VIRTUAL CURRENCIES, MICROPAYMENTS AND THE PAYMENTS SYSTEMS: A CHALLENGE TO FIAT MONEY AND MONETARY POLICY?

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Abstract:

In this paper we explore the concept of virtual currencies, a concept that is fairly new not only to Economic Theory but especially to Monetary Dynamic General Equilibrium models with micro-foundations. From the perspective of the conventional wisdom associated with the design and implementation of monetary policy, we are used to models where currency takes one of two forms: it is either a commodity money, from which people derive utility, or a fiat currency, whose value is mainly determined by the people's beliefs regarding its future acceptability in exchange for goods and services. Either of them may arise as the legal tender in the economy, and they both operate in close proximity with our every-day physical environment.

However, the recent advances in electronics and telecommunications, coupled with the creation and expansion of social networks, micro-products, among other things, pose a challenge to the standard models of money. In many cases, these changes are associated with the creation of alternative and "virtual" realities that differ significantly from the standard physical environment of an Arrow-Debreu economy. This paper is a first and still incomplete attempt at closing the gap between these advances, their definitions and their implications for Economics as a science.

Key Words: Virtual currencies, Micropayments, Virtual goods, Digital goods, Micro-products, Social networks

Introduction

Our economic environment has been characterized by continual technological advancement, especially since the last decade of the 20th century; moreover, not only have these changes been abundant but they have also occurred at break-neck speed, causing significant alterations to the way in which we carry out our day-to-day lives. Without having to look exhaustively or in the farthest places of the globe, one could find any number of middle-aged individuals who can still remember the ordeal implied by telecommunications not so long ago. Just for illustration purposes, allow us to refresh your memory by mentioning a couple of examples: we were subjected to either very expensive telephone calls of below par quality that would disconnect without any warning, or we were supposed to print, cut and paste documents together so that they could be photocopied and later faxed to their destination.

The almost incredible speed at which all these changes are being thrown at us has not allowed us yet to take a step back to try to understand and comprehend the whole picture implied by them. Nowadays, we have virtual games that create virtual realities and need virtual currencies to function, together with digital goods that are traded electronically, as opposed to the standard physical environment with traditional brick-and-mortar stores that we are used to deal with in the Arrow-Debreu economies. On top of that, we also have many kinds of electronic purses and a variety of accounts that are needed in order to transact directly or indirectly in these virtual worlds or with digital goods. We must not forget to mention either the quickly expanding social networks, which create new necessities as well. Overall, we can hardly keep up with the pace of these innovations, and so we also struggle when trying to define these many newly created objects.

It is undeniable that we all feel overwhelmed in the middle of all this over-spreading novelty. In spite of this, but maybe also because of it, some of us think that maybe the time has finally come

when must take up the challenge of building a new class of general equilibrium models that are responsive to our ever-changing and complex reality. In particular, now it is the time for us monetary theorists to start moving gradually away from our standard monetary general equilibrium models, since the latter deal only with very limited kinds of currencies: they deal either with standard commodity money or fiat money in a regular physical environment. But our new reality needs more than that: to start thinking about virtual or digital currencies in virtual and/or digital worlds. Our Arrow-Debreu economies, as they are now, are not ready yet to allow us to respond to these new needs and worlds.

The empirics of common wisdom and the highly sophisticated intellectuals both agree that most of the above-mentioned changes have been concentrated on the sectors of electronics and telecommunications. We propose to start building upon three very simple ideas: first, that the emergence of virtual or electronic currencies is at the heart of these happenings and that it has been the oil lubricating its workings; second, all the events mentioned are something that our models cannot deal with yet; and third, that this is a multi-dimensional issue.

We are proposing, accordingly, to take our general equilibrium models one step forward, and for us, economic theorists, to move with them. But this must be done sequentially, little step after little step. We believe that this paper is a first step in this direction, where we propose to undertake a particularly important first task (that may not work out to be as simple as we would like): the immense undertaking of trying to come up with an all-encompassing definition of virtual/electronic/digital currency. We are aware that we are proposing to define something that we may not understand fully as yet, but this is also the beauty of this challenge. Moreover, we will follow our own advice and will be focusing mostly on the economic and financial aspects of this phenomenon at this stage; this is to be complemented later on with the legal and institutional aspects, which are equally important but are for now a bit out of our reach.

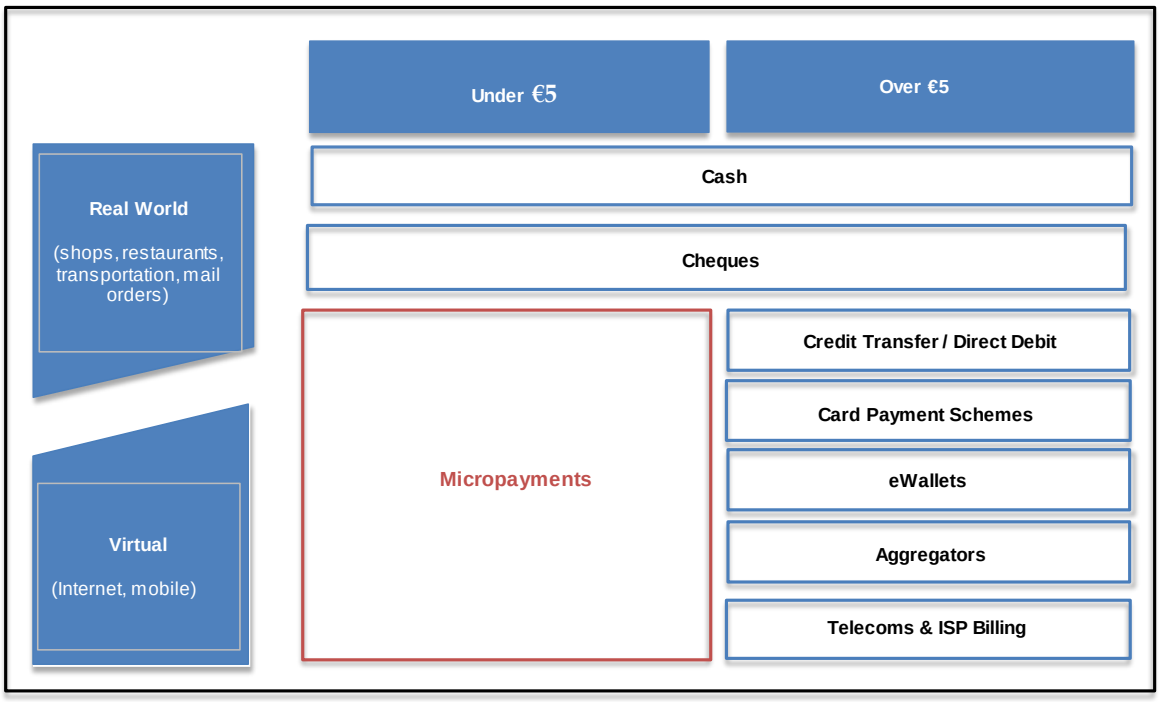
There is a notion deeply ingrained in every one of us and that comes up whenever we try to deal with the concept of a currency, whichever its form: one way or another, a currency is something that requires trust and a very high involvement by the government and related institutions. Keeping this in mind, we propose to start by mentioning these definitions as they are put in place by some "official" institutions. A first take on the subject is by the Financial Service Authority of the United Kingdom, who defines electronic money as follows:

> Electronic money (e–money) is electronically (including magnetically) stored monetary value, represented by a claim on the issuer, which is issued on receipt of funds for the purpose of making payment transactions, and which is accepted by a person other than the electronic money issuer. Types of e-money include pre-paid cards and electronic pre-paid accounts for use online.
> *Financial Services Authority.*

We must be aware that assigning a value to the goods and services we wish to consume directly or that we use to produce other goods is, most frequently, expressed in monetary units, since one of the most essential functions that a money must carry out is to be a unit of account; i.e. we use the legal tender every day to value all of our transactions and things we care about. But nowadays we must also account for a new kind of money, which use is expanding rapidly: one can use virtual currencies that are redeemable in fiat money but not necessarily backed by it, as a representative currency would. The value of such transactions performed over the Internet has increased enormously: goods and services that before were purchased at "bricks-and-mortar" stores are now acquired over the Internet. Interestingly, these transactions mostly use electronic equivalents of fiat money (e.g. electronic funds transfers, debit cards or credit cards) as media of exchange. Moreover, the current forms of electronic money (including digital cash or stored value cards) have been engineered to operate in such a market.

Before getting started, we must lie out what we understand to be the most important issues related to e-commerce. Among them, we must highlight the definitions of micro payments, virtual currency, digital goods and virtual goods.

Figure 1. The position of micropayments in the payments landscape



ISP = Internet service provider

Source: Burelli et al (2011). Adaptations by the authors.

Regarding micropayments, we must say that the related technological advances have created a market for micro-products. The exact definition of what constitutes a micro-product varies widely by audience; and the differences arise from the defined monetary value below which we have a micropayment. To illustrate this wide variety, we must mention that this upper value varies from €1 (as in Innopay) to USD 12 (by PayPal). We must pick a value before moving ahead, so we will use the definition by [3]:

> 'Micropayments' is a term that identifies transactions of low value; however the exact definition varies considerably by audience. For the purposes of this report, a micropayment is defined as 'an online or mobile, real-time or deferred, financial transaction below five Euros which initiates the instantaneous delivery of a digital good'. They can be used to charge customers on a purchase-by-purchase basis for a range of digital goods, including access to news content, online music, TV shows and films.
>
> *Burelli et al (2011), p. 9.*

For the purpose of comparability, we transformed the value of €5 into US dollars, which is equivalent to $6.5, and this cipher is attributed by [3] to The Economist. A couple of related definitions are those of digital goods and virtual goods. On the one hand, a digital good is defined by Webopedia as follows:

> In electronic commerce, digital good is a general term that is used to describe any goods that are stored, delivered and used in its electronic format. Digital goods are shipped electronically to the consumer through e-mail or download from the Internet. Usually when you purchase digital goods online, after payment has been received the merchant will provide you with your digital item as an e-mail attachment or they may provide you with a secure link where you can download the item. Examples of digital goods include e-books, music files, software, digital images, Web site templates, manuals in electronic format, and any item which can be electronically stored in a file or multiple files.
>
> *Webopedia.*

We must clarify as well that digital goods are sometimes labeled electronic goods in the related literature. We believe that it is also important to define a virtual good. As stated by The Computer Language Company Inc.:

> Virtual goods are images of real things that are purchased to enhance online games and social networks. For example, players can purchase elaborate avatars to represent themselves, send an image of flowers to someone.
> *The Computer Language Company Inc.*

For the sake of completeness, we must also define a virtual currency. As before, one could find many definitions, but we believe that they all complement each other. Wikipedia gives the following definition of virtual currency:

> **Virtual currency** (or **in-game currency** depending on environment) is used to purchase virtual goods within a variety of online communities; which include social networking websites, virtual worlds and online gaming sites…
> Some virtual currencies are time-based, relying upon measurement of in-game achievements in order to accrue exchangeable points.
> The word (sic) **virtual currency** or **cyber currency** is also often used, in a more broad sense, to indicate electronic money, that is not contractually backed by tangible assets nor by legal tender laws, and which is not a tangible commodity itself. Examples are peer-to-peer crypto-currencies like bitcoin and the above mentioned in-game currencies that are backed by virtual goods.
> *Wikipedia (2012)*

But we must also complement this definition by saying a couple of other things. First, there are examples of virtual currencies where their value is actually backed by tangible assets (as in the case of Ven). Secondly, a virtual currency can be issued either by a government or by private agents (like most cases). An example of the former would be Mintchips: it is a currency not in use yet but that will be issued in the near future by the Canadian government to substitute the use of small change. Mintchips are intended to cover micro transactions (with value below $10) and nano transactions, (with value below $1) [2]. Regarding examples of virtual currencies issued by private agents, we can mention (among many) Facebook Credits and Bitcoin. See Table 3 for a more complete list of examples of virtual currencies.

The remainder of the paper is organized a follows: section 2 details the nature of the transactions and the institutions that deal with micro-payments. Next, we present a brief review of the previous literature. In section 4, we present what we consider to be the main challenges that will be faced by monetary policy, and Section 5 concludes.

The Industry of Micropayment Services

There are many different definitions of what constitutes a micropayment, which mostly vary according to the upper limit of the price of each transaction. We believe that there is not a definition that is, a priori, better than the others, but we must pick one in order to move forward with our study. Thus, we have chosen, for the purposes of this study, to define a micropayment as an online or mobile transaction with a value below $6.50. In the remainder of this section we will present what we believe to be the main characteristics of the micropayments industry.

In this paper, we focus our attention on some particular aspects of the micro-payment system, i.e.: the Internet payments system for the micro-products market. We start by describing the recent evolution of this industry. Next, we turn to describe the different niches in this market; we will focus on two: transaction grabbers [16] and virtual currencies (although we are aware that there are more niches, they tend to overlap in this two). We believe it is very important to describe not only the market niche of virtual currencies, but also the second niche labeled as transaction grabbers, highlighting the fact that transaction grabbers are, among other things, facilitators of the use of virtual currencies.

Let us summarize the recent evolution of the micropayment industry. Most of this section is based on Burelli et al (2011). The evolution of the micro-payments has been enabled by three mutually reinforcing trends, which we list below:

a) The growth of broadband infrastructure and e-commerce

> The Western European broadband penetration has grown from 19% of households in 2004, to 56% at the end of 2009; in addition a further 9% of households have access to mobile broadband. Building on this, widespread consumer adoption of online payments has fuelled considerable growth in global e-commerce. This behavioral shift, supported by a thriving online payments industry, has increased online spending from £150 billion in 2004 to over £350billion in 2009.

The authors highlight that online shopping is so popular that even in the global recession of 2008/09, as UK high street retailing revenues contracted by approximately 2.5%, online sales rose 17.8%, compared year on year. Moreover, a survey of U.K. consumers showed that more than two-thirds of the population aged 14 or above bought goods and services online in 2010.

b) The growth of social networks, online gaming and virtual goods related businesses

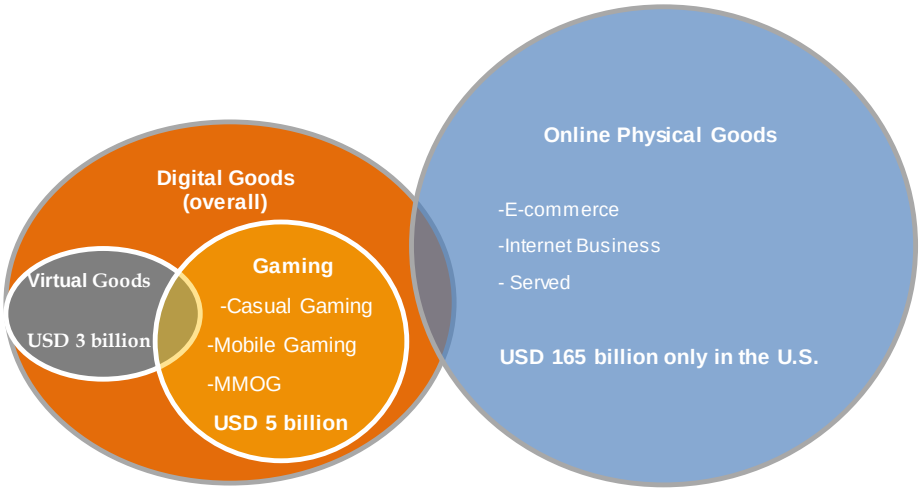
The online gaming sector has rapidly gained popularity among Internet users. The period 2007–2009 saw a proliferation of online games with built-in virtual currency systems and virtual goods stores. Currently, these systems attract over 400 million active users every month. The use of these online games has been driven by integration into social networks. For example, FarmVille, a game designed by Zynga, is accessed by more than 63 million active users who each month spend an average of 15 minutes a day in the game.

Typically, virtual goods are bought for small sums of money within online games and are supported by a range of micropayment-style processes. For example, Facebook introduced their own virtual currency, called Facebook Credits, in mid-2010, which can be used to buy virtual gifts or spent within applications. In 2011 the overall market for only virtual goods in the US was headed towards $2.9 billion for 2012, against $2.2 billion in 2011, and $1.6 billion in 2010.

c) The emergence of new online payments services and user interfaces

Value Partners estimates the European micropayments market was worth €6 billion in 2011, and is set to grow to over €15 billion by 2015. The use of electronic equivalents of fiat money became excessively costly, especially because of the size of the fees charged relative to the value of the micro-products. What seemed to be a serious problem in the micro-product market was the presence transaction costs so high that precluded very small transaction values: the currency available was not divisible enough, because it could not be used for transactions of value below the transaction costs [21]. The presence of these indivisibilities precluded some trade in this market.

Figure 2. Market size of online trading in the U.S. in 2009



MMOG: Massively multiplayer online game

Source: Glenbrook Partners (2011)

Reducing the scope of these indivisibilities by introducing a new electronic medium of exchange that is cheap and accepted in different Internet communities has proven to improve social welfare. As comScore Inc. indicates, 29.7% of social gamers do not have the ability or the means to pay for virtual currency with cash options [15]. Companies like Google, PayPal and Amazon have leveraged their respected brand names and established trust-based customer relationships to enter the financial services market, while incumbent payment and banking infrastructures have increased their reach and new entrants are trying to establish themselves. Even so, according to Osama Bedier Google's vice president of payments and of Google Wallet, only about 7% of retail sales occur online, compared to the 93% that is still spent in person at stores [43].

Consumers and merchants are driving the alternative payments market as they look for new ways to pay and get paid. Mobile commerce has lowered the costs for merchants to accept old and new

types of payments. Take Square, founded by the creator of Twitter, lets people accept credit cards with their smart phones.

The parameters that we will take into account for analyzing the examples that we mention below are based on Burelli et al (2011), and they are displayed in detail in Table 1.

Table 1. Parameters for assessment for virtual currencies and transaction grabbers

Payment functionality that supports many digital content providers that may be available also for either on-line or off-line payments across multiple retail industries.	**Openness** Open- Closed ← O - C →	Payment functionality that supports one or very few digital content provider(s) and works in a closed transaction environment.
Transaction funded on the base of an instant, real-time transaction.	**Payment finality** Real Time -Both- Pre Paid ← RT B PP →	Transaction enabled by advanced deposit of value prior to the transaction.
Transaction denominated by monetary currency value.	**Type of currency used** Real money[a/] - Virtual Currency ← RM - VC →	Transaction denominated by units other than monetary currency.
Settlement of micropayment transactions made on a one-by-one basis.	**Rule for settlement** Single Payment- Aggregator ← SP - A →	Settlement of multiple micropayment transactions that are processed in an aggregated manner.

[a/] This refers to actual fiat legal tenders.

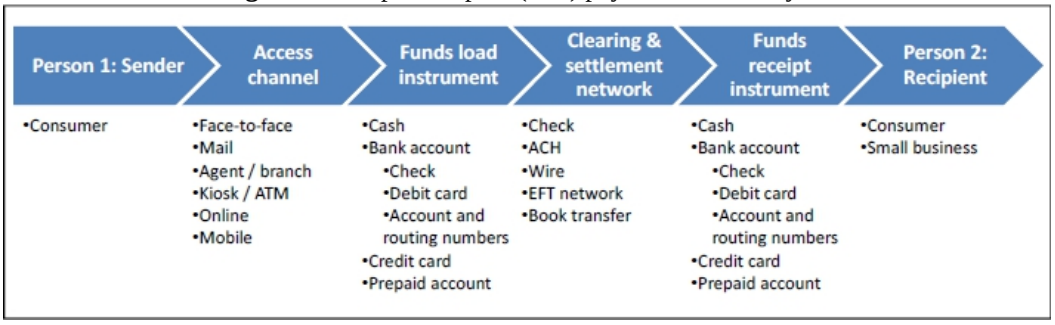
Source: Burelli. et al. (2011). Elaborated by the authors.

In the next two sections, we present a detailed description of each of the market niches of the micropayments industry.

The Transaction Grabbers

In the first niche, we find micro-payment companies playing the role of intermediaries between senders and recipients of money; we will call them the transaction grabbers; mainly they all work like peer-to-peer payments systems, as in Figure 3. Table 1 presents the cost structure of some of the existing electronic payments systems and Table 2 presents the way that these systems normally work. According to InvestingAnswers, peer-to-peer payments systems (P2P) are an online technology that allows customers to transfer funds from their bank accounts and credit cards to another individual's account via the Internet or a mobile phone. We think one shall include as well pre-paid accounts or other sources of funds.

Figure 3: The peer-to-peer (P2P) payment lifetime cycle



Source: Windh, J. (2011). Surveying a rapidly changing landscape.

For example, PayPal introduced their micropayment product worldwide in 2008. PayPal is a Web-based application for the secure transfer of funds between member accounts. There is no application fee for the user, and also there is no cost for sending money through the service, but there is a fee structure for those members who wish to receive money. That fee is still high for products with prices around ¢5-¢10, that is why they release a special micropayment service, and also in July 2011 PayPal bought Zong for $240 million, one of the main reasons was to attract this market on a full scale. Zong allows you to pay for purchases from your mobile phone or computer by adding the payment to your wireless bill. Zong verifies your wireless phone number and account, and clears the payment on your mobile phone bill: there is no credit card number, expiration date, nor billing address to enter [45]. They charge a transaction fee of 5-10% depending on the volume of the sale, without setup or monthly fees.

Table 2. Main characteristics of transaction grabbers

Transaction grabber	**Application or set-up fee**	**Monthly fee**	**Transaction fee charged to the recipient**	**Openness**	**Payment finality**	**Type of currency used**	**Rule of settlement**
Zong	None	None	5-10% transaction fee	O	RT	RM	SP
Payclick (only for Australia and some cities in the U.S.)	Not revealed until applying	Not revealed until applying	Not revealed until applying	O	B	RM	SP
PayPal	None	None	¢5 plus 5% for micropayments (i.e. transactions under $12)	O	B	RM	A
PayNearMe	Around $199*	Around $1,199 (annual)*	• Standard fee of $2.99 for cash payments up to $300*. • $3.99 for payments ranging from $300 to $500*. • $4.99 for payments up to $1,000*	O	RT	RM	SP
Dwolla	None	None	• No fee for transactions up to $10. • ¢0.25 for all transactions above $10	O	RT	RM	SP
Google Checkout	None	None	Based on the value of monthly sales: For less than $3,000: 2.9% + $0.30 per transaction. Between $3,000	O	RT	RM	SP

			and 9,999.99: 2.5% + $0.30 Between $10,000 and $99,999.99:2.2%+$ 0.30 Above $100,000: 1.9%+ $0.30				

* This information does not appear in the official PayNearMe website.

Source: official websites.

Visa launched their own micropayment system in Australia in 2010, which was called Payclick, and it is similar to PayPal´s micropayments product, the system just asks you to fill in your password and the transaction is done, they do not reveal their fees until you apply for the account (this means give information about your business) but they claim to be very competitive. Visa has recently declared their interest in opening Payclick in the U.S. and Europe as well.

Almost all the transaction grabbers share the common characteristic that they do not require the clients to reveal their financial information at the time when the transaction is made, since doing so would be involve more risk and it would also be annoying if the client would have to do this on every purchase for only a small quantity of money.

Virtual Currencies

The second niche is occupied by virtual currencies. Its main use is to buy virtual goods in online games, social networks and massively multiplayer online role-playing game (MMORPG). On the one hand, Facebook credits are an example of virtual goods in online games and social networks (their value as today is 1 credit for 0.10 USD). On the other hand, Linden Dollars in Second Life is an example of virtual currency that works in a MMORPG. The growing mass of online gaming and social networks has facilitated the rapid increase in the global virtual goods market. Players of online games and members of virtual communities are spending more and more on virtual goods to enhance their gaming experience. In 2010, Europeans spent over $1 billion on virtual goods, the Asian market is already worth over $5 billion annually, and Americans will spend over $2 billion by 2011 [3]. Their growth will continue as it is becoming easier and cheaper to be a part of this market.

Some virtual currencies are exchangeable for other virtual currencies and a few for fiat money, you can purchase them by the payments services explained above and/or trade them at web sites like Virwox or First Meta Exchange. Because there are ways to create wealth in these virtual worlds and online games, this opens an interesting area of business to study. For example, players of Entropia Universe (an MMORPG) already exchange real money for a virtual currency. And virtual money they make in the game, through virtual hunting, mining, trading or other activities, can be cashed out into real money. The virtual currency Project Entropia Dollars has a fixed 10-to-1 exchange rate to the U.S. dollar. Credit card companies are aware of this, for example, American Express bought in 2011 a company called Sometrics, which in 2010 did 3.3 trillion units of virtual currency on their platform. You can buy virtual goods such as gold coins or whatever it may be. That acquisition let the company tap into the massively growing space of online gaming and to develop capabilities to manage virtual currencies, a business that is projected to nearly double by 2014 [25].

One should notice two things about virtual worlds: in the first place, they have no measure to control money supply. The balance between goods and money is determined by collective consumption/saving decisions by players. Secondly, there are no interest rates in virtual worlds in general. The absence of interest rates, ceteris paribus, reduces incentive for saving and raises that for consumption. Since many virtual worlds do not have inflation of the general price level, we cannot say in general that consumption is preferred in virtual worlds relative to the real world. Nevertheless, still there should be greater incentive for consumption compared to the case in which there are interest rates [51].

There are other types of virtual currencies that work directly in the global economy. For example, Bitcoin; defined by its creator as a purely peer-to-peer version of electronic cash that allows

online payments to be sent directly from one party to another without going through a financial institution [30]. The main challenge for developing this kind of currency relied on the "double spending" problem. According to [26], [10], Bitcoin´s solution was to ensure that each coin was its own certificate of authenticity. As soon as a transaction takes place, the recipient publishes the transaction to the global Bitcoin network. Now every Bitcoin user has evidence that the coin has been spent, and users will only accept that coin from the new owner. Also, Bitcoin is almost 100% anonymous. "In the Bitcoin system, a new coin is produced whenever a computer can calculate an answer to a difficult problem, and then attaches that answer to a digital record of every transaction of every Bitcoin ever traded" [10]. Anyone is free to create a new coin, within proscribed supply limits, by providing computer power that helps to prove that it was in fact a valid Bitcoin. Bitcoins can also be traded for dollars and they are accepted in different online retail stores an also in a few "bricks and mortar" retail stores and cafés (for the list of the different currency exchange business, and stores that accept Bitcoins, visit Bitcoin Wiki web site). Also its target market is not only digital and virtual goods you can also obtain physical goods in some retail business. In 2011 they were seven million of these "coins" in circulation and the rate of increase —currently 50 coins are added every 10 minutes— will slow each year until the number tops out at 21 million coins around 2025.

Another example is Ven currency: The value of Ven floats against other currencies and the price is based on a basket of currencies, commodities (like gold, silver, brent crude) and carbon futures which intends to make the value of this currency very stable because no single unit has a strong influence relative to the other influences in the basket. Also, the introduction of carbon to the basket is to support and stimulate demand for carbon credits and social impact development, driving offsets for every transaction used with Ven. At the moment $1 is equivalent to 9.35 Ven. Ven trades against other major currencies at floating exchange rates and is mainly used in an online community called Hub Culture a site when members can trade goods and services as well as knowledge. Nevertheless you can also use it in Pavilions (retail places specially developed to accept the currency). According to At the beginning of the present year over $100 million in assets were available for purchase in 130 hubs worldwide using Ven [40]. As opposed to Bitcoin, Ven does not provide anonymity, and is generated centrally (though exchanged).

Nevertheless, almost all of today's existing electronic currencies (with the exception of Bitcoin and Ven) are surrogates of fiat money: they are denominated in fiat currency, and their purchasing power fluctuates with the purchasing power of the denominating currency. Moreover, except for Bitcoin, they are fiat in the sense that there is no backing of these electronic monies, and thus they are not redeemable to the issuers. For example, Avios is a currency that you accumulate for traveling on Iberia airplanes and that you can trade for traveling tickets and some products in partners' stores; one may also transfer Avios to other Iberia clients as gifts or one could buy them, but they are not redeemable in fiat money. The exchange rate between Avios and euros depends on many things. First, the exchange rate is different whether you are purchasing or transferring Avios; second, there are economies of scale since the euros you pay increase less than proportionately to the amount of Avios traded (for example 2,000 Avios are worth €54 and 8,000 Avios represent €164).

On the one hand, since Avios only works for 3 airline groups (Iberia, Vueling, British airways) and a limited retail market, it will not likely become a generally accepted transaction medium: people who are not interested in their offers may not value them at all, and might not want to accept Avios currency.

On the other side of the spectrum, we have the case of the Facebook credits: because Facebook is a most popular company, it is easy to imagine that such a currency would be more generally accepted than others. Until now, Facebook credits could mostly be used to buy virtual goods inside online games and some digital products like movie rentals. Nevertheless, Facebook have started an initiative called Deals that makes users able to purchase a voucher that is redeemable for real goods. According to [19] "Mark Zuckerberg, Facebook's chief executive, said recently that the company may choose to do 'a lot more' with Credits in the future. Over time, the company plans to turn Credits into a system for micropayments that could be open to any application on Facebook, be it a game or perhaps a media company, people with direct knowledge of Facebook's plans said. They spoke anonymously because plans have not been announced publicly".

There are several advantages of this kind of virtual currencies: its value would not fluctuate with the value of fiat currencies, but instead it would depend upon the value of the commodity bundle

backing it and/or maintaining its reputation as an issuer. This type of electronic currency has its similitudes with commodity money it is now the product bundle that serves as the anchor. This new form of electronic money has the potential of being a currency with more stable value than fiat currency [21]. In addition, a global Internet currency would eliminate the need of foreign exchange. This is also why the issuer of such a currency should be a firm that is world-wide recognized, like Facebook (that it has a user base of some 800 million people worldwide).

Hernandez-Verme et al (2004) claimed that three technical elements are necessary for any virtual currency to be accepted by the public: low cost, security, and privacy. In particular, these authors highlight greatly the importance of low costs in micropayment transactions, practically regardless of the payment method utilized. They also point out, nonetheless, that there exist alternative ways of reducing costs; in this regard, they emphasized the importance of the avoidance of expensive intermediaries, such as banks and credit card associations, in this kind of transactions, since they could act as an indivisible sunk cost that may reduce the firms' margins and their profitability within the network. According to [27] p.3 "… about 2.5 billion people in the world do not have access to a bank account", because of this some of them are out of these kinds of markets. Security plays an important role in generating trust is an electronic environment: security becomes a must for electronic payments, where cryptographic security mechanisms, including encryption and digital signature schemes, are often used to provide the desired security for the transactions. Finally, privacy, the third element of the list, has become a much bigger concern in today's information world; so much so, that an ideal virtual currency should provide anonymity or at least a high level of privacy so it can compete against fiat money [21].

Table 3. Main characteristics of virtual currencies

Virtual currency	**Openness**	**Payment finality**	**Type of currency used**	**Rule of settlement**	**Exchange Rate in USD (selling price)**
Bitcoin	O	RT	VC	SP	$10.87 for 1 BTC
Ven	C	RT	VC	SP	$1 is equivalent to 9.35 Ven
Avios	C	RT	VC	SP	Depends on how much Avios you buy. For example 2000 Avios are €54 and 8000 Avios are €164
Project Entropia Dollars	C	RT	RM	SP	1 credit for .10 USD
Linden Dollars	C	RT	RM	SP	280.1 L$/USD
Facebook Credits	C	PP	RM	SP	1 credit for .10 USD

Source: official websites. Elaborated by the authors.

1

Notice from Table 3 that Bitcoin satisfies two of the three characteristics mentioned above: it has low cost and it is anonymous, but it has a bad reputation for its safety and has been victim of speculation, this has caused that its exchange rate fluctuates unpredictably over time. In table 4 we provide an historical review of the exchange rate of Bitcoin. One reason could be that, as according to [38] p. 14 "In the United States and Europe, Bitcoin's meteoric rise was mostly driven by speculators; hardly anyone used the currency to actually pay for goods and services".

Table 4: Historical exchange rate of bitcoin as traded by Mt Gox
(USD per unit of Bitcoin at the closing time of the day)

Date	Exchange rate	Important event
04/25/2010	¢0.3	Bitcoin trade publicly for the first time (1,000 go for 0.3 cents each).
02/10/2011	¢0.98031	Bitcoin receives a write-up on Slash-dot for achieving dollar parity.
04/20/2011	$1.1421	Forbes publishes "Crypto Currency" a profile of bitcoin.
06/01/2011	$9.57	Gawker runs a story about Silk Road, an online bazaar of illicit goods that accepts bitcoins.
06/09/2011	$28.919	Bitcoin reaches its peak value.
06/19/2011	$17.51	Mt. Gox, the largest bitcoin exchange admits its database was compromised and user information leaked.
07/29/2011	$13.49832	Wallet service MyBitcoin. Com becomes inaccessible; six days later, it comes back online with 51% (roughly $250,000) of its bitcoin holdings missing.
11/18/2011	$2.04999	Bitcoin exchange rate falls dramatically.
01/04/2012	$4.8808	Bitcoin exchange rate starts to grow again.
08/12/2012	$ 11.67001	Latest exchange rate.

Sources: Bitcoin Charts and Wallace, B. (2011).

1

Benefits and Disadvantages of Virtual Currencies

In this section, we present a summary of what believe to be some of the pros that an "ideal" virtual currency should have to be widely accepted, together with the cons that it may find along the way. It is crucial to take each of the elements in this list into account for a proper analysis of existing virtual currencies; but it is equally important to consider them when designing the main characteristics of prospective virtual currencies. This part of the paper was mostly based in [1], [15], [38], [47].

The Benefits of Virtual Currencies

Below, we list what we believe are the advantages that an ideal virtual currency shall possess:

- Allows almost anybody to buy goods online without the need of using a credit card or disclosing private information.
- Acts as a substitute currency allowing customers to buy, sell, and trade items without having to use real world money.
- Provides anonymity or privacy to a point.
- Allows users to generate revenues and create profits online, which can then be exchanged for other goods (real and virtual).
- Reduces cost of entry to the market.
- Issuance is decentralized or centralized but only in the case that is from a private issuer that cannot induce inflation (like Ven).
- Distributed middleman or no middleman.
- Faster transfer than banks.
- Always available and instantaneous.
- Ubiquity.
- Good reputation of the issuer.
- Recorded in a public ledger.
- Solves the double-spending problem, encrypted transactions and friendly -fraud immune.

- Safer and better store of value than fiat money.
- Expandable and divisible.
- Deflation/Inflation Hedge. According to [16] "…the potential for fiat currency de-valuation or appreciation in the face of mounting debts and uncontrolled deficit spending has given everyone with significant wealth an interest in finding a liquid, hedge to the big three (dollar, yen, euro). Gold has been the traditional favorite in this spot, but with gold prices soaring and the threat of a bubble looming….the need for alternatives is strong".

The Drawbacks of Virtual Currencies

- Vulnerable to system failures.
- It could be used to pay for "illegal" activities or products, such as money laundering or buying prohibited products or services.
- Its valuation can fluctuate in some cases.
- Difficulty for making futures contracts or floating against fiat currencies (with the exception of Ven).
- Risk of Unknown Technical Flaws.
- Not accepted for paying taxes or as bank reserves.
- Decentralization is both a curse and a blessing, since there is no valuation guarantee. Since there is no central authority governing, no one can guarantee its minimum valuation. If a large group of merchants decide to "dump" virtual currency and leave the system, its valuation will decrease greatly which will immensely hurt users who have a large amount of wealth invested in this currency [1].

Notice that most of the disadvantages listed above are not particular of virtual currencies: historically, fiat currencies have also been used for money laundering and the financing of illegal activities –such as illegal drug dealings; but, because of their lack of intrinsic value, fiat currencies are prone as well to speculation, and particularly to the kind of self-fulfilling attacks that make their value fluctuate without any noticeable alteration in the fundamental of the economy; finally, we must also keep in mind that both inflation or hyperinflation crises might hinder severely the acceptability of a currency and the credibility of the government in general, and of monetary authorities in particular.

Review of the Previous Literature

Two of the most important papers about the potential effects of private money are Williamson (1999) and Temzelides and Williamson (2001). They both used a random matching model of the foundations of money for economies populated with infinitely lived agents. Among their results and recommendations, they emphasized that transaction costs, informational frictions, and related factors are the main causes explaining the discounts observed when trading different private currencies (most of the virtual currencies can be seen as private electronic currencies). The private money they study is a surrogate of fiat money that takes the form of a medium of exchange issued by financial intermediaries. However, according to Hernandez-Verme et al (2004):

> … However, as argued convincingly by Schreft (2001), even though the models offered by Williamson (1999) and Temzelides et al (2001) are a good representation of how the financial system worked during the 19th century, they do not provide a clear insight on how a modern system of private electronic money would work and how the necessary network shall function. Moreover, these models are clearly not designed to address the problems faced in the micro-product market.
>
> *Hernandez-Verme et al (2004), p. 4*

Nevertheless Temzelides et al (2001) did address the importance of restudy private money systems because there are fewer government impediments to private money issue and advances in information technology now permit private money systems where private liabilities are electronically transferred rather than by way of a physical medium of exchange thus it reduces the cost of operating a private money.

Williamson (2004) explored the implications of private money issue for the effects of monetary policy, for optimal policy, and for the role of fiat money. He uses a locational model and finds that when private money issue is permitted it changes dramatically the nature of optimal monetary policy. With private money, fiat currency is no longer used in transactions involving goods,

but currency and central bank reserves play an important part in the clearing and settlement of private money returned for redemption, because private money has the advantage of being "elastic," in that its quantity can respond to unanticipated shocks in ways that the stock of fiat currency cannot. In this model private money is redeemable in outside money instead of commodity money (either gold or silver), which was a common feature of historically observed private money systems.

Schmitz (2005) gives a general critique to some of models of electronic and private money and concludes that the method of institutional analysis is the appropriate conceptual framework to investigate the impact of the diffusion of electronic money on the efficacy of monetary policy and the future of central banking; and that existing models do not particularly take this into account. He states that the analysis of recent and long run institutional change in payments systems demonstrates that its main drivers are politico-economic factors and demand of commercial banks and final customers rather than technological innovations. Although he does not propose a model his contribution is important because he raises the question of how much weight does technological innovations have in monetary policy evolution.

Micropayments systems are not a simple market to study or develop since most of them exhibit two-sided network effects. According to Rochet et al (2004) p. 2 "Two-sided (or more generally multi-sided) markets are roughly defined as markets in which one or several platforms enable interactions between end-users, and try to get the two (or multiple) sides "on board" by appropriately charging each side". See-To et al (2007) found that the underlying dynamics of these two-sided markets are not very well understood and this may lead to the mixed results of various micro-payment initiatives. They concluded that a "survival mass" of merchants and consumers is required for the market to exist and a "critical mass" for the acceptance levels to take off and remain stable. The survival mass is completely determined by the normalized cost of adoption. The critical mass is higher than the survival mass due to two-sided network effects. Merchants will not adopt the system unless there are enough consumers who use the system. At the same time, consumers will not consider the system until there are enough adopters on the merchant side. Thus, the value of a micro-payment system to a consumer increases as more merchants adopt the system. Similarly, the value of the system to a merchant will augment as more consumers are willing to transact with the merchant using the new electronic means. They use anecdotal evidence to reinforce their conclusions, they compare the failure of initiatives like Mondex and Visa Cash with the success of the Octopus Card in Hong Kong, the latter was originally introduced to the public in 1997, targeting a public transportation market with 10 million passenger journeys per day. Octopus card system has been growing almost ever since its appearance to support non-transportation micro-payment transactions too because it quickly gained a critical mass. We need to take to account that this analysis was made when new technologies that make transaction costs cheaper (like mobile payments) weren't develop as today, so that could be another cause of the failure of the first initiatives like the Visa example mentioned above.

Edward Castronova (2001) is the pioneer in analyzing economies of virtual worlds in MMORPGs from an academic perspective. He analyzed the economic activity in the virtual world "Everquest". In Castronova (2003) he proposes a model with a utility function that differs substantially from ordinary ones, but what an economic agent does in the model is not so different. According to Yamaguchi (2004) in the model of Castronova (2003), avatars are like goods, and an economic agent purchases the avatars by spending time instead of money. The utility maximization through allocation of time to avatars is in essence the same as that through allocation of money to goods to consume. In Castronova (2008) they show the results of an experiment of massively multiplayer online gaming called "Arden: The World of Shakespeare". They documented that people in fantasy games act in an economically normal way, purchasing less of a product when prices are higher, all other things being equal. This finding may open the way for future study in synthetic worlds of real economic behavior, he gives a very good insight of how virtual worlds can be studied from on the same basis of the "real" economy. Another paper of virtual currencies is the one of Irwin et al (2005) he proposed a self-recharging virtual currency model as a common medium of exchange in Cereus, a computational market for community resource sharing. Self-recharging means that the purchasing power of spent credits is restored to the consumer's budget after some delaying effect, the credits recharge automatically, ensuring a stable budget but bounding the opportunity for hoarding. The purpose of self-recharging currency is to eliminate reliance on fragile mechanisms to recycle

currency through the economy. A community admits members based on their identities; in return for the benefits of membership, members submit to accepted standards of behavior within the community. Community resource sharing in Cereus is accountable: actions taken with a member's identity are non-repudiable, and members are subject to auditing and sanctions for misbehavior, including forfeiture of currency or ejection from the community. Similar to Castronova (2008) he concludes that alternative currency models can help to harness market principles as a technology for flexible, robust distributed resource allocation, enabling market-inspired systems that are simpler, more stable, more predictable, and/or more controllable than real-world economies.

The Future of Monetary Policy

Electronification and the use of alternative means of payment has been growingly at tremendous speed over the years changing the incentives and costs structure underlying particular institutional arrangements in payment systems. Thus, the ratio of central bank money to total value of payments has decreased considerably. This development gives rise to concerns about the future role of money and the central bank. Although we are still far from living in a cashless society, the role of monetary policy is in the verge of changing dramatically, especially because of two elements: a) the falling use of cash as a form of payment and b) the changes of regulation.

a) The falling use of cash as a form of payment.

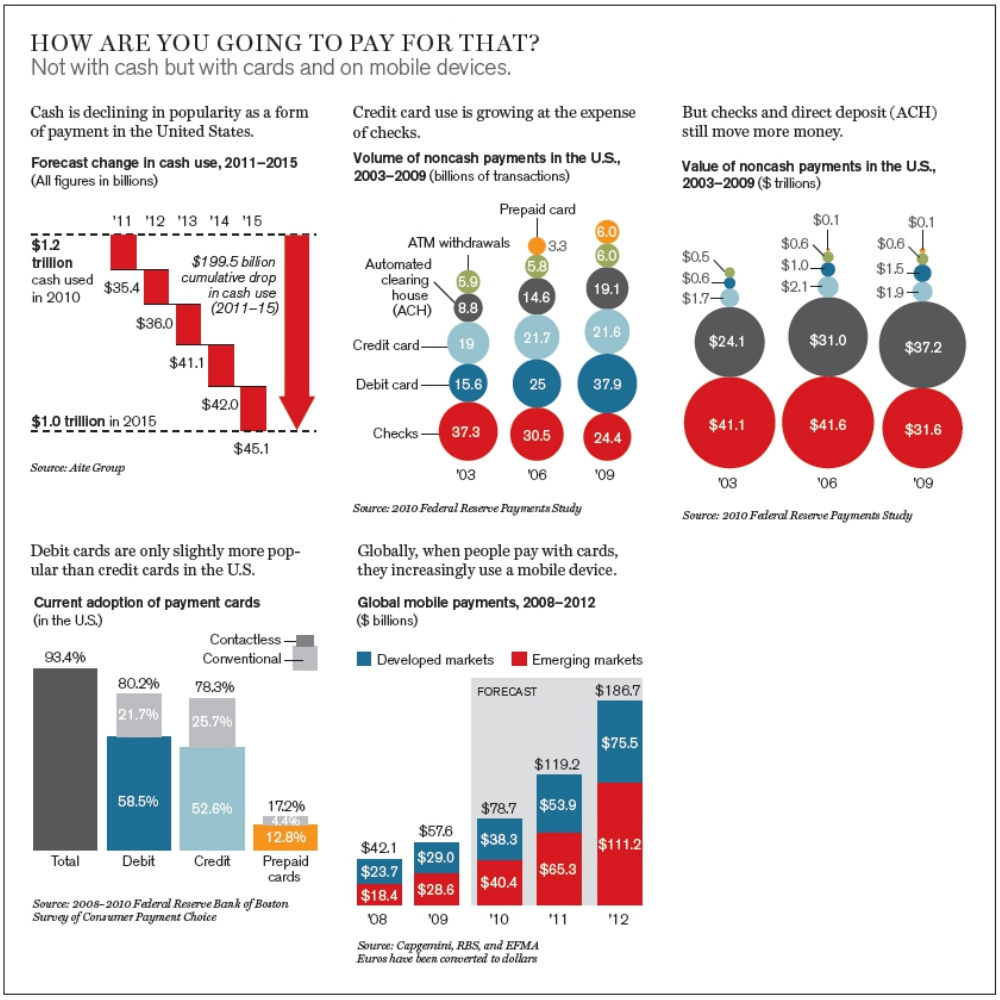
   The use of cash as a payment method has been clearly decreasing over the years and it has been substituted by cards, mobile devices and alternative means of payment like the ones described in this paper. According to [37] p. 63 "The costs of handling cash are high compared to that of electronic money. Printing, distributing and controlling cash are estimated to cost approximately for a developed economy 0.75% of annual GDP and an emerging economy 1% to 2%. Social savings of using electronic micro-payment means over cash are substantial."

   The role to be played by the central bank in the near future will be as important as it is today, and will remain the same for quite a while, almost all of new payment instruments in the retail payment market (e.g. electronic bill presentment and payment; person-to-person payments via PayPal; stored value prepaid cards; phone-based payments) are linked to the banking system and eventually settle in central bank money [35]. The demand for virtual currencies that are not denominated in fiat currencies is still low, but is increasing at such a pace that is important to improve the way that we study them. The existence of private monies is hardly new, but technological innovations could lead the way to a world where private monies have an important role in the world economy.

b) Regulation

   Money and banking are highly regulated improvements on technology in the payment systems so they have a slow effect in the change of them policies. According to [27] p. 3 "… the intricacies of regulation make it difficult for banks to be truly customer-centric".

Figure 4: The declining use of cash in the U.S.



Source: Pontin, J. (2011).

According to [35], in recent history central banks have demonstrated their determination and their political ability to maintain control of the monetary system in the face of institutional change in the payments system and to actively shape. They have a large range of instruments at their discretion to react to but also to influence institutional change in the economy-wide payment system, they can adapt the instruments of monetary policy implementation and their own payment systems policies to cope with institutional change in the payments system. Changes in the reserve-maintenance system of the generally accepted medium of exchange (GAME) are of particular relevance in this respect (i.e. the averaging of minimum reserve requirements, the averaging period, its relation to the interval of central banks' refinancing operations and the potential employment of minimum reserves for settlement purposes).

Actually, you can only pay your taxes with fiat money, and virtual currencies do not allow you to create a positive return by saving or lending (other than to your friends, like at RipplePay) or making futures contracts at a large scale, and, thus, fiat money will stay around the map. Nevertheless, is important to improve the way we study this markets for developing the appropriate banking policies. One example on how far we still far from adapting to this alternative means of payment is the fact that almost all virtual currencies are not taxable. The profits you make online can be converted into real monies without tax deductions.

Conclusion

The analysis carried out in this paper attempts to provide readers with an important insight of the list of tasks that are ahead of academic researchers in furthering their study of both virtual currencies and the micropayment systems. It intends to reach a more unified way to use the definition of virtual currencies, micropayments and virtual and digital goods.

Modern transaction grabbers have facilitated the emergence of virtual currencies by lowering costs of entry to this new market and making this alternative means of payment easier to manage. Virtual currencies are still in an early stage of development; as of now, they mostly work in the micropayments market for virtual goods. But the impressive growth of this market's size and scope, like in the case of Bitcoin and Ven, foretells that sooner or later they will have a crucial role in the design and implementation of monetary policy and on the future discussions of the political and economic agenda.

The potential benefits that these monies may provide are something we cannot ignore, since although they are not perfect, many of their defects are also similar to the ones presented in fiat money. A smaller role of the central bank should not be something to be "afraid" of as in [11]:

> Time and again, banks have been willing to increase their portfolio of mortgage loans in response to higher real estate prices. These higher real estate prices, however, have often been caused by excessive money creation. This has often led to bank crises and collapses. In the absence of a central bank this feature of private banking could go on unchecked".
>
> *Costa et al (2001), p. 9*

It is plausible that the generalization of alternative ways of payment could also prevent central banks on acting in an irresponsible way, for political purposes.

We must point out that there is a significant dearth of academic studies related to these emergent currencies. Among them, the work by Schmitz (2008) presents an interesting proposal for studying the effects or the arising of these currencies on monetary policy, from an institutional perspective. Also, the works by Castronova provide a helpful way to study the way that virtual currencies are used inside virtual worlds and online gaming.

It seems crucial that academics and banks reconcile the benefits of a world with both fiat and virtual currencies and try to find ways to integrate physical cash into the electronic world; the former should start changing some aspects in the modeling of monetary policy, and the latter must change their former structure in a way that allows people to take full advantage of this novel means of payment.

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