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Technology versus trust: Non-bank credit systems from notarized loans in Early Modern Europe to cryptolending

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ABSTRACT

The application of distributed ledger technology (DLT) in the financial sector has fostered the development of new services that are frequently referred to collectively as 'decentralized finance', or DeFi. In the wake of these recent developments many observers and practitioners regard DLT as a major technological disruption to the financial system, possibly leading to the complete disintermediation of banks and to their substitution with a network of bilateral relations between borrowers and lenders recorded in a common ledger. Recent historiography has shown that a potentially analogous system existed in Ancien Régime societies whereby finance was provided not only by specialized intermediaries, but also by an 'informal' credit network where debtors and creditors entered directly into relationship through notaries. In this paper, we carry out a systematic comparison between cryptolending, an extreme form of DeFi at the technological frontier, and the early system of peer-to-peer lending represented by notarized loans in the early modern period. Our aim is to assess the true novelty of current practices and to understand if, and in what sense, the technological innovation represented by DLT can effectively produce a structural change in the functioning of the financial system.

1. Introduction

The banking system plays a crucial role in modern economies. Banks finance investments by issuing loans and collect savings in the form of deposits.[1] With a stroke of the pen in a virtual or physical account book, banks grant credit to borrowers and quantify the funds accumulated by lenders. Banks therefore act collectively as intermediaries between creditors and debtors: the consolidated balance sheet of the banking system can be regarded as a centralized ledger, in which all debts and credits are recorded. Through their accounting systems, commercial banks, together with the central bank, control the two essential functions of money creation and credit allocation.

However, the Global Financial Crisis has cast a shadow on the ability of the banking system to perform those functions adequately, to foster growth without compromising financial stability. Financial innovations, most notably securitization, encouraged the creation of excessive credit and risk, leading to insolvencies and the need for central banks to intervene as lenders of last resort in an effort to absorb losses and avoid further contagion. After the failure of Lehman Brothers in September 2008, many banks were bailed out or even nationalized. The dependence on support from governments and central banks was widely seen as a source of moral hazard and regulatory capture requiring structural reform of the financial system.[2]

In this context, cryptocurrencies were developed as an alternative way of creating and managing money. The first of them, bitcoin, was presented in 2008 and launched at the beginning of 2009 as the invention of digital cash, i.e., as a form of electronic currency which, unlike the traditional form of digital money represented by bank accounts, did not require an intermediary to be created, held, or transferred. As a bookkeeping device, bitcoin substituted the centralized balance sheet of the bank with distributed ledger technology (DLT): instead of having to be preserved by a trusted third party that centralizes

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[1] This is not to say that banks 'transform savings into investments' or that the collection of deposits represents a precondition for banks to grant loans. As the Bank of England has still recently felt the need to clarify, bank lending is financed not by preliminary savings, but by the creation of money. It remains true, however, that the banking system is required to maintain a balance between the amount of money it creates by issuing loans and the amount it collects by taking deposits. In this sense, it may still be appropriate and useful to characterize banks as intermediaries between lenders and borrowers and ultimately between savings and investments.

[2] For a critical assessment of this literature, see Allen et al. (2015).

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the collection of savings and the funding of investments (i.e., a bank), accounts could be held on a public record, the truth and safety of which would be ensured by innovative cryptographic techniques (hence the name of cryptocurrency).[3]

The application of distributed ledger technology (DLT) in the financial sector has fostered the development of new services that are frequently referred to collectively as 'decentralized finance', or DeFi (Robson, 2022). The idea behind this expression is that DLT allows a direct relationship between creditor and debtor, without requiring the intermediation of banks, which traditionally act as a trusted third party. Indeed, the first DLT, the bitcoin blockchain, was designed expressly to offer a 'peer-to-peer electronic payment system' (Nakamoto, 2008). Now, DeFi entails an extension of DLT to the entire financial system, with the prospect of enabling a form of peer-to-peer credit. In the wake of these recent developments, many observers and practitioners regard DLT as a major technological disruption capable of promoting a structural change in the financial system, eventually leading to the complete disintermediation of banks and to their substitution with a network of bilateral relations between creditors and debtors recorded in a common ledger (Kaili, Psarrakis, 2021). Recent historiography has shown that peer-to-peer lending was already common in preindustrial societies, where financial activity was performed not only by early forms of specialized intermediaries, such as pawnbanks, but also by an 'informal' credit network where borrowers and lenders entered into a direct relationship via the agency of notaries (Hoffman et al., 2000).

In this paper, we carry out a systematic comparison between cryptolending, an extreme form of decentralized finance at the technological frontier, and the early system of peer-to-peer lending represented by notarized loans in the early modern period. Our aim is to assess the true novelty of current practices and to understand if, and in what direction, the technological innovation represented by DLT can effectively produce a structural change in the financial system. By comparing it with early modern practices, we are able to show that cryptolending may indeed contribute to reducing costs via automation of certain procedures, but it can in no way substitute the trust which is intrinsically involved in financial relations. We therefore conclude, in contrast with most conventional views of decentralized finance, by suggesting that cryptolending should be viewed as a complement, rather than an alternative, to the institutionalized financial intermediaries.

The paper is structured as follows: we start by presenting the sources and method of our analysis (Section 2). We then illustrate the theoretical background, why we regard early modern notarized loans and cryptolending as cognate practices performing analogous functions, and the relevant parameters by which they can be compared (Section 3). Against this backdrop, we perform a systematic comparison of the two practices according to these parameters (Section 4). We follow this with a discussion of the main results (Section 5) and draw our preliminary conclusions and identify lines for further research (Section 6).

2. Sources and methods

This article draws mainly upon secondary sources concerning lending practices both in the early modern period and today. As regards the Ancien Régime economies, our source documents consist essentially of debt and credit contracts underwritten by individuals before notaries, who exercised their profession by state concession. Developing within the framework of Roman law, notaries conferred authenticity and public validity on the operations (e.g., wills, sales, rents, dowries, loans) of private individuals, who were not intrinsically endowed with these attributes (Bartoli Langeli, 2006, p. 13).

The geographical scope encompasses states sharing a similar legal system, i.e., Roman law (civil law), therefore continental Europe with specific attention to northern Italian regions in the seventeenth and eighteenth centuries. Our research on present times takes a global perspective and is based on websites providing cryptolending services and on reports produced by consultancy firms, traditional financial intermediaries, and regulators.

The analysis is structured as a systematic comparison between the two non-bank credit systems: notarized loans which were practiced before the emergence of universal banks, and cryptolending, which aims to be independent from banks. We investigate the distinctive features and main parameters of each: actors, type of certification provided respectively by notaries or the blockchain, criteria adopted to assess creditworthiness and to determine the characteristics of the loan, transaction costs, time horizon, information flows and asymmetries, amounts supplied, risks and returns, collateral provided, and uses for which the loan was requested. We examine whether cryptolending represents a radical structural change that will elide traditional intermediaries or if it could play a complementary role in the overall financial system.

3. Theoretical framework

The financial system performs the essential function of collecting savings and financing investment, fostering capital accumulation and economic growth. Traditionally, in capitalist economies, this function is performed by banks, which act as intermediaries by receiving money from those who save and lending it to those who invest and by creating loans to finance investments resulting in new deposits. The core of finance, however, rests on the relationship between borrowers, who need an advance, and lenders, who are willing to provide it. Finance ultimately consists in a promise to pay (Amato and Fantacci, 2012). Intermediaries are merely instrumental to this relationship.[4] Their function is *ex ante* to assess the creditworthiness of borrowers to prevent adverse selection, and *ex post* to monitor their behaviour in the employment of capital to avoid moral hazard.

Recent historiography has shown indeed that financial activity in the modern era was carried out not only by the first types of specialized intermediaries, such as pawnshops or public banks (*banchi pubblici*), but also by an 'informal' credit network, in which creditors and debtors entered directly into relationship through notaries. In their activity of preparing deeds, notaries acquired a great deal of information about their clientele. They knew who had cash to invest and who needed it to pay taxes, purchase a house or plot of land, or for sundry other purposes. Hence notaries could mitigate the issue of asymmetric information, a criticality in financial markets (Hoffman et al., 1994). The notarial credit market can be defined as 'informal' because it developed outside the formally established institutionalized financial system (which is not to say it did not have its own formalities): notaries were not certified financial agents and did not take any position of their own in the transaction; their role was to certify and authenticate private deeds; brokerage services were added on later, presumably in the second half of the sixteenth century.[5] In this sense, notaries acted as brokers rather than dealers.

Today, the innovations introduced by cryptocurrencies have ushered in a new type of informal credit market represented by decentralized finance, which aims to 'disintermediate' banks in the exercise of the credit function. Computer platforms based on blockchain technology directly connect demand and supply, permitting borrowers and lenders to enter into automatically executing loan agreements (smart contracts) (Mauri et al., 2018).

[3] For a discussion of the rise of cryptocurrencies in the context of the Global Financial Crisis, see Amato and Fantacci (2020).

[4] Indeed, even money itself is ancillary and incidental, since what is advanced may be money but also goods, and payment can be made in either goods or money, as in the case of commercial credit under countertrade agreements.

[5] With the spread of *census consignativus,* after the issuance of the papal bull *Cum Onus* in 1569 (De Luca and Lorenzini, 2018, p. 15).

Table 1
Notarized deeds and loans in Trento and Rovereto (1750, 1760, 1770, 1780).

Year	Trento Notaries drawing up loans	No. of deeds	No. of loans	Loans (%)	Total value of loans (lire)	Average value of loan (lire)
1750	27	806	77	9.5	161,860	2130
1760	28	848	40	4.7	27,886	697
1770	35	1038	78	7.5	97,987	1256
1780	35	1165	110	9.4	165,647	1505
Mean	*31*	*964.25*	*76.2*	*7.7*	*113,345*	*1397*
	Rovereto					
1750	18	1624	248	15.2	406,156	1637
1760	19	1714	231	13.4	391,426	1694
1770	19	1576	251	15.9	395,606	1545
1780	16	1295	212	16.3	383,124	2059
Mean	*18*	*1552*	*235.5*	*15.2*	*394,078*	*1734*

Source: Lorenzini, 2018, p. 108–109. At the time Trento was the capital of the Prince-Bishopric, while Rovereto was under the Habsburg Monarchy.

Modern-era notarized lending and emerging cryptolending schemes may be regarded, therefore, as two comparable forms of 'informal credit' or 'shadow credit'. Both represent an additional channel through which money can be conveyed directly from savers to investors without going through bank-like intermediaries. Cryptolending is still at an embryonic stage of development: its opportunities and threats have yet to be thoroughly appreciated. The analysis conducted in this paper is based on the idea that the peculiar features of cryptolending as a distinct financial practice can be better understood in the light of a somewhat analogous activity that proved highly effective, establishing itself as a complementary system to specialized intermediaries in the pre-industrial age. The following subsections present the distinctive features of each of the two practices, before we undertake a systematic comparison between them.

3.1. Notarized loans in early modern Europe

In the early modern period, an informal lending system slowly took form alongside the formal and institutionalized credit market. The formal credit market, which today we would call 'banking', was controlled by institutions and operators specialized in financial activities, namely pawnshops, public banks, moneychangers, merchant-bankers, and matchmakers (*sensali*). The first bodies, devised with the aim of providing credit, were pawn banks (Monti di Pietà)[6]; they were founded in the second half of the fifteenth century in central Italy and later spread throughout Europe, with the aim of providing free pawn loans to the working poor. They later developed their credit activities by charging interest on money and extending their services to a broader swath of the population.[7] In addition to pawn banks, public banks operated as financial institutions, but with the specific purpose of funding public debt, which was ballooning as a consequence of long and costly wars and the cost of the new bureaucratic apparatus that accompanied the birth of the modern state (Bonney, 1999). The service they performed consisted of collecting capital from citizens and lending it to the government, which would employ it to finance state expenditures (De Luca and Lorenzini, 2018, pp. 169–173).[8] Other qualified actors, such as merchant-bankers, moneychangers, and matchmakers, were also operating within this institutionalized credit framework. The matchmakers were specifically brokers of manufactured goods, cereals, and financial products (Amato, 2008; Fornasari, 2008; Boyer-Xambeau et al., 1991). In the State of Milan they were foreign exchange brokers, in charge of mediating bills of exchange, currency, and other negotiable papers, receiving a commission equal to 1 percent of the brokerage (De Luca, 2010, p. 242); while in the State of Venice their commission was 2 percent of the sum they negotiated (Corazzol, 1986, p.17).

While this highly specialized sector was able to meet various financial needs, both domestic and international, a share of demand, especially local, remained unsatisfied. This gave rise to a 'shadow credit system' able to reach the furthest corners of society. Notaries in particular were able to connect demand and supply of money amongst private citizens, including those who were unfamiliar with financial practices. Unlike the 'formal' financial market, which was institutionalized and clearly identifiable, the 'informal' market was relatively invisible as it operated through alternate channels but nevertheless absorbed the lion's share of credit transactions. It has been calculated that the amount of capital circulating within the notary system in mid-eighteenth-century France amounted to approximately 16 percent of GDP (Hoffman et al., 2019, p. 10). In the same period, four of Milan's best-known notaries drew up contracts for a total of 19,663,229 Milanese lire, equivalent to 3 percent of tax revenues (De Luca and Lorenzini, forthcoming; Bianchi, 1978, p. 188). In 1750, in the smaller community of Rovereto, near Trento (Italy), loans signed before notaries amounted to approximately 406,000 Venetian lire, more than three times the revenue from duties (123,000 Venetian lire) (Table 1).

In the seventeenth-century Venetian mainland, Veronese notaries drew up credit contracts for an amount of money that was equal to a quarter of the revenue of the provincial treasury [*Camera Fiscale*] (respectively: 380,624 Venetian lire and 1,539,088 Venetian lire) (Lorenzini, 2016, p. 126) (Table 2).

In larger cities, such as Milan, loans were growing as a percentage of total deeds in the latter half of the eighteenth century. We see this in the data regarding two prominent notaries, Aureggi and Pizzigalli, where loans as a percentage of total deeds grew, respectively, from 34.04% to 47.22% and from 14.54% to 31.70% (the peak of 61.3% in 1775–1780 is due mainly to a decrease in other types of deeds rather than to an increase in loans) (Table 3).

Even after the emergence of banks, 'informal' credit between private individuals in the rural regions of Valtellina and Ticino accounted for 57 percent compared to 22 percent for banks (Lorenzetti, 2018, pp. 137–160).

Notaries were widely distributed in the territory, and citizens could easily have access to their offices. In 1790-Paris there were 114 notaries for 524,000 inhabitants, or one notary every 4,596 inhabitants (Hoffman et al., 2000, p. 27). In 1825-Milan there were forty-five 'active' notaries in a population of 126,000 inhabitants, or one notary every 2,800 individuals. In the smaller city of Verona in the second half of the seventeenth century, there was one active notary every 500 inhabitants: the smaller the city, the higher the concentration of notaries in relation to the population.[9]

[6] Monti di Pietà were founded by the Friars Minor Observant, i.e., Franciscans. The first Monte di Pietà was established in Perugia in 1462 (Muzzarelli, 2001).

[7] It was in particular with Pope Leo X's bull *Inter Multiplices* issued in 1515, that even the church admitted the legitimacy of charging interest, though moderate (around 5 percent), on a loan. This choice was justified as management expenses, like for instance the payment of the personnel, the payment of rents, and other operating costs. Such a change marked the end to the distinction between credit born of piety and credit understood as an economic act (Fanfani, 2003, pp. 2-7). On the origins and evolution of Italian pawnshops, see Carboni and Fornasari, 2019, pp. 147-170.

[8] Several public institutions dealt with credit during the early modern age. In Italy the most important were Banco di San Giorgio in Genoa, Banco della Piazza di Rialto and Banco Giro in Venice, and Banco di Sant' Ambrogio in Milan. Their activity was mainly focused on deposits, transfers and state financing. They managed fiscal revenues and issued public debt, mainly in the form of backed securities.

[9] 'Active' notary refers to one actually drawing up loans in the benchmark years. In fact, not all members of the guild of notaries (*Collegio notarile*) were practicing the profession.

Table 2
Notarized deeds and loans in Verona (1676, 1681, 1686, 1691).

Year	Notaries drawing up loans	No. of deeds	No. of loans	Loans (%)	Total value of loans (lire)	Average value of loan (lire)
1676	16	3193	241	7.6	358,373	2410
1681	20	3049	269	8.8	497,008	1847
1686	22	2582	248	8.6	459,404	1852
1691	28	2346	184	8.4	207,710	1128
Mean	*21*	*2793*	*235.5*	*8.3*	*380,624*	*1809*

Source: Lorenzini, 2018, p. 125. Verona was part of the Republic of Venice.

Table 3
Milanese notaries Aureggi and Pizzigalli (1751–1785).

Period	Total deeds	Total loans	Loans as% of total deeds
	Carlo Giuseppe Aureggi		
1751–1755	47	16	34.04
1755–1760	98	30	30.61
1760–1765	115	28	24.34
1765–1770	137	54	39.41
1770–1775	96	29	30.20
1775–1780	82	32	39.02
1780–1785	73	34	47.22
	Marco Antonio Pizzigalli		
1751–1755	55	8	14.54
1755–1760	113	28	24.77
1760–1765	114	30	26.31
1765–1770	166	38	22.81
1770–1775	221	53	23.98
1775–1780	106	65	61.31
1780–1785	205	65	31.70

Source: De Luca, 2007, p. 11.

Notaries played a key role within this shadow credit system. Their certification of deeds, as mentioned above, conferred authenticity and public validity on the transactions of private individuals (Bartoli Langeli, 2006, p. 13). However, more importantly, the information that they gathered while drawing up contracts contributed to reducing information asymmetries and transaction costs, enabling a peer-to-peer credit market to grow and spread. Almost all citizens turned to the notary in order to draw up a will, a dowry, a sale, or a loan. Indeed, aristocratic households customarily had their own trusted notary, who – via their descendants - was privy to their vicissitudes from generation to generation, through matrimonial, patrimonial, and financial events. Notaries thus gained deep, long-term knowledge of their clients, acting as advisors, brokers, and sometimes even confessors (Pedani Fabris, 1996, p. 129). [10]

Setting up a loan contract was not just a matter of matching a party seeking money with a party willing to lend it, but required a careful assessment of the degree of reliability of both counterparties. Selecting a trustworthy debtor and an honest creditor reduced moral hazard and adverse selection risks. In premodern peer-to-peer lending, it was information and not the price of money (interest rates) that drove capital allocation. This information was in the hands of notaries. The intermediation costs were intended to remunerate the *ex ante* activities in gathering information on debtors (such as the value of their collateral), and the *ex post* monitoring of borrowers to ensure that they honoured their commitments, and did not employ money in risky activities (Hoffman et al., 2019, p. 274). Both these activities discouraged opportunistic behaviour. In Italian notarial deeds, the names of debtors were often preceded by appellatives such as *degnissimo* [most worthy], *prudente* [cautious], or *legal* [loyal], emphasizing their trustworthiness. Similarly, notaries in Pavia used to specify in their contracts that the debtor was 'a person known to me' or a person of 'great reputation' to underscore the low risk of the transaction made under their supervision. Reputation was a closely guarded value built up slowly over the course of one's life (Wrightson, 2002, pp. 300–303). In 1750 the glassworker Isach Valentino from Trento, for instance, burdened with debts and persecuted by creditors, decided to sell his house, which he specified was 'his only stable effect', in order to honour old obligations and, he added later, to 'preserve his own and his family's reputation' (Lorenzini, 2018, p. 115). The inability or impossibility of settling one's debts could lead to exclusion from the community; credit itself became a means for communicating values such as trust, respectability, and honour (Muldrew, 1998, p. 9).

Information also circulated because notaries themselves travelled; while deeds were often drawn up in the notary's office or house [*in casa di me nodaro*], in other cases it was the notaries who travelled from one village to another, from one dwelling to another. The Veronese notary Africo Clementi used to go to his clients' homes to draw up dowries and wills; in Venice, novice notaries conducted business in gondolas (Pedani Fabris, 1996, pp.132); in Ticino, 'itinerant' notaries moved from bailiwick to bailiwick (Ostinelli-Lumia, 1997, p. 62). Notaries' ability to reduce information asymmetries allowed the credit networks to expand and shift from a personal to an impersonal level, increasing the number of transactions between people who were not personally acquainted. As an example of the growing trust in the assurances of notaries, in late-17th-century Verona, only 10 percent of contracts were signed between members of the same family (Lorenzini, 2016, p. 89). Formal and informal credit markets in premodern societies were not in competition but coexisted and intersected without harming each other.

3.2. *Cryptolending*

In recent decades, the spread of the internet and digital technologies has favoured the creation of new businesses, generically labelled 'fintech', which compete with traditional intermediaries in offering financial services. A new type of informal credit, called 'DeFi lending' or cryptolending, has also developed, which is a form of peer-to-peer lending, allowing for a direct relationship between debtor and creditor through distributed ledger technology (DLT).[11] Unlike the similar practices of the early modern period, where mediation relied on notaries and their knowledge networks, in cryptolending, platforms are designed to facilitate the direct meeting of lenders and borrowers. The financial relationship has progressed in the direction of removing all forms of intermediation, allowing counterparties to enter into and settle loans directly via the vehicle of smart contracts (i.e., automatically executing contracts) registered on DLT.

The development of cryptocurrencies was inspired by the desire to create alternatives to the institutional circuits, dominated by central banks and the private banking system. The underlying idea is to promote a disintermediation in the monetary field similar to what digital technologies have made possible in other arenas. Just as digital platforms have replaced different types of real intermediaries in various contexts, from travel agencies to music shops, so cryptocurrencies, and first and foremost bitcoin, were born out of the ambition to enable direct monetary exchanges between counterparties, without the need for any intermediation.

Insofar as they make it possible to circumvent traditional

[10] For ratio between notaries and population see Lemercier and Trivellato, 2021. On notaries as credit intermediaries in early modern Italy, see: Corazzol, 1986; D'Errico, 1994; De Luca, 2007; Cattini, 2010, pp. 127-142; Lorenzini, 2016. For rural France see Dermineur, 2019. For German territories see Clemens and Reupke, 2009, p. 16-22. For Spain see Carvajal, 2018; Peña-Mir, 2020. For seventeenth-century Brazil, see Wasserman, 2014.

[11] The obvious novelty is represented by the technology enabling peer-to-peer relations, namely the blockchain. Whether there are further differences with respect to previous forms of informal credit, and of what type, it is the purpose of the following comparison to flesh out.

intermediaries, cryptocurrencies can be considered as an 'informal' network, distinct and independent from the 'formal' network of legally recognized, regulated, and supervised credit and payment institutions. However, unlike the informal market of the early modern period – performing a complementary function to pawnshops and public banks –, cryptocurrencies are created with the deliberate intention of offering a radical alternative to the institutionalized market governed by banks and central authorities, which are accused of being ineffective, if not fraudulent (Amato and Fantacci 2020, pp. 5–12). In other words, the development of cryptocurrencies was inspired by the intent to truly 'disintermediate' monetary and financial relations.

The first form of brokering that these newly created instruments seek to circumvent concerns payment systems. The intention is immediately explicit in the title of the white paper published in 2008 under the enigmatic pseudonym of Satoshi Nakamoto, which presents bitcoin as 'A Peer-to-Peer Electronic Cash System' (Nakamoto, 2008). In effect, the real novelty of bitcoin as an electronic representation of value consists in not requiring the presence of a broker in order for such value to be held and transferred. In this respect, it is different from the electronic money that can be kept in banks as a savings or current account, and can only be transferred via a host of other intermediaries who issue cards, produce POS (point of sales) technology,[12] and manage the information systems that transmit the payment orders, guaranteeing their security. In this precise sense, bitcoin had the claim of constituting a form of 'electronic cash': a digital currency, i.e., a pure number, that exists only as an accounting entry in a ledger, but that can be received, stored, or spent in the same way as a banknote or coin, again, without the need for any intermediary.

However, the challenge posed by bitcoin regards not only the payment system, but also, more radically, the monetary and credit system. Its ultimate purpose is to bypass not only the intermediaries involved in the transfer of money but also those responsible for the creation of money and credit: the central bank and the entire private banking system. Some indication of this intention can already be found in the white paper mentioned above, which states that no central bank is required for the issue of bitcoin and that the system aspires to substitute trust with cryptography. Specifically, it is about eliminating any form of 'trusted third party' or intermediate guarantor. Ultimately, in the face of the inefficiencies and failures of traditional intermediaries and authorities that came to the fore during the Global Financial Crisis, bitcoin emerged from the cybernetic project of completely disregarding the human factor of trust in order to build, on a computerized basis, an automated financial system, namely a credit system in which no 'credit' is involved.[13]

The incentive for buying cryptocurrencies has mostly been the prospect of a capital gain, i.e. the expectation of being able to resell them at a higher price. However, another earning possibility has appeared and begun to propagate: direct or platform-mediated cryptocurrency lending at interest. Cryptocurrency loans taken out in the form of smart contracts on a blockchain have started to spread since 2020, growing exponentially in the following two years. Today, the total value of credit contracted in this form is around USD 50 billion. The majority of these (with a value of over 25 billion) are registered on the Ethereum blockchain. Such amounts are still very small when one considers that the total volume of bank loans in the US alone exceeded 16 trillion in 2022.[14]

Like all decentralized finance (DeFi), the objective of DeFi lending is to avoid having to rely on a centralized intermediary, in this case to match demand and supply of loans. The aim is twofold: to reduce transaction costs and to increase confidentiality (Aaramonte et al., 2021, p. 23). The distinguishing features of DeFi lending are that lending is not based on an assessment of creditworthiness by a centralized entity, but on the evaluation of a guarantee on the basis of a codified IT protocol, and the use of smart contracts to ensure the automatic execution of the contract between debtor and creditor (Bartoletti et al., 2021, pp. 553–578).

One of the essential drivers of bitcoin is suggested in an epigraph embedded in the blockchain itself, in the first block, emphatically called 'Genesis block', where we read 'The Times 03/Jan/2009 Chancellor on brink of second bailout for banks'. These were the days of the Global Financial Crisis: from September 2007 to December 2009, the British government injected £137 billion of public money in loans and capital to shore up banks and stabilize the financial system (Mor, 2018). After the bankruptcy of Lehman Brothers on 15 September 2008, also the U.S. Treasury intervened to bail out banks on the brink of insolvency. Similar policies were adopted by governments in most advanced economies, tapping sources of liquidity made abundantly available by the central banks, which inaugurated a season of monetary expansion that continued for over a decade. In evoking bank bailouts, the inventors of bitcoin implicitly denounced a financial system in crisis: having made private profits by exercising a public function, banks forced governments and central authorities to absorb their losses in order to prevent the collapse of credit, monetary, and payment systems on which the entire economic and productive system depends. The promise embodied by bitcoin was to create a new peer-to-peer system, completely horizontal, with no hierarchies and no privileges, governed solely by a computer code, in which the public function of monetary creation and transaction authorization would be carried out in turn by the members of the system themselves in a regime of competition. Fifteen years later, it is worth asking whether bitcoin and its successors have lived up to such ambitions.

In spite of the rhetoric of disintermediation, the cryptolending sector has seen the emergence and growth (and demise) of specialized intermediaries, such as Celsius, BlockFi, Genesis, and Nexo, which managed tens of billions of dollars of cryptocurrency assets, offering services similar to banking: interest-bearing deposits or current accounts in cryptocurrencies, loans secured by cryptocurrency collateral (the collateral required can be very high, up to 200 percent of the loan value, in the case of particularly volatile cryptocurrencies), credit cards (such as the one Visa co-branded with BlockFi offering customers a 1.5 percent cashback in bitcoin on every purchase).

Again, some cryptocurrency loans are contracted directly between those with excess funds to invest and those in need of liquidity, without any intermediary, using smart contracts registered on a blockchain[15] in an arrangement properly called DeFi lending, but we are also witnessing the growth of what is known as centralized cryptolending or CeFi, where some form of intermediation is involved (see Table 4). Whether or not the crypto universe can live up to its goal of removing the perils of human mediation is still very much in question.

4. Two non-bank credit markets compared

In this section, we carry out a systematic comparison between cryptolending and notary-mediated loans with respect to all the relevant aspects that characterize the financial relationship, understood as an advance in view of a payment. Since credit consists ultimately in a promise to pay, the primary aspect and the first that we shall consider is how this promise is written, i.e., its notarization. This regards not merely the technical medium used to record the loan agreement, but also the terms in which it is expressed (e.g., the unit of account) and, more

[12] Cash registers, card readers, and other POS (point of sale) devices.

[13] Cryptocurrencies were designed to address the fragilities of the financial system that were eventually widely acknowledged as factors of propagation and amplification of the Global financial crisis, such as 'the run-prone designs and weak regulation of the markets for securities financing and over-the-counter derivatives; the undue reliance of regulators on market discipline; and the interplay of too-big-to-fail and the failure of market discipline' (Duffie 2019).

[14] Data are registered by DeFi Llama (defillama.com).

[15] According to data provided by statista.com

Table 4
Types of cryptolending.

Service	DeFi	CeFi	Traditional finance
Secured loans	Crypto decentralized lending platforms (Aave, Compound)	Crypto centralized lending platforms (BlockFi, Celsius)	Broker-dealers active in repo and securities lending
Unsecured loans	Crypto credit delegation (Aave)	Crypto banks (Silvergate)	Commercial banks and non-bank lenders

Source: Aaramonte et al., 2021.

generally, the juridical framework that ensures its legal validity and enforceability (Section 4.1).

Another essential feature of finance is its relationship nature (Fantacci, 2017). The second aspect therefore concerns the parties involved in the loan agreement. Who are the borrowers? Who are the lenders? What are their respective characteristics, motivations, objectives, constraints? What role do the intermediaries play in selecting them, assessing their creditworthiness, and arranging the match? Is there a systemic risk and how is it managed? (4.2)

As emphasized from the beginning, finance is an indispensable prerequisite to production and trade. The third element of our analysis concerns the purpose of the loans. Where does the money come from and where is it going? What do the borrowers use it for? What investment will allow them to repay principal and interest? How are the underlying real returns expected to be generated? (4.3)

Risk and returns are a further element. Critical here is the time that elapses between the promise and the payment, which entails uncertainty and justifies a premium for the lender. What are the conditions under which the loan is granted? What is the typical maturity? How are interest rates determined? (4.4)

Creditors will typically require some form of reassurance that they will recoup at least part of the value of the loan, even in case of insolvency. This is the function of collateral. The fifth aspect of our analysis thus concerns the guarantees provided by debtors. Do they offer collateral for the loan? What kind of collateral is provided? (4.5)

Finally, the management of the financial relationship – from the matching of borrowers and lenders and the stipulation of the contract to the final payment that extinguishes the obligation – entails a series of activities and costs. This is where cryptolending promises advantages through a form of mechanization of the entire procedure. The last dimension we shall investigate thus concerns transaction costs. How are they determined? How do they vary? (4.6)

Underpinning all these aspects is the question of trust (Patel and Varma, 2022; Bodo and De Filippi, 2022; Milosav and Nistotskoya, 2022). The financial relationship typically entails faith between borrower and lender, as even the etymology of the word 'credit' suggests.[16] Since their inception with bitcoin, cryptocurrencies aim to create a monetary and financial system that does not rely on a 'trusted third party' and is thus ultimately trustless (De Filippi et al., 2020). Our comparative analysis aims to assess the role of trust in the two forms of credit. Given cryptolending's goal of disintermediating banks, another purpose of our analysis is to appreciate to what extent cryptolending may be regarded as a substitute for or a complement to traditional intermediaries.

4.1. Two forms of notarization

Whereas the instruments in preindustrial informal credit markets were private contracts drawn up by notaries (properly called *censi consegnativi* or *livelli affrancabili*, depending on region), in cryptolending, smart contracts are used. The latter are 'drawn up' in the blockchain and decoupled from bank intermediation, this function being transferred to technology and technological platforms.

Most loan contracts drawn up by notaries in the early modern period were long-term, with a maturity of about five years on average, within a range of roughly six months to ten years or more. Such transactions needed to be certified and preserved for consultation, also by heirs; repayment of debts after decades or generations was not uncommon. Three copies of the contract were drawn up: one for each of the counterparties and one for the notary's archives. In Verona, for example, the Magistrate of the Conservators and Executors of the Laws (*Magistrato dei Conservatori ed Esecutori delle Leggi*) ruled that notaries 'both inside and outside the city' were obliged to write down the 'minutes of their deeds in sewn notebooks and to record them from month to month in protocols that had to be numbered and alphabetized, and which also had to have an index' (Lorenzini, 2016, p. 92). The notary who falsified or failed to properly perform the registration of the deed according to the criteria established by the Guild of Notaries [*Collegio Notarile*] would be expelled from the association.[17] Containing personal details of each party – name and surname, family origin, place of residence, and in some cases the profession and the reason underlying the loan request – deeds represented a precious source of information.

The function of notaries' protocols is replicated in the blockchain, also known as distributed ledger technology (DLT), for bitcoin. The blockchain constitutes a computerized register that allows the notarization (annotation of transactions) that makes it possible to determine ownership of a digital object. However, the word 'distributed' immediately calls forth the main difference between the blockchain and the notary. The notaries' registers are 'centralized', i.e., located in one place, and the protocols, containing the deeds, are kept in their archive, to which only they had access. As public officials, notaries ensured the authenticity and public validity of the deeds by virtue of their own reliability. In contrast, the blockchain ledger is 'distributed': a copy is kept at each node of the network and is accessible to all users; everyone can read it, although only some can write on it, according to a consensus protocol that ensures, thanks to cryptography, the validity of each block of transactions and the immutability of the entire ledger made up of a chain of subsequent blocks (hence the name 'blockchain').

The key value in the notarial register is the respectability of its keepers, the notaries, and, ultimately, of the central authority legitimizing their work. In a blockchain, on the other hand, the key value is an algorithm that ensures the authenticity and inalterability of records. The force of the legal code is replaced by the certainty of the computer code: 'the code is the law' (Adam, 2022). In bitcoin, pseudonyms are used, no reference is made to the personal identities of the counterparties.

Considered at the strictly technical level, before looking at monetary or financial aspects, bitcoin represents a genuine paradigm shift thanks precisely to the technology behind it: through its registration on a public distributed ledger, the blockchain allows the creation of unique digital objects for the first time. The IT revolution had opened the door to abundance, thanks to the indefinite, immediate, and virtually free replicability of any digital object, whether photo, document, film, or music track. Now blockchain technology makes it possible to generate digital objects, whose ownership is uniquely determined by the possession of a cryptographic key and which cannot be shared, copied, or pasted, but only transferred, in the same way as a physical object. It can never be in two different hands at the same time. By virtue of this characteristic, bitcoin has been appropriately equated to a form of 'digital gold'. The analogy is reinforced by bitcoin's intrinsic scarcity, e.g. by the fact that the bitcoin protocol pre-fixes the quantity issued,

[16] Middle French, reputation, commercial credit; from Old Italian *credito*; from Latin *creditum* loan, from neuter of *creditus*, past participle of *credere* (trust, entrust). Merriam Webster Unabridged Dictionary (online).

[17] The purpose of the guild was mutual assistance through actions defined to prevent competition, especially among the brethren, and not least, the consolidation and defence of common property and privileges. But still a task of the guilds was the technical control (Faccioli, 1980, p. 16).

according to a growth path that asymptotically levels out below the threshold of 21 million units.

As regards the monetary function, proponents hold that the uniqueness of each bitcoin and the limit on the total number of bitcoins make them suitable as money through substitution of technology for traditional institutional intermediaries: instead of the central bank, the computer protocol that determines the quantity of currency in advance and issues it according to an unalterable schedule; instead of payment institutions, miners who compete for the task of authorizing a block of transactions every ten minutes in exchange for the allocation of newly issued coins; rather than trust in an intermediary, the certainty of the algorithm that ensures the reliability of the accounting entries on the blockchain. However, it is with respect to its financial goals that bitcoin has fallen far short of its promises, as we explain below.

The quantity of bitcoin is regulated by the computer code. The creation of bitcoin serves the purpose of remunerating 'miners', users who certify transactions. As it is a decentralized system, this function is not always performed by the same actors. In principle, any user can participate in authenticating transactions and receive the respective remuneration in bitcoin. Every ten minutes, newly issued bitcoins in a block of transactions are put up for grabs and are awarded to the user or group of users in a consortium (mining pool) who first manages to solve a cryptographic puzzle.

The number of bitcoins issued per block was initially fifty bitcoins. To prevent excessive growth, the algorithm halves this number every 210,000 blocks, approximately every four years. Fig. 1 shows the resulting growth path, which was defined *a priori* to converge asymptotically to 21 million bitcoins. Today, fifteen years after its launch, a total of just over 19 million bitcoins have been issued and, following three halvings, 6.25 bitcoins are issued for each new block.

Bitcoin was thus devised to be a scarce currency. However, economically speaking, a currency with a predetermined quantity is by no means more stable than one whose quantity is regulated by a central bank: while the latter can make mistakes, the computer protocol cannot correct itself if the programmed supply of currency should prove to be excessive or insufficient. The fixed supply leaves the price to depend solely on variations in demand, which in turn are at the mercy of self-fulfilling expectations: the more bitcoin's price is expected to rise, the more it attracts demand which contributes to driving up its price (and vice versa). Moreover, the inability to increase the money supply in response to growth in the volume of trade makes bitcoin a deflationary currency. Conceived to counter inflationary trends resulting from excessively expansive and generous monetary policies toward insolvent debtors (through quantitative easing and lending of last resort), bitcoin risks causing deflation, which could prove even more damaging.[18] The rigidity of computer code leaves bitcoin unable to adjust to vagaries of the market, thus compromising its ability to replace the central bank.

Paradoxically, bitcoin has failed to be used as a substitute for the payments system, despite the fact that its technical characteristics seem to make it ideal for disintermediation in this sphere. Instead it appears to be a poor medium of exchange: a currency without relatively stable value will not be accepted as payment. Bitcoin has proven even less reliable as a unit of account in credit relationships. A scarce currency is no better than an over-abundant currency; while the latter risks causing inflation (via hyper-expansionary monetary policies), the former leads to deflation, which is even worse because it increases the burden of debt.

The intrinsic volatility of bitcoins has been addressed in second-generation cryptocurrencies, and here we make reference mainly to stablecoins. In principle, because of the stability of their value in relation to an official currency (mainly the dollar), stablecoins would be more suitable as a means of payment as an alternative to traditional intermediaries. They may be particularly advantageous for international payments, where transaction costs are rather high, making retail payments, such as emigrant remittances, particularly costly. Nevertheless, it seems that to date, stablecoins are little used for transactional purposes and much more as a pass-through currency for speculators and as a way of holding liquidity for corporations (ECB, 2022).

Where stablecoins do seem to be gaining ground is in decentralized credit, e.g. in cryptolending practices. Unlike other forms of peer-to-peer lending, cryptolending uses the programmability of cryptocurrencies to enable a direct relationship between debtor and creditor in the form of a smart contract, which is a contract with automatic execution for the protection of both counterparties. The smart contract not only records the mutual commitments of the contracting parties, but also ensures their implementation, for instance by registering the digital asset pledged as collateral for the loan on the blockchain and arranging for its automatic liquidation, as well as the transfer to the creditor of the corresponding sum, in the event of the debtor's non-payment (Muayad and Abumandil, 2022).

4.2. Borrowers and lenders

Except for the poorest, whose credit demand was met by pawn banks or pious institutions, people of all social classes participated in the credit market mediated by notaries. The *sine qua non* for access was property that could be used as collateral.

On the supply side, lenders could be from the patrician class, but also businessmen, merchants, widows, institutions, and religious bodies. Convents and monasteries in particular enjoyed large amounts of liquidity coming from testamentary legacies, bequests, and, for women's orders, dowries. The gradual softening of the church's attitude toward interest-bearing loans led religious bodies to make credit a source of income and, for some of them, the main source of livelihood.

The demand side was much more heterogeneous: cash-strapped nobles, peasants, or artisans (blacksmiths, carpenters, shoemakers, bricklayers, goldsmiths, etc.). Normally considered alien to the financial world, also women (married, unmarried, or widowed) partecipated in this market, (Lorenzini, 2021, pp. 193–213; Pompermaier, 2022). In eighteenth-century Rovereto, then in the heyday of the silk industry, creditors mainly came from the trade sector (manufacturers or merchants) but also included patricians (they too often engaged in manufacturing activities), and city institutions. Debtors were likewise tradesmen, shopkeepers, as well as members of the aristocracy. Nearby Trento, which was the seat of the bishopric, hence a city with an administrative function, was economically less dynamic and the borrowers were mainly farmers or institutions, especially municipalities in the neighbouring valleys. On the supply side, operators were chiefly patricians and ecclesiastical bodies.[19]

Eighteenth-century Milan represented a quite different scenario. The city was one of the most financially advanced on the Italian peninsula and one of the first to industrialize. Its lending system was thriving, brisk, and modern. The credit market operators came from the wealthy class in which it became difficult to distinguish between nobles and bourgeoisie. An emerging middle class, endowed with a lively entrepreneurial spirit, had a firm grip on political and economic life: physicians, engineers, lawyers, notaries, accountants, architects, and merchants, both as creditors and as debtors, populated the peer-to-peer lending market.

Today it is computers coupled to the internet that facilitate access to information and accelerate its circulation. However, because of the horizontal nature of the network and social media, information is not always secure and controlled, therefore the use of cryptolending remains

[18] The ideological underpinning of scarcity as a design feature of bitcoin, and its possible implications, both intended and unintended, are more amply discussed by Amato and Fantacci (2020, pp. 49-52).

[19] In one year, 1760, the nobleman Leonardo Piomarta de Langenfeld lent more than 45,000 florins (225,000 Venetian lire) in a score of transactions, most to finance the surrounding municipalities (Lorenzini, 2018, p. 105).

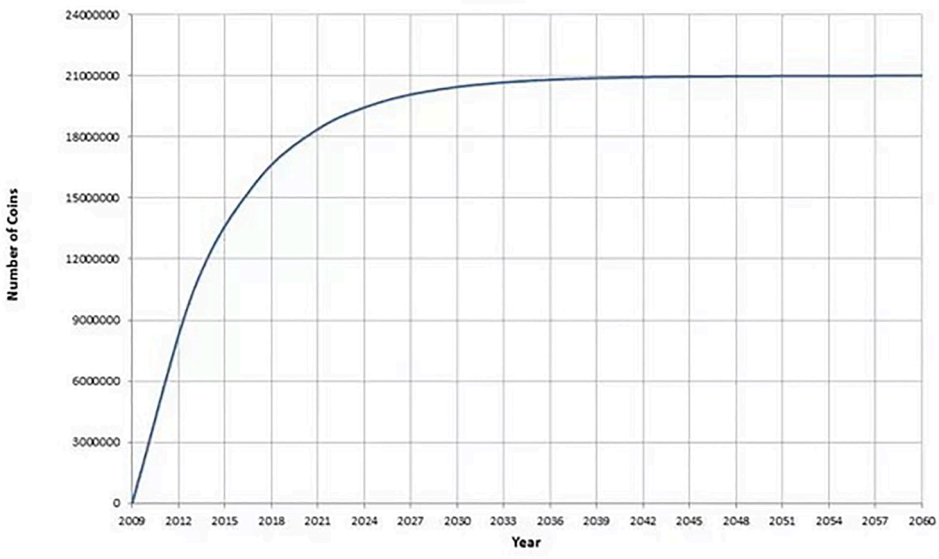

Fig. 1. Number of issued bitcoins.
Source: cointelegraph.com

largely confined to a limited niche. Also the service of matching lenders and borrowers is concentrated on a relatively small number of platforms: even though the number of service providers has ballooned to over two thousand, the majority of the funds are secured by the ten largest (Fig. 2).

Notary-mediated credit has been compared to the dark matter of the physical world: though invisible, it covered the bulk of credit transactions. For cryptolending this is not (yet) the case: it is a marginal market, although the development of the metaverse may increase its importance in the future. While lending through notaries was for many, cryptolending is still for a few; a democratization of credit has not been achieved.

4.3. *Where the capital is employed*

Thanks to the certification and registration of credit contracts in notarial registers, which preserved records of transactions, loans could have maturities of 10 years or more. The average however ranged between 4 and 6 years. The structure of maturities depended in part on borrowers and where the capital was employed. In Ancien Régime economies cash was chronically scarce and the reasons underlying a debt were diverse (Kindleberger, 1985, p. 17). Money was borrowed for everyday necessities, e.g., to pay arrears, tributes, to repair or buy a house or a plot of land, to purchase working equipment, to create a daughter's dowry, or 'for the remedy of my pressing needs' (Carvajal, 2018, p. 205). In eighteenth-century Valladolid, farmers got into debt to maintain their land and cope with exceptional events such as storms that damaged harvests (Carvajal, 2018, p. 215).

Notarized loans were very critical tools also for long-term investments, such as building infrastructure (roads, bridges, canals), establishing new partnerships or firms, or modernizing technology. In 1771, for instance, Marco Antonio Chiappone asked for 3,250 Milanese lire to open a silk factory in Civate Pieve di Oggiono, part of the Duchy of Milan. Similarly, Dario Gio. Batta and his son went into debt for 2,000 Milanese lire 'to increase a drapery shop' in Piazza del Duomo. Angelo and Giulio Carlo Caldara asked for a loan of 14,000 Milanese lire to 'set up a company […] for the construction of a spinning wheel for a silk mill' (De Luca and Lorenzini, forthcoming). A few years later, in 1780, the mayor of Cremona asked for a loan of 33,500 lire to build the road linking Cremona to Mantua. In the early years of the following century, the Lorini-Marocco irrigation canal was constructed using money raised on this credit market. Specifically, Ignazio Besana, as the representative of his brothers in the Balabio & Besana company, borrowed 30,000 lire at a rate of 5.5 percent per annum for 5 years from Giovanni Battista Camagni to excavate the canal. Notaries were able to mobilize large amounts of capital, which became fuel for modernizing local economic activities in the absence of banks. The 'informal' lending system proved pliant and effective, able to sustain economies in time of crises, as credit could easily be renewed or transferred through subrogation, and to be propulsive in times of growth, funding agriculture, industry, and trade.[20]

Unlike notary-mediated peer-to-peer lending in the early modern economies, cryptolending, in spite of its initial impetus, today plays a very marginal role. The volume of DeFi lending increased steadily in the first few years, reaching a maximum of 180 billion dollars toward the end of 2021. After experiencing a further inflow of capital at the beginning of 2022 (Brookins, 2022), cryptolending was hit by the broader crisis of cryptoassets in early 2022, and has hence stabilized around a total value of around 40 billion dollars (Fig. 3).

The use of DeFi lending has been mainly confined to investments on the cryptoassets market. In other words, those who have borrowed stablecoins through DeFi lending platforms did it mostly to leverage investments in other cryptocurrencies in order to obtain capital gains on the expected appreciation of the latter (Xu and Vadgama, 2022). This does not mean that DeFi lending is completely disconnected from real economic activities. Investment in this market can also be made by ordinary economic actors, such as companies wishing to find a more profitable way to manage their liquidity or even individuals willing to take the risk of entrusting their investments to unregulated instruments in order to receive a higher return. Moreover, the knowledge required to assess the risks (technological and financial) in the use of these instruments is by no means trivial. This should discourage those who are not adequately informed from using them.

[20] Noteworthy is the role of notaries in time of critical junctures such as the years of conflict in France, (1648-1659; 1756-1763). The Monarchy was able to borrow and to cope with liquidity shortage thanks to notaries who acted as financial brokers on primary and secondary markets for public and private debt. (Beguin, 2018, pp. 193-194).

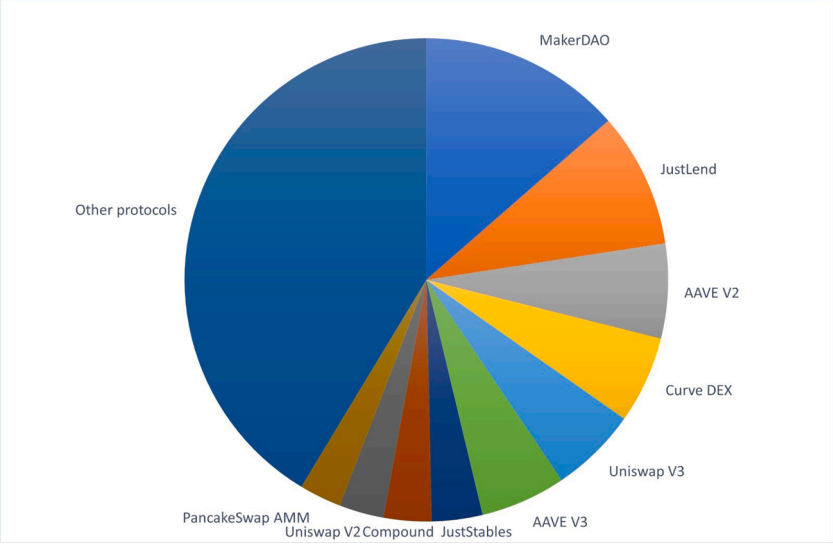

Fig. 2. Market share of major DeFi protocols.
Source: authors' elaboration on data provided by defillama.com (August 2023).

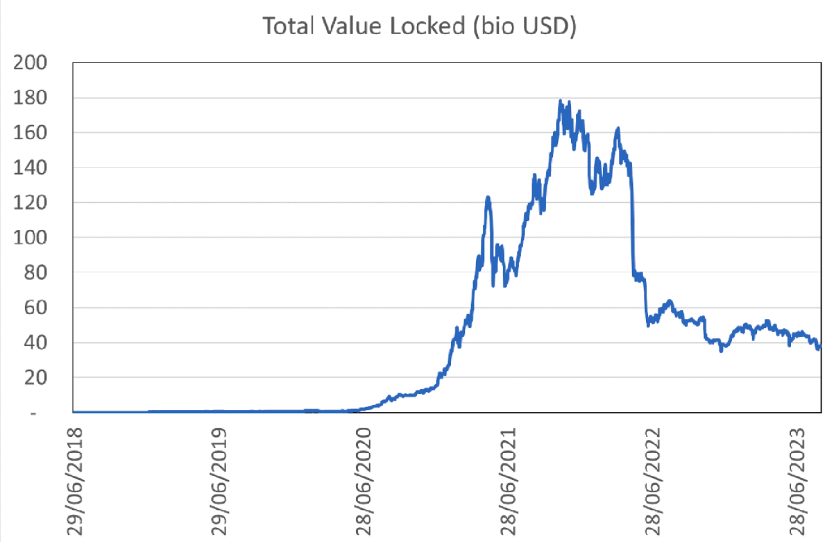

Fig. 3. Total DeFi lending volume.
Source: Authors' elaboration on data provided by defillama.com.

4.4. Risks and returns

Although many countries of early modern Europe were highly influenced by the Church and prohibitions against interest-bearing loans, credit was a common practice, even amongst religious bodies.[21] Various strategies were put in place to circumvent bans on usury. It was very likely medieval notaries who devised a kind of contract that enabled money lending between individuals, always in the form of credit backed by collateral.[22] Originally two different deeds, stipulated at different times, established a credit contract: the first one was an *emptio* (sale) and the second a *locatio* (rent) of real property. They were later incorporated into one document known as an *emptio cum locatione*, literally a 'sale with lease' (Collodo, 1940, p. 196).[23] Successively the clause of redemption (*affrancatio*) was included, which enabled borrowers to regain ownership of the property put up as collateral once they had repaid the debt. During the timespan stipulated in the contract, the borrower had to pay an annual rent (in two six-month instalments), which essentially corresponded to interest on the capital.

The interest rate ranged between 3 and 7 percent, with an average of 5 percent,[24] across different European nations such as France, Germany, Spain, and Holland (Lorenzini et al., 2018). It was a good rate if compared to the more traditional investments in land, which yielded between 3 and 5 percent. It was easier to manage and more profitable than investment in the Mint, where deposits yielded between 3 and 5

[21] As mentioned above, abbey, convents and monasteries made interest-rate loans one of their main sources of income.

[22] More precisely, in the second half of the thirteenth century, when the word 'mutuum' (loan) was banned by the Church and notaries could not use it any longer in their contracts (Collodo, 1940, p. 196). It came into use again only five centuries later, in the eighteenth century.

[23] In the seventeenth century, the interest rate was clearly spelled out in the formula 'in ragione di [5%]'.

[24] As in other towns like Belluno, Feltre, or in the Trentino region.

Table 5
Interest rates on cryptocurrency loans charged by major platforms.

Cryptocurrency	Platform			
	BlockFi	Celsius	Abra	Nexo
Bitcoin	4.50 %	6.25 %	3.15 %	4.00 %
Ether	0.25 %	3.25 %	3.65 %	4.00 %
Tether (Stablecoin)	9.50 %	10.00 %	9.00 %	10.00 %
USD Coin (Stablecoin)	8.00 %	10.00 %	8.00 %	8.00 %

Source: Fonda, 2021 (www.barrons.com).

percent (Pezzolo, 2006, pp. 89–91). [25] It was also more remunerative than deposits in pawn banks (Monti di Pietà). The relation between interest rates and capital suggests that they were indirectly proportional: the higher the sum, the lower the rate. In eighteenth-century Milan, Domenico Rocca paid 6 percent for a loan of 2,158 Milanese lire, while the count Antonio Greppi paid 4 percent for a loan of 106,500 Milanese lire (De Luca, Lorenzini, forthcoming). In seventeenth-century Verona, compared to the 3,250 ducats given on credit by Count Bailardino Saibanti to Leonardo Iuvani at an interest of 4 percent, Cesare Borchia lent 25 ducats to Bernardo Molani di Monte at 6 percent (Lorenzini, 2016, p. 251). The negative correlation between capital and interest rate may be attributed to the fact that those who borrowed large sums were usually members of the elite, backed by solid collateral.

Lending bitcoins can generate annual returns of between 3 and 8 percent, while stablecoins can yield up to 10 percent (Table 5). Other lesser-known and less popular cryptocurrencies (altcoins) can generate even higher returns. These are attractive figures, especially in an environment where interest rates are very low and it is difficult to find profitable investments. However, a comparison is not possible, as the return must always be compared to the risk and, for this kind of instrument, there are no reliable risk assessment models.

Cryptocurrency loans offer returns that are on average much higher than the interest rates charged on loans in official currencies. On the large platforms that collect tens of billions of dollars in cryptocurrencies, the ability to remunerate depositors is based on revenues from arbitrage activity exercised on a large scale and in highly inefficient markets, where there are large differentials between the price offered and the price demanded. Moreover, intermediaries who collect deposits in cryptocurrency often reserve the right to use the funds collected as collateral for other loans. On DeFi platforms, the lenders are remunerated directly from the interest paid by the borrowers (although the fact that deposits are roughly twice the volume of loans should squeeze returns).

The main risks associated with DeFi lending stem from several weaknesses. The first concerns the very nature of the stablecoins that are the subject of the loan. Stablecoins constitute, in effect, liabilities of the issuer covered by assets whose composition is not (yet) subject to adequate transparency and supervision. As a result, a liquidity mismatch can occur: in addition to on-demand liabilities, issuers may hold less liquid assets, such as government bonds or even loans. Moreover, in the event of a 'run on the counter' in the form of a request to convert stablecoins into official currency, issuers cannot even rely on adequate safeguards along the lines of the deposit guarantee enjoyed by traditional banks (Aaramonte et al., 2021, pp. 30–31).

4.5. Virtual vs real collateral

The contracts drawn up by notaries were mostly loans secured by a property yielding an income, which had to be worth a third more than the sum loaned. Such property was most commonly a plot of cultivated land, a house, a workshop, a mill, etc. Collateral, together with reputation, was the discriminating factor in granting the loan (Hoffman et al., 2019). In the most thriving economies, the mortgage could be on movable assets, rents, duties, tithes or 'the right to tithe', future profits, or census contracts themselves (De Luca, 1996, p. 112). There was a shift from the rigid view that land was the best form of security against the risks of a monetary loan to an acceptance as collateral of any potentially profit–generating asset. It was the expression of a new mentality that helped to make the credit market more liquid and transactions faster. The greater 'liquidity' of the system did not necessarily mean greater risk; it was a market that had defences put in place by the notary. Faced with a borrower unable to honour the debt, the notary was able to find a new lender willing to take over from the previous one (a sort of subrogation), to have the loan renewed, or to extend the maturity.

The *censo consegnativo* (or *livello affrancabile* on the Venetian mainland) was one of the most widely used financial instruments on the Italian peninsula since the second half of the sixteenth century, after the papal bull *Cum Onus* in 1569. The document defined criteria of acceptability for interest-rate loans, thus legitimizing them. It also set a maximum interest rate of 7 percent and added a clause of redeemability for borrowers.[26]

The majority of DeFi loans are secured and generally the collateral demanded is worth more than the loan disbursed (this is referred to as 'overcollateralization'), as the cryptoassets offered as collateral can be extremely volatile in value. Unlike early modern informal lending, the collateral offered is not real estate, such as a plot of land, a house, a shop, but other cryptocurrencies. In some cases, the smart contract also provides for the automatic liquidation of the asset if its price falls below a certain threshold, determined on the basis of the value of the loan. Unsecured loans called 'credit delegations' are also available on some platforms, although they mostly take place only between parties with previous off-blockchain economic relationships.

4.6. Intermediation costs

Unlike specialized financial intermediaries, such as merchant-bankers or money changers, notaries acted 'informally' as brokers and did not charge commissions for their service.[27] The notaries' interest in making a successful transaction lay in retaining customers, increasing their own reputation, and consequently expanding their business.[28] Drawing up a deed had an implied cost, essentially the price of the contract, varying on the basis of duration and amount, and a tax. This meant that going to the notary to sign a loan was advantageous only above certain amounts. In seventeenth-century Verona notarized loans were worth over 50 ducats. The annual income of a labourer in a 250-day working year was around 40 ducats (Lorenzini, 2017, p. 12). The price of contracts set by the Venetian Republic in 1605 was 3 lire for a notarial deed up to 100 ducats and 21 lire for deeds of 2 to 3000 ducats for 'sales [which we may assume included the aforementioned *emptio cum locatione* for collateralized loans], exchanges, dowries, donations, renunciations, cessions, redemptions, and divisions'. Above 3000 ducats, the fee increased by 3 lire for every 1000 ducats, up to a maximum of 50 lire.[29] A tax, the *datium instrumenti et testamenti*, was

[25] Mauro Carboni and Massimo Fornasari similarly point out that from the end of the seventeenth century in Bologna, public securities lost their attractiveness due to falling interest rates. This led families to seek new uses for their capital (Carboni,Fornasari, 2010, p. 161).

[26] On *census consignativus* see, among others, Alonzi, 2011.

[27] At the moment there is no evidence that notaries got paid a commission for their intermediation service, although it cannot be completely ruled out, see Carboni, Fornasari, 2010.

[28] As Giuseppe De Luca states: 'It is precisely in the management of these reputational mechanisms that notaries found the microeconomic incentives, in terms of retention and customer growth, that drove them to provide reliable and accurate references with the result of making this market expand' (De Luca, 2007, p. 14).

[29] The official unit of account in the Venetian Republic were the Venetian lira, divided into 20 *solds* and 240 *dinars,* and the Ducat of 6 *lire* and 4 *solds*.

then added to the price: for deeds of less than 100 ducats, the tax was 12 soldi, doubling for deeds between 100 and 500 ducats and further increasing by half a ducat for contracts over 500 ducats.

One of the motivations that led to the development of distributed ledger technology in the first place was precisely to wipe out the costs of intermediation, thanks to the possibility of bypassing traditional intermediaries and mechanizing the notarization and the execution of monetary and financial transactions. In principle, therefore, the costs involved in cryptolending should be limited essentially to two components: the costs of validating transactions on the blockchain and the costs of running the smart contracts.

Let us start by considering the first component, the transaction costs. In the traditional banking system, where bookkeeping is centralized, a fee is paid to the intermediary precisely for the service of preserving and updating the records in a safe and reliable manner. Distributed ledger technology allows this same function to be performed by the members of the network, according to the consensus algorithm, remunerating them with the issuance of new tokens. In principle, therefore, transaction costs could be zero for the counterparties involved in the transaction, since they are covered by newly created currency (i.e., by seigniorage). Nonetheless, in most blockchains, users are required to sustain fees to regulate access to the scarce resources of the network: since there is a limited number of transactions per second (TPS) that each blockchain can process, fees are imposed to avoid spamming. This can be done by introducing a fixed charge that everyone must pay to transact on the blockchain and/or by requiring users to offer a voluntary tip to the validators in order to gain priority for their transaction and accelerate its execution. This type of cost is clearly proportional to the congestion of the network.[30]

However, cryptolending does not involve just plain transactions on blockchain, but smart contracts, i.e., transactions that are automatically executed according to predetermined rules. Smart contracts run only on specific types of blockchains and require processing power. The cost of running a smart contract depends on its complexity and hence on the computational effort that it absorbs. The second component of cryptolending costs reflects, therefore, the costs of running the underlying smart contracts. Overall, the costs of smart contract deployment on Ethereum, the most widely used blockchain, has been estimated to be between $500 and $5000, depending not on the value of the transaction but on the complexity of the contract.[31]

5. Discussion of the main findings

Our comparative analysis of cryptolending and credit stipulated by notaries in early modern Europe highlights the analogies and differences between the two practices, with a view to better understanding the character of the innovation implied by decentralized finance in its relationship to conventional finance. The main dimensions of the comparison are summarized in Table 6.

What is perhaps most striking, at first sight, are the similarities that an apparently absolute innovation like cryptolending bears to a financial practice that originated over five centuries ago. It is these resemblances that justify the comparison in the first place. Both cryptoloans and notarial loans can be characterized as 'informal credit', since they do not originate in and are not managed by formal, specialized institutions. In this sense, they have been even described as a form of 'shadow banking'.

Secondly, and perhaps more significantly, both are forms of peer-to-peer credit: they involve a direct relationship between creditor and debtor, with no financial brokering, i.e., no intermediaries lending and borrowing money, taking positions on their own behalf, or recording credits and debits on their own balance sheets. Indeed, in both cases, intermediation may be understood as 'matchmaking': unlike formal credit institutions, both notaries and blockchain platforms act as brokers rather than dealers. The purpose of both is to facilitate the encounter between borrowers and lenders and the establishment of direct contact between them.

Table 6
Itemized comparison of notaries vs. exchange platforms.

Elements	Notaries	Exchange Platforms
Notarization	Notarial protocols	Blockchain
Borrowers/lenders	All asset owners	Only cryptocurrency owners
Capital employment	All economic activities: agriculture, manufacturing, tax payments, etc.	Speculation in cryptoassets
Interest rates	3–7 %	0.25–10 %
Collateral	Movable and immovable assets	Cryptocurrencies
Basis of inter-counterparty trust	Personal relations with notary	Automated procedures built into the algorithm make trust unnecessary
Relation with institutional intermediaries	Complementary	Substitutive

Notarization is another obvious analogy: both the notary and the blockchain act as a third party, as a guarantor of the bilateral relationship between debtor and creditor by keeping an official record, which – according to the state of art of the time – is immutable, not subject to falsification, enforceable, visible to all,[32] and yet capable of preserving the confidential character of the transaction.

Both the network of notaries in early modern Europe and networks of computers connected to a DLT today contribute to the reduction of transaction costs between borrowers and lenders by allowing the sharing and transfer of information. As a consequence, both types of informal credit instruments are capable of offering higher returns to lenders compared to formal instruments, while ensuring universal accessibility to borrowers.

A final common feature is the existence of some form of collateral, albeit of different nature in each case: in notary-mediated credit it is real property, typically some form of real estate; in cryptolending it is a digital asset, specifically a cryptoasset.

On closer inspection, a number of significant differences appear beyond the apparent analogies. The two practices perform similar functions in very different ways, following from their very different nature as financial instruments. Notaries decrease transaction costs by reducing information asymmetries thanks to their personal acquaintance with the parties; cryptolending platforms decrease transaction costs by automating the origination and execution of credit contracts.

A further significant difference lies in the grounds for granting a loan: on the one hand, the creditworthiness of the borrower assessed by the notary on the basis of information he has acquired and certified by his reputation; on the other, the certainty of the collateral pledged on the blockchain.

Trust is key in the informal credit of the early modern period: not only confidence in the ability of the debtors to repay their loan, but also upstream trust in the ability of the notary to identify and present creditworthy borrowers to willing lenders (Burns, 2005). By contrast, cryptolending is conceived, like bitcoin, with the deliberate intention of doing without any form of trusted third party and ultimately of eliminating trust itself from the financial relationship, which is 'entrusted' to automatized procedures.

Notaries are the guarantors of the legal form of a contract, and specifically of the debt contract. Their function is entirely inscribed within the juridical system: they are representatives of the law who take

[30] https://www.bitcoin.com/get-started/what-are-transactions-fees/
[31] https://www.antiersolutions.com/smart-contract-deployment-on-ethereum-estimated-cost-key-factors-to-consider

[32] Notaries were depositaries of *publica fides* and their deeds were public documents, with legal value in Court.

their authority from the law and who operate in observance of the law. Cryptocurrencies, instead, originate in the desire to make monetary and financial relationships possible and enforceable without any legal form or any specific jurisdiction, thanks to the automatic execution of algorithms on a computer network where 'the code is law'.

The purpose of loans, and consequently their time horizon, also differs widely: debts contracted through notaries could last years, especially when they were used to fund major real estate purchases, start new businesses, or invest in industry or infrastructure; by contrast, cryptolending has been primarily restricted so far to short-term loans to finance trading in cryptoassets. Unlike the typically long-term notarized loans in the early modern period, cryptolending is characterized by instantaneity.

Overall, the informal credit of preindustrial Europe was strongly anchored to real economic activity, whereas cryptolending is essentially confined to self-referential speculative networks. Indeed, credit brokered by notaries represented a significant, sometimes even predominant share of total financial activity, whereas cryptolending volumes are trivial in relation to the size of the financial system today.

However, it is not just a matter of relative size, but also of the type of relationship between 'informal' and 'formal' credit systems. Notarial loans in early modern Europe are seen as a complement to, rather than a substitute for, the finance provided by pawnshops or merchant bankers. Conversely, cryptolending is frequently represented, particularly by those who practice it, as an alternative to traditional banks, aimed at undermining their oligopoly and ultimately replacing them entirely.

6. Conclusions

In the light of what we have discussed above, we can return to the original questions motivating our research: Does cryptolending represent a structural change in the financial system or is it a mere technological innovation that leaves the underlying financial relations unaltered? Should it be regarded as an alternative or a complement to formal finance? How does it impact, directly and indirectly, the business model of traditional banking intermediaries?

Our aim was to assess the true novelty of current practices and to understand if, and in what direction, the technological innovation represented by DLT can effectively produce a structural change in the financial system. Our comparative analysis has shown that, like early modern practices, cryptolending may indeed contribute to reducing transaction costs, albeit by vastly different mechanisms. However, it can in no way substitute the trust which is intrinsically involved in financial relations. We therefore conclude, in contrast with most conventional views of decentralized finance, by suggesting that cryptolending should be viewed as a complement, rather than an alternative, to the institutionalized financial intermediaries.

Trust and reputation are the connective tissue of the social body. They are critical factors in the exchange of money; credit is itself a powerful vector through which these values circulate (Muldrew, 1998, p. 5). On the other hand, cryptocurrencies aim to create a 'trustless' monetary and financial system relying exclusively on the technical certainty of smart contracts. The purpose of substituting technological mechanisms for interpersonal trust responds to the desire to solve the problem of uncertainties arising from human weaknesses, dishonesty, and ignorance. There is, however, a persistent unpredictability in this system that does not derive from the behaviour of the counterparties and which must nevertheless be addressed, such as periodic financial crises or catastrophic events such as a pandemic or a war. The conditions affecting the executability of contracts will always have some degree of indeterminacy and there is an unavoidable need for flexibility and trust between counterparties. Lending without intermediaries is possible, for instance, between people who know each other well, such as members of the same family, or within a small local community, where the value of reputability within a limited and tight-knit group incentivizes rectitude. However, extended to a broader and even global scale, the credit market cannot circumvent intermediation – and indeed DLT systems have tended to quickly recentralize and re-introduce the role of intermediaries – if only for the provision of reliable and relevant information regarding the structuring and continuation of the relationship between the parties.

According to the cryptolending philosophy, the intermediary must be excluded from the equation. Yet the problem is not brokerage itself, but rather that the intermediary can obtain an advantageous position without offering value-added services: information first and foremost.

Cryptolending today presents itself as a system that is still immature, that requires regulation, standardization, and above all a review of some of its underlying principles. The etymology of the term 'credit' dates back to ancient Sanskrit, in which *çrad,* has the same root as *cor/cordis* (in latin), which means heart and refers to faith: a credit market without this essence becomes hard to sustain.

CRediT authorship contribution statement

Luca Fantacci: Conceptualization, Data curation, Supervision, Validation, Writing – original draft, Writing – review & editing. **Marcella Lorenzini:** Methodology, Validation, Data curation, Supervision, Writing – original draft, Writing – review & editing.

Data availability

No data was used for the research described in the article.

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