

# The Model of Coexistence of Fiat and Cryptocurrency in an Economic Area

## A Case Study of El Salvador: Monetary and Economic Implications

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**Abstract-** This paper assesses an alternative economic and monetary model based on the coexistence between fiat and those cryptocurrencies that show real functionalities. A few years ago, I named the relation between cryptos and some independent factors which can influence the quantity demanded of virtual currency in a certain economic area  $\{Q_{cy} = f(p, y, t, e)\}$ , the '*the functioning demand curve of cryptocurrency*'. In fact, the model shows that a coexistence between a currency and a cryptocurrency with real functionalities like Bitcoin may exist by reaching alternative equilibria along the curve that we can assume to be an economic or regional area with certain characteristics. By assuming the quantity of cryptocurrency that sellers are willing to accept, because households prefer to hold and spend this alternative functioning currency, is equal to  $Q_{cy}$ , it could be possible theoretically to demonstrate that an equilibrium exists in which the quantity required in a given economic area matches the general demand and supply of money with this alternative form of liquidity. By considering a single state or a regional economic area, the model, therefore, states that this trade-off may form a possible stable equilibrium that I named 'a coexistence point' along the 'frontier curve of functionalities' where the utility and functionalities are maximized between sellers and households. To demonstrate it, I assumed for simplicity a linear function of the demand for cryptocurrencies assuming that it is dependent by the typical variables similar to the Keynes's 'Theory of Demand for Money.' Specifically, I found a relation between the costs to hold and exchange fiat with a digital currency, including inflation expectations, and the functionalities or more generally the technology behind a hypothetical cryptocurrency since I realized that digital innovation is becoming more and more of an essential element of today's money creation and spending, forming literally a new preference for an alternative form of liquidity that holds cryptocurrencies. The intuition here is also that the technology factor is the most significant endogenous variable for the future process of money and credit creation or transmission, assuming the continuing development of blockchain and DeFi and their full integration with AI, IoT, mobile technologies and quantum computing technologies. The model states that an economic area can reach a stable point of equilibrium along the curve (let's recall an economic area) that represents '*a point of coexistence*' between fiat and cryptocurrency since the sellers have the same maximum utility and functionality in holding both fiat and cryptocurrency. I have named the curve on which this equilibrium is potentially

stable the '*frontier curve of the functionalities*.' My research, therefore, aims to explore the future of money and credit creation and transmission mechanisms in some economic areas that present certain characteristics. The model supports, therefore, the decentralization of the current financial system since the coexistence between fiat and cryptocurrency with real functionalities may exist.

**Index Terms-** Cryptocurrency, Demand for Money, Demand for cryptocurrency, Bitcoin, Economic national and regional area, DeFi, Blockchain.

### I. INTRODUCTION

The world of cryptocurrencies is bound to blockchain technology. There are several definitions of blockchain and cryptocurrency. In essence, blockchain is a "net of digital ties that transfer value amongst them." It is formed by a distributed decentralized ledger that can be modified only by more than one node tie of the net. To validate the adjustments that need to be carried out to the register, the nodes of the net must reach consent amongst them. This sharing of data is automatic and occurs in the absence of trust through a system of algorithms and cryptographic rules. Although blockchain and the other distributed ledger technologies appear to be new, instead they are a mix of preexistent and well-known techniques, combined in a pioneering manner (blockchain, digital signatures, different mechanisms of consensus, smart contract, cryptographic resources). The crypto assets are used inside of these nets to transfer value and to reward the transactions in the net. 'Crypto asset' is a generic term that we can also define as the "fuel" to boost the blockchain application itself. Technically we can define them as "digital representations of value" based on cryptographic techniques to protect and verify the transfer of transactions. The main difference between crypto assets is made between "cryptocurrencies" and "tokens" which can incorporate and represent different types of economic and property rights. The former are native elements of a blockchain such as "Bitcoin" and "Ether," which represent the two most famous virtual currencies, and the latter are generated through an existing blockchain, using part of code that is represented by the so-called "smart contracts" that are self-enforcing agreements embedded in computer code managed by a blockchain itself. In short, the code contains a set of rules under which the parties of that smart

contract agree to interact with each other. In other words, a cryptocurrency is generated through smart contracts that allow users to perform a series of automated computations and actions to release a given amount of cryptocurrency in line with the rules agreed between the parties. Blockchain technology can reduce, therefore, the costs and increase the security of transactions, efficiency, immutability, and transparency, without the necessity of third parties to act as an intermediary. In 2008, an anonymous and freelance developer (Satoshi Nakamoto) invented Bitcoin, which can be considered the first peer-to-peer model of cryptocurrency released in the real economy. Blockchain is the technological infrastructure at the base of Bitcoin, which can be considered the first user of blockchain in the world. As said, there is a strong correlation between blockchain and cryptocurrency in the sense that blockchain is the technological structure that permits the functioning of the mechanisms that regulate the cryptocurrency transactions using techniques of cryptography to protect and verify the transfer of transactions inside the net.

In this research paper, we also assess the case study of El Salvador, which has started to consider Bitcoin as legal tender first as of the 7th of September 2021. This key decision seems likely to be the beginning of a new revolution for some states which are suffering from the dollarization of their economies and may represent the confirmation of the model of coexistence as I imagined years ago.

## II. RESEARCH

In this paragraph, I am going to introduce the main research, which is the basis of this economic theory which explains how it is possible to reach alternative monetary national or regional equilibria according to certain factors. The model follows the belief that fiat and cryptocurrencies can coexist, and the choice to adopt a digital currency, holding fiat or both, depends on some independent variables. In particular, I focused on the real costs that households and sellers must pay to hold and use both currencies, including the volatility (exchange costs), inflation expectations, and functionalities (technology). It shows that the process of adopting a digital currency is driven endogenously by the functionalities behind cryptocurrencies which are a result of the technology factor growth rate which I have simply added to the general demand for money compared to any cryptocurrency. Finally, I realised that the market may tend toward different equilibria which can be unstable but also stable where the utility and functionality to hold both is maximized. What led me to carry out the research and to figure out this theory was the empirical finding of how using cryptocurrencies in addition to the fiat currency can occur wholly and spontaneously in response to the wishes and expectations of the sellers and households driven by the real functionalities behind a cryptocurrency itself. The result is that Bitcoin and any other cryptocurrency, including a stable coin, can coexist alongside national currencies by being not only a store of value and in that sense matching the other characteristics of money.

## Crypto assets and money

A crypto asset is a fully digital asset because it exists only digitally, thanks to cryptography and blockchains. The virtual currencies are, therefore, a type of crypto asset and they can potentially have an intrinsic value bonded to the functionality that they can express in any economic area where they are used by sellers and households. Therefore, they can have the capacity to be accepted as a medium of exchange spontaneously and used as digital money because the trust in their value is universally accepted due to the intrinsic utility that they can generate in any economy. The study of these digital assets began as early as 1989 with the Digi Cash founded by David Chaum, who wanted to create a digital system that would have allowed users to carry out untraceable anonymous transactions. Perhaps it was too early at that time and the project went to bankruptcy in 1998, just as eCommerce was taking off. Then E-Gold came out in 1996 by Douglas Jackson, who was the founder. E-Gold was a digital currency backed by real gold. Even though the project was valid, the company suffered various legal claims and failed. B-Money and Bit-Gold were proposed in 1998. Wei Dai (B-Money) and Nick Szabo (Bit-Gold) both proposed separate but somewhat similar decentralized digital monetary systems with a limited supply of money. In 1998, Nick Szabo developed the idea of a decentralized online payment system which he called Bit Gold. From a technical point of view, Bit Gold was based on the calculation of a string of bit according to functions called variously “client puzzle function”, “proof of work function” or “secure benchmark function.” The resulting bit string is proof of the work (PoW) which creates a transaction validation chain. At the time, Szabo defined Bit Gold not only as a “payment tool” but also as a long-term “value reserve” independent of any “trusted authority”. In fact, with significant intuition he declared that Bit Gold was nothing more than an attempt to replicate the economic properties of gold or its value but improving its security properties, since it claimed that gold had historically often shown a lack of security, referring to historical events to prove it. He cited the Spanish conquistadors looting the Aztecs and the English looting the Spaniards and other historical events. He also claimed that the gold was also not safe for several reasons related to political events. To prove it, he recalled some contemporary historical events, including the historical fact that in 1933, President Franklin D. Roosevelt asked Americans to consign a large part of their gold to the federal government. Still today cryptocurrencies are often used in different similar ways without knowing the real differences between them.

## Categorization of crypto assets

To this day there is no financial regulatory framework dealing expressly with cryptocurrencies across the world. Instead, there is a complex patchwork of domestic legislations and regulations which are not uniform. Central banks regularly repeat that cryptocurrencies are not money because they have neither an intrinsic value (like the commodity content of gold coins) nor an external value (like one assigned to traditional fiat currencies by the trusted public issuing authority). Thus, because they show high volatility, we cannot treat them as a medium of exchange, and they

are not money essentially. However, not all central banks have been immediately antagonistic toward cryptocurrencies. Some of them recognize that cryptocurrencies can serve a very similar function to cash and the digital nature of cryptocurrencies is attractive because it may be cheaper and easier to manage cryptocurrencies than other kinds of cash systems. A few central banks around the world are also exploring the idea of creating their cryptocurrency as a substitute or replacement to their current money base. In general, there is a wide variety of opinions about cryptocurrencies. Many financial institutions and central banks started to analyze cryptocurrencies and Distributed Ledger Technologies (DLT), considering that they can potentially help the banking system to fix critical problems that emerged after the financial crisis. Most of them believe that DLTs could significantly improve the accuracy, efficiency, and security of processes across payments, clearing, and settlement, but they do not consider them a medium of payment or storage of value, and they repeat that Bitcoin is useful for money laundering and tax avoidance. The European Central Bank (ECB) warned that Bitcoin and other cryptocurrencies are unregulated and are therefore very risky assets. In particular, the ECB's official position states that the underlying technology supporting cryptocurrencies needs further development and research before the Central Bank would consider using them. Regardless, ECB continues to consider the impact of digital currencies on the Eurozone economy as limited, and they cannot be considered a threat to central banks' monopoly on money. Anyway, even though there is no plan to move forward, ECB has repeatedly warned about the dangers of investing in digital currencies, which are often called "tulips," alluding to the 17th-century bubble in the Netherlands. Moreover, ECB's representatives have warned several times of Bitcoin's unstable value and that the links to tax evasion and crime create significant risks. Concerning the US Federal Reserve's position on cryptocurrencies, we observe that traditionally, the Fed's view has been conservative too, and it has declared several times that cryptocurrencies are speculative assets and 'an unstable source of value.'

More specifically, the ECB stated that a 'virtual currency' is a digital representation of value not emitted by any central bank or other public authority. It is not necessarily attached to a fiat currency, but natural or legal persons use it as a means of exchange, and it can be transferred, stored, or traded electronically. There is no definition regarding digital coins, and EU law takes a different approach compared to that of the United States; judgement may vary substantially from country to country. Recently, the 5th EU Money Laundering Directive (5AMLD) introduced, in particular, a legal definition of cryptocurrency: "a digital representation of value that is neither issued by a central bank or a public authority, nor necessarily attached to a fiat currency, but is accepted by natural or legal persons as a means of payment and can be transferred, stored or traded electronically." In the United States, the SEC has held that virtual tokens may be securities and they cannot generally be sold unless a registration statement is filed with the SEC and a detailed prospectus accompanies the offering. This scenario is bound to change through the crucial decision of El Salvador, which has become the first country to accept Bitcoin as legal tender since the 7th of September 2021. Of course, it seems likely to be the beginning of a new revolution for some states which are suffering

from the dollarization of their economies since Bitcoin could allow every country to become more independent from US monetary policies and US business cycles even though, to be clear, it will not let the country control the increase or the reduction of the money supply or affect inflation rates, change interest rates on loans, or even influence exchange rates.

It is possible to distinguish the following crypto assets:

#### **Payment Token**

The 'payment tokens' are native components of a blockchain (cryptocurrencies in the strict sense) and used as a simple medium of payment or a store of value. For this reason, 'payment tokens' are also called 'virtual currencies'.

#### **Token utility**

The 'utility tokens' represent digital tokens that can be used within a given ecosystem generated by a "decentralized" digital platform ('DApps') developed on a blockchain. In other words, we may compare them to a voucher issued by a vendor to buy or receive a discount on a good or service. They may also be used to raise capital through an 'initial coin offering' event. The utility tokens do not represent securities even if the related regulations may apply to them, depending on the jurisdictions.

#### **Asset token**

The 'asset tokens' are a digital representation of certain rights reserved to the token holders who can ask to convert them into another tangible or intangible asset according to certain rules defined by the issuer.

#### **Equity token**

The 'equity tokens' are digital representations of the value of the share of ownership of a given project and/or a company registered on a blockchain. These tokens can be assimilated, in a nutshell, to the shares representing the capital of a company (Equity). Indeed, whoever holds an 'equity token' assumes the business risk with respect to the project underlying the issue of the tokens themselves.

#### **Security token**

The 'security tokens', may not represent any digital representation of share ownership in a company. The owner of a 'security token' usually holds part of the value of an underlying security created ad hoc by third parties. In other words, it is comparable to an investment or financial product that may also be a complex derivative instrument.

From an academic point of view, my studies refer mainly to the economists John Maynard Keynes, with regard to his liquidity preference theory as it evolved from the Treatise on Money to The General Theory, and by Friedrich Hayek, with regard to his inspiring capital, money, and business cycle studies. In short, he argued that "a monopolistic governmental agency like a central bank can neither possess the relevant information which should govern supply of money, nor have the ability to use it correctly." In his Prices and Production (1931), Hayek argued that the business cycle resulted from the central bank's inflationary credit expansion and its transmission over time, leading to a capital



misallocation caused by the artificially low interest rates. Hayek claimed that “the past instability of the market economy is the consequence of the exclusion of the most important regulator of the market mechanism, money, from itself being regulated by the market process [1]”.

### III. FINDINGS

My analysis, therefore, explains how the demand of any virtual currency can interact with national currencies in a modern economy which is technology oriented, introducing the functionality and/or technology factor in the demand for money and deriving in such a way ‘*the functioning demand curve of cryptocurrency*’. The thought here is that the technology factor is the most significant endogenous variable for the future process of money creation and credit transmission, assuming the continuing development of blockchain and DeFi and their full integration with artificial intelligence, IoT, mobile technologies, and quantum computing technologies. The model states that an economic area can reach various points of equilibrium along the curve of demand for money which we can call an economic area with certain characteristics. This equilibrium can be potentially unstable, but at the same time it is possible to find a stable equilibrium or a ‘*point of coexistence*’ between fiat and that cryptocurrency since the sellers have the same and maximum utility and functionality in holding both fiat and cryptocurrency. I have named the curve on which we assume that this equilibrium is stable the ‘*frontier curve of the functionalities*.’ The consequences of this new money and credit creation process have a direct impact on the nominal aggregate demand growth since cryptocurrencies with real functionalities can address money and credit creation transmissions, generating different economic implications on the aggregate demand of an economic area which suffered, for example, the dollarization of the area or get influence from neighboring areas or states. In fact, it often happens that business cycles and macroeconomic monetary policies of the strongest countries can subdue single regional areas and/or states since they represent exogenous variables that cannot be controlled by the latter. The effects of this system may generate shocks in the economic growth or production structures and/or huge misdirections of capital and credit out of these regions. The result is, therefore, an ultimate impact on the business cycles of these areas that can decrease the per capita growth rate and the unemployment of their population. According to these economic implications, I always took a different look at the dogma declared by the financial authorities to refuse that a cryptocurrency can be integrated in an economic and monetary system and that’s why I theorized the potential coexistence of Fiat money with those cryptocurrencies with real functionalities driven by the technology factor mainly even though inflation expectations can play an important role likewise in some regional and economic neighboring areas particularly.

### IV. THE MODEL OF COEXISTENCE BETWEEN FIAT AND CRYPTOCURRENCY

#### A. Case study: El Salvador and the model of the coexistence of cryptocurrencies

Since the 7th of September 2021 El Salvador has become the first country to accept Bitcoin as legal tender. Of course, it seems likely to be the beginning of a new revolution for some states which are suffering from the dollarization of their economies since Bitcoin allows any country to become more independent from US monetary policies and US business cycles even though, to be clear, it will not let the country control the increase or the reduction of the money supply or affect inflation rates, change interest rates on loans, or even influence exchange rates. That’s a fact that the mainstream media is continuing to repeat everywhere, although we could argue that this is not news since this country has not had control over their monetary policies for 20 years at least. That’s why I’m not surprised that almost all financial institutions have criticized this decision. On Thursday 16<sup>th</sup> September 2021, S&P Global declared, indeed, that El Salvador’s adoption of Bitcoin as legal tender will have some immediate negative implications for its credit rating. Other international financial regulators have raised other many exceptional concerns, like the World Bank and the International Monetary Fund. These policymakers have said that adopting Bitcoin could leave a country open to a deep money laundering environment and other illicit financial activities, even though the government could be able to track most of the payments and transactions through the Bitcoin wallet Chivo, which comes pre-loaded with \$30 worth of Bitcoin for users who register with a Salvadoran national ID number. However, the mainstream media seem to forget that this decision only involves the possibility to accept Bitcoin as a form of alternative currency and payment in the country because households and sellers may simply decide to hold Bitcoin or continue to hold US dollars, of course. In other words, they all tend to forget to consider that the nation is moving towards a possible clear scenario of coexistence between fiat and Bitcoin, rather than the substitution of the US dollar for Bitcoin in the economy. This fact should be explained more clearly. In a sense, Bitcoin could get back to its original vision that was more a modern version of a sort of electronic cash peer-to-peer, which would have allowed peer-to-peer digital transactions between parties with any financial intermediary. Today, we are, of course, more confused by the speculation and volatility that Bitcoin has shown. As we know, it seems to have more of the nature of a store of value than a medium of exchange and payment, but only because its diffusion has been discouraged by the fact that it is not still accepted as legal tender. Now the future of Bitcoin could change once again if we combine it with the surge of some

alternative digital asset class of altcoins and the development of DeFi.

The event that has just happened in El Salvador can be the confirmation of the model that this paper assesses to explain: a possible economic system in which there is the coexistence between fiat and a cryptocurrency. In fact, El Salvador's experiment is so interesting that I have started to analyze and research this country and its economy to understand more deeply the reasons behind this decision which seems like the most pivotal decision that this nation has ever made. In fact, the adoption of Bitcoin in this state would require the analysis of so many economic implications before assessing the real effects on the El Salvadorian economy. However, just looking into the macroeconomic indicators of this country, you would not be surprised to find that the government is trying to use an alternative form of currency and payment mechanisms to stimulate the economy and facilitate in particular credit transmission for the benefit of a large part of the population whose money remittances from abroad are still difficult and costly. Then, if you see that El Salvador's high crime rate and extreme poverty have been driving migration to other countries in the region, as well as the United States, for several years, you can understand how this nation and its population have totally lost control over their own future since they are linked to the monetary and fiscal policies of US policy makers and the world's potential tensions, even though they are a small country and would like to take care of their own internal problems rather than being affected by, for example, the Chinese and US trade war or their business cycles or crises. The event that has just happened in El Salvador, and very soon we can predict in other neighboring countries, might cause some economic implications in the real economy.

Of course, in the case of massive adoption of this digital currency, we can argue that in the long term the business cycles of this country could be more independent of US monetary and fiscal policies. Indeed, we can expect that it will be freer from the dollarization effects but potentially subject to exogenous variables that cannot be controlled by El Salvador directly. In this sense, it will avoid the cyclical effects of US policies generating shock in economic growth or production structures, typically causing the misdirection of capital and credit out of these regions. The equilibrium in the market will be the key to understanding if the coexistence can work naturally or by adopting some mechanisms of stabilization that are possible. However, in the long term, the opportunity to have a system not US dollar-centric will lead to benefits if the countries use this freedom to build up a robust economy focusing on the improvement of the credit transmission mechanisms. The result is, therefore, an ultimately positive impact on the business cycles of these regions that could increase the per capita growth rate and decrease the unemployment of their population. In other words, my angle is totally different from what all the media have reported about this news.

My approach is different not only from the theory that I have elaborated on a few years ago, but also because I have focused on exploring the implications that the coexistence will have on the process of credit creation that I consider one of the most important practical implications and issues of the modern era. That's why I'm so interested in monitoring what the implications of the legalization of Bitcoin will be in this small, real economy. The

challenge here will be coexistence with the US dollar. In practice, we can conclude that it will remain an alternative medium of exchange coexisting in the economy or, alternatively, become predominant and perhaps generate a robust impact on the balance of payments and facilitate credit creation if the system decides to take advantage of the promised deflationary design of Bitcoin, which displays functioning characteristics in the long-term perspective despite its current volatility remaining an issue in the short term. Of course, it will happen if the adoption of the technology continues to expand in that economic area.

In this way, my main argument states that it could form a sort of equilibrium between the two currencies following the model of coexistence I designed years ago. To facilitate the adoption of Bitcoin and force the sellers to increase the technology adoption and households to use it, the government has created the Bitcoin wallet '*Chivo*', which comes pre-loaded with \$30 worth of the currency for the users who register with a Salvadoran national ID number.

### **Dollarization**

Looking into this important decision, we can affirm that it was surely the most historic decision ever since 2001 when the Law of Monetary Integration allowed the circulation of the US dollar (USD) in Salvador with a fixed exchange rate of 8.75 colones, allowing the two currencies to circulate at the same time. The real effect which followed this decision was that, even though the colón is still legal tender, it is no longer in circulation and is rarely used.

At that time, the main strategic reason behind the decision was to establish a static exchange rate between the US dollar and the local currency, promising macroeconomic stability and avoiding devaluation. The most important effect was that the national banks converted all their accounts to dollar-denominated deposits, and in a very short time, the colón practically disappeared. In fact, although it is still the official currency, in practice, it doesn't exist anymore. This dollarization has in practice made the monetary policy of the country useless, losing any influence to impact the quantity of money and credit in the economy, limiting its action to managing fiscal policy. In fact, today, El Salvador, along with other countries such as Ecuador and Panama, are so-called 'dollarized countries' in Latin America, and this dollarization in practice implies that the nation has lost the opportunity to react to economic crises through a combination of monetary and fiscal policies. In other words, these countries are linked to the decisions of the United States Federal Reserve and, of course, global world affairs in which the US government is involved. Behind the dollarization of the economy, there was the expectation of the arrival of investments from abroad, more exports, and quality jobs. Unfortunately, after 20 years, the result was a sort of economy controlled by third parties and with no chance to regain control of the currency.

According to the latest World Economic Outlook of the IMF[2], El Salvador's economic situation is very complicated. It closed in 2020 with an account deficit of -4.9%, which is expected to decrease to -4.5% in 2021 and -4.4% in 2022. Public debt stood at 88.2% of GDP in 2020 and is projected to increase to 93.3% in 2022. Although the inflation rate remained low in 2020, at 0.2%, and should slightly increase to 1.1% in 2021 and 1.4% in 2022, it

does not generate jobs. Additionally, remittances from the two million Salvadoran immigrants in the United States — that is, 20% of El Salvador's population — are an important source of income as they represent nearly a quarter of GDP.

The true single effect that the dollarization has generated is the increase of inequality and, logically, the beneficiaries of this economic stagnation were imports in favor of multinational companies and large importers or financial institutions, which were able to buy foreign currency abroad at low rates and grant loans locally with high interest rates. What this acceptance implies on the ground is that Salvadorians can use Bitcoin as a medium of exchange in pretty much the same way they use the US dollar and, previously, the old coin colón. One can now buy products in any outlet countrywide. Finally, the government making Bitcoin into legal tender makes the process of receiving funds from abroad more accessible to recipients. There are cost benefits, helping users to avoid the high transfer fees charged by third parties. In any case, despite all concerns raised by the most notable institutions, the country has started to accumulate Bitcoin. In fact, Nayib Bukele, El Salvador's president, announced that the country has just bought 450 BTC of which 150 BTC during the Bitcoin price flash crashed to \$42.9K on Tuesday the 7<sup>th</sup> of September 2021, the same day that Bitcoin became legal tender. In essence, El Salvador has therefore begun to allocate its own bank's central reserves to Bitcoin as a new reference currency and to potentially shift to a new Bitcoin standard monetary system.

### *B. The Coexistence of a Cryptocurrency and Fiat*

The coexistence of a cryptocurrency and fiat is an economic model which shows the possible coexistence between fiat and cryptos with real functionalities and involves a wide range of potential virtual coins starting with Bitcoin, which is still predicted to become a supranational currency, or as I also used to say, a potential 'fractional reserve' for commercial banks in any state or economy with quantitative effects in the money and credit creation process while other altcoins will likely show their utilities and functionalities more and more or their nature of being an alternative asset class of investment. In my research, I started to explore, therefore, the correlation between the demand for fiat and cryptos with effective real functionalities which may be found in any country or economic and neighboring area that for some characteristics can be considered more fit than others. The model explains the relation of some independent variables and traces the 'curve of demand for cryptocurrencies' and the 'frontier curve of functionalities' that I consider an alternative form of liquidity as El Salvador has confirmed with its decision. Now that a few years have passed, this theory may show its practical utility and application in El Salvador, for example.

In essence, this theory focuses on the curve of demand for fiat compared to any cryptocurrency which may be accepted in any state or economic area. The theory may demonstrate the possible coexistence between a national currency and any cryptocurrency like, for example, Bitcoin. In particular, the model stands that there may exist a coexistence between money and cryptocurrency by reaching alternative equilibria along the curve of demand that we can call an '*economic area*'. To demonstrate it, I assumed for simplicity a linear function  $f(\ )$  depending on some variables.

Essentially, I introduced the technological factor to the typical  $f(\ )$  for money similar to the Keynes's 'Theory of Demand for Money,' since I realized that it is a part of money creation and spending, and it may represent one of the most significant endogenous variables in the money and process creation in this modern era dominated by technology and AI. In my research, as I said earlier, I was inspired from an academic point of view by two great economists of the past: John Maynard Keynes and Friedrich Hayek, with regard to their inspiring capital, money, and business cycle studies. In particular, I found Hayek's thinking so visionary when he stated that: 'a monopolistic governmental agency like a central bank can neither possess the relevant information which should govern the supply of money nor have the ability to use it correctly.[3]' Then, in his *Prices and Production (1931)*, Hayek argued also that the business cycle resulted from the central bank's inflationary credit expansion and its transmission over time[4], leading to capital misallocation caused by the artificially low interest rates. In my opinion, one of the most important visionary intuitions of Hayek was in affirming that "*the past instability of the market economy is the consequence of the exclusion of the most important regulator of the market mechanism, money, from itself being regulated by the market process [5].*" Finally, I also believe, like the economists of the post-Keynesian school and some members of the Austrian school, too, that credit cycles are the fundamental process that can drive the business cycle in a modern economy, even though I also consider essential to set the right fiscal policies since they may have an impact on the real economy, of course.

### *C. The equilibria in an economic area*

Assuming the fundamental assumption that sellers are allowed to hold and store both a cryptocurrency accepted as legal tender and fiat in an economic area with certain characteristics, as is happening in El Salvador, without any limitation, and households are allowed to receive, spend or store the digital currency, including the possibility of paying taxes or salaries, the model determines different possible equilibria that can be stable along a frontier of what I call '*the frontier curve of functionalities*.' The point of equilibrium may vary depending on the mass of sellers and households who accept Bitcoin or other cryptocurrencies and fiat. This equilibrium is generated by an endogenous process, even though some external mechanisms can help the stabilization of the system. In a stable equilibrium, sellers and households are indifferent to accepting a currency or cryptocurrency since they have maximized their own utility to hold both functioning currencies. The thought here was that the choice of a cryptocurrency will depend on an endogenous process driven by the technology factor, which, together with other factors, can demonstrate the possible coexistence between fiat and cryptocurrency inside any nation or economic and neighboring area in which there is a competitive vantage to exchange goods and services between the two countries for some reasons. The choice of adopting a new digital currency, maintaining the fiat currency, or choosing both will be a function of the real costs that households have to pay for the seller to accept two currencies — including the price of transactions in the digital currency (the price of a cryptocurrency in terms of the other currency) and inflation expectations, and the income spent on goods and services due to



functionalities of that virtual coin driven by the technological factor of the economy in which it happens.

From a probabilistic point of view, we address the problem of great practical importance concerning the existence of a relationship between a given variable (endogenous or dependent variable) and one or more other variables (explanatory or independent variables) in which technology can play a fundamental role for accelerating the process. The mass of sellers who accept the cryptocurrencies increases as functionalities of the cryptocurrency grow and households' incomes spent in that virtual coin increase due to the increase of functionalities driven by the technological factor. The theory states that the choice, therefore, depends on an endogenous process based on the real functionalities that are behind the adoption and diffusion of technology. Following these assumptions, we can now explain what the 'functioning demand curve of cryptocurrency' is. By assuming the quantity of cryptocurrency that sellers are willing to accept because households prefer to hold and spend this alternative functioning currency is equal to  $Q_{cy}$ , we can theoretically calculate the equilibrium in which the quantity required in a given economic area matches the general demand and supply of money and this alternative for of liquidity. By considering a single state or a regional economic area, the model, therefore, states that this trade-off may form a possible stable equilibrium that I named a point of coexistence along 'the frontier curve of functionalities'; where the utility and functionalities are maximum, that's the coexistence.

From a mathematical point, we can define a function as a relationship  $y = f(x)$ , which links two or more variables. The set of points  $(x; y...K)$  that verify this relationship generates a line (straight or curve), which is represented in a Cartesian plan through a chart (function diagram). The variable  $y$  is called dependent, the variable  $x$  is called independent.

If we denote by  $Q_{cy}$  the dependent variable (amount of cryptocurrency required in a given economic or regional area), we can assume that any equilibrium of the system happens at a certain level in which it is equal to the quantity of digital currency that sellers are willing to accept and households to spend compared to the fiat one, and it is dependent on a few variables which we explicit hereafter connected to its use and above all the functionalities (technology factor) of the crypto asset ( $T$ ). Assuming for simplicity that  $f(\ )$  is linear and consequently, that is a linear model that expresses the quantity of digital currency required by a certain economic area, the theory shows that the adoption depends on an endogenous process linked to some variables driven by the functionalities that influence the movement of the 'curve' on the plan and its adoption in the real economy. In this way, this new form of liquidity competes until an equilibrium has not been reached, naturally or through a potential mechanism of stabilization.

The model stands that quantity of cryptocurrency ( $Q_{cy}$ ) and Fiat ( $D_{cy}$ ) required in a given economic area depends on the quantity of digital currency that sellers choose to accept and households to hold with an immediate effect on the demand of fiat that decreases or increases accordingly. The equilibrium is dependent on a few

variables such as: the transaction and administrative costs of holding and exchange of cryptocurrency compared to fiat, including their volatility ( $p$ ), the income spent in that cryptocurrency ( $y$ ), and the functionalities of the cryptocurrency considered and/or more generally what I named the 'technology adoption factor' ( $t$ ), and of course the inflation expectations ( $e$ ).

In formula:

$$Q_{cy} = f(p, y, t, e)$$

In equilibrium:  $Q_{cy} = D_{cy}$

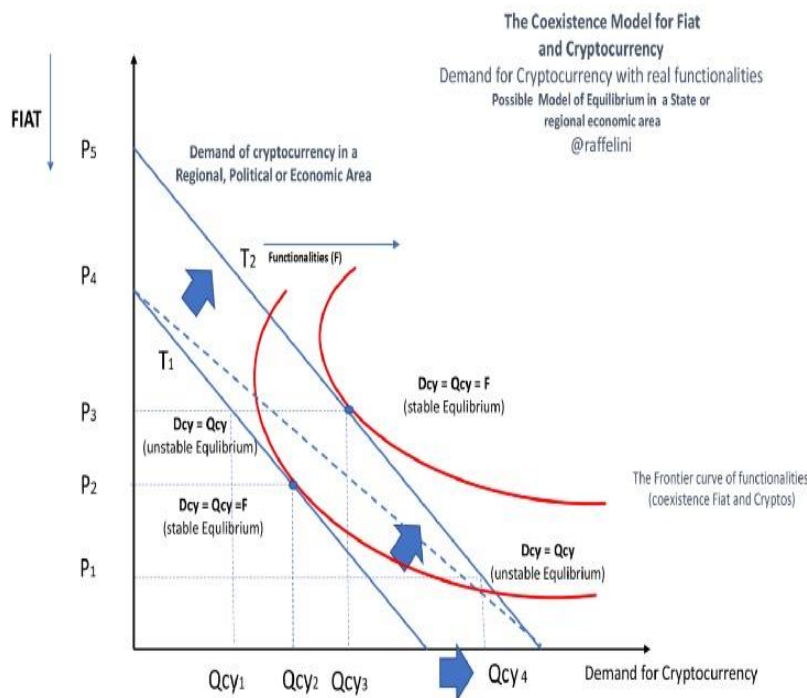
For simplicity, we do not consider adding any variable difference as measurement errors and so on.

To make it possible to represent in a two-dimensional graph, then, we consider all variables as constants except ( $p$ ). In this way, we can create the relationships and logical links between different variables, which we can describe, two by two, within the same model. Of course, the relationship between those independent variables and the quantity of cryptocurrency demanded may be not linear, but let's assume that it is.

In other words, we trace a linear function of the type

$$Q_{cy} = a - b p$$

In Fig.1 I have plotted Fig. 1 **The Model of Coexistence of Fiat and Cryptocurrency in an economic area.**



Along the curve, it may represent an economic area, therefore, we can find different equilibria ( $D_{cy} = Q_{cy}$ ) between the demand for

cryptocurrency which sellers are willing to accept and households to hold and spend compared to the fiat one.

Any point along the straight line may represent a potential equilibrium between the demand of cryptocurrency and the quantity offered (amount required in an economy) compared to fiat ones where the  $f()$  stands the identity of this relation. A stable equilibrium is what I have called the 'coexistence point' (F) between fiat and cryptocurrency since the sellers have the same maximized utilities and functionalities in holding both currencies constantly with the variables above explained.

Therefore, along this straight line may exist alternative equilibria that we can consider only stable and constant along the curve that I have named the 'Frontier curve of the functionalities' (F) on which:

$$D_{cy} = Q_{cy} = F$$

If any of the factors of the above function stay constant, the curve moves on the plan if functionalities and technology grow and at the same time the quantity of cryptocurrency demanded grows and Fiat decreases of course. In other words, the inverted correlation is intuitive about the relationship between fiat and cryptocurrency, which depends on the said independent variables. The slope of the line is indeed given by its angular coefficient  $b$ , which is nothing other than the ratio between the variation of  $P(\Delta p)$  and the variation of  $Q_{cy}(\Delta Q_{cy})$ .

The rate of variation (the ratio between two variations) is therefore the slope of the demand curve and, in this particular case, the ratio ( $P$ ) and the quantity ( $Q_{cy}$ ). The slope of the demand curve serves to be a measure of the delta that represents the change in ( $\Delta P/\Delta Q_{cy}$ ). While the coefficient remains constant along the entire demand curve, the ratio of price to quantity  $P/Q$  changes depending on where we are over the demand curve. At very low cost  $P/Q_{cy}$ ,  $Q$  is high of course and vice versa and the same happens with technology  $T/Q_{cy}$ . We can conclude that along the frontier curve that we can call an optimal economic area, a stable equilibrium may exist where the functionality and utilities are maximized for both sellers and households. This level, therefore, is nothing other than the tangent to the 'Frontier curve of the functionalities.' More precisely, along with the market, the variation rate varies at any point and we can consider equal to the slope of the tangent to the curve at that point. The relationship between the variations  $\Delta P/\Delta Q_{cy}$  used for the calculation of the angular coefficient can also be defined as the first derivative and indicates the ratio between two infinitely small variations. It is graphically represented by the angular coefficient of the tangent to the curve. In this sense, we can say that the first derivative represents an instantaneous variation of the function that is the variation of the dependent variable ( $Q_{cy}$ ) for an extremely small variation of the independent variable ( $p$ ) or ( $t$ ).

We can conclude that this scenario depends mainly on an endogenous process driven by the technology factor and

functionalities that may have a large influence on the demand curve for cryptocurrency.

## V. CONCLUSION

The model of coexistence between fiat and cryptocurrencies shows that the choice between a cryptocurrency with certain characteristics and fiat is, therefore, a 'false dilemma' in which financial institutions and most of the notable persons have been trapped. The dilemma should not exist since it explains that a coexistence of cryptocurrency and fiat money may exist, and it is driven by the technology factor. The model that I propose, therefore, assumes that the technology behind cryptocurrencies will continuously spread out across the real world. The massive adoption of cryptocurrencies driven by the capacity to share and generate value through technology will also accelerate thanks to the interaction of blockchain, AI, and IoT (The Internet of Things) solutions. The model stands that quantity of crypto currency ( $Q_{cy}$ ) and the demand of Fiat ( $D_{cy}$ ) required in each economic area depend on the quantity of digital currency that sellers choose to accept and households to hold and spend. This quantity is influenced by some independent variables. In particular, the equilibrium is dependent on a few variables such as: the transaction and administrative costs of holding and exchanging a cryptocurrency compared to fiat, including volatility ( $p$ ), the income spent ( $y$ ) in that cryptocurrency, and, above all, the functionalities of the cryptocurrency or more generally what I named 'the technology adoption factor' ( $t$ ), and of course the inflation expectations ( $e$ ). Therefore, we can conclude that the process is endogenous and in some economic or regional area the system may move naturally towards cryptocurrencies with real functionalities, forming possible alternative equilibria with fiat. The stable equilibrium is what I have called a 'coexistence point' (F) between fiat and cryptocurrency, since the sellers have the same maximized utilities and functionalities in holding both currencies constantly with the variables explained above.

Therefore, along the 'the functioning demand curve of cryptocurrency' that can be represented generally as  $Q_{cy} = \{f(p, y, t, e)\}$ , that is also an economic area, there may exist alternative equilibria that we can consider only stable along the 'frontier curve of the functionalities' around the 'coexistence point', where:

$$D_{cy} = Q_{cy} = F.$$

If any of the factors of the above function are constant, the curve moves on the plan if functionalities and technology grow and at the same time the quantity of cryptocurrency demanded grows while fiat is reduced.

From a general point of view this theory responds to what I called the false economic 'dilemma of cryptocurrencies', since dilemmas often involve a choice between alternative courses of actions. In fact, we often use to face moral dilemmas, which are choices between two options where neither fully resolve the situation in an ethically acceptable way. The example of Sophie's Choice can help to achieve a better understanding of the problem we need to solve. In Styron's novel (1979), Sophie is forced to choose which one of her two children is gassed and which would proceed to the



labor camp of Auschwitz. To avoid having both children killed, she decides her son, Jan, is sent to the children's camp, and her daughter, Eva, is sent to her death [6]. Considering the circumstances, she acted for the best: the boy probably had more chance of survival than the girl. However, one may ask: is there a "best" option in such a situation? Of course, we can argue that there is no solution to this dilemma as all the solutions are terrible for all involved. The above scenario can be applied to the current monetary system, which has to deal with the cryptocurrency sector. The coexistence of digital and fiat is more likely than we can believe because in the past it has already happened in both small countries and large economies where more than one currency was adopted for short or long periods. The main difference here is that the process is endogenous because it is driven by the 'technological factor'. Unfortunately, the financial establishment is still debating whether cryptocurrencies match the criteria of money and if they are a sufficiently stable store of wealth or an efficient medium of exchange. The model of coexistence between fiat and cryptocurrencies shows that there is no dilemma similar to the one in Styron's novel which has no solutions, but the problem here is not only whether cryptocurrency is money or not money but whether fiat and cryptocurrencies which have real functionalities can coexist since they are driven by the development of technology which makes this scenario possible. The conclusion is that in an economic area with certain characteristics, cryptocurrencies may coexist with fiat and because of the intrinsic value of their functionalities, they can be adopted

endogenously through the development of the technology in the society.

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