

DIRITTO DELL'ECONOMIA

Collana diretta da
Eugenio Picozza e Raffaele Lener

BEYOND MICA

An overview of developments on crypto-assets

edited by

Maria-Teresa Paracampo



G. GIAPPICHELLI EDITORE – TORINO

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DECENTRALIZED LENDING PROTOCOLS AND REGULATED BANKING SERVICES

by *Raffaele Lener*

SUMMARY: 1. Regulatory issues of lending protocols. – 2. Functioning of lending protocols. – 3. *Collateral*. – 4. *Non-custodial* services. – 5. The similarities between lending protocols and bank-reserved activities. – 6. Preliminary notes on the possibility for lending protocols to be considered performing bank-reserved activities. – 7. The need for legislative reform.

1. *Regulatory issues of lending protocols*

Lending protocols (also referred to as *lending and borrowing* protocols) occupy a liminal space between private ordering *by code*¹ and activities traditionally reserved to licensed credit institutions. Their architectural premise is straightforward: thanks to the service offered by a decentralized autonomous organization (DAO)² users supply and obtain credit through smart contracts that operate without custodians, order-matching intermediaries, or a managerial center. This functional disintermediation strains long-standing categories in financial regulation, which presuppose (i) clearly identifiable “funds” being handled or transformed and (ii) a professional provider bearing duties of prudence,

¹ Reference is made to the slogan “code is law” originates in Lessig’s account of cyberspace, where software architectures (“code”) structure and constrain behaviour as effectively as legal rules—indeed, often more efficiently and invisibly than statutes or contracts (L. LESSIG, *Code and Other Laws of Cyberspace*, 1999; rev. ed. *Code 2.0*, 2006). In decentralised finance, the maxim is frequently invoked to suggest that smart-contract logic exhausts the relevant normativity: rights and obligations are what the code executes, and nothing more.

² The corporate law profiles and issues characterising DAOs have already been extensively examined in R. LENER, S.L. FURNARI, *Prime riflessioni su DAO e principi generali del diritto dell’impresa*, in *Riv. dir. priv.*, 3, 2022, 335-350, to which reference is made. On this matter, see also R. LENER, S.L. FURNARI, *DAO e impresa collettiva*, in B. DE DONNO, F. RAFFAELE (eds), *Saggi di diritto societario e finanziario delle nuove tecnologie*, forthcoming; U.W. CHOHAN, *The Decentralized Autonomous Organization and Governance Issues*, 2017; S. HASSAN, P. DE FILIPPI, *Decentralized Autonomous Organization*, in *Internet Policy Review*, 10, 2, 2021.

capitalisation, integrity, and governance. The result is a tension between person-centred regulatory concepts and IT-based financial infrastructures whose relevant conduct is, to a large extent, machine-executed.

Two preliminary ambiguities frame the analysis. First, the legal status of the assets mobilised within these systems is unsettled. Protocols may operate with volatile crypto-assets, with stablecoins designed to approximate fiat value, or with tokenised claims against off-chain money. Whether these heterogeneous instruments qualify as “funds”, “deposits”, “electronic money”, or mere digital commodities conditions the applicability of banking-law concepts and associated prudential duties. Secondly, the non-custodial and automated design of leading protocols frustrates the search for an accountable “operator”: the smart contract enforces collateralisation, accrues interest, and liquidates positions pursuant to pre-set rules, while governance—where present—is widely dispersed. Absent a determinate professional counterparty, the conventional allocation of responsibilities for conduct-of-business, capital requirements, and organisational safeguards risks becoming ineffectual.

This paper situates decentralised lending within the broader debate on the legal character of decentralised finance (DeFi)³ and its regulatory touch-points with bank-reserved activities. It advances the claim that the self-executing nature of lending protocols complicates—without necessarily foreclosing—the extension of existing frameworks on authorisation, own funds, internal controls, and accountability. In particular, where protocols rely predominantly on stable-value instruments, functional equivalences with traditional credit intermediation become more salient; yet, the absence of custody and the programmability of risk management (e.g., liquidation engines, oracle-driven pricing, and algorithmic interest-rate curves) continue to undermine the prerequisites for attributing legal responsibility to a human or corporate subject.

Lending protocols raise specific regulatory issues.

Looking at the entire DeFi sector in which these protocols operate, it should be noted that lending protocols are not the only protocols that exist in this sector. The specification ‘lending’ is, in fact, nothing more than a classification label. As with crypto-assets, protocols can also be classified on the basis of the individual service offered. Among the most common types today are ‘*exchange protocols*’, i.e. protocols that offer exchange services in the broad sense of crypto-assets, and ‘*yield aggregator*’ protocols, i.e. protocols that aim to optimise the

³ See, on this matter, among others, S.L. FURNARI, *La Finanza Decentralizzata. Cripto-attività, protocolli, questioni giuridiche aperte*, Roma, 2023; E. PRANDIN, *Decentralized Finance: A new challenge for Regulators*, Bocconi Legal Papers, n. 16, 2021, 51-62; S. BOYKEY SIDLEY, S. DINGLE, *Beyond Bitcoin*, London, 2022.

asset management of crypto-assets by ‘depositing’ them in protocols where a higher return is offered⁴.

All protocols have common characteristics and, therefore, common regulatory issues. The study of *lending* protocols is therefore also useful for the study of other protocols and, ultimately, of the entire sector.

2. Functioning of lending protocols

To give a *concise* (and somewhat non-technical) definition, ‘lending protocols’ are applications used in the decentralised finance sector to offer services very similar to those offered in traditional finance by credit institutions⁵.

Thanks to these ‘tools’, a mass (indistinct and unidentified) of individuals can interact and, in principle, enjoy the same services as a bank’s customers.

But is this really the case? In this regard, some technical and IT background is necessary to fully understand the legal issues involved.

The term ‘protocol’ is used to highlight that these tools work thanks to *smart contracts*⁶ (i.e. computer algorithms running on a *blockchain* network). More

⁴ S.L. FURNARI, *La Finanza Decentralizzata*, cit., 59 ss.

⁵ Another relevant difference from credit institutions lies in the fact that lending protocols are not usually operated by a traditional company. From a legal perspective, a lending protocol may instead be classified as a Financial Protocol DAO, as extensively discussed in S.L. FURNARI, C. VILLANI, *Regulation of Financial Protocol DAOs: Addressing the Problems of Decentralization and AI Governance*, in *Decentralized Autonomous Organizations – Governance, Technology, and Legal Perspectives*, Springer, 2025.

⁶ S.L. FURNARI, *Validità e caratteristiche degli smart contract e possibili usi nel settore bancario finanziario*, in E. CORAPI, R. LENER (a cura di), *I diversi settori del fintech*, Padova, 2019, 89-110; F. SARZANA DI S. IPPOLITO, M. NICOTRA, *Diritto della Blockchain, Intelligenza Artificiale e IoT*, Milano, 2018, 90-114; M. RASKIN, *The Law and Legality of Smart Contracts*, in *Georgetown Law Technology Review*, 1, 2017, 306 ss., disponibile su SSRN: <https://ssrn.com/abstract=2959166> (ultimo accesso: 22 settembre 2025); K. WERBACH, N. CORNELL, *Contracts Ex Machina*, in *Duke Law Journal*, 67, 2017, 102 ss., disponibile su SSRN: <https://ssrn.com/abstract=2936294> (ultimo accesso: 22 settembre 2025); M. PROTO, *Questioni in tema di intelligenza artificiale e disciplina del contratto*, in R. GIORDANO ET AL. (a cura di), *Il diritto nell’era digitale*, Milano, 2022, 179 ss.; F. GRECO, *Gli smart contract nel settore bancario e finanziario*, in R. GIORDANO ET AL. (a cura di), *Il diritto nell’era digitale*, Milano, 2022, 189 ss.; A. STAZI, *Smart Contracts in Comparative Law. A Western Perspective*, Springer, 2021; M. MAUGERI, *Smart Contracts e disciplina dei contratti*, Bologna, 2021; P. GALLO, *DLT, Blockchain e Smart Contract*, in M. CIAN, C. SANDEI (a cura di), *Diritto del Fintech*, Milano, 2020, 146-147; G. LEMME, *Gli “smart contract” e le tre leggi della robotica*, in *AGE*, 1, 2019, 129-152; S.A. CERRATO, *Appunti su smart contract e diritto dei contratti*, in *Banca, borsa, tit. cred.*, 3, 2020, 370 ss.

specifically, the *smart contracts* that make up the *lending* protocol allow each user (i) *first*, to deposit crypto-assets and, (ii) *then* to borrow a certain amount of the same or a different type of asset.

Even with this simple operating mechanism, we can already see the first similarities and differences with credit institutions. In fact, users who deposit their crypto-assets (known as *lenders*) receive a certain interest rate in return, which is usually variable and calculated based on the demand for those specific crypto-assets from other users who intend to borrow them (known as *borrowers*). In this respect, there are no significant differences compared to how a bank works for account holders.

The only difference is that an interest rate on deposits, albeit low and ‘variable’, is still provided. The variability of the interest rate paid to the depositor is also an interesting feature, as it allows for the maintenance of an essentially positive business model.

As we will see later, *a lending protocol cannot fail*, i.e. there is no *scenario* in which this instrument can lend more crypto-assets than those actually deposited within it.

Returning to how it works, and now analysing the actions of *the borrower*, a clarification is necessary. In *lending* protocols, there cannot be a *borrower* who is not also a *lender*. The protocol does not allow ‘loans’ to be taken out without a guarantee being provided. The guarantee always consists of the crypto-assets deposited by the same user requesting the loan.

This is one of the (perhaps apparent) differences between the *lending* protocol and a bank. The models used by banks do not require the *prior* deposit of collateral exceeding the amount of the loan granted. Or, at least, this is true for loans of ‘modest’ value.

For larger loans, such as those for the purchase of real estate, banks normally obtain a guarantee on the asset being purchased (the property) *at the same time* as the loan is granted, which is normally higher than the value of the loan (unless external guarantors are involved).

In return, the *borrower* will be required to pay interest on the ‘loan’ obtained. Loans can usually be repaid at any time by returning the crypto-assets received plus the interest accrued.

3. Collateral

For the functioning of a *lending* protocol there must always be a maximum ratio (the so-called *collateral ratio*) between the value (usually expressed in a legal tender currency, such as the dollar) of the crypto-assets borrowed and that of the crypto-assets deposited, which cannot be exceeded and which makes it

possible to calculate, at a specific moment in time, the maximum amount of crypto-assets that can be borrowed.

The *collateral ratio* varies according to the crypto-assets considered and, in particular, their volatility. Generally speaking, the more ‘risky’ the crypto-asset, the less likely it is to be borrowed and, if it is the case, the protocol will require a higher interest rate.

This means that those who want to borrow a riskier crypto-asset must provide greater guarantees, i.e. the loan of these crypto-assets will be characterised by a lower *collateral ratio*. When the crypto-asset is considered excessively volatile or risky, the protocol may *not* allow it to be used as collateral for a loan.

Understanding how the *collateral ratio* works is essential to understand their “unlikely-to-fail” business model, but also the systemic risks that these protocols can give rise to. In fact, if at any given moment the *collateral ratio* is exceeded, the protocol will initiate the so-called ‘liquidation’ procedure of the crypto-assets deposited or given as collateral; i.e. it will sell the deposited crypto-assets and use the proceeds to repay the loan. The difference will be returned to the user after deducting a so-called *liquidation fee*, which usually amounts to as much as 10%.

The liquidation procedure is a defence mechanism that allows the protocol to maintain a consistently ‘positive’ *business model*.

However, it should also be noted that the ‘automatic’ liquidation of *lending* protocols is one of the causes of the high volatility of the crypto-asset market.

In the event of sudden shocks to the price of a given crypto-asset, the triggering of a liquidation procedure creates an ‘avalanche’ effect on the price of that crypto-asset, triggering further liquidations, with effects that can quickly spread to the price of many crypto-assets on the market.

4. Non-custodial *services*

The real peculiarity of the services offered by *lending* protocols is their ‘*non-custodial*’ nature. This means that the crypto-assets deposited are kept within the *smart contract* without anyone, not even those who programmed it, being able to acquire the availability of those crypto-assets and, therefore, dispose of them.

Smart contracts ensure that the service is carried out in a ‘differently mediated’ manner, acting as an automated intermediary, independent even from itself, and free from *moral hazard*.

Obviously, it is difficult to say that the protocol’s managers and/or programmers can never influence its operation. In fact, they usually retain the power to make changes to the algorithms that constitute it, such as the power to vary *collateral ratios* or add new crypto-assets for deposit or lending.

However, as a rule, before making such changes, a vote is taken among the *tokenholders* holding the governance token of the protocol.

Notwithstanding the powers to modify the protocol, it remains true that the performance of the ‘service’ is still beyond the control of the ‘programmers’. So, considering apart *programming* errors, the performance of the service is immune from human error, with this just meaning the impossibility for the crypto-assets collected to be used in a manner inconsistent with the programming of the *smart contract*.

5. *The similarities between lending protocols and bank-reserved activities*

The *lending* protocol activities could potentially be considered as comprising two different reserved activities. The first is the activity of collecting savings from the public; the second is the granting of loans.

As is well known, Article 11 of the Italian Consolidated Banking Law states that ‘*the collection of savings is the acquisition of funds with an obligation to repay, whether in the form of deposits or in any other form*’ and that this activity ‘*is prohibited to entities other than banks*’ if carried out ‘*among the public*’.

The definition outlines the fundamental elements of the concept of deposit-taking, namely: (i) the acquisition of *funds* and their subsequent repayability; and (ii) the direction of the activity towards the public.

With regard to the first requirement, the resolution of the Interministerial Committee for Credit and Savings (*Comitato Interministeriale per il Credito e il Risparmio*, CICR) of 19 July 2005, subsequently supplemented by the resolution of 22 February 2006, states in Article 1(1), that ‘*savings collection is the acquisition of funds with an obligation to repay, whether in the form of deposits or in other forms*’.

However, the resolution does not provide further guidance on the concept of *funds* (as do the European directives on payment services), raising doubts as to whether crypto-assets fall within this concept. This doubt is reduced in relation to crypto-assets that are more similar to currency, such as *electronic money tokens*, which are now fully regulated by *MiCAR* as a *tokenised* version of electronic money.

With regard to the second element underlying the definition of savings collection, i.e. the exercise of the activity ‘*among the public*’, the CICR Resolution only provides partial guidance. In particular, Article 2(2) merely defines the element in negative terms, stating that ‘*the following shall not constitute collection of savings from the public: in connection with the issuance of electronic money; from shareholders, employees or companies of the group in accordance*

with the provisions of this resolution; on the basis of personalised negotiations with individual persons, through contracts which indicate the nature of the financing'. Due to the partial obscurity of the provision, attempts have been made in legal literature to complete the definition *in a positive manner*. In particular, it has been stated that only deposits aimed at unidentified and not predetermined persons, as well as those characterised by standardised and 'impersonal' negotiation, should be considered *as deposits from the public*⁷.

Considering the above provisions applicable to *lending* protocols would have serious consequences. The activity of collecting savings in violation of the restriction contained in Article 11 of the Consolidated Banking Law is, in fact, punishable under Article 131 of the Consolidated Banking Law. As is well known, this article, entitled 'abusive banking activity', punishes with imprisonment and a fine anyone who engages in the activity of collecting savings and the simultaneous exercise of credit⁸, in violation of the reserve of activities⁹.

The activity of granting loans is also an activity whose boundaries are not clearly defined. Article 106 of the Consolidated Banking Law states that '*the granting of loans in any form to the public is reserved to authorised financial intermediaries*', leaving it to Ministerial Decree No. 53 of 2015 to clarify the specific content of the provision, with particular regard to the definition of limits and content.

Pursuant to Article 2 of Ministerial Decree No. 53/2015, '*the granting of loans in any form*' shall be understood as the provision of credit, including the issuance of credit substitutes and commitments to underwrite. This activity includes, among other things, all types of financing provided in the form of: a) financial leasing; b) purchase of receivables for consideration; c) consumer credit, as defined in Article 121 of the Consolidated Banking Law; d) mortgage credit; e) loans on pledge; f) the issuance of sureties, endorsements, documentary credit facilities, acceptances, transfers, commitments to grant credit, and any other form of guarantee or underwriting commitment.

Article 3 of Ministerial Decree No. 53/2015 then specifies that the activity of granting loans is considered to be carried out to the public when "*it is carried out towards third parties on a professional basis*".

⁷ R. COSTI, *L'ordinamento bancario (The Banking System)*, Bologna, 2012, 211.

⁸ It should be noted that the objective element of the offence consists in the simultaneity of the activities of collecting savings from the public and granting credit. On this subject, see P. FERRO-LUZZI, *L'attività bancaria*, in P. FERRO-LUZZI, G. CASTALDI (eds), *La nuova legge bancaria*, 1, Milan, 1996, 241 ff.

⁹ F. CAPRIGLIONE, *Comment on Article 132 of the Consolidated Banking Law*, in *Commentario al Testo Unico delle Leggi in materia Bancaria e Creditizia*, Milan, 131 ff.

The applicability of these rules would also have significant consequences. In addition to Article 131 of the Consolidated Banking Act, in particular, when the granting of loans is not accompanied by the collection of savings from the public, the unlawful conduct of the activity would be punishable by a fine and imprisonment under Article 132 of the Consolidated Banking Act (unlawful financial activity).

6. Preliminary notes on the possibility for lending protocols to be considered performing bank-reserved activities

In order to determine whether the rules governing the offering of banking services to the public apply to lending protocols, two interpretative issues must be resolved. The first concerns the possibility of including crypto-assets in the concept of ‘funds’. The second concerns the classification of the activity carried out by the protocol, in order to understand whether it can be defined as ‘professional’.

The answer to the first question can be found in the type of crypto-asset that can be used to interact with the protocols.

If we refer to the definition of ‘funds’ given in the rules issued at the European level¹⁰, we see that this concept is only applicable when the crypto-assets in question fall within the definition of electronic money.

Such a “strict” interpretation would lead to the conclusion that the rules examined would apply only in cases where stablecoins can also be qualified as electronic money. For instance, this is the case of e-money tokens regulated under Title III of MiCAR.

A more extensive interpretation, on the other hand, would lead to the assimilation (at least) of *stablecoins* to ‘funds’, in light of the function of these crypto-assets, which is similar to that of *fiat* currency¹¹.

However, based on both interpretations of the concept of ‘fund’, the qualification of a reserved activity could be excluded when the protocol’s activities concern utility tokens, investment tokens, or other cryptocurrencies that are not stablecoins.

Nevertheless, the most thought-provoking analysis concerns the attribution of the activity performed to an “entity”, with a view to assessing whether such

¹⁰ Reference is made to the Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market (so called PSD2).

¹¹ That is, a currency whose value is not based on a physical asset (such as gold or silver), but is established by law and *accepted* because of the general trust placed in the State’s ability to maintain its value stable.

activity is carried out in a professional capacity. On this point, as already mentioned, it is necessary to investigate whether the fact that the reserved activity is carried out entirely by a DAO and by its smart contracts, and not by the person who, in any way, created and/or controls it, can render the aforementioned legislation inapplicable¹². On closer inspection, the law, and in particular criminal law, requires that the (imputable) entity carries out the reserved activity in a professional manner.

That said, the ‘self-enforceability’ of *smart contracts* seems to sever the links with the persons who programmed them, so that it seems difficult to attribute the performance of a bank-reserved activity, such as the one in question, to the program developers of the code of the smart contract.

It should be remembered that what characterises lending protocols is their ability to act as an infrastructure that manages the activities carried out by individual users¹³. From this point of view, *smart contracts* do nothing more than coordinate individual behaviour.

If it is not possible to attribute the performance of the activity to *the software*, it seems reasonable to conclude that there is no ‘subject’ (properly understood) to whom the performance of the activity can be attributed.

It does not seem correct to say that the developers of the *smart contract* programs are, *by exclusion*, the subjects *closest* to the performance of the activity. In fact, very often, program developers have no control over either *the smart contracts* that make up the protocol or the crypto-assets of users.

¹² It should be noted that according to some authors some protocols could be created to hide a fake scheme just to avoid regulation. The issue has been addressed by L. ANKER-SØRENSEN, D. ZETZSCHE, *From Centralized to Decentralized Finance: The Issue of “Fake-DeFi”*, working paper, December 2021, and by S. ARAMONTE, W. HUANG, A. SCHRIMPF, *DeFi Risks and the Decentralisation Illusion*, in *BIS Quarterly Review*, December 2021. The latter authors argue that the notion of decentralisation, often presented as a defining feature of DeFi protocols, is largely illusory. They note that, while many DeFi projects are marketed as decentralised, substantial control frequently remains in the hands of key actors—particularly developers, who design and manage the code. Such actors not only retain the ability to alter the protocol but, in some instances, can even disable its functionality. In this sense, “decentralisation” appears less a genuine technological feature than a strategic device to mitigate regulatory scrutiny. Most recently, see also BANK FOR INTERNATIONAL SETTLEMENTS, *The Crypto Ecosystem: Key Elements and Risks*, July 2023, 9. However, as noted in S.L. FURNARI, C. VILLANI, *Regulation of Financial Protocol DAO*, cit., innovation of DeFi protocols reside in their “impossibility to function without a collaborative participation transcending a sort of “mutualistic symbiosis” relation”.

¹³ As noted in S.L. FURNARI, C. VILLANI, *Regulation of Financial Protocol DAO*, cit., this mutualistic symbiotic relationship supports the qualification of the protocol as an infrastructure rather than as an enterprise or a company. On the qualification of Protocol DAO as infrastructure, see also R. LENER, S.L. FURNARI, *DAO e Impresa Collettiva*, in B. DE DONNO, F. RAFFAELE (a cura di), *Saggi di diritto societario e finanziario delle nuove tecnologie*, Roma, 2025, where this form of classification is proposed for the first time.

This is even more evident considering that, when savings are collected or loans are granted by banks or other authorised financial intermediaries, there is a tendency for the funds collected or lent to be assimilated into the intermediary's assets.

The legal form used, as is well known, is that of irregular deposits, in which the assets are merged within the intermediary's assets and there is no separation. However, as mentioned above, *lending* protocols do not allow any confusion of assets with the entity that developed the protocol or that can, in various forms, control it.

This entity has no power over the assets managed by *the smart contract* and cannot use them to carry out any type of activity. At most, it can assume the role of '*guardian of the software*', generally retaining only support or assistance powers, but without being able to influence or have material access to the assets managed by it.

Therefore, the protocol program developers should not be held responsible for carrying out the activity (and the related responsibilities).

However, if it is not possible to identify a person offering the service, it is effectively impossible to apply the relevant legislation to the protocol. This is precisely because there would be no 'person' carrying out such activities 'professionally'.

7. *The need for legislative reform*

The current legislative framework does not appear to be adequate for many of the phenomena associated with decentralised finance. This inadequacy is evidenced, for instance, by the (im)possibility of imposing prudential capital requirements – or requirements relating to integrity, professionalism, and competence – on an 'instrument' that possesses no assets of its own and operates without the involvement of administrators or identifiable corporate officers. Traditional banking and financial regulation is premised on the existence of a legal person who bears responsibility for compliance and on whom supervisory authorities can impose sanctions or corrective measures. In the case of decentralised protocols, however, no such legal subject is readily identifiable.

This structural gap has significant consequences. Comparable difficulties emerge with respect to the regulation of individual services, such as the enforceability of contracts under the doctrine of "relative" nullity, the requirement for written form, and the application of statutory transparency obligations. Rules designed to protect clients assume the presence of a counterparty able to undertake disclosure, to provide documentation, and to bear liability for misleading

or incomplete information. Where transactions are executed entirely by self-executing code, the attribution of such duties becomes problematic.

What is truly unprecedented is the nature of the innovation: a computer code composed of ‘bytes’ is increasingly replacing a financial intermediary composed of ‘people’ in the organisation and management of client activities. This transformation challenges the person-centric foundations of financial law, which is historically built around notions of agency, fiduciary duties, and accountability.

The legislator is therefore called upon to recognise this fundamental difference. Only by acknowledging the replacement of the human intermediary with an IT-based infrastructure can coherent and effective rules be crafted. Such rules must account for the technological architecture of decentralised finance, while still ensuring the achievement of public interest objectives—namely, the stability of the system, the protection of investors and consumers, and the preservation of market integrity.

In order for this regulatory endeavour to be effective, legislators and supervisory authorities must work in close cooperation with the academic community. Such cooperation, however, should not be confined to scholars of regulation and financial law alone, but must also involve expertise from economics and computer science. The advent of new technologies that so profoundly reshape financial services requires moving beyond a ‘siloed’ approach, so that the emerging legal challenges can be addressed from multiple perspectives simultaneously.

