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Abstract

From Aristotle to Ricardo and Menger, economists have emphasised the function of money as a medium of exchange together with the intrinsic qualities that increase its saleability and credibility as a most liquid store of value. But the social institution of money co-evolves with technology. It is significant that the advent of digital cryptocurrencies was initiated by computer scientists and has taken economists completely by surprise. As a consequence, it also forces our profession to rethink the basic phenomenology of money. In accordance with the views of Wieser and Schumpeter, digitization brings to the fore its immaterial function as a standard of value and social technology of account, which increasingly absorbs that of a medium of exchange. The potential impact on economic policy is huge. The variety of different crypto coins has proven the technical feasibility of competing private currencies as proposed by Hayek. In the long term, however, there is reason to doubt the persistence of intense competition. One must fear that major digital platforms will extend their current dominance in multisided virtual market places to include digital payments and money. Central banks are increasingly anxious to preserve public sovereignty over the common unit of account and consider issuing their own digital fiat money. After the current era of intense creative experimentation, the potentially new spontaneous order of private crypto-currencies is likely to be supplanted by central bank digital currencies (CBDCs), the design of which will depend on deliberate public choices and policies.

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DIGITIZATION AND THE EVOLUTION OF MONEY AS A SOCIAL TECHNOLOGY OF ACCOUNT

MICHAEL PENEDER*

ABSTRACT. From Aristotle to Ricardo and Menger, economists have emphasised the function of money as a medium of exchange together with the intrinsic qualities that increase its saleability and credibility as a most liquid store of value. But the social institution of money co-evolves with technology. It is significant that the advent of digital cryptocurrencies was initiated by computer scientists and has taken economists completely by surprise. As a consequence, it also forces our profession to rethink the basic phenomenology of money. In accordance with the views of Wieser and Schumpeter, digitization brings to the fore its immaterial function as a standard of value and social technology of account, which increasingly absorbs that of a medium of exchange. The potential impact on economic policy is huge. The variety of different crypto coins has proven the technical feasibility of competing private currencies as proposed by Hayek. In the long term, however, there is reason to doubt the persistence of intense competition. One must fear that major digital platforms will extend their current dominance in multisided virtual market places to include digital payments and money. Central banks are increasingly anxious to preserve public sovereignty over the common unit of account and consider to issue their own digital fiat money. After the current era of intense creative experimentation, the potentially new spontaneous order of private crypto-currencies is likely to be supplanted by central bank digital currencies (CBDCs), the design of which will depend on deliberate public choices and policies.

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Key Words: Digitization, evolution of money, currency competition, general ledger, crypto coins, central bank digital currency (CBDC), Austrian economics

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1. INTRODUCTION

Throughout the classical and neoclassical period, the primary interest of monetary considerations was in the proper functioning of money as a means of exchange, generally thought to depend on intrinsic qualities of the matter it is made of. According to the prevailing commodity view, ‘sound money’ either had to consist of precious metals or be strictly backed by them. Carl Menger thus explained the evolution of money as a market-driven spontaneous order, which must eventually converge towards a good of utmost saleability. Later the situation changed due to factual circumstances, when fiat money became common after the collapse of the Bretton Woods system in the 1970s. However, the basic premises of monetary theory seemed largely settled, and the discipline was reluctant to re-examine them. Fundamental questions about the actual phenomenology of money had little appeal, as the vanguard of monetary research advanced ever new theoretical models of growing complexity. As a consequence, the recent advent of digital crypto-currencies that is based on inventive algorithms developed by computer scientists eventually took the economics discipline by surprise.

The key message of this paper is that digitization forces us to rethink the basic phenomenology of money along Schumpeter’s conception of a social technology of account in the credit economy. At a time when money was generally conceived in its material form and intrinsic qualities, he identified its principal function with the clearing of current accounts that establish the accepted differences between debits and claims. He even pointed at a hypothetical *general ledger* of economic transactions to be its purest form and logical conclusion. Furthermore, he believed that in the course of history the evolution of a form tends to crystallize its essential nature and indispensable functions and was confident that this also applies to the social institution of money.

The argument is made in three steps.¹ Section 2 starts with the Austrian theoretical discourse on the proper phenomenology of money, contrasting the canonical explanation by Menger with the ‘heretic’ and largely forgotten views of Wieser and Schumpeter. The latter correspond not only with modern historical records, but also surprisingly well with the recent development of digital currencies. Section 3 offers a brief look back at the early origins of money and shows that credit and related accounts became important drivers of financial development long before coins were minted. In Section 4 two major innovations of the current digitization of money are examined. First, the emergence of crypto coins that demonstrate the technical feasibility of Hayek’s earlier vision of competing private currencies. And second, the upcoming policy response by means of ‘central bank digital currencies’ (CBDCs). Section 5 concludes by contrasting the idea of spontaneous order from competing private currencies with the role of deliberate policy choices in the design of public digital fiat currencies.

¹This paper benefitted greatly from the very constructive comments of two anonymous referees, who contributed to the clarification of important concepts and the organisation of the overall argument. Furthermore, the collaboration with Andreas Resch on a related book project and the repeated discussions at Kurt Dopfer’s Vienna Seminar on Evolutionary Economics were highly appreciated.

2. THE NATURE OF MONEY

2.1. **The substance matter.** The beginnings of systematic monetary thinking are generally attributed to the Greek philosophers. Their economic analysis was rudimentary and mainly concerned with business in the context of a general theory of society and the state. However, the Greeks were already addressing two of the most enduring questions in monetary theory: What is the ‘substance matter’ and, relatedly, what are the constitutive functions of money? Thereby Schumpeter credited *Plato* and *Aristotle* with originating the two archetypes of monetary thought: Plato, the elder scholar, considered money in its ‘symbolic’ form as a means to facilitate exchange.² In contrast, Aristotle considered metal coins the outcome of an evolution towards a superior form of commodity tokens with an intrinsic exchange value. Furthermore, he introduced the influential trinity of functions that money serves foremost as a medium of exchange, but also as a measure of value, and implicitly as a store of value.

Aristotle’s metallist concept of money prevailed throughout many centuries. It perfectly aligned with the preeminent practical concern of the times: the frequent debasement of coinage by the authorities. To western societies that debasement simply associated with the moral conviction of fraud. The scholastic philosophers of medieval times therefore endorsed the metallist interpretation of money and carried it onwards up to the classical period of Adam Smith and others. Since “men are unable to make them easily by alchemy, as some endeavour to do,”³ specie posed bigger obstacles to counterfeiting and misuse by the authorities. Relatedly, precious metals were the only generally accepted currency in international trade.

With the advent of bank money and after Ricardo’s (1816) influential ingot plan, the general norm “was a commodity-based monetary system, with the liabilities of banks being convertible at a legally stipulated rate into gold or silver (or both). Under such an arrangement, the value of money was ultimately the value of the precious metals.”⁴ Even when the role of credit as a circulating medium was explicitly acknowledged, such ‘fiduciary’ money remained in a separate category. The idea of a managed currency without intrinsic value was maintained only by a few heterodox ‘heretics’, while the monetary orthodoxy firmly embraced metallism as the undisputed embodiment of ‘sound money.’ The socialist Karl Polanyi poignantly described the universal rule of metallism:

“Belief in the gold standard was the faith of the age [...] Whether the gold itself has value for the reason that it embodies labor, as the socialists held, or for the reason that it is useful and scarce, as the orthodox doctrine ran, made for once no difference. The war between heaven and hell ignored the money issue, leaving capitalists and socialists miraculously united. Where Ricardo and Marx were at one, the nineteenth century knew not doubt” (Polanyi, 1944, p. 26).

²Schumpeter (1954, p. 56).

³Cesarano (2014, p. 187) referring to a text by Oresme from 1360.

⁴Laidler (1991, p. 10).

2.2. Spontaneous order. The marginalist revolution, which occurred at the height of the classical gold standard from about 1879 to 1914,⁵ did not much alter the situation. The leading authorities, including Jevons, Menger, Walras, and Marshall considered money proper to be foremost a commodity for facilitating exchange, and further attached importance to its function as the most liquid store of value by assimilating the individual choice of preferred cash balances into their theory. In addition, *Carl Menger* (1840-1921) combined a distinctive focus on social coordination with an Aristotelian interest in characteristic phenomenal forms, i.e., the fundamental ‘nature’ and function of its constitutive elements.⁶ Focusing on the ‘genesis’ of money as a medium of exchange, Menger (1892) elaborated Aristotle’s explanation to an evolutionary narration of spontaneous order, stressing the different ‘saleableness’ of goods, defined as the “greater or less facility with which they can be disposed of at a market at any convenient time at current purchasing prices.”⁷ Since individuals aim to exchange less saleable for more saleable goods, the institution of money emerges from pure economic self-interest as a common mechanism of social coordination: “the spontaneous outcome, the unpremeditated resultant of particular, individual efforts of the members of a society.”⁸

Menger’s perspective on the nature of money remained within the Aristotelian emphasis on its function as a medium of exchange in which the precious metals exhibit intrinsic advantages, such as their durability, homogeneity, and divisibility, along with a lower fluctuation of prices. Consequently, “their saleableness is far and away superior to that of all other commodities.”⁹ Once adopted as a medium of exchange, increasing returns render such advantages self-reinforcing and cumulative. In other words, money did not need to be generated by law: “In its origin it is a social, and not a state-institution.”¹⁰ To conclude, Menger’s emphasis on spontaneous order and unrestricted interaction among self-interested individuals remained a distinctive characteristic of the Austrian School, and his careful theoretical analysis is still a hallmark of evolutionary institutional reasoning. The monetary core of his analysis, however, was not novel. It essentially fit the orthodoxy of the time and complemented it with a well-reasoned process theory.

2.3. Dematerialisation. Menger’s disciple *Friedrich Wieser* (1851-1926) had reservations about the paradigmatic individualism of his teacher’s theory of money. Menger had portrayed money as the outcome of mere self-interest of those who follow a successful example. In contrast, Wieser placed emphasis on the distinctive quality that adoption by the masses adds to the process: while “success is the driving force that moves the masses to copy the example of the leaders,” the masses establish “the universal practice which gives to a

⁵Redish (2016, p. 329).

⁶Mittermaier (2018).

⁷Cesarano (2014, p. 244).

⁸Menger (1892, p. 250).

⁹Menger (1892, p. 252).

¹⁰In contrast, G.F. Knapp’s (1905/1924) ‘State Theory of Money’ challenged the orthodox commodity view with a deliberate emphasis on the role of government fiat in the enforcement of legal tender, postulating that “money is a creature of law” (ibid., p. 1ff). Schumpeter (1954, p. 1090) called the state theory a mere “tempest in a teapot” and insisted on the priority of an economic explanation.

rule its binding force and social power.” Hence, “money represents something more and stronger than the will of participating individuals.”¹¹ Where Menger had laid the emphasis on spontaneous order and the intrinsic advantages of specie, Wieser considered the evolution of money to be in flux, pointing at a historical tendency towards its *dematerialisation* by means of a growing separation of its services from the substance matter.¹²

“I confess to the often fought and, I believe, not refuted heretical opinion that [...] money is conceivable which, without receiving any value from its materials, i.e., without receiving any value from its ‘use’, would quite exclusively serve circulation and would thus be good money held in full value” (Wieser, 1904, p. 167).

Joseph Schumpeter (1883-1950) had a genuine admiration for Menger, but among his Austrian peers the strongest intellectual kinship was with Friedrich Wieser. In his opposition to the commodity view,¹³ Schumpeter strictly distinguished between theoretical and practical rationales. His repudiation of ‘theoretical metallism’ was clear and explicit:

“Money is not a commodity – not even when it happens to consist of a valuable material. For as soon as the latter is used as money, it must necessarily cease to fulfil its role as an economic good.” Therefore, “it is not essential for money to consist in something, or to be covered by something, that has an economic value of its own” (Schumpeter, 1917-18/1956, p. 161).

While dismissing ‘theoretical metallism’, Schumpeter acknowledged that ‘practical metallism’ had a valid point in imposing discipline on governments against the overissue of inconvertible paper and the resulting perils of inflation. In practice, any case for or against a fiat currency depends on the degree of confidence and security a society can attach to its money as legal tender.¹⁴ Distinguishing between the two provided him with an institutional explanation of the historical prevalence of gold, despite its untenable theoretical foundation. He believed, however, that in the due course of time, novel and more effective arrangements would likely act as a substitute for secondary characteristics – that the ongoing evolution of technological and social systems would bring money closer to its essential economic function. This he found in the following ‘claim theory’ of money.

2.4. The ‘claim’ theory. Alternative to the commodity theories, Schumpeter characterised money at its core as a technology¹⁵ of social accounting. Already the young Schumpeter (1908) had flamboyantly elaborated the importance of money to the formation of

¹¹Wieser (1914/1927, p. 162, 165).

¹²Wieser (1927, p. 693).

¹³John Maynard Keynes (1923) similarly dismissed the orthodox commodity views of money. Different from Schumpeter, he later based his monetary theory on the concept of liquidity preferences that proved to be highly influential in the development of monetary macroeconomics.

¹⁴“It is, of course, clear that in primitive conditions only money made of an intrinsically valuable material can obtain its definite market valuation and continue to circulate. Money made of valueless material presupposes so high a standard of legal security, that in international trade even today only money based upon ‘valuable’ material functions smoothly” (Schumpeter, 1917-18/1956, p. 157).

¹⁵“[T]he function of money in the economy is in principle of a merely technical nature, i.e. money is essentially a device for carrying on business transactions” (Schumpeter, 1917-18, p. 150).

equilibrium prices through indirect trade. Later he illustrated it by the opposite hypothetical case of a pure socialist economy and argued that a socialised clearing mechanism may eventually dispel the need for direct monetary transactions, just as coin and other currency had eliminated the need for physical barter. Conversely, he insisted that even an idealised socialist system must be monetised by some common unit of account. Stripped down to its essential logic, to him this was where the indispensable nature of money resides.¹⁶

Following Wicksell's earlier example of a pure credit economy – but long before the age of electronic payments and digital currencies – Schumpeter envisioned a system of 'universal' current accounts consistent with the modern idea of a general ledger¹⁷ to be the purest form and logical conclusion of a monetary system:

“The generalized notion of this current account relationship, i.e. the idea that everyone's economic acts are recorded on a real or imaginary current account, is extremely revealing and so useful for grasping the social connections and processes that make up the monetary and credit system that one could call it the basic concept of monetary theory” (Schumpeter, 1970, p. 127).

The key point here is that Schumpeter regarded money neither as a commodity nor a good, but as a *claim ticket* to goods. It originates in the liability of an issuer, who is trusted to hold the according assets. Consequently, the monetary system is foremost an institution of account and the attention accordingly shifts from money as a definite object to its representation of “shares in the mass of goods.”¹⁸

2.5. Endogenous money. Abandoning analytical convenience Schumpeter further focused on the endogenous nature of money that is driven by the demand for credit. His dissenting view originated in the earlier but forgotten work of *Henry Thornton* (1760-1815), who had turned the classical canon upside down by asserting that credit logically exists prior to money:

“Even in that early and rude state of society, in which neither bills nor money are as yet known, it may be assumed, that if there be commerce, a certain degree of commercial credit will also subsist. [...] it must happen, even in the infancy of society, that one man will deliver property to his neighbour without receiving, on the spot, the equivalent which is agreed to be given in return. It will occasionally be the interest of the one party thus to wait the other's convenience. [...] This commercial credit is the foundation of paper credit” (Thornton, 1802, p. 75f).

¹⁶Schumpeter (1970).

¹⁷“The concept of a general ledger is the abstract notion that all economic actions in the real world (all transactions, all exchange, contract, and production) can be hypothetically mapped to a general ledger that records that change in a state of the data of an economy” (Berg et al, 2019, p. 59).

¹⁸Schumpeter ascribed the claim *analogy* to the German banker Friedrich Bendixen (1864-1920), and even earlier to J.S. Mill (Schumpeter, 1917-18/1956, p. 153). In contrast, Mises (1953, p. 470) explicitly attributed the claim *theory* to Schumpeter.

Schumpeter praised Thornton for his “amazing performance”¹⁹ and adopted his ‘credit theory of money,’ considering credit relations to be “essential, and the logical prior.”²⁰ Going beyond the notion of a ‘spontaneous order’ in the accepted medium of exchange (as in Menger, Mises or Hayek) he focused on an institutional interpretation of money as a clearing mechanism to establish the accepted differences between liabilities and claims.²¹ Though acknowledging the theoretical possibility of the monetary system to emerge from mere social practice, or routine, he maintained that, in practice (and again consistent with Thornton), a public authority, such as the central bank, is needed to anchor it.²² Focusing on the interdependence between finance and real production, he elaborated on how the ‘money ligament’²³ holds the system of mutual transactions together by connecting debits and claims as denominated in the accepted unit of economic calculation.²⁴

In anatomy the ‘ligament’ is a band of tissue which connects the bones. Characteristically, it must be firm, but also elastic and capable to expand. In a similar vein, Schumpeter pointed at the endogenous creation of new balances in response to the demand for credit by new entrepreneurial ventures and considered them to be the great lever which extends the reach of the monetary circulation. Further examining the credit channel of creative destruction, Schumpeter’s distinctively monetary theory of development finally linked the credit-based pre-financing of innovations (broadly defined) with changes in the structure and volume of production.²⁵

2.6. Currency competition. Another example of heterodox monetary thought bears a close relationship to the recent rise of digital money. Again, it originates with the particular strand of Austrian monetary theories. *Friedrich Hayek* (1899-1919), who in his early years had elaborated ideas of Mises and others into a monetary theory of the business cycle, returned to monetary questions in his late career. In the 1970s, after the dollar’s convertibility to gold had ended and the Bretton Woods system of fixed exchange rates collapsed, he began to champion the case of free competition between privately managed currencies. This was different from the principle of ‘free banking’, which he considered valid only as long as commercial banks must redeem in specie the notes they have issued in terms of a single national currency. Instead, Hayek more radically suggested to abolish the national monopoly of legal tender and open currencies to free competition. Reasoning that

¹⁹Schumpeter (1954, p. 689).

²⁰“Whatever the criteria used to define the concept of money, this money, in its use as a means of payment, always serves, as we have seen, to provisionally settle credit relationships that owe their origin to the non-simultaneity of the services and counterparts entering into economic clearing” (Schumpeter, 1970, p. 209; posthumously published but written in the 1920s/30s; translation by the author). For an early and radical proponent of the credit theory of money see also Hahn (1924; and Hagemann (2010) on Hahn).

²¹Schumpeter (1954, p. 717).

²²Schumpeter (1970, p. 219).

²³Schumpeter (1970, p. 224, 229).

²⁴As a pun, Schumpeter (1917-18) referred to the old term *Rechenpfennige*. These were small metal tokens (‘counters’) that looked like coins, but were used as an auxiliary means of calculation before mathematical calculus was generally performed in writing.

²⁵“The essence of modern credit lies in the creation of such money. It is the specifically capitalistic method of effecting economic progress” (Schumpeter, 1917-18, p. 205f).

Gresham’s law (of ‘bad money driving out good currency’) only applies if exchange rates are fixed, he expected an opposite impact for monetary regimes with variable exchange rates:

“[T]he inferior quality money would be valued at a lower rate and, particularly if it threatened to fall further in value, people would try to get rid of it as quickly as possible. The selection process would go on towards whatever they regarded as the best sort of money among those issued by the various agencies, and it would rapidly drive out money found inconvenient or worthless” (Hayek, 1976/90, p. 41ff).

In practical terms, this requires the full liberalisation of international capital flows among participating countries including, for instance, the abolition of exchange controls, the freedom of foreign banks to open branches on the same terms as domestic ones, or the “full freedom to use any of the currencies for contracts and accounting.”²⁶ Confiding in the virtues of long-run competitive equilibrium, Hayek expected that (in the absence of government intervention) only the most stable currencies will survive:

“I have now no doubt whatever that private enterprise, if it had not been prevented by government, could and would long ago have provided the public with a choice of currencies, and those that prevailed in the competition would have been essentially stable in value and would have prevented both excessive stimulation of investment and the consequent periods of contraction” (Hayek, 1976/90, p. 14).

To understand the motivation, one must recall that these ideas were introduced during a period of high inflation and turmoil in the international monetary system. Accordingly, in Hayek’s vision, currencies compete mainly in their function as a store of value.²⁷ Though the proposal had little impact at the time, similar ideas resurged later in a vigorous new movement, which combined Hayek’s libertarian ideals with the technical prowess of the internet generation. Before addressing these current developments in Section 4.1, we will turn to the early evolution of money and briefly highlight the eminent role of credit and account throughout monetary history.

3. HISTORICAL ORIGINS

Money is one of the oldest social institutions. Its practical import is so deeply engrained in the fabric of economic relations that monetary history necessarily predates any recorded history of deliberate theoretical thought. This section briefly summarises the historical record on its early evolution. Contrary to the prevailing opinion of economists in the period that shaped the classical and neoclassical foundations of monetary theory, it demonstrates that the function of money as a unit of social accounts largely predated that of facilitating exchange.

3.1. Credit and interest. Comprehensive accounts of monetary history date back to about ten thousand years ago, when the neolithic revolution brought about agriculture in association with higher population growth. Increased commercial interaction contributed to the rise of complex social structures, and the record-keeping of the value of economic

²⁶Hayek (1976/90, p. 23).

²⁷Brunnermeier et al (2019, p. 8).

transactions was among the first needs to arise. Archaeological evidence from the Near East dating back to about 7000 BCE suggests that *clay tokens* were the first proto-financial tools, predating even the invention of writing. Berg et al (2019) refer to it as the early forms of a ledger technology.²⁸ At the time, they symbolized specific economic commodities and were generally of a simple and abstract shape.

At the beginning of the Bronze Age, the innovation of irrigation agriculture in Mesopotamia allowed communities to settle year-round and develop first urban societies with growing populations, increased division of labour, and expanding trade relations that secured the supply of tin and other resources. Writing and credit soon became two indispensable elements of exchange.²⁹ As early as 3000 BCE there is evidence that in Mesopotamia clay tokens were stored in sealed clay balls, called *bullae*, a kind of contract which specified the commitment of future payments (e.g. tributes to the temple, taxes, or loans). Abstract symbols on the surface of these hollow and fist-sized envelopes of clay depicted the number and type of tokens inside. Later, the Sumerians began inscribing pictographs into clay *tablets* and the accounting symbols evolved into ‘cuneiform’, the world’s first writing.³⁰

Temples were the political and administrative centre and the clay tablets were used to record the contribution and distribution of goods such as barley, cattle, or other means of subsistence. Agricultural shortfalls, the failure to meet obligatory contributions to the temple or social commitments, such as bridal gifts, and the capital needs of long-distance trade triggered *credit*, with its earliest appearance documented for the period of about 3200 to 1600 BCE. Credit was generally short term, typically in the form of an advance from the central storehouse, and had to be paid back during the next harvest. The loan contracts could be passed on to another person, although there is no indication that they were commonly traded. Most credit called for *interest* in terms of additional payback at the end of the specified period. Apart from barley or silver, interest was often paid in the form of own labour or that of family members or a servant. Debt servitude caused social unrest and occasionally resulted in the annulment of debts or the release of debt slaves by royal decree.³¹ As time passed, more private contracts emerged and tax-farmers, for instance, acted as middlemen, balancing and converting the payments into silver. Shekels of silver became the common unit of currency with which the government set the price of commodities, labour or penalties. Rather than being widely circulated, silver presumably served mainly as a unit of account.³²

²⁸Berg et al (2019, p. 65). The term ledger refers to the principal file, or ‘book’, which records and totals economic transactions.

²⁹van de Mieroop (2005, p. 17).

³⁰Goetzmann (2016, p. 24) vividly portrays the practice of the “scribes who took wet lumps of clay, shaped them into lozenges, and wrote on them with a wooden stylus. The stylus had a sharp end and round end – one end for lines and the other for dots. Laid sideways, the stylus could also make triangular and cylindrical impressions. The combination of these formed a lexicon that scholars have now concluded was the first writing.”

³¹van de Mieroop (2005, p 28).

³²“Although they used a silver based pricing system, more than likely they recorded their small payments or obligations in accounts – like running a tab at a local store. They used silver as a ‘language’ of accounts,

3.2. Money and banking. According to modern historical records, credit thus existed long before the invention of *coinage*, which evolved in the Mediterranean from the early sixth century BCE onwards.³³ In the fifth century BCE, the advancement of legal systems and public institutions to enforce common rules and contractual commitments was a driver of financial development among Greek city states. An ancient banking business arose in the port of Piraeus, where the ‘trapezitai’ took deposits and provided loans for maritime trade and domestic business or backed expensive social obligations. Importantly, the thicker markets made it easier to finance risky commercial ventures, since the lenders could more easily diversify their funding. Written contracts allowed to document loans and commit debtors to certain payments. These were the basis of the ancient forms of *bills of exchange*,³⁴ which probably first emerged in India and Rome, and which later became an important instrument used to settle accounts among Arab merchants.³⁵ In the vast Roman Empire money changers (‘*argentarii*’) started to provide various kinds of banking services, ranging from taking deposits to carrying out money transfers or lending.

When the Chinese first introduced fiat paper money in the ninth century CE, the initial impulse came from private merchants who began to issue ‘exchange bills’ (called *jiaozhi*), which soon enjoyed growing circulation, but were also prone to abuse and led to a surge of legal disputes.³⁶ Its success depended on a strong government taking control and operating within a large and unified territory – just as its fate later turned with growing military conflicts that induced overissue and inflation. Similar developments were inconceivable in the fragmented European territories. As precious metals tended to drain off to markets with higher purchasing power, fiat money would have rapidly led to a shortage of convertible currency. Instead, the increasing demand for sovereign debt by rivalrous European rulers, together with the expansion of trade routes and commercial relationships, offered opportunities for financial innovation and induced the evolution of new instruments, such as life annuities, merchant banks, or negotiable bills of exchange.³⁷ These fostered the emergence of liquid markets for a growing variety of securities. Having to overcome the additional burden of a widespread prohibition of interest, the growing volume of transactions led to increased specialisation and finance gradually evolved from auxiliary services into a sophisticated industry.

but a grocer could not constantly and reliably weigh out shekels of silver while bargaining over barley, cress, and dates” (Goetzmann, 2016, p. 100).

³³The oldest troves were found in Ephesus in Lydia (which is near Izmir), Athens and other Greek city states. See, for instance, Ferguson (2008).

³⁴Denzel (2008).

³⁵One of the earliest recorded examples was the Indian *adesh*, which constituted orders of payment from a banker to a third person. In large towns it was used as a letter of credit among merchants. See, e.g., Reserve Bank of India (1998, chapter II, p. 1).

³⁶Goetzmann (2016), Peng (1994), von Glahn (2005).

³⁷Negotiable bills allowed to endorse another person as the claimant of a payment, who was not mentioned in the initial document.

Among the important milestones in the evolution of money and banking, England substituted the prohibition of interest through a legal rate as early as 1545.³⁸ From the mid-sixteenth century onwards, scribes and lawyers acted as loan brokers who subsequently turned to issuing notes drawn on deposits.³⁹ Goldsmiths started to exploit their connections to the royal mint on a bigger scale, adding deposit banking and by the 1670s also the issue of paper money to their regular trade in bullion.⁴⁰ In the 18th century, private banking thus strived on the practice of fractional reserves,⁴¹ while the growing influence and power of the Bank of England helped anchor England's monetary system.⁴² In the second half of the 19th century, Walter Bagehot therefore characterised English commerce as "a trade on borrowed capital."⁴³ Notably, the Bank of England had only assumed its role as the 'banker's bank' through a series of financial crises and political struggles, which led Bagehot to advocate the cause of deliberate central banking, arguing that "[m]oney will not manage itself."⁴⁴

In short, fractional reserves that are based on credit rather than any intrinsic commodity value had enabled a major expansion of monetary circulation. Due to their larger volumes, sovereign debt and commerce benefitted most from it. But this fact is misleading if one neglects the transformative function of financing new ventures that was at the heart of Schumpeter's concern. Even if such 'venture money' accounted only for a small portion of the total of financial flows, its impact on the structural change of productive systems through the financing of small and nascent enterprises was substantial.⁴⁵

To conclude, specific historical situations shaped the evolution of different institutional arrangements, among them the emergence and diffusion of novel banking practices. In the western hemisphere, these increased the supply of money, or substitutes thereof, thereby establishing refined tools of credit, which fuelled the fast growth of commerce and the ascent of capitalism through new business ventures. However, money continues to evolve. Exploiting the current stream of innovations in financial technologies (FinTech) a variety of new digital initiatives began to challenge the conventional institutional boundaries of money and raised concerns in particular about the possible disintermediation of banking services.

³⁸Böhm-Bawerk (1884, p. 42) thus dryly commented that "the theoretical question whether loan interest was justifiable or not was practically answered before there was any theoretical economic doctrine."

³⁹In Amsterdam the Exchange Bank (*Wisselbank*) was founded in 1609 and started to denominate accounts in a standardised currency, while private cashiers offered commercial credit and other banking services after a ban on their activities had been lifted in 1621. See Ferguson (2008, p. 48).

⁴⁰Cassis and Cottrell (2015, p. 34).

⁴¹Cassis and Cottrell (2015, p. 30). See Usher (1934; 1943); de Roover (1963); or Binswanger (2015).

⁴²See the British financier *Walter Boyd* (1796/1811) for an early descripton.

⁴³"All banks depend on the Bank of England, and all merchants depend on some banker." Consequently, "all our credit system depends on the Bank of England for its security" Bagehot (1873, p. 16, 35).

⁴⁴Bagehot (1873, p. 20).

⁴⁵Peneder (2012), Peneder and Resch (2015, 2021). Of related interest, Heblich and Trew (2019) demonstrate that the presence of country banks outside London raised the degree of industrialisation within their local vicinity and tended to shift employment from the production of mature commodities towards specialised intermediate goods.

4. DIGITAL MONEY & ACCOUNT

For most of the second half of the twentieth century the financial sector was among the first to adopt the new information and communication technologies (ICTs) and to benefit from the progress achieved in terms of computing power, the internet, or cryptography. Money and banking thus co-evolved with industrial technology.⁴⁶ Examples include the indispensable role of new ICTs in the internal accounting operations of the banking organisations, the evolution of digital payment cards, or the growing practice of electronic banking and mobile payment services. As a consequence, “[t]oday, people exchange units of account.”⁴⁷

When the financial crisis of 2008-09 led to a significant loss of public confidence in the monetary system and the institutions in support of it, the subsequent expansionary monetary and fiscal policies raised the fear that governments would spend themselves out of the crisis and depreciate their debts by means of inflation. Having undermined the legitimacy of the established system, the financial crisis thus gave momentum to the proponents of alternative monetary concepts. In the immediate aftermath of the crisis, one particularly significant development was the introduction of the Bitcoin protocol. Exploiting the explosive growth in the performance of new ICTs over the past decades, it established the first peer-to-peer system of electronic cash that operates without the intermediation of a financial organisation.

4.1. Crypto coins. Deliberately designed to substitute for bank intermediation, *Bitcoin* was introduced in 2008 under the pseudonym of *Satoshi Nakamoto*. The opening statement left no doubt about its radical objectives: “A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution.” Seemingly discarding the fundamental premise of money as a social institution, Nakamoto “proposed a system for electronic transactions without relying on trust.”⁴⁸ Coming from computer sciences rather than economics or business, the core innovation was to substitute cryptographic proofs that verify the integrity of information about a transaction in a decentralised network of computers for that of a trusted third party.

Rather than eliminating trust, Bitcoin arguably provides for an automation of trust through blockchain and *distributed ledger* technologies (DLTs).⁴⁹ In short, algorithms record transactions in blocks and add them to the chain of existing blocks by means of cryptographic signatures. This ‘block-chain’ represents a ledger of transactions, whereby hash functions map keys of variable size to fixed-size values. In ‘distributed’ ledgers, new blocks must be validated by either all or a permissioned group of participants (‘nodes’) that synchronize and maintain the entire history of transactions. Producing many replicas of the same ledger thus enhances the security of the system.⁵⁰

⁴⁶Allen, Berg et al (2020).

⁴⁷Evans and Schmalensee (2005, p. 26).

⁴⁸Nakamoto (2008, p. 1, 8).

⁴⁹Berg et al (2020).

⁵⁰Allen, Capkun et al (2020).

DLT can support systems that are either decentralized or under the control of a central authority. Bitcoin is an open and decentralized permissionless system that needs no prior authorisation of participants. Either way, transactions are recorded in distributed ledgers of information, where each block of data references the previous one, creating a chain of complex hash functions that impede any modification of past entries without the deliberate consensus among the majority of nodes in the system.⁵¹ Since each node must maintain and continuously update the records of all historical transactions, distributed ledgers come at a considerable marginal cost of operations and time delay for the verification of transactions, if compared to conventional electronic payments by card or direct electronic transfer between accounts. Given the current state of technology, these pose serious restrictions on the general scalability of the system.⁵²

Overall, the monetary concept behind Bitcoin constitutes a radical departure from the conventional institution of money. Absent any central organisation, the system is exclusively based on rules, such as those algorithms which define the maximum number of new coins to be issued per period and establish the first transaction of a new block. The ‘mining’ of new coins is competitive and requires verifying transactions in the network by solving computational problems of growing complexity as ‘proof-of-work’. Successful miners chain their new block to the previous blocks and broadcast it to all other nodes. These accept it by adding their blocks to the same chain after having verified that the items have not been spent before.

Nakamoto designed electronic coins as a chain of digital signatures. Bitcoin thus accords with the idea of ‘money as memory,’ which is crucial to solve the double-spending problem of digital information. Without such a memory, it could be easily copied for multiple uses.⁵³ To be secure, honest nodes must collectively control more computing power than any alliance which aims to hack the system. But even if such an alliance would control more than 50 per cent, the idea is that the pay-offs (including transaction fees) must be higher for using that computing power to mine new coins rather than for hacking past transactions. Privacy is imperative, and Bitcoin aims to preserve cash-like anonymity by cryptographic means. Unlike cash, however, blockchains record the historical data of past transactions by account. This increases the stakes considerably once privacy is lost due to a successful hack of a node’s identity.⁵⁴

⁵¹Government Office for Science (2016), Tinn (2019), Berg et al (2019).

⁵²“Bitcoin’s design is built for a world where individuals can trust neither institutions nor each other. Such a world is very costly, because trust in institutions must be substituted by precautionary measures against potential abuse on the individual and systemic level” (Weber, 2018, p. 115).

⁵³Kocherlakota (1998a,b) models money as a societal memory of transactions, a record-keeping device to maintain balances. Luther (2019) further elaborates the role of collective coordination in establishing particular devices.

⁵⁴Luther and Olson (2014, p. 24) call the system “quasi-anonymous,” or “anonymity through obscurity,” since a “user’s key does not contain any personally traceable information in and of itself.” Referring to blockchains, more generally, the UK Government Office for Science (2016, p. 34) claims that “[c]ontrary to public perception, the underlying architecture makes it relatively easy to track transactions and establish the identity of people who misuse the system.”

As is the case with conventional fiat currencies, the price of a Bitcoin depends on expectations about its future value. Emulating the nature of gold as an exhaustible resource, the total number of Bitcoins has been restricted to a maximum of 21 million units and the rate at which they can be mined is scheduled to decline by half about every four years. The quantitative restriction promises a steady, non-inflationary supply of coins. However, this does not imply a high stability of its value: Critically missing is a mechanism to adjust the supply of coins to fluctuations in the demand for Bitcoins.⁵⁵ Unlike conventional money, it enjoys neither the elasticity of the endogenous system of credit – Schumpeter’s ‘money ligament’ – nor the discretionary powers of a central bank to adjust the supply of base money to changes in demand. As a consequence, the price of Bitcoin has fluctuated strongly over the past years.

Nodes can agree to change the rules. If they disagree on the rules, communities may *fork* into separate blockchains adopting a different set of rules. Forks are particularly significant to the economics of blockchains for at least three reasons:

- To begin with, they demonstrate that despite their technical origin in the computer sciences peer-to-peer electronic cash remains first and foremost a social institution. Its success depends on the ability to form a consensus about the rules applied, which are then cast into the algorithms of the technical protocols.⁵⁶
- Second, they induce speciation in terms of functional differentiation, but also competition between a variety of different protocols.⁵⁷
- Third, they show that crypto-currencies need not contradict the credit theory of money. Though Bitcoin represents a special variety of cash-like tokens that are ‘mined’ by proof-of-work, forks have enabled competing digital monies that are backed by various assets, deposits and securities, capable of implementing the ‘ligament’ of mutual claims and liabilities.

The question of currency competition relates to the proper definition of what constitutes an independent currency. Brunnermeier et al (2019) define a collection of payment instruments to form an independent currency, if they are denominated in the same unit of account and are fully convertible. Convertibility implies a legally binding peg to the common unit. In contrast, if a payment instrument retains the option to break that peg it also remains an independent currency. Hence, they conclude that Bitcoin and other “[f]iat crypto-currencies are clearly independent currencies, as they are not convertible into anything and have their own unit of account.”⁵⁸

In principle, Bitcoin is designed to cover all of the three classic functions of money. Not only does it establish an independent unit of account, but it serves as a liquid store of value and facilitates exchange as a convenient means of payment for online transactions.

⁵⁵“Bitcoin is a pure asset not related to credit creation processes. There is no central issuing authority behind Bitcoin and it does not represent anybody’s liability” (Weber, 2018, p. 121).

⁵⁶Berg et al (2019, p. 67) consider blockchains an “institutional technology” for decentralised coordination. They emphasise that “the study of ledgers in historical time is the study of how human societies organise and come to consensus around facts.”

⁵⁷Abadi and Brunnermeier (2018), Biais et al (2019).

⁵⁸Brunnermeier et al (2019, p. 5f).

In practice, however, these functions are severely hampered by the high volatility of its exchange rate relative to other currencies. As a consequence, many consider it “an object of speculation, instead of functioning money.”⁵⁹ Speculation is nourished by the limited quantity of coins and the according expectation of an appreciating exchange rate. This tends to induce agents to withdraw it from circulation and hoard it, thus further impeding its function as a means of payment. But even the prospects of profitable speculation are clouded by a systemic risk that is likely to undermine its long-term viability. Bitcoin’s proof-of-work principle is extremely costly and inefficient in terms of energy use. In addition to the significant constraints on the scalability of distributed ledger systems, the very operation of the blockchain depends on the willingness of nodes to verify transactions, which means that mining plus transaction fees must be profitable. The distributed ledgers may thus imply a significant fragility of the system. If in a scenario of increasing energy costs, falling demand, and, perhaps, additional regulatory hurdles, the cost of energy ever puts sufficient pressure on miners’ incomes, the most spectacular financial innovation of the early 21st century may end in a burst bubble.⁶⁰

Bitcoin’s success and the built-in possibility of forks has induced the creation of numerous other crypto-currencies, which are based on blockchains, distributed ledgers and open source protocols. One example is *Ether*, which runs on the Ethereum platform and was introduced in 2015. It uses a more general scripting language in support of so-called ‘smart contracts’.⁶¹ Another smart contract running on Ethereum is *Uniswap*, a protocol for the decentralised exchange of tokens.⁶² Ethereum has also become a popular platform for *initial coin offerings* (ICOs), where entrepreneurs raise funds by selling specific crypto tokens to be used as an exclusive means of payment for the services of a newly founded venture (e.g., another digital platform).⁶³

The high volatility in the price of Bitcoins has induced the creation of so-called *stablecoins*. While some peg their value by algorithms which adjust the supply of coins to changes in demand, most are collateralised by various assets held in reserve. An early example is *Tether*. It was launched in 2014 on the Ethereum blockchain, is pegged to the US\$ and claims to be fully backed by reserves.⁶⁴ Having started the same year, the open source project *Maker DAO* enables users to monetize surplus collateral by creating tokens of the crypto-currency *Dai* from collateralized debt positions (CDPs) denominated in Ether.⁶⁵ Different from the above movement towards decentralized finance, two resourceful ‘permissioned’ systems caught most of the public attention in 2019. One is the dollar-backed *JPM coin* for interbank payments, which JP Morgan Chase offers to its institutional clients.

⁵⁹Weber (2018, p. 122ff).

⁶⁰Das and Dutta (2020).

⁶¹‘Smart contracts’ are computer protocols with self-executing and self-enforcing clauses (for instance, executing payments conditional on a specified event).

⁶²See <https://uniswap.org>.

⁶³Catalini and Gans (2018), Fatas and Weder di Mauro (2019).

⁶⁴Reserves are comprised of traditional currency, cash equivalents, and other assets, such as loans to affiliate entities. See <https://tether.to>.

⁶⁵See <https://makerdao.com/en>.

The second example is *Libra*, which was announced with the backing of a most powerful alliance of private businesses and is aimed at a broader retail customer base. Initiated by Facebook, the founding members of the Libra Association included many of the major players in electronic payments (e.g., Mastercard, PayPal, and Visa) and successful digital platforms (e.g., Booking Holdings, eBay, Spotify, and Uber) as well as telecommunications, blockchain technologies, venture capital, and non-profit organisations.⁶⁶ Although several founding members soon withdrew from the association due to the bleak prospects of major regulatory obstacles and political headwinds, they reportedly remain in a waiting position to see how the project develops.⁶⁷

The mission statement of Libra emphasises the objective of financial inclusion, especially for regions that lack efficient financial institutions. Its ambition is none lesser than “to enable a simple global currency and financial infrastructure that empowers billions of people.”⁶⁸ On the technology side, Libra applies distributed ledgers. But unlike Bitcoin, only members of the Libra Association can form nodes that register transactions. This shall preserve the advantage of higher security and reliability through redundant information being distributed among the different nodes. At the same time, it significantly improves the scalability of the system. For similar reasons, Libra replaces the conventional blockchain with a structured database. On the economics side, Libra is designed to be a stablecoin – that is, fully backed by liquid assets, such as cash (equivalence) and short-term government securities. Since the weighted average of reserves determines its value, Libra is not independent of the monetary policies of the central banks. This is particularly true if Libra, as announced, supplements its multi-currency coin with coins denominated in a single currency.⁶⁹

As far as monetary policy is concerned, the emergence of a growing variety of cryptocurrencies has given a big boost to the idea of currency competition. Friedrich Hayek would have approved and be confident that the market would ultimately select the better design. While “Hayek’s proposal languished for decades, more as a curiosity than as a workable idea,” technological innovations have made it a real possibility. In a recent theoretical model Fernández-Villaverde and Sanches (2018) provide for a ‘partial vindication’. Among their main findings, they show that immutable protocols, which enforce an upper bound to the issue of coins, can achieve price stability, but generally won’t be welfare efficient. Furthermore, they report a continuum of equilibrium trajectories, where the value of the private currencies would converge to zero. While private currencies do create problems for monetary policy, central banks can drive them out of the market by pegging the real value of their money and thereby also establish a welfare optimal equilibrium. To conclude, the main effect of crypto coins is then to make currencies contestable (also within a national territory) and to enforce discipline in the issuance of money by the governments.

⁶⁶Libra Association (2019, p. 4).

⁶⁷Segendorf et al (2019). Notably in June 2019 the G20 mandated the Financial Stability Board (FSB) to examine potential vulnerabilities of the financial system because of global stablecoins (GSC) and to advise on a multilateral approach to their regulation. See FSB (2020).

⁶⁸Libra Association (2019, p. 1).

⁶⁹Libra Association (2020).

4.2. Digital platforms. Schumpeter would have embraced the idea of contestability and discipline imposed on governments by the ongoing stream of financial innovations. However, he would have doubted Hayek’s confidence in an enduring welfare-optimal equilibrium of unfettered competition between currencies. Instead, from a Schumpeterian angle particular attention must be paid to the impact of technological change on the industrial organization of digital markets.⁷⁰ The reason is, that network effects arising from the transaction costs of reporting, searching, and comparing the price of services and goods in different currencies, favour the emergence of dominant units of account. Admittedly, these transaction costs have decreased with the growing speed and computational power of new ICTs. Also, the internet has enabled the proliferation of global markets for specialised interests and communities that may agree to trade in a particular token. According to Brunnermeier et al (2019), low switching costs will therefore lead to an effective *unbundling* of the traditional functions of money and enable a variety of crypto-currencies that specialise on separate functions, such as unit of account, medium of exchange or store of value. However, they also expect a *re-bundling* of money with specific functions of the respective digital platforms, which aim to exploit indirect network effects that are typical for ‘multisided’ markets.⁷¹

As a consequence of such indirect network effects, consolidation is likely to prevail for at least the most populated virtual market places in the long term. When different groups of customers interact on a common platform, network externalities can arise, because the demand on one side of the market (e.g., online advertising) depends on the different demand of another side (e.g., tools for online search). Platforms then face opportunities to optimize their business models and pricing strategies, for instance, by means of cross-subsidies between the different groups of customers. A tendency towards market concentration and ‘winner-take-all’ dynamics becomes evident as today’s most successful digital platforms thrive on leveraging dominant positions in one area to enhance their competitive advantage in others.⁷²

In recent years two private Chinese digital payment services, Alibaba’s *Alipay* and Tencent’s *WeChat Pay* have demonstrated the powerful lever of network effects in the multisided ecosystem of ‘big tech’ commercial and social media platforms. Replacing bank intermediaries and point-of-sale terminals with digital wallets, smartphones and QR codes, they succeeded in making direct commercial and person-to-person (P2P) payments a convenient and cost-efficient alternative to the Western model of credit and debit cards, together controlling more than ninety percent of China’s huge mobile payment market.⁷³ Though digital wallets generally do not offer revolving lines of credit and do not bear interest, Klein (2020) points out that money from the digital wallets can be transferred at no charge to interest-bearing accounts, mutual funds or other financial services on the same platform.

⁷⁰The extraordinary economies of scope of popular digital platforms such as Amazon, Google, or Facebook are clearly reminiscent of the late warning and gloomy predictions about the growing trustification of a post-capitalist society in Schumpeter (1942/50).

⁷¹Rochet and Tirole (2003).

⁷²Evans and Schmalensee (2016).

⁷³Auer et al (2020, p. 22).

Low marginal costs of individual transactions and the fixed costs to be borne by the platform leave much scope to favour transactions within a well integrated ecology of businesses. On top of this, the platforms' privileged access to data about their customers' financial transactions and social networks raises profound concerns about privacy and fair competition, especially for the information sensitive credit business.

At the international level, the announcement of Libra added a sense of urgency to such worries. It is to be feared that the major digital platforms, in cooperation with the big card associations, which are also very experienced and successful in exploiting network effects, might eventually extend their dominance first to the market for electronic payments and ultimately perhaps also to the provision of a global currency. By writing contracts in their own unit of account, such a scenario would severely undermine the existing monetary system and leave the responsibility for its efficiency and the public good of financial stability to the rationality of private profit maximisation.⁷⁴

4.3. Central bank digital currencies (CBDCs). The conventional means of policy in responding to the kind of challenges posed by digital platforms and new crypto-currencies is regulatory rules and restrictions. But the global reach of initiatives such as Libra will make international coordination particularly difficult and regulatory arbitrage very likely. An alternative policy option is to extend the current activities of the monetary authority and to make greater use of the technological opportunities by introducing itself a *central bank digital currency* (CBDC) as a means of payment that is available to the general public and represents liabilities of the central bank.⁷⁵

The idea of extending reserves to the general public goes back to James Tobin, a former student of Schumpeter, who in the 1980s took issue with the moral hazard that emanates from the public insurance of private bank deposits. His solution was to replace it by "100%-reserve deposits – payable in notes or coin on demand, transferable by order to third parties, secure against loss or theft" and which he considered "a perfect store of value in the unit of account."⁷⁶ Tobin envisaged that individuals can hold this "deposit currency" either directly in (branches of) the central bank, or with the commercial banks and other financial organisations. The important point to emphasise was that "[t]he payment system and the integrity of the medium of exchange are public goods. The sovereign monetary fiat, partially delegated to private agents, must be protected." Therefore, "the government should make available to the public a medium with the convenience of deposits and the safety of currency, essentially currency on deposit, transferable in any amount by check or other order."⁷⁷

⁷⁴See, e.g., Brunnermeier et al (2019, p. 28).

⁷⁵This definition refers to a 'general purpose', or *retail* CBDCs. In contrast, *wholesale* CBDCs would be used only for the settlement between financial organisations.

⁷⁶Tobin (1985, p. 25). Backed by the liability of a central bank, these deposits represent a new form of base money in addition to cash and the central bank deposits available to financial organisations. In contrast, conventional bank money and electronic money are secured by the liability of a private issuer. A crypto-asset, such as Bitcoin, is mined by proof-of-work and does not carry the intrinsic value of a particular liability.

⁷⁷Tobin (1987, p. 179, 172).

Tobin aimed at separating deposit money from commercial lending, considering their institutional linkage a mere ‘accident of history.’ The proposal differs from the idea that bank money should be fully backed by reserves (the ‘Chicago Plan’), or initiatives for ‘sovereign money’ (‘Vollgeld’). In contrast to both, his proposal merely intended to provide safe and liquid deposits directly with a currency from the central bank, whereas commercial banks should continue to provide credit by means of fractional reserves. Tobin’s deposit currency would therefore not allow for overdrafts and pay only modest interest, thus leaving higher interest-bearing checking accounts, savings deposits, and time deposits an attractive option for commercial banks to offer.

Despite Tobin’s intention of maintaining a viable banking industry, the risk of crowding out bank intermediation and thereby causing a contraction of credit remains a major objection to the introduction of CBDCs. In addition, many savings of transaction costs will be realised at the expense of current banking incomes, which must induce considerable political resistance to such reforms.⁷⁸ Panetta (2018) therefore points out that the disruption to the banking sector could be mitigated if central banks offer only sight deposits with low remuneration, while banks can compete on additional services (e.g., credit and payment services) and enjoy better recourse to wholesale funding. To this one should add that the banking sector may ultimately prefer to maintain a monetary system, which is anchored by the central bank and offers recourse to a lender of last resort. This will be the case, if it feels threatened otherwise by an ‘anchorless’ system of private crypto-currencies, probably dominated by a few global big technology companies.

Panetta, however, also points at the fear that during periods of crisis the opportunity to conveniently transfer funds to a CBDC may increase the probability of bank runs.⁷⁹ Several design principles have been developed to counteract such a scenario, and which aim to mitigate the crowding out of bank financing. For instance, according to Kumhof and Noone (2018) CBDCs should neither be convertible into reserves nor be issued only against eligible (government) securities. In addition they should pay a variable interest, which can also turn negative if needed to mitigate bank disintermediation. Bindseil (2019) proposes a two-tier system in which up to a quantitative ceiling (e.g., close to average cash balances, or the average monthly net income) the remuneration is non-negative, but above the threshold must be generally lower and can also be negative. The idea is that Tier 1 preserves the payment function of the CBDC, while Tier 2 makes it unattractive as a store of value and thus prevents the displacement of private intermediation. De Lis et al (2020) doubt the effectiveness of such a tiered system, since the interest rate must be very penalizing during a crisis or a bank run. In contrast, Brunnermeier and Niepelt (2019) argue that a bank run need not undermine financial stability, because funds from the central bank would automatically substitute for the bank deposits held by households and firms. If central banks thus become large depositors in the private banks, they must increasingly internalize the externalities of a bank run and hence will be less inclined to run

⁷⁸Cukierman (2019, p. 18).

⁷⁹Panetta (2018). See also Agur et al (2019) or Fernández-Villaverde et al (2020).

themselves. As depositors conceive the according greater stability of the banking system, they should also become less likely to run.

If we are willing to accept that the above risks can be contained by means of a proper design of the instrument, its proponents credit CBDCs with at least three significant economic benefits.⁸⁰ To begin with, low transaction costs fare prominently among the main arguments. Another advantage is the higher contestability of the market for retail payments. Finally, the interest paid on CBDCs provides for an additional instrument of monetary policy. Bordo and Levin (2018) further argue that a well-designed CBDC could eliminate the need of an inflation buffer and thus allow to target a stable price level with zero inflation. Like others, they refer to the possibility of reducing the interest rate beyond the ‘effective lower bound’ (ELB) at which people would exchange their account balances for cash. But this also implies that CBDCs must largely displace cash from circulation, which would raise at least three new problems:⁸¹ First of all, cash does not require special technical devices and is therefore the most inclusive means of payment. Second, cash adds variety and thus enhances the resilience of the payment system in case of a technical breakdown of the digital infrastructure. Finally, cash is the most anonymous and untraceable medium of exchange. Different from blockchains, it does not (need to) keep any records of who paid, or what for.

Gnan and Masciandaro (2018) therefore consider the valuation of individual privacy versus state control to be the characteristic difference between those parties which are in favour and those which are opposed to CBDCs. On the one hand, anonymous payments facilitate all kinds of illicit transactions, fraud, and tax evasion. On the other hand, if protective measures fail to be effective, a government-controlled payment system is a most powerful means of systematically screening the personal affairs, tastes and preferences of individual citizens. It could be the ultimate doorway through which a *Leviathan* state can intrude. Hence, a society’s overall trust in the political institutions, its democratic maturity, the status of individual liberty, and the rule of law will be important factors in the assessment. Once more, we arrive at the conclusion that, also in the age of digitization, money at heart remains a social institution.

The central banks are a most resourceful and experienced contender to further exploit the technological opportunities of digitization. Nevertheless, for a long time most of them seemed to be rather reluctant and cautious when it came to the question of issuing their own digital currency. First experiments by individual central banks have been largely confined to token-based electronic wallets that substitute for cash. An early example, albeit for different purposes, was the prepaid retail card *Avant*, which the Bank of Finland had already issued in 1993-95.⁸² Sweden is another case in point. Being one of the most

⁸⁰Barrdear and Kumhof (2016), Bordo and Levin (2018), Engert and Fung (2018), or Eichengreen (2019).

⁸¹Pichler et al (2019, p. 42f).

⁸²See Grym (2020). It pioneered the use of smart card technologies and offered *e-money* for small denominations, while maintaining the anonymity of cash. *Avant* ceased to be a CBDC, when the Bank of Finland sold it to a consortium of commercial banks in 1995. Though lacking the benefit of anonymity, private debit cards displaced the system in about 2005.

advanced nations in terms of digitization, traditional cash is already on the verge of extinction. The Sveriges Riksbank has therefore recently started a test-pilot for the introduction of electronic cash (the *e-krona*).⁸³

The announcement of Libra in 2019 and the growing tensions in international economic relations seem to have turned the tide. By mid-2020, the Bank for International Settlements (BIS) counted at least 36 central banks that have initiated various work on CBDCs, ranging from preliminary research to a few pilot projects. In addition, the BIS noted that since the end of 2018, the attitude in public speeches by central bank governors and board members has turned from predominantly negative to a majority of positive opinions.⁸⁴ A good example is the European Central Bank (ECB, 2020) which recently examined the basic options for a digital euro in retail payments and launched a public consultation on the subject.⁸⁵ By mid 2021 it plans to decide whether to launch a project for further experimental investigation. In enumerating various reasons for a digital euro,⁸⁶ the ECB refers, among others, to the goal of strategic autonomy from foreign payment systems. Similarly, the European Commission pointed out that “[o]nce relegated to the back-office, payments have become strategically significant” and explicitly embraces the ECBs initiatives towards a European retail CBDC in its recent digital finance strategy.⁸⁷ Among the key benefits it identified (i) cheaper cross-border payments, (ii) the promotion of financial innovation, (iii) reduced dependence on the big technology companies, and (iv) a strengthening of the euro in global currency competition (and hence increase the ability to conduct international trade in one’s own unit of account).

Currently, however, the most ambitious project appears to be the Digital Currency Electronic Payment system (CD/EP) initiated by the People’s Bank of China (PBC). Digitizing the monetary base through a renminbi-backed form of electronic payment, it will likely be the world’s first comprehensive CBDC to become operational.⁸⁸ In 2020 the PBC initiated pilot projects in four designated cities and announced one for the 2022 Winter Olympics in Beijing.⁸⁹ Auer et al (2020) characterize it as a *hybrid model* of direct claims on the central bank, which controls the technical infrastructure and the central ledger, while authorized intermediaries operate the retail payment services.⁹⁰ Digital accounts are expected to coexist with wallets, where the lesser requirements for personal identification associate with stricter limits of the permitted volume of transactions. So far, however, little

⁸³Sveriges Riksbank (2017, 2018).

⁸⁴Auer et al (2020, p. 7f).

⁸⁵The European TARGET services already offer a wholesale CBDC, comprising wholesale payments (T2), securities settlement (T2S) and instant payment settlement (TIPS) in central bank money. See ECB (2020, p. 52).

⁸⁶For instance, technological change, the declining role of cash, monetary policy, resilience of the payment system, the international role of the euro or cost efficiency (ECB, 2020, p. 9ff).

⁸⁷European Commission (2020B, p. 2; 2020A, p. 10).

⁸⁸Yang and Lockett (2019), Duong (2020).

⁸⁹CSIS (2020). The selected cities are Chengdu, Shenzhen, Suzhou, and Xiong’an.

⁹⁰Auer et al (2020, p. 18) further distinguish the hybrid system from *direct* CBDCs, where the central bank also offers the retail services, and *intermediated* CBDCs, where the central bank controls only the wholesale ledger instead of a central ledger of all transactions.

is known about the details of the projected system. In one of the few revelatory international documents, Yao Qian, an early architect of the Chinese program, acknowledges that “the private sector has already taken a lead” and warns of the “increasingly monopolistic power” of China’s private payment systems.⁹¹ The primary objective therefore is to reinforce the PBC’s monetary authority and prevent the proliferation of other international digital currencies, while preserving intermediation within the traditional ‘binary’ system of commercial and central banking. Finally, in accord with the basic tenets of Schumpeter’s monetary theory, Yao places special emphasis on the fact that the value of a digital fiat currency (DFC) must reside in the securitization of sovereign credit and gives priority to its function as a unit of account.

5. SUMMARY & CONCLUSIONS

Money evolves with technology, and as digitization proceeds, the perpetual flow of financial innovation forces us to rethink even its basic phenomenology. The fundamental premises that had shaped monetary orthodoxy culminated in Carl Menger’s famous explanation of the nature and origin of money as an example of spontaneous order that exploits the intrinsic qualities of a medium of exchange to facilitate transactions and serve as a most liquid store of value. The classic gold standard was seen as its appropriate realization and the embodiment of ‘sound money’. Older historical examples of symbolic money, fiat currency, or the increasing importance of credit were considered either irrelevant, of lesser importance to the development of a proper theory, or dangerous aberrations that must inevitably lead to inflation.

Friedrich Wieser did not share Menger’s paradigmatic individualism with regard to money, but emphasised how adoption by the masses establishes a ‘universal’ practice of strong binding and enabling forces. He also noted an inherent tendency towards the progressive dematerialisation of money. Joseph Schumpeter similarly dismissed the commodity view and envisioned money as a *claim ticket* to the social product, which originates in the liability of an issuer. To him, credit is the principal mover of capitalist development by enabling the pre-financing of innovation and forcing structural change. In the credit-economy, money is a ‘ligament’ which holds the entire productive system together by connecting liabilities and claims denominated in the accepted unit for calculation. Envisioning money basically as a social technology of account, Schumpeter already pointed towards the modern idea of a *general ledger* of all economic transactions to be its purest form and logical conclusion.

The modern historical records on the early evolution of money confirm the special significance which Schumpeter attributed to the functions of enabling credit and corresponding accounts. Examples include the clay tokens and tablets in ancient Mesopotamia, the early Chinese invention of paper currency, or the development of varied securitized debt instruments in the Western hemisphere. Yet Schumpeter did not ground his position on historical examples. Rather, he insisted that a theoretical rationale takes precedence over

⁹¹Yao (2018, p. 6). From 2016 to 2019 Yao Qian was the first head of the PBC’s Digital Currency Research Institute.

the historical-genetic origin of money, arguing that “the essence of the matter became crystallized only in the course of history, and it is precisely the most modern forms of manifestation that are here the purest logically and the simplest substantively.”⁹²

The burden of proof is therefore on the further evolution of money, where the most striking development of recent years has been the rise of crypto-currencies. These have proven Friedrich Hayek’s idea of *private currency competition* – once far-fetched and largely ignored – to be technically feasible. However, it is doubtful whether truly competitive structures can endure for long. If digital monies develop more or less undisturbed by government regulations, it is more likely that network effects and the multisided nature of digital markets will impair the contestability by new entrants and reinforce the dominance of major commercial and social digital platforms. For example, Libra is a powerful alliance that strives towards the consolidation of a market which currently is characterised by an astounding degree of creative destruction. Beyond the present excitement about crypto-currencies, its success could have deep impacts on competition in the various sides of digital markets.

Private crypto-currencies, however, give additional cause for worry about monetary policy. With growing concerns about the monetary sovereignty of governments and their ability to serve the public good, *central bank digital currencies* (CBDCs) are set to become the next radical innovation in the evolution of money. Thereby, CBDCs do not necessarily have to crowd out other forms of payment and thus inhibit financial innovation. On the contrary, as Cukierman (2019) argues: If CBDCs maintain the sovereign capacity of monetary policy, this also reduces the need for stricter rules on private currencies. Or as Brunnermeier et al. (2019) point out: If central banks fix the short-term interest rate for their own liabilities, arbitrage would extend its effect to payments in private tokens, provided that the convertibility and interoperability of private instruments is maintained. Thus “[t]he unit of account role of money, arguably its most important and basic function, gives the central bank power even when its liabilities are not used as a medium of exchange or a store of value.” Consequently, “a regime in which all money is convertible to CBDC would uphold the unit of account status of public money.”⁹³

In short, the likely realization of a comprehensive digital monetary system will consist of a variety of private crypto coins, enhanced by smart contracts that tailor them to specific purposes, while central banks will strive to retain the monetary anchor and the capability to act as lenders of last resort by means of issuing their own digital currency. Conversely, bank intermediation is becoming ever less a prerequisite for loans. In the long term, the integration of smart contracts of increasing complexity and the concentrated power of big data and artificial intelligence in the central ledger of a digital fiat currency might enable it to surpass many of the informational advantages of decentralised banking services. Whether publicly owned CBDCs will contribute to bank disintermediation remains foremost a political decision. For instance, both the PBoC and the ECB appear to be credibly committed to maintain the current division of labour and stress that commercial banking clearly goes

⁹²Schumpeter (1970, p. 35).

⁹³Brunnermeier et al (2019, p. 27, 29).

beyond their competencies. However, private crypto-currencies and the large technology companies associated with them could simultaneously challenge both central banking and commercial banking and thus redefine the strategic framework for future central bank policies. Ultimately, their superior international reach may even prompt major central banks to co-operate in a *multilateral* system of CBDCs for the settlement of payments between different currency areas.⁹⁴

To conclude, even in the digital age, money will not be the product of a spontaneous order, but will result from deliberate political decisions, for example regarding the regulation of private crypto-currencies or the design of a CBDC. For the latter, the degree of disintermediation will depend on whether individual customers have access to it directly from the central bank or only indirectly through commercial banks. Another example concerns the privileged access to the big pool of transaction data. Policy must decide whether the central bank's ledger will record all transactions or only the wholesale clearing operations with banks and other authorized intermediaries. Finally, by offering a combination of account-based CBDC and prepaid digital wallets, privacy also becomes a matter of design. Either way, in the course of digitization the function of money as a standard of value gradually absorbs that of facilitating transactions. With digital payments, the two are no longer distinguishable, and verified units of account have become the actual medium of exchange. Digitization thus brings to the fore the immaterial essence of money as a social technology of account.

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⁹⁴The ECB (2020, p. 22) already points at this possibility.

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