixed combination of warehouse warrants for a number of storable commodities and be redeemable in the same 'commodity unit'. For example, £100, instead of being defined as so-and-so many ounces of gold, would be defined as so much wheat, plus so much sugar, plus so much copper, plus so much rubber, etc. Since money would be issued only against the complete collection of all raw commodities in the proper physical quantities (twenty-three different commodities in Benjamin Graham's plan) [Graham, 1937, p. 57], and since money would be redeemable in the same manner, the aggregate price of this collection of commodities would be fixed, but only the aggregate price and not the price of any one of them...there are many ways gold could be linked with the new scheme if desired without thereby impairing the advantages of the scheme" (Hayek, 2008, 2, pp. 106, 109, 113).

In fact, the special drawing right (SDR), under the auspices of the International Monetary Fund (IMF), was adopted under the Bretton Woods gold exchange system in 1944, but it too collapsed in 1971, and the U.S. dollar emerged as the global international reserve currency backed no longer by gold, but by debt. Under the weight of debt and paper, the U.S., Europe and other economies have experienced numerous monetary and financial crises, reflected in the breakdown of monetary order, which has accelerated over the 20<sup>th</sup>-21<sup>st</sup> centuries. Accordingly, a number of monetary economists and theorists (Table 2) have suggested monetary reform, although Meera (2004) suggests pricing commodities in gold is sufficient, whilst Abdullah argues for a return to a bullion commodity standard, or even a bullion standard, perhaps in conjunction with fintech (Abdullah, 2016; Alzubaidi & Abdullah, 2017).

Table 2. Contemporary chronology of *a priori* views on monetary reform

Century	School	Scholar	Comments
19 <sup>th</sup> -21 <sup>st</sup>	Monetary Reformers	Ricardo (1816), Berkley (1876), Fisher (1920), Graham (1937, 1944), Hayek (1943), Keynes (1923, 1942) Gesell (1958), Friedman (1963), Huber & Robertson (2000), Lietaer (2001), Davidson (2002), Stiglitz (2007), Bonpasse (2009), Greco (1990, 2001, 2009) influenced by E.C. Riegel, Meera (2004), Brown (2010, 2013), Abdullah (2016, 2018).	Other than Ricardo, these authors called for monetary reform that requires an alternative to the use of gold and silver as a primary medium of exchange. Instead, they suggest a new global clearing mechanism and <i>fiat</i> reference currency, involving a basket of commodities: except Meera whose analysis called for a return to gold and Abdullah who called for a return to a <i>dinar</i> and <i>dirham</i> commodity standard perhaps in conjunction with fintech.

Source: Adapted from Abdullah (2016).

### 2.3 Bullion Backed Digital Payment Systems

In the run up to the global financial crisis the price of gold strengthened and the dollar weakened as a result. During this time, a number of precious metal-backed digital payment solutions were established in the U.S. between 1996 and 2008, including, **E-Gold**, **OS-Gold**, **E-Bullion** and **INTGold** - all failed as a result of their inability to secure a “money transmitting business” license from U.S. authorities. In reality, they could have all been trading in unallocated gold.

- **E-Gold** (1996-2008) allowed payments to other account holders within the E-gold system via a national currency, or weight in metal on an online platform. E-gold used an operation model that permitted online micropayments as small as 0.0001 gram, which allowed a highly divisible and practical micropayment system (Mullan, 2016, p. 25). It was closed in 2008 since it was operating as an unregistered money transmitting business.
- **OSGold**, or Off-Shore Gold, (2001-2003) was introduced as online digital gold currency operation. OSGold allowed its clients to convert money to gold, save and spend gold from gold reserves stored in an off-shore vault. In reality, it was a Ponzi scheme so that eventually outflows exceeded new investors, and authorities closed the operation down due to money laundering and fraud. Indeed, without any licensing, registration or auditing, it was revealed that there was no evidence that gold ever existed (Mullan, 2016, pp. 209-29).
- **E-Bullion** (2001-2008) was introduced to hold and transfer value in gold and silver online, as a hedge against the loss in value of fiat currencies. E-Bullion was reported to be 100% backed by precious metals and offered its U.S. customers an ATM debit card linked to a digital currency account, which enabled them to convert and withdraw their bullion balances to U.S. Dollar, Swiss Franc and Euro’s at an ATM or use it for debit purchases (Mullan, 2016, pp. 124-141). The U.S. authorities closed E-Bullion in 2008 since it was unregistered money transmitting business, and all its assets, including bullion held at the Perth Mint, were confiscated.
- **IntGold (2003-2005)** initially stated, but subsequently withdrew the claim, that its transactions were fully backed by gold. IntGold involved a software platform and offered a prepaid IntGold debit card that was linked to IntGold digital currency accounts (Mullan, 2016, p. 197). IntGold had 300,000 account-holders, although by the time the U.S. authorities closed IntGold down (as an unregistered money transmitting license), there were still 25,000 active accounts.

Meanwhile, there are other gold-backed online investment and payment systems, such as e-Dinar, EuroPacific, GoldMoney, OneGram, Glint Pay and HelloGold which operate outside of the restrictions of U.S. money remittance licenses, but have separated the digital payment system and auditable vaulted gold, which would confirm that they are trading in allocated gold.

- **e-Dinar** operates out of Labuan and Dubai, is an online payment system 100% backed by audited allocated gold, which is subject to UAE Central Bank regulatory audits. E-dinar now incorporates an e-Dinar wallet and block-chain technology.
- **Euro-Pacific Bank** operates out of St. Vincent with a Precious Metal Storage Account (PMSA) is 100% backed by allocated gold stored in the Perth Mint and issues a PMSA gold and silver debit card.
- **GoldMoney** (owned by **BitGold**) operates out of Jersey and Canada offering a gold network accounts (payment) and wealth holding (investment) system, 100% backed by audited allocated gold, combined with a Mastercard, such that remittances can be in gold or fiat currencies. They have obtained *Shari’ah*-compliance from Amanie Advisors on the basis of AAOIFI’s standard on gold developed with the World Gold Council (WGC).
- **OneGram** commenced operations in July 2017 from Dubai, as a block-chain gold-backed crypto-currency: each OneGram transaction generates a 1% transaction fee, 70% of which is used to acquire more gold to increase the value of each virtual OneGram coin (20% of the fee is used to fund operations, 2.5% is given to charity and 2.5% paid to miners). Hence, the value of the coin increases with additional gold purchased such the coin would not actually represent one gram of gold.
- **Glint Pay** commenced operations at in 2017 from London, involving a gold-backed crypto-currency. Users will be able to make payments through mobile phone apps or a conventional MasterCard, allowing customers to transact with gold by the gram, or a fraction thereof. Working with Lloyds bank in the UK as (an insured) deposit holder, customers will be able to purchase auditable allocated gold vaulted in Switzerland.

- **HelloGold** was founded in 2015 claiming to have built the world's first *Shari'ah* compliant gold digital application, that adopts a block-chain technology operating from Malaysia, backed by auditable allocated gold vaulted in Singapore.

#### 2.4 Crypto-Currency Development

One of the first early works in a decentralized peer-to-peer (P2P) e-money system started in 2008 with the creation of Bitcoin (Nakamoto, 2008). The source code was released in 2009, tested and ran on the network, making Bitcoin the first decentralized P2P e-money to provide payments in exchange for goods and services. Bitcoin technology relies on cryptography and hashing functions to construct and chain blocks of transactions together called block-chains. These blocks are then shared throughout the network and maintain an immutable state by using consensus algorithms. The distributed block-chain is also referred to as distributed ledger technology (DLT).

DLT has many applications that can be applied to many different use cases. However, one of the main concerns of its original use case was in e-money. Since Bitcoin started in 2009, many several other crypto-currencies have had started to emerge. Crypto-currencies can be of two types, an alternative to Bitcoin called (altcoins), or tokens representing fungible and tradeable assets or utility offered through ICO (assets in the form of Initial Coin Offering) or contracts. Altcoins can be implemented by either extending or modifying the Bitcoin based code or by re-implementing the original source code based on the Bitcoin whitepaper. As an example, Litecoin is an altcoin created based on the original Bitcoin based code, while Ethereum is a crypto-currency created by a complete re-creation of the Bitcoin source code.

Crypto-currencies may be the future of money and may soon replace the old fiat money due to its ability to easily track transactions, prevent fraud and provide a convenient payment system. However, currently, there are some concerns about crypto-currencies that require further analysis. For example, its inherent anonymity that prevents the implementation of Anti-Money Laundering (AML) and Know-Your-Customer (KYC) regulatory policies, although Bank Negara Malaysia (BNM) has issued an exposure draft, which aims to regulate institutions engaged in exchanging crypto-currencies. Also, crypto-currencies require a process called consensus, which involves validation that prevents transfer of money from being instantaneous. Fortunately, new algorithms are being developed and tested to accelerate the consensus process. For example, hyper-ledger fabric (Github/Hyperledger, 2017), which provides a modular design for developers to customize its' consensus algorithm to allow the implementation of KYC, or e-KYC, and to speed up communications between miners/verifiers. To increase the number of transactions and speed of processing transactions, Bitcoin Segwit (Github/Bitcoin, 2017), otherwise referred to as "Bitcoin2", has provided source code implementation for segregating blocks into several sub-blocks to reduce the time required for verification of transactions. To accelerate the speed of transactions even further, Ethereum has also started providing code for its implementation of the lightning network that currently implements off-chain methods of transferring funds from one e-wallet to another.

In terms of centrally banked crypto-currencies, the Bank of International Settlement (BIS) noticed the development of a number of retail and wholesale proposals, including a retail crypto-currency referred to as **FedCoin**, involving the Federal Reserve managing the supply in relation to demand, and it would become a component of the monetary base, alongside cash and reserves. In this regard, it would represent an alternative sovereign currency. The Central Bank of Canada has used **CADcoin** in simulations involving digital assets representing bank money in the Bank of Canada's proof-of-concept for a DLT-based wholesale payment system. Additionally, the Riksbank of Sweden has embarked on a project to determine the viability of an **eKrona** for retail payments (Bech & Garrat, 2017). Meanwhile, the Bank of England (BoE) commissioned the University College London (UCL) to determine a proof-of-concept of **RSCoin** as an official crypto-currency, with the intention of rolling out a pilot-project in eighteen months (Danezis & Meiklejohn, 2016). None of these proposals have developed a national crypto-currency in the context of monetary reform and do not explore under what framework a central bank should adopt the underlying technology.

#### 2.5 Summary

The literature review, for purposes of this study, has focused on the contributions by economists on monetary reform, a summary analysis of contemporary bullion-backed digital savings and payments systems, and an appraisal of issues and developments relating to crypto-currency design. Essentially, digital gold is primarily being invested in as an asset, rather than as a currency. So, this study proposes to explore whether the technology can be adopted as an official crypto-currency that can replace a national fiat currency.

### 3. Methodology

#### 3.1 Introduction

The research methodology involves a quantitative analysis of the monetary performance of crypto-currencies (CC) including backed by gold, silver, and a basket of commodities to measure RO1 and RO2. A full population of macro-economic and commodity price secondary data would be obtained from Bank Negara Malaysia (BNM), International Monetary Fund (IMF), London Bullion Market Association (LBMA) and the Malaysian Dept. of Statistics (DoS), in order to measure volatility and stability over the period of the fit standard in Malaysia, from 1970-2017. It will also undertake simulation testing of transaction involving various types of centralized crypto-currency adopting a block-chain based ledger, where the central bank maintains control over money supply, relying on distributed servers, operating within an efficient, transparent, auditable and scalable framework.

#### 3.2 Monetary Design and Performance

In meeting the objectives of RO1 and RO2 (from Table 1), our base analysis must be the current fiat standard, where the medium of exchange involves debt organized into currency. The methodological framework, with Abdullah (2013; 2015; 2016) as precedent, should,

- (i) Analyse the nature of *fiat* money and debt, determine the relationship between interest and money supply, and examine the relationship between money supply and GDP, to reveal the impact of aggregate interest in growing money supply and GDP.
- (ii) Determine prices and the purchasing power of money (PPM) by adopting the quantity theory to reveal monetary and price instability as a result of conventional monetary theories and policies.
- (iii) Apply the monetary theory of value to reveal the relationship between the value of money (VM) reflected in an index of the price of gold (PG) in relation to an index of nominal commodity prices (CP) and GDP, and to test the hypothesis that by correcting the loss of value by expressing real prices in terms of pure gold or silver (adjusting CP by the PG), to reveal monetary and price stability, and then compare the performance of nominal and real prices in terms of long term stability and short term volatility.

The research can measure the impact of debasement (devaluation), by expressing nominal prices in real terms, in terms of gold or silver. Real prices would reveal what prices would have been if the authorities had maintained a currency of high quality. Another way of assessing the performance of a monetary system is to present a summary analysis of long term stability and short term volatility of prices and rank their performance (Mueller, 2010, pp. 329-331, 441). Two techniques are adopted: (1) long term price stability measured by the average absolute annual change in the index for prices, and (2) short term volatility, measured by the population standard deviation of annual price changes. Weighing each measure equally, we can then present a stability rank for prices in nominal and in real terms.

The performance analysis can then be extended to measure the effect of a crypto-currency (CC) on the real economy, including a CC backed by gold, backed by silver and backed by a basket of commodities, including gold and silver and even other currencies. The Islamic precedent for this is the *dinar* and the *dirham* in terms of the Islamic theory of money and the Islamic monetary standard (Abdullah, 2016) and Salahdin's army *dinar* (*dinar jayshi*) (Abdullah, 2016, pp. 135-142). Also, contemporary monetary theorists have developed similar proposals involving a basket of commodities to stabilize prices (Fisher, 1920; Lietaer, 2001; Greco, 2009). The research can also benchmark a CC to macro-economic variables, in particular GDP, in order to assess the impact on the real economy.

In terms of a basket of commodities, Lietaer (2001) suggested a national currency defined as a standard basket of commodities and services that reflects, in terms of weightage, their importance in international trade. To the extent that the currency is expressed in terms of a basket of commodities and services, it should keep prices (P) constant by definition, given that total economic transactions, or exchanges,  $(T) = \sum(PQ) = MV$ . Since, a market basket of commodities should reflect their importance in global trade (Lietaer, 2001, p.249), they should also be selected according to certain criteria (Greco, 2009, p. 246), such that they are (i) freely exchanged, (ii) important in world trade (high volume), (iii) necessities (satisfy basic human needs), (iv) stable in price in real terms over time, (v) homogeneous (standardized quality). Accordingly, we can determine the economic importance of each commodity  $(I_x) = PQ$  (value of production), and it's weight is determined from the sum of the economic importance of all commodities in the basket  $(W_x) = I_x / (I_1 + I_2 + I_3 + \dots I_n)$ . The market basket of commodities could also be adjusted to include gold and silver (weighted in accordance with official stocks), as well as other currencies (weighted in accordance to share of trade).



This can be compared to defining money in terms of a fixed weight of gold or silver (as a commodity or precious metal standard) that maintains a high value of money (VM) exchanged against goods and services (Abdullah, 2016), so that real prices are expressed in terms of pure gold or silver, and the expected effect of which would be constant and low prices over the long term.

### 3.3 Crypto-Currency Design and Testing

In terms of constructing a crypto-currency (CC), we propose to adapt an open source code block-chain algorithm from Ethereum, Bitcoin SegWit, or Hyperledger Fabric, which can be obtained from a code repository (Github, 2017a,b,c). We would then undertake exploratory performance analysis by simulating a number of transactions using Amazon, Microsoft, or Google cloud servers and laptop PCs in similar fashion to Danezis & Meiklejohn (2016, p.8).

Our proposed infrastructure network consists of 30 servers (miners), each running on a vCPUs (up to 3.3GHz), up to 2G of RAM and at 30G storage in data centres located in Japan or Singapore. Within the cloud data-centre network (figure 1), we assign three miners to each (database) shard within a block (the transaction space), where the required consensus comprises a quorum of at least two miners. A different set of 25 test-servers (users) on the same data centre is used for stress testing and estimating throughput in terms of transactions per second, latency (network delay), processing time of hashing, signing and verifying the transactions. Each of those test machines issues 1,000 transactions consisting of two inputs and two outputs. For wide area networking latency experiments we adopt a broadband cable service and an Ubuntu 14.02.2 LTS Linux VM running on a MAC OS.

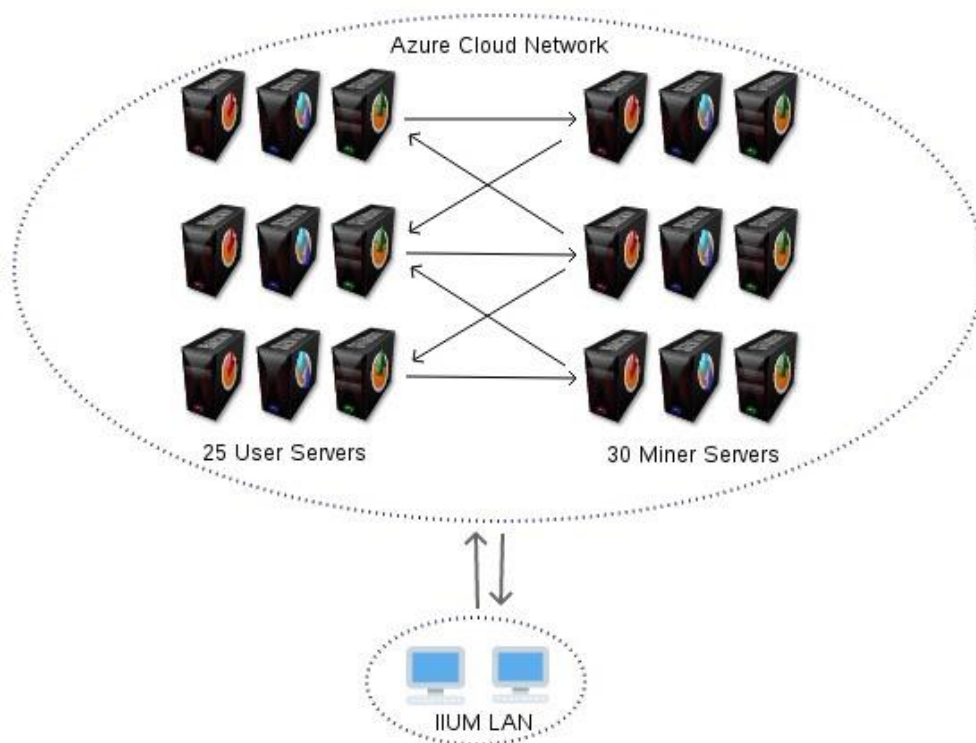


Figure 1. Cloud data-centre network

Source: Authors (Abdullah & Mohd Nor).

The transactions are generated by users through a distributed ledger (Figure 2), which are validated by the miner servers, so that a centralized money supply is generated according to demand in the real economy by the central bank, in the form of a unit of account in the block-chain. The unit of account is the national crypto-currency, which we shall refer to as MCoin. Each user (customer) has an account (e-wallet) directly with the central bank. Initially, a fiat currency, such as the MYR, could be redeemed into the new MCoin, which could also be backed by official stocks of gold, silver, commodities (including oil), and/or other currencies, or be simply generated against the credit (wealth) of the nation.

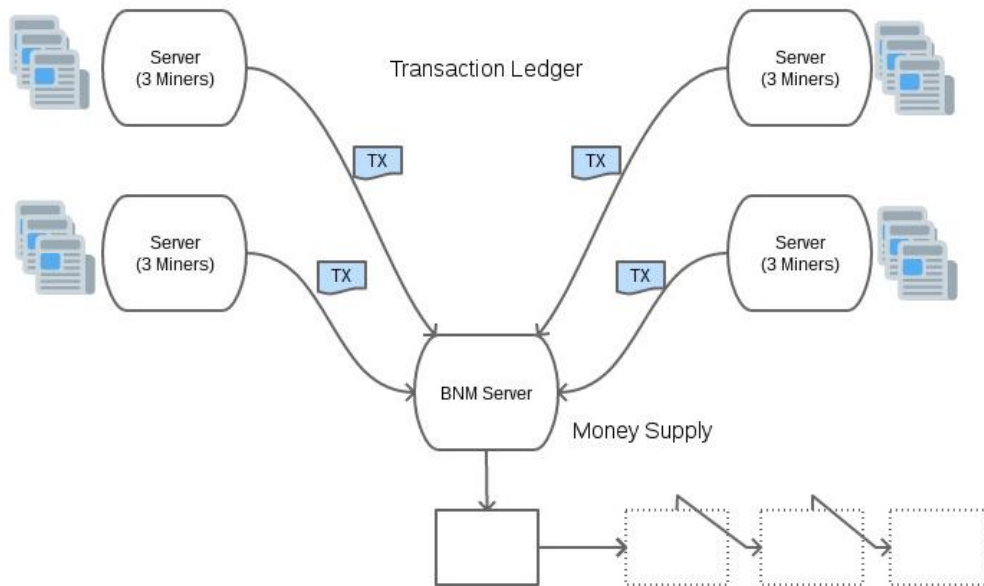


Figure 2. De-centralized ledger with centralized money supply

Source: Authors (Abdullah & Mohd Nor).

### 3.4 Implementation

A qualitative case study and impact assessment analysis would have to be developed in order to measure RO3 (from table 1) in determining what aspects of the current financial system would be affected by the adoption of a new crypto-currency. This would also incorporate unstructured focus group discussion(s) with a monetary authority, or central bank, before any final presentation is made on the overall findings and recommendations.

## 4. Conclusion

In this paper we have provided a conceptual framework for the development of a national crypto-currency. Indeed, we have identified as to whether a central bank should issue a crypto-currency and assessed related monetary and financial issues in doing so. Under the fiat standard, national fiat currencies have experienced an exponential decay in the value of money (the cause) and prices have increased exponentially (the effect). Since central banks are responsible for monetary and financial stability, we have proposed a suitable methodology that involves both quantitative and qualitative analysis to measure the comparative monetary performance, stress testing and impact assessment of a new crypto-currency that includes backing either by gold, silver or a basket of commodities (that includes gold and silver). The proposed framework involves a monetary economic analysis, supported by a technological investigation, under the framework of *Shari'ah* compliance that would explore an impact assessment of the adoption of a national crypto-currency. The outcome would involve the public issuance of a crypto-currency, which would retain its store of value in terms of monetary performance and price stability, since it is backed by tangible (*'ayn*) assets rather than debt (*dayn*) as with fiat money, and then examine as to whether its implementation is viable, given its impact on other areas of the monetary and financial system.

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## Notes

Note 1. *Banc* is the old French word for 'bank', and *or* in French means 'gold'.

Note 2. Based on Benjamin Graham's *Storage and Stability* (1937) and subsequently updated in *World Commodities and World Currencies* (1944).

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