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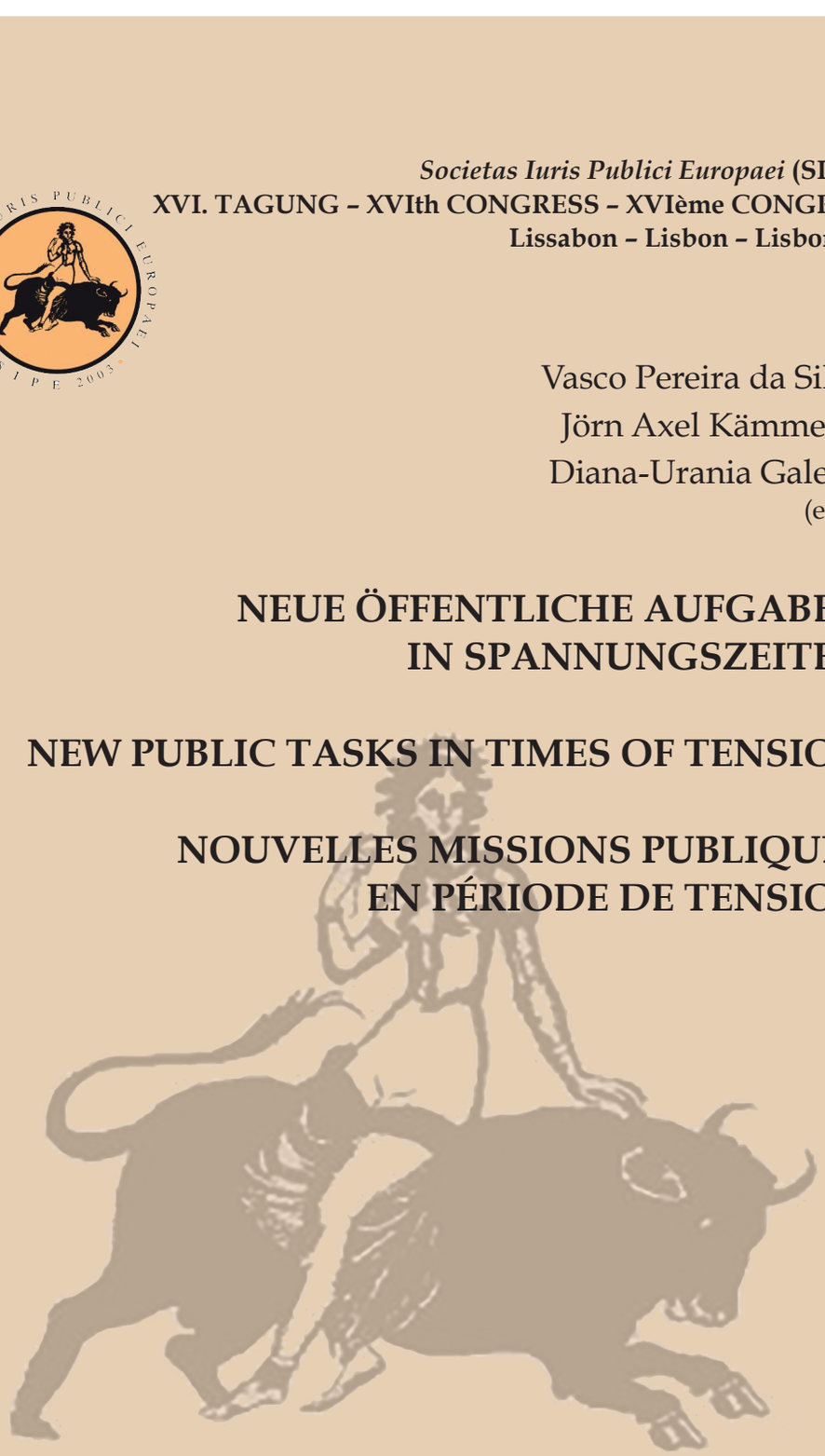
Vasco Pereira da Silva
Jörn Axel Kämmerer
Diana-Urania Galetta
(eds.)

NEUE ÖFFENTLICHE AUFGABEN IN SPANNUNGSZEITEN

NEW PUBLIC TASKS IN TIMES OF TENSION

NOUVELLES MISSIONS PUBLIQUES EN PÉRIODE DE TENSION



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DIGITAL CURRENCIES. CHALLENGES AND OPPORTUNITIES FOR PUBLIC TASKS

Miguel J. Arjona Sánchez[*]

Money is an essential tool for public tasks. How much to spend, where to spend it and how to manage it reflect the concerns of society, which is why it has been regulated by public law. However, its material medium has limited its possibilities. The use of metal (coins) and paper (banknotes) made it easy to make personal payments, but not at a distance. This limitation has been overcome by electronics, with the invention of so-called plastic money and electronic money (which is really just a means of payment). However, the process of digitalisation is opening up a new, disruptive stage: cryptocurrencies make it possible to bypass financial intermediaries, but their nature does not go beyond that of financial assets, whereas central bank digital currencies are real money that can overcome their limitations thanks to their intelligent nature. The potential of this digital money will depend on the model chosen by the public authorities, who will decide what role the central bank and financial intermediaries will play.

1. Money and Public Tasks

That there is a link between the use of money and public functions is self-evident. However, the way in which this link is developed is not a peaceful issue. The understanding of money tends to become ideological. For example, there are those who speak of public money management, while others prefer to speak of public money management, denying the existence of public money. In any case, what is certain is that the decisions that public authorities make about money – how much to spend, where to spend it and how to manage it – are fundamental to the development of public tasks. These decisions reflect society's concerns and aspirations, its priorities and needs, its promises and disappointments.

[*] Assistant Professor Dr. Miguel J. Arjona Sánchez, University of Granada, Department of Constitutional Law.

There is no doubt that the management of public money has an impact on the development of the country; and this is determined by rules that govern the actions of both politicians and civil servants.[1]

All these issues have been central to public law. The way the budgetary process evolved was fundamental to the constitutional state. The motto of the revolution in the American colonies, "no taxation without representation", is a good example of this.

But these issues are not a thing of the past. None of these issues is alien to the current political-constitutional debate. National constitutions are full of mandates for public authorities, reflecting concerns about what their priorities should be. The way in which public authorities manage money has been the subject of recent constitutional reforms in several European countries, constitutionalising the deficit and debt rules established by the Economic and Monetary Union.

In the context of these changes, we should highlight the process of digitalisation. One of the reasons for the redefinition of the European Union's monetary strategy was the impact of digitalisation. In the strictly monetary field, digitalisation has led to the emergence of cryptocurrencies and a series of projects for the digitalisation of money. It is true that, from a historical perspective, the transformations of money are nothing new, since throughout history money has evolved by adapting to technological and ideological changes in society; however, the digitalisation of money is worrying because it raises questions about the speed and depth of the social changes we are experiencing.

2. *The Digitalisation of Money*

Money is a complex instrument, which is why we need to start with a clarification provided by John Maynard Keynes. The British economist considered money as a measure of value but made it clear that its value is not defined by the substance of which it is constituted: "and is like confusing a theatre ticket with the performance".[2] Indeed, money is a measure of value which may take different forms. Nowadays, every currency

[1] David Alexander GOOD, The Politics of Public Money, Second edition, 2014, p. 3.

[2] John Maynard KEYNES, The Collected Writings of John Maynard Keynes – Volume XI: Economic Articles and Correspondence: Academic, Edited by Donald MOGGRIDGE (ed), 1983, p. 402.

takes the form of coins or notes, but the metal or paper of which they are made does not change their nature: a dollar is a dollar whether it takes the form of a coin or a note, just as fifty euros are fifty euros whether they take the form of a coin or a note.

Although the reason why money took the form of coins or banknotes is disputed, there is no doubt that it is easy to carry (a simple purse or wallet suffices), which makes it easy to make payments or transactions in person. But it is obvious that their form has some limitations, especially when payments or transactions have to be made remotely. This is probably one of the reasons for the development of the financial industry. Banks are financial intermediaries. As custodians of their customers' money, they enable secure remote payments and transactions. This activity, one of the simplest in the banking system, has also been affected by technological changes.

2.1. Electronics and Money

The information and communication technology revolution began in the second half of the 20th century with the development of electronics. Electronics modernised the financial world, facilitating more convenient and faster transactions. One of these innovations took place in the monetary field, with the emergence of debit and credit cards (plastic money), which are still very popular.

2.1.1. Plastic Money

In reality, this plastic money is nothing more than a means of payment that was developed by the financial industry. Expenditures made with a card are debited from the cardholder's current account, providing electronic access to bank liabilities. Unlike payments with coins or banknotes, these payments require the authorisation of the issuing bank and the identification of the cardholder or owner.[3] The use of a card is an order (carried out electronically) by which the cardholder instructs the bank to make a payment and simultaneously authorises the debit of his/

[3] Aurora ALEJANO / Juan María PEÑALOSA, Implicaciones del desarrollo del dinero electrónico para la actuación de los bancos centrales, in: *Boletín del Banco de España*, March (1998), p. 55 (55).

her account. Thus, the use of a card eliminates the inconvenience of cash and allows remote access to the funds deposited at the bank. In fact, this is the usual way we interact with our bank, not only when we go to pay in commercial establishments, but also when we use telephone or online banking.

2.1.2. Electronic Money

Plastic money was the first step of electronics in finance; the next step was electronic money. In electronic money, cards have been replaced by an e-wallet or a multi-purpose prepaid card and software or network money. The use of electronic money does not require authorisation from the bank, as the expenditure is charged to the balance available in the device itself (the electronic purse or the multi-purpose prepaid card and the software-based money or network money). This requires a prior operation: the user recharges the electronic device concerned. This recharging process may e.g. be carried out against a bank deposit, so that the balance of the latter is reduced by the amount transferred to the electronic money device.[4] In both cases, cards and e-money, the transactions are carried out via telecommunications and computer networks, but the difference is that in the case of e-money there has been a pre-loading, i.e. the money has been previously stored on the hard disk of the payer's computer.[5]

The International Monetary Fund's definition of electronic money captures this functioning. For the IMF, electronic money is a payment instrument in which a monetary value is stored on a technical medium held by a person.[6]

The same approach is also followed by the Committee on Payments and Securities Settlement (CPSS) of the Bank for International Settlements. The Bank of Basel defines e-money as monetary value represented by a claim on issuers, which is stored on an electronic device, such as a chip card or hard disk in personal computers or servers or other devices such as mobile phones. It is issued upon receipt of funds of an amount

[4] Ibid., p. 55 (56).

[5] Ibid., p. 55 (56).

[6] Enrique García Dubón, Dinero Electrónico, https://www.secmca.org/wp-content/uploads/2019/02/articulo60ENE2013.pdf, last accessed 3 August 2022, p. 1.

not less than the monetary value received and accepted as a means of payment, by undertakings other than the issuer.[7]

The European Union has also defined electronic money. The Directive 2009/110/EC of the European Parliament and of the Council of 16 September 2009 on the taking up, pursuit and prudential supervision of the business of electronic money institutions amending Directives 2005/60/EC and 2006/48/EC and repealing Directive 2000/46/EC (OJ L 267, 10.10.2009, p. 7/17) states in Article 2 that "'electronic money' means electronically, including magnetically, stored monetary value as represented by a claim on the issuer which is issued on receipt of funds for the purpose of making payment transactions as defined in point 5 of Article 4 of Directive 2007/64/EC, and which is accepted by a natural or legal person other than the electronic money issuer'".

The use of plastic and e-money is therefore a modernisation of the traditional relationship between a bank account holder, his bank and his payments. (In the case of cards, payments are debited from the cardholder's current account; in the case of e-wallets, for example, they are debited from a bank deposit.) In both cases, transactions always require the intervention of a third party: Payment Service Providers (also called Merchant Service Providers); third party companies that help business owners accept a wide range of online payment methods, such as online banking, credit cards, debit cards, e-wallets, cash cards and more.

As both are means of payment, their use requires a reduction in the corresponding bank balance expressed in the relevant currency; unlike the use of coins or banknotes, which are money in their own right.

2.2. Digital Money

In my mother tongue, Spanish, the dictionary defines digital as "a device or system: that creates, represents, transports or stores information by combining bits" or "that is created or transmitted by digital means".[8] According to the same dictionary, a bit is a "unit of measurement of the quantity of information, equivalent to the choice between two equally

[7] Bank for international settlements, A Glossary of Terms Used in Payments and Settlement Systems, https://www.bis.org/cpmi/glossary_030301.pdf, last accessed 24 December 2023, p. 22.

[8] Diccionario de la Real Academia de la Lengua Española, Digital, https://dle.rae.es/digital, last accessed 24 December 2023.

probable possibilities".[9] On the basis of these definitions, digital currency is money that is created, represented, transported, stored, realised or transmitted as bits, i.e. as pieces of information. However, the meaning is so broad that it does not explain much. In fact, electronics can be digital in the sense that there is analogue electronics (based on electrical impulses) and digital electronics.

The difference is not in the nature of this money. It is simply that this money has overcome the limitations of the metal that coins are made of, or the paper that banknotes are made of. Digital money is money in the same way as coins and banknotes, but in digital form.

Like cash, digital money can be used to make local payments, even without an internet connection, but it can also be used to make electronic payments by accessing our cards or bank accounts.[10] Instead of metal or paper, digital money requires a digital wallet created by the government or authorised private entities. It may even be directly linked to the central bank. This depends on the decision of the relevant authorities in defining such a digital currency.

In the case of the euro, for example, the so-called offline solution will follow a peer-to-peer validation model, where individuals will be able to make and receive payments in physical proximity without the need to involve a PSP in the transaction (a phone or smartwatch will suffice). The payment will be settled locally (between the two devices), with no connection to third parties for validation or registration.[11] In this chaos, the logic is that of traditional payments with coins or banknotes.

Unlike e-money, when a payment is made with digital money, it does not have to be debited from a current account or other form of monetary deposit. It does not reduce the balance of the current account or financial instrument previously debited, and it does not require the assistance of a third party intermediary (payment service provider, also known as merchant service provider), since the transactions are settled directly be-

[9] Diccionario de la Real Academia de la Lengua Española, Bit, https://dle.rae.es/bit, last accessed 24 December 2023.

[10] European Central Bank, A stocktake on the digital euro. Summary report on the investigation phase and outlook on the next phase, https://www.ecb.europa.eu/paym/digital_euro/investigation/profuse/shared/files/dedocs/ecb.dedocs231018.en.pdf, last accessed 24 December 2023, p. 8.

[11] Ibid.

tween the two devices.[12] The money received can even be kept in the digital wallet, although the amount is likely to be limited. As in the case of coins or banknotes, it will also be possible to carry out e-money transactions, which will allow the digital wallet to be topped up with digital euros from our bank.[13]

The mission of digital money is therefore to overcome the limitations of cash or paper money. It allows access to digital payments even without an internet connection, bank account or cards.[14]

But digital technology has had an impact not only on money, but also on finance. Electronic money institutions have given way to various financial technology instruments known as fintech. Although the term covers a wide range of technologies, it is worth highlighting the emergence of cryptocurrencies, which use encryption technologies and allow financial transactions to take place without intermediaries. Some have therefore considered them to be a form of digital money.

3. Private Cryptocurrencies

The emergence of cryptocurrencies is another innovation brought about by digitalisation. The proliferation of cryptocurrencies has been very rapid and there are currently more than 9,500 different types.[15] However, their capitalisation is very uneven, with the leading cryptocurrency (bitcoin) accounting for 80% of the total, followed by Ethereum, which accounts for less than 10% of the total.[16]

The name cryptocurrency comes from the Greek word "kriptós" and the word "currency".[17] "Kriptós" means hidden or concealed and is a

[12] Ibid., p. 13.

[13] Ibid., p. 8.

[14] Ibid., p. 8.

[15] It even increases to 19,000 if cryptocurrencies that are not active are included. Arjun KHARPAL, Crypto firms say thousands of digital currencies will collapse, compare market to early dotcom days, https://www.cnbc.com/2022/06/03/crypto-firms-say-thousands-of-digital-currencies-will-collapse.html, last accessed 24 December 2023.

[16] On the capitalisation of bitcoin and its evolution, see: Alexey MIKHAYLOV, Cryptocurrency Market Analysis from the Open Innovation Perspective, in: *Journal of Open Innovation: Technology, Market, and Complexity* 6.197 (2020), p. 1 (9-10).

[17] Merriam-Webster dictionary defines " cryptocurrency " as: "any form of currency that only exists digitally, that usually has no central issuing or regulating authority but instead uses a decentralized system to record transactions and manage the issuance of

term related to "cryptanalysis" and "cryptology". The first word means "the theory of solving cryptograms or cryptographic systems"[18] and the second "the scientific study of cryptography and cryptanalysis".[19] Thanks to the use of cryptography, the computer systems that give shape to this money allow electronic monetary transactions to be accounted for without the need for intermediaries. Safe from manipulation, the system makes it possible to transfer money without the use of bank accounts, which, supported by financial institutions, can only operate through central banks, thus becoming an alternative to the conventional financial system, which operates around the central bank.[20] In fact, cryptocurrencies propose an alternative financial system by generating capital that is not denominated in national currencies.

The invention of a new computer technology called "blockchain", capable of linking all the users of a system in an encrypted form, made the birth of cryptocurrencies possible.[21] Presented in an academic article, signed under the pseudonym of Satoshi Nakamoto, entitled "A peer to peer electronic cash system", this invention created the first cryptocurrency: bitcoin.

Bitcoin is a cryptocurrency generated by computers through a process called "mining", which consists of solving complex mathematical problems called algorithms. The solution of each algorithm generates a

new units, and that relies on cryptography to prevent counterfeiting and fraudulent transactions", MERRIAM-WEBSTER DICTIONARY, Cryptocurrency, https://www.merriam-webster.com/dictionary/cryptocurrency, last accessed 24 December 2023. The Real Academia de la Lengua Española defines "cryptocurrency" as: "Virtual currency managed by a network of decentralised computers with an encryption system to secure transactions between users"; in addition, the dictionary shows us the two particles of which the word is composed: crypto and currency, a calque of the English "cryptocurrency", DICCIONARIO DE LA REAL ACADEMIA DE LA LENGUA ESPAÑOLA, Criptomoneda, https://dle.rae.es/criptomoneda, last accessed 24 December 2023.

[18] "The theory of solving cryptograms or cryptographic systems: the art of devising methods for cryptanalysis", "the theory of solving cryptograms or cryptographic systems: the art of devising methods for cryptanalysis". MERRIAM-WEBSTER DICTIONARY, Cryptanalysis, https://www.merriam-webster.com/dictionary/cryptanalysis, last accessed 24 December 2023.

[19] "The scientific study of cryptography and cryptanalysis", MERRIAM-WEBSTER DICTIONARY, Cryptocurrency, https://www.merriam-webster.com/dictionary/cryptology, last accessed 24 December 2023.

[20] Satoshi NAKAMOTO, Bitcoin: A Peer-to-Peer Electronic Cash System, in: *Decentralized Business Review*, 2008, p. 1.

[21] Ibid., p. 2.

new bitcoin.[22] Its key feature is encryption. Encryption is crucial to the system as a whole, as it eliminates the need for an intermediary to make payments. Each user of the system is a node that will be able to carry out bitcoin transactions without intermediaries, i.e. without using financial institutions. Each node becomes a trustee of the transactions through the interrelationship between the nodes created by the blockchain.[23]

3.1. Non-Cash Assets

The absence of an intermediary explains why cryptocurrencies are not a simple means of payment and have a monetary appearance, but are they digital money?

The absence of a legal definition of money does not make the answer easy, but case law provides some key points. Advocate General Giovanni Pitruzzella stated: "In economic theory, a functional definition of money – understood in the more general sense of 'money' or 'Geld' – tends to be used which, according to a concept dating back to Aristotle, reveals the three functions it serves, namely: (i) a unit of account; (ii) a means of payment (or exchange); and (iii) a store of value".[24]

According to the Advocate General, there are three properties that a currency must have: it must be a means of payment or generalised exchange; it must be a unit of account, i.e. it must serve as a reference for the magnitudes of the prices of goods and services; and it must be a store of value, i.e. it must serve as a means of saving for individuals.

Let us start with the first characteristic, i.e. whether cryptocurrencies are a widespread means of payment or exchange. It's impossible to shop in cryptocurrency, and that's unlikely to change in the short to medium term.[25]

No cryptocurrency is a unit of account, i.e. it is not used to mea-

[22] Jérémie Cohen-Setton, Understanding the mechanics and economics of Bitcoins, https://www.bruegel.org/blog-post/blogs-review-understanding-mechanics-and-economics-bitcoins, last accessed 24 December 2023.

[23] Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System, in: *Decentralized Business Review*, 2008, p. 2-7.

[24] Opinion of Advocate General Pitruzzella of 29 September 2020 – Joined Cases C-422/19 and C-423/19, *Johannes Dietrich and Norbert Häring./.Hessischer Rundfunk*, ECLI:EU:C:2020:756, para. 77.

[25] David Yermarck, Is Bitcoin a Real Currency? An Economic Appraisal, in: David Lee Kuo Chuen et al. (ed.), Handbook of Digital Currency, 2015, p. 31 (36-38).

sure prices. On the contrary, the value of cryptocurrencies is expressed in terms of their price in conventional currencies such as dollars, euros or yen. This is because their value fluctuates enormously, making it impossible for it to become a common means of payment. The explanation is simple: cryptocurrencies are highly volatile, which leads to huge and rapid price fluctuations.[26]

In contrast, cryptocurrencies are an effective store of value, i.e. a means of saving or investing, due to their rising value. In fact, it is precisely the rise in the price of cryptocurrencies relative to conventional currencies that has turned them into a way of multiplying savings, even though they do not pay dividends like bonds or shares. Cryptocurrencies are therefore assets, albeit highly volatile ones.[27]

Indeed, the true nature of cryptocurrencies, and bitcoin in particular, has been reinforced by this last characteristic. Statistics show that 73 per cent of bitcoins are held in dormant accounts, making them less likely to fulfil the first two characteristics of real money.

If cryptocurrencies are not real currencies because they are not able to fulfil the properties they are supposed to have, what is their legal nature[28]?

The way they work shows that they are a financial asset and a means of payment (which is not widespread), but they are not real money. They are very unique financial assets that do not use the traditional financial system and do not express their capital in real currencies, although they are priced in these currencies, which determines their true value.

One of the first countries to regulate these assets was Brazil. Despite initial rumours that the South American giant would consider them legal tender,[29] Law No. 2303/15 was only intended to regulate "virtual assets" and virtual financial service providers, thereby increasing investor protection. In the end, they were approved as virtual assets by "Lei nº 14.478, de 21 de dezembro de 2022".

[26] Ibid., p. 38-39.

[27] Ibid., p. 39-42.

[28] In favour of its consideration as a currency, see: Peter K. Hazletta / William J. Luther, Is bitcoin money? And what that means, in: *The Quarterly Review of Economics and Finance* 77 (2020), p. 144.

[29] Cristian Rus, Brasil se suma a la ola del Bitcoin: prepara un proyecto de ley para que sea moneda de curso legal, https://www.xataka.com/criptomonedas/brasil-se-suma-a-ola-bitcoin-prepara-proyecto-ley-sea-moneda-curso-legal, last accessed 28 August 2022.

The European Union has also taken this approach. The EU Regulation on markets in crypto-assets – also known as the Markets in Crypto-assets Act (MiCA) – was adopted in June 2023 and will come into force gradually until December 2024. The Regulation on markets in crypto-assets and amending Regulations (EU) No 1093/2010 and (EU) No 1095/2010 and Directives 2013/36/EU and (EU) 2019/1937 establishes harmonised rules for crypto-assets at EU level, thereby providing legal certainty for crypto-assets not covered by existing EU legislation.

This regulation defines crypto-assets as digital representations of values or rights that can be stored and transferred electronically using digital ledger technology (DLT). This regulation is part of a regulation on financial instruments in crypto-asset form. The legislation regulates the issuance and trading of crypto-assets as well as the management of the underlying assets.[30]

There are, however, some exceptions. In El Salvador, bitcoin has been legal tender since the entry into force of Legislative Decree No. 57 of 8 June 2021.[31] The fall in the price of this cryptocurrency has raised questions about this measure, but the government continues to maintain that it is confident that its value will recover.[32]

3.2. Inflationary, Polluting and Criminal?

3.2.1. Inflationary?

The reason cryptocurrencies have proven to be a successful financial asset, despite paying no dividends, is their scarcity. These cryptocurrencies were designed with a nostalgia for the fixed exchange rate monetary system, which was considered more stable. Following this philosophy, most of them chose to limit the number of coins by setting a maximum

[30] See the briefing of The European Parliament. Issam Hallak / Rasmus Salén, Non-EU countries' regulations on crypto-assets and their potential implications for the EU, https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/753930/EPRS_BRI(2023)753930_EN.pdf, last accessed 24 December 2023, p. 2.

[31] Official Gazette No. 110, Volume No. 431 of 9 June 2021.

[32] Lyllah Ledesma, El Salvador Remains in the Red on Bitcoin Holdings, But Losses Are Narrowing, https://www.coindesk.com/markets/2023/11/15/el-salvador-remains-in-the-red-on-bitcoin-holdings-but-losses-are-narrowing/, last accessed 24 December 2023.

number of coins which are "minable". In the case of bitcoin, for example, this number has been set at 21 million. After that, it should no longer be possible to produce new bitcoins.[33] Until the last mining takes place, which according to some estimates should be around 2040, it will be increasingly expensive to solve the algorithms.[34]

Bitcoin attracted great interest and success when it was launched in 2008 in the midst of the financial crisis. The new technology was seen as an alternative to the traditional financial system, which was suffering from public distrust as a result of the crisis. In fact, many other cryptocurrencies have replicated blockchain technology.[35]

The promise of scarcity, which is repeated in most cryptocurrencies, has helped them to be seen as a safe asset for their users, as they tend to increase in value as long as there is an audience interested in them. However, what has made them a store of value has also made them a risk, as they are a source of deflation for the economy.[36] The deflationary process is simple: if a cryptocurrency is limited in number, and as long as there is a public interested in it, its value will increase. As the quantity of goods and services in a society tends to increase, their value will constantly rise.

This phenomenon is disastrous for both consumers and producers. The former because they are no longer interested in buying goods and services, given that money increases in value in the short term, the tendency is to spend it as late as possible; and the latter because they are left without selling their goods or services. This situation only benefits the debt holders, albeit temporarily, because there will come a time when there is no money to pay them back.[37] A study of the graph of bitcoin

[33] María Nieves Pacheco Jiménez, Criptodivisas: Del bitcoin al MUFG. El potencial de la tecnología blockchain, in: *Revista CESCO de Derecho de Consumo* 19 (2016), p. 6 (9).

[34] In January 2018, the milestone of 80% exploitation of the total 21 million Bitcoins available was reached. Ethel Baraona Pohl / César Najera Reyes, El peso de Bitcoin, in: *ARQ (Santiago)* 98 (2018), p. 32.

[35] Arjun Kharpal, Crypto firms say thousands of digital currencies will collapse, compare market to early dotcom days, https://www.cnbc.com/2022/06/03/crypto-firms-say-thousands-of-digital-currencies-will-collapse.html, last accessed 24 December 2023.

[36] Yanis Varoufakis, Bitcoin and the dangerous fantasy of 'apolitical' money, https://www.yanisvaroufakis.eu/2013/04/22/Bitcoin-and-the-dangerous-fantasy-of-apolitical-money/, last accessed 24 December 2023.

[37] Ibid.

transactions shows that the behaviour of cryptocurrency users is not harmonious, and their volatility is very high.[38]

3.2.2. Polluting?

There are also other risks associated with cryptocurrencies.

Most technologies have environmental risks, and cryptocurrencies are no exception. The mining process, which is becoming more and more complex as more and more complicated algorithms have to be solved, requires a very high level of technical and human resources. In the beginning, a simple computer was enough to solve the algorithms. Nowadays, a large specialised computer system is needed, close to a cheap energy source and operated by skilled workers.[39] As a result, these activities have become increasingly concentrated in what are called "mining farms". For a while, these farms were concentrated in China. According to some authors, this was due to the use of coal, which is cheaper despite its environmental impact.[40] Then China changed its policy on cryptocurrencies.[41] In any case, the financial interests they represent should not be confused. Although the farms are located in non-Western countries, they mainly work for investors from developed countries.

3.2.3. Criminal?

Cryptocurrencies have also been linked to their use in illicit activi-

[38] Dorit Ron / Adi Shamir, Quantitative analysis of the full bitcoin transaction graph, in: Ahmad-Reza Sadeghi, Financial Cryptography and Data Security: 17th International Conference, FC 2013, Okinawa, Japan, April, Revised Selected Papers 17, p. 6 (39-42).

[39] Luis Enrique Piñero Sánchez, Riesgo y rentabilidad de la inversión en el minado de criptomonedas en las pymes de servicio del Municipio San Cristóbal del Estado Táchira durante el periodo 2016-2019, https://repositorio.unet.edu.ve:8443/jspui/handle/123456789/1089, last accessed 22 March 2022. Humoud Alsabah / Agostino Capponi, Pitfalls of bicoin's Proof of work. R & D Arms race and mining centralization, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3273982, last accessed 25 August 2023.

[40] Eddie van der Walt / G Gao / Thomas Biesheuvel / H Warren, Coal Is Fueling Bitcoin's Meteoric Rise, https://www.bloomberg.com/news/articles/2017-12-15/turning-coal-into-bitcoin-dirty-secret-of-2017-s-hottest-market, last accessed 1 October 2022.

[41] Garrick Hileman / Michel Rauchs, Global Cryptocurrency Benchmark Study, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2965436, last accessed 25 December 2023.

ties, such as money laundering. However, contrary to what many people think, cryptocurrency transactions can be recorded. What happens is that there are no names behind them, but codes that make transparency difficult.[42]

As for the future, it seems that Western countries are tending to move towards standardised regulation.[43] This is also supported by certain international economic organisations, including the World Economic Forum.[44] For their part, countries subject to financial sanctions have adopted a pragmatic approach, as cryptocurrencies can help them to circumvent them. This is the case in the Russian Federation, where there is a Regulation on Transactions with Digital Financial Assets (DFA), which legalises cryptocurrency transactions but prohibits their use as payment for goods and services. Russian financial institutions and banking intermediaries may operate with these assets, but they must register with the Central Bank, which has the authority to maintain the Register of Information Systems, register DFA operators, and "supervise" the business of information system operators.[45] This is also the case in Iran, which signed a bilateral agreement with Russia on cryptocurrency cooperation in November 2018.[46] However, many other countries have shown a strong suspicion of the use of cryptocurrencies. China, for example, eventually banned the use of cryptocurrencies altogether.[47]

[42] U.S. Department of the Treasury, Questions on virtual currency, https://home.treasury.gov/policy-issues/financial-sanctions/faqs/topic/1626, last accessed 1 February 2022.

[43] Allyson VERSPRILLE, Crypto Needs Consistent Regulation Across Nations, https://www.bloomberg.com/news/articles/2022-07-07/crypto-needs-consistent-regulation-across-nations-treasury-says, last accessed 9 July 2022.

[44] Kathryn WHITE / Sandra WALICZEK / Ousmène MANDENG, Cryptocurrency regulation is changing. Here's what you need to know, https://www.weforum.org/agenda/2022/07/cryptocurrency-regulation-global-standard/, last accessed 10 October 2022.

[45] FREEMAN LAW, Russia and Cryptocurrency, https://freemanlaw.com/cryptocurrency/russia/, last accessed 25 December 2023.

[46] Eric LOB, Iran and cryptocurrency: Opportunities and obstacles for the regime, https://www.mei.edu/publications/iran-and-cryptocurrency-opportunities-and-obstacles-regime, last accessed 25 December 2023.

[47] Macarena VIDAL LIY, China intensifica su campaña contra las criptomonedas y declara ilegal toda actividad con ellas, https://elpais.com/economia/2021-09-24/china-prohibe-toda-la-actividad-vinculada-a-las-criptomonedas.html, last accessed 25 September 2021.

4. Transforming the Financial Relationship?

4.1. The Different Financial Architectures of Digital Money

As we have seen in the previous sections of this chapter, there is a digital money, similar to coins and banknotes, which is very different from cryptocurrencies. This digital money is real money and, as such, is backed by a central bank, which is why it is called "central bank digital currency" (CBDC) or "digital fiat money". Like cash, it is real money issued and backed by a central bank, which simply takes the digital form.

Having cleared up any doubts about its status as money, the question we need to ask is whether its digital form will bring about any major changes in the way money and finance work. It is one thing if its value does not depend on the thing with which it is represented (following Keynes), and it is another thing if that thing does not entail changes.

In fact, history offers us an interesting example. The appearance of paper money has been linked by some authors to an important fact: the creation of central banks. According to this view, the advent of paper money led to the relative abandonment of coins, the concept of which was that of commodity money, i.e. money whose value was determined by its metal. This new form of money meant that there was less need to hold metal reserves, which reduced banking costs and thus expanded bank lending. This expansion of lending, which required fewer reserves to guarantee liquidity, increased the risks in the financial system and governments were forced to impose a monopoly on the issue of banknotes. The banks that were granted this privilege (the monopoly of issuing paper money) eventually became central banks.[48] Moreover, the creation of central banks led to the transformation of the financial system as a whole.[49]

Although many countries had plans to launch their own digital currencies before 2019, the acceleration of the digitalisation process brought about by the Covid 19 pandemic has increased interest in the development of digital currencies around the world. More than eighty-seven countries, representing more than 90% of global GDP, are currently

[48] See: Oren Levintal / Joseph Zeira, The Evolution of Paper Money, https://ssrn.com/abstract=1461991, last accessed 25 September 2021.

[49] Ibid.

working to launch digital versions of their national currencies, and nine of them, including China, have already fully launched.[50]

However, not all these projects follow the same model. Although this type of currency is issued solely by the central bank, there are different operational designs, each defining a different functional architecture. Some want to give the central bank a very important role in monetary transactions, while others want to change the current functioning of the monetary system as little as possible.

Broadly speaking, we can distinguish three models: a highly centralised model, in which the central bank plays a very important role; a highly decentralised model, in which the central bank hardly changes its current powers; and, finally, a mixed model.

The centralised model is characterised by placing the central bank at the centre of all monetary transactions. By design, the central bank manages all monetary transactions in real time and keeps a record of all retail holdings. In the decentralised model, transactions are recorded by financial intermediaries and reported to the central bank. In the mixed model, on the other hand, payments are processed by financial intermediaries who immediately report these operations to the central bank (which records all retail holdings), which is empowered to execute the transactions directly if it deems it appropriate.[51] Finally, it is also possible to introduce a fourth model, called indirect or synthetic, which is operated entirely by financial intermediaries who manage all the transactions, backed by central bank credit. Its operation is similar to that of the traditional financial system.[52]

It is up to each country to decide how its financial system will ultimately be organised. The choice is not easy and will depend on the degree of boldness and risk that each country is prepared to take. Adopting a radical model that takes full advantage of the possibilities offered by the digitalisation of the currency may help central banks to supervise

[50] Stefano Leucci, Central Bank Digital Currency, https://edps.europa.eu/press-publications/publications/techsonar/central-bank-digital-currency_en, last accessed 20 September 2022.

[51] Raphael Auer / Rainer Böhme, The technology of retail central bank digital currency, in: *BIS Quarterly Review,* March 2020, p. 85 (89). Stefano Leucci, Central Bank Digital Currency, https://edps.europa.eu/press-publications/publications/techsonar/central-bank-digital-currency_en, last accessed 20 September 2022.

[52] Francisco Hernández Fernández, Hacia una moneda digital europea. El euro 2.0, *Revista de Derecho Comunitario Europeo*, 70 (2021), p. 1006 (1014).

and conduct monetary policy, but it may also be highly disruptive for the financial industry, with all the consequences that this may entail.

For example, a centralised financial architecture would have important consequences for existing financial institutions, which would face a seriously increased risk of deposit flight.[53] For some, it would force them to rethink their role in the economy. Beyond their current function in payment processing, their activities should turn to their more traditional, relevant and constructive role in the so-called real (as opposed to the financial) economy: "carrying out credit analysis and collateral evaluation".[54]

Moreover, although the decision on the model to be followed is a national one (or, in the case of the euro area, the choice of the Eurosystem as a whole), the trend followed by the different economic blocs, or at least by the main world economies, will have consequences for the financial system as a whole. For example, some authors believe that the prevailing trend will be towards a financial architecture in which both retail and wholesale transactions are settled through a universally accessible digital payment network in the hands of the central bank, without recourse to the current system in the hands of financial intermediaries.[55]

4.2. The Flight of Deposits

But let's take a closer look at some of the risks associated with a digital currency whose architecture explores the more radical possibilities of digital money.

As we have said, one of the most important features of digital money is that it allows payments or transfers to be made without intermediaries. If these transactions are possible, it can be expected that a large part of the public will prefer to make their payments using digital currencies, taking advantage of their technology and avoiding banks. This poses a

[53] John Barrdar / Michael Kimhof, The Macroeconomics of Central Bank Issued Digital Currencies, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2811208, last accessed 15 February 2022.

[54] Rohan Grey, Banking in a digital fiat currency regime, in: Philipp Hacker / Ioannis Lianos / Georgios Dimitropoulos / Stefan Eich (ed.), Regulating Blockchain: Techno-Social and Legal Challenges, 2019, p. 169 (170).

[55] Jonathan Dharmapalan / Rohan Grey, The Macroecomic policy implications of digital fiat currency, https://www.ecurrency.net/static/resources/201802/TheMacroeconomicImplica, last accessed 26 February 2022.

major risk to commercial banks: on the one hand, the loss of this activity, for which they usually charge fees, and, on the other hand, the much more serious risk of deposit flight.

At this point, we must ask ourselves what the position of the public authorities should be in the face of this possibility: to preserve the banking system as it currently exists, or to rethink the future of banking?[56] In a way, the digital euro seems to have opted for preserving the stability of the current financial system, since it has declared its intention to allow digital euros to be kept only up to a certain limit in the digital wallet, forcing them to be deposited in the bank.[57] Although this is a cautious position at the moment, it may be forced to change its mind in the future, as a permanent renunciation of the technological possibilities of digitalisation raises doubts in the long term.

The curious thing is that the future of banking in a digital monetary system could be to return to its original activities, such as credit analysis and collateral evaluation, in a way that promotes the development of the economy's capital.[58] For much of the public, banking is simply a financial intermediary between the saver and the borrower, so the absence of deposits would be catastrophic for credit. In reality, commercial bank lending involves the creation of new purchasing power ex nihilo, through the banks' acceptance of borrowers' loans or other appropriate collateral in exchange for newly created demand deposits.[59]

It is therefore perfectly possible to allow commercial banks to allow creditworthy loan applicants whose collateral meets prudential regulatory standards to grant overdrafts in digital money. These overdrafts could be obtained from the central bank, through a secure loan, secured by the newly created loan asset (which would become a liability for the lending bank and an asset for the central bank).[60]

[56] Rohan Grey, Banking in a digital fiat currency regime, in: Philipp Hacker / Ioannis Lianos / Georgios Dimitropoulos / Stefan Eich (eds.), Regulating Blockchain: Techno-Social and Legal Challenges, 2019, p. 169 (169-170).

[57] European Central Bank, How would a digital euro work?, https://www.ecb.europa.eu/paym/digital_euro/how-it-works/html/index.en.html, last accessed 25 December 2023.

[58] Rohan Grey, Banking in a digital fiat currency regime, in: Philipp Hacker / Ioannis Lianos / Georgios Dimitropoulos / Stefan Eich (eds.), Regulating Blockchain: Techno-Social and Legal Challenges, 2019, p. 169 (170).

[59] Ibid., p. 171.

[60] Ibid., p. 175-176.

However, this is just one example of how to address the challenges that the introduction of digital money will bring to the financial system as a whole.

4.3. Financial Privacy

But it is not only this disruptive nature that needs to be analysed. The right to privacy and anonymity in financial transactions also faces new questions. If cash (or banknotes) has provided users with a high degree of privacy, the traditional financial system, centred on financial intermediaries, has allowed greater control over transactions, subject of course to the appropriate legal safeguards. In this sense, the emergence of digital money represents an opportunity to secure these rights technologically, but also an enormous risk. The development of an IT architecture based on strict data protection would improve the security and protection of payments, while at the same time increasing control over personal data. This is without prejudice to appropriate access to this information in cases defined by law, such as tax evasion, the prevention of money laundering or the financing of illegal activities such as terrorism.[61] On the other hand, however, the concentration of this data in the hands of central banks could create a panopticon with a consequent increase in the risks associated with it, not necessarily because of possible abuses of public power, but also in other respects, such as the interest of criminal organisations in accessing this data through cyber-attacks, etc.[62]

Nor should it be forgotten that in a globalised financial system, where international transactions are increasingly important and frequent, and where not all states act with the same standard of respect for privacy, these risks may increase.

4.4. Artificial Intelligence and Digital Money

Public tasks have always been conditioned by the administration of money. Economists have tried to provide public authorities with economic forecasting models to help them set priorities and anticipate eco-

[61] Stefano Leucci, Central Bank Digital Currency, https://edps.europa.eu/press-publications/publications/techsonar/central-bank-digital-currency_en, last accessed 20 September 2022.

[62] Ibid.

nomic problems. However, the problem with all the models developed by economists has been the lack of reliable data. Can digital money provide data to improve monetary management and regulation?

As we have argued, digital money poses certain risks precisely because of the data it can accumulate, but this data can also generate important benefits. Let's start by understanding how it differs from paper money. Paper money is much more limited in its ability to provide data than digital money. While paper money contains only issuer information, not holder information, nor information about the currency's life cycle during its circulation (as such information remains with the holder), digital money allows its holder greater control over its own money by providing important information.[63]

These advantages are multiplied with regard to the central bank itself. As the creator and issuer of currency, the central bank centralises all monetary accounting and has the power to make decisions throughout the network.[64] And it is precisely the collection of large amounts of data that the digital currency collects for the central bank that, with the help of artificial intelligence, will allow a detailed analysis of the issuance, circulation and storage of the currency; very valuable information for decision-making on monetary policy and banking supervision.[65]

In addition to data analysis and as a designer of the system, digital money can behave as smart money, which offers numerous advantages to the public authorities (mainly the central bank) by introducing certain parameters. For example, it could be determined that the money is valid only after a certain point in time, for example when a commercial bank issues a loan; or it could be determined to which sectors and entities a bank loan can be directed; or the immediate application of established interest rates, both for loans granted by banks and for those they take from the central bank.[66] This should facilitate the introduction of money into the real economy and contribute to the transmission of the monetary policy decided by the authorities.[67]

[63] Qian YAO, A systematic framework to understand central bank digital currency, *Science China Information Sciences* 61 (2018), p. 1 (7).

[64] Ibid., p. 5.

[65] Ibid.

[66] Ibid.

[67] Ibid.

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