

## Money is a token of cooperation: The biology of indirect exchanges

**Jose Maanmieli**

j.maanmieli@gmail.com

**Abstract:** I propose a clear definition of money, as opposed to credit, by elaborating on the distinction between the biological concepts of cooperation and altruism. I argue that these aspects of animal sociality are often confused because they are evaluated from an anthropocentric perspective. Ecologically speaking, the function of a monetary token is to mediate interactions that are more constructive than reciprocal altruism, as they involve partner-choice and non-additive benefits. This focus on proximate mechanisms explains the challenges encountered by monetary theorists, who typically emphasise the utility of a token versus its symbolism. The invention of Bitcoin provides empirical support. Indeed, the value of bitcoins does not come from any intrinsic utility nor does it come from an institution. This form of digital money has simply emerged on the internet, a social environment akin to the ecological environment in which trade has evolved. Like Bitcoin and other cryptocurrencies, money is naturally created by humans as a signal of cooperative intent. This potential for indirect exchanges is then seized by processes of cultural group selection that transform money into credit.

**Keywords:** game theory, partner-choice, morality, social evolution, credit-money, bitcoin

## 1. Introduction

Ordering a coffee in Europe requires having money to pay for it. The café wants money and the customer wants coffee in what should be a win–win situation. However, when the coffee arrives, the customer often says ‘thank you’, and when the customer pays for it, the waiter replies accordingly. We call it politeness and even goodness, but these words merely explain away what is a genuine puzzle: if both parties act out of self-interest, then why are they thanking each other? What do they feel grateful for?

In Western society, these kinds of exchanges appear impersonal and individualistic. Even anthropologists have regarded the market economy as fundamentally different from what goes on in traditional societies [1] (p. 55). Yet the above situation suggests otherwise. Gifts have always served to cement important relationships of gratitude and debt, or, in the words of Mauss, ‘to put people under obligations’ [2] (p. 73). In reality, altruism coexists with the issues of reciprocity and self-interest that money has come to encapsulate [3].

We should be able to solve this puzzle through the biological study of sociality. However, as in the case of morality [4] and cooperation [5], the lack of conceptual clarity tends to be unacknowledged. One exception is Dawkins’ proposal that money is ‘a formal token of delayed reciprocal altruism’ [6] (p. 188). This elegant definition does explain why the waiter is grateful, as he can use the dollars he earned to get a coffee himself at some point in the future. However, in Dawkins’ view, reciprocity is the basis of morality and altruism synonymous with cooperation. So, if the waiter cannot get a coffee from another waiter who does not accept dollars, the latter is possibly acting immorally and against his own interest.

There certainly are reasons to speak of monetary and moral behaviour as sociocentric [7-10]. It does not take an anthropologist to see that our different tribes prescribe their own members to ‘cooperate’ preferentially with other members, something perhaps reflected by Dawkins’ choice of the word ‘formal’. Therefore, in order to genuinely describe the nature of these social phenomena, it is a good idea to avoid normative contexts that may be confused with nature. In this article, I shall focus on individual decision-makers, who are always able to choose alternative tokens and partners. These ecological interactions are more accurately understood in the framework of game theory [11]. I shall describe these games in a way that is more relevant to human life, though I have included a mathematical appendix.

## 2. Direct interactions

Consider two partners, A and B, who may be individuals or groups of coordinated individuals. Each partner can choose to act in a way that benefits the other, or choose not to act in such a way. In an economic context, this will involve transferring a good or providing a service in two kinds of interactions, basically, one in which mutual action does not bring the greatest benefit, and another one in which it does:

1) *Altruism*: If A does not act but B does, the benefit A receives ( $b$ ) is *greater* than if A did act. Therefore, partners have an incentive to cheat. For example, A has an apple and B has an orange, and they can both benefit ( $b'$ ) from an exchange because they prefer each other's fruit. However, if A and B are hungry, each altruistic action is risky, because they are better off keeping both fruits and receiving an additive benefit.

2) *Cooperation*: If A does not act but B does, the benefit A receives ( $b$ ) is *lesser* than if A did act. Therefore, partners have an incentive to work together (the etymological meaning of cooperation) in order to obtain a non-additive benefit ( $b'$ ), and failing to act cannot be considered cheating. This often involves cases in which no benefit will emerge without coordinated action, for example, in hunting down big prey, rowing a boat, or specialising in growing different crops. The possible cost of acting without the other's cooperation is not comparable to the benefit sought through such an *investment*. To use the above example, A has invested in apples and can afford to lose one in a failed exchange with a hungry B.

The above distinction leaves little room for ambiguity, especially since it outlines the two economic games of Prisoner's Dilemma (P-D) and Stag Hunt (S-H), respectively (see the appendix). Some textbooks discuss it because organisms do not always associate at each other's expense, not least by reproducing sexually [12,13] (chapter 3, chapter 2). Still, the concepts of cooperation and altruism are confused throughout the literature. West et al. [5] recognised this problem but introduced more ambiguity (see e.g. their Table 4). In their view, reciprocal altruism is 'not altruistic' (sic) but cooperative, so cooperation itself must be distinguished from 'mutual benefit'. More recently, Marshall [13] disagrees (see his Table 2.3).

Generally speaking, theorists see interactions as additive games of P-D because partners 'get paid' for their actions in the ultimate currency of reproductive success. Individuals are seen as

necessarily interacting, competing for a limited number of offspring, and their proximate ability to make decisions based on perceived value becomes irrelevant. This tendency goes back to the celebrated work of Hamilton and Axelrod on the evolution of cooperation [14]. Again, cooperation necessitates reciprocity, meaning reciprocal *altruism*. Individuals engage with one another in sequence, eventually coming across ‘cooperators’ who punish those ‘cheaters’ who do not reciprocate. This evokes feelings that have more to do with Western morality and less with the behavioural ecosystem.

Nobody goes on a boat trip with someone who will refuse to row. When we trade, we normally look for suitable partners first, and prepare to use our skills or give up our products in exchange for something else. We do not wish to stay unemployed or keep all the goods for ourselves so that an active means of enforcement becomes necessary to enable trades. This is because we are planning and looking for an emergent benefit ( $b'$ ) in cooperation with others. However, imagine that we (A) were forced to interact with B. It would be difficult to predict B's possible failure to cooperate and mitigate the resulting costs. In the first case, A has a perception that  $b' > b$ , whereas in the second case, A necessarily sees ‘cooperation’ as having less value.

As I illustrate throughout, this dual perception of value explains why we confuse cooperation with altruism, money with credit, and ethics with morality. It happens because the traditional context of family, clan, tribe or nation (ingroup) restricts the freedom of individuals to choose partners and thus benefit from cooperation, yet cooperation can still be said to occur within such a restrictive context insofar as  $b'$  remains greater than  $b$ . Interactions become altruistic when choosing a specific partner is morally required to the point that  $b > b'$ . Individuals then ‘cooperate’ not so much to obtain economic benefit but to secure *partners* through debt obligations, and this quantitative factor dominates their perception of value.

### **3. Indirect interactions**

Morality has been extensively described as a system of indirect reciprocity [16,17]. As shown above, this does not necessarily mean that it is a system of indirect cooperation. I have made the corresponding distinction by calling the latter *ethics* [10]. This is not because it is ethical to always cooperate, but because it seems unethical to punish those who do not cooperate. Someone who does not cooperate cannot be called a cheater or a defector. They are, in fact, losing out, so they must be somehow unable to cooperate, as is often the case in the context of dispersion, mistrust or

contingency that exists in nature. In this definition, partners are still being ethical by not cooperating, unlike those who do not return altruistic actions, who would be immoral.

Morality is thus more clearly viewed as a sociocentric system of indirect altruism, as opposed to an ecological system of cooperation. In this system, actors do not directly benefit from the recipient of their help but indirectly from someone else. That is, B remains the object of A's helpful action, and A is helped by C later on. This creates the problem of whether C, in turn, will be helped by B and close the cycle, otherwise B will have exploited the system. This is, in essence, the problem of how moral and monetary systems can evolve on their own, where the latter systems involve establishing the reliability of a token instead of that of a partner: namely, C helps A not because B is a reciprocator who will help C anyway, but because C believes that B will accept the token that C will get from A in exchange for help, and that A had initially got from B.

Again, the literature on indirect interactions largely deals with the case of indirect reciprocity, meaning the problem that B has an incentive to cheat by not forwarding *altruistic* help. There is little hope of closing the cycle between A, B and C because, unlike cooperative help, altruistic help entails a cost that is comparable to the benefit B has received from A (e.g. B gives C an orange after receiving an apple from A). In order to solve this problem, complex mechanisms of monitoring and enforcement are usually conjectured [14,18]. But these mechanisms are unlikely to appear in nature [19,20] and must assume that partners are living in close proximity. Consequently, they do not help solve the problem of how money evolves to mediate interactions among strangers. Rather, they help explain how an additional phenomenon of indirect exchange appears in an already cohesive human society. This suggests a distinction between money as a biological phenomenon that arises naturally, and 'money' as a cultural, symbolic phenomenon that arises normatively.

### 3.1. Money

Indirect cooperative actions are analogous to three partners, instead of two, who embark on an unknown enterprise. Think of the social cohesion displayed by lions hunting a gazelle. The animals take different roles toward a common purpose, but rather than occurring in such an immediate context, imagine their efforts were separated in time and space. Money can be understood as a beacon enabling this extended cohesion in a state of uncertainty about what each partner will contribute and whether they will contribute at all. Money is therefore a means for B to select a

suitable A and C.

All animals possess their own bodies in most circumstances, and failing that, they still possess their own minds. They are also capable of individually possessing things, not least human animals. Birds possess the food they endeavour to cache, female orangutans possess their dependent offspring, and humans possess their individual memories and thoughts, among other things. Money, however, is a special kind of possession that serves to reliably signal the ability and intention to cooperate. The signal is reliable if and only if it results from a previous effort; for example, it is an elaborate piece of work or a substance requiring much effort to obtain. This incentivises partners to hold on to these symbolic tokens.

From the perspective of others, if B has secured this token (*m*), it has already acted. B can then receive its respective benefit from A, who cooperates with B because by obtaining *m*, A is investing into its future need for C's cooperation; and C, in turn, cooperates with A because it knows that B will be willing to cooperate to get *m* back. B will always want *m* back, either due to the time and energy B put into it, or due to the fact that *m* reliably signals cooperative intent. This closes the cycle and makes their partnership a self-reinforcing success. When all parties prefer *m* in this way, they continue to add to its credibility as a memory of past investment, whether they have obtained it themselves or from a partner. The token becomes a reliable signal that enables indirect cooperation.

### 3.2. Credit

Credit reverses the logic of money by mediating altruistic actions that presuppose group cohesion. Without such a previous social environment, it is difficult to see how it could evolve. Exchanges begin because they are normatively enforced (e.g. through the law that a token must be accepted as payment), though they are sustained by what is called a network effect (individuals want the token because others want it). In this case, B does not need to secure any special item or make any previous effort. The cycle begins with A's altruistic action toward B, who simply defers its reciprocal action by giving A a token "*m*" that represents B's indebtedness. This makes B a debtor to C, who receives "*m*" from A. Once B satisfies C's respective demand for help, the cycle is closed. However, this should also mean that "*m*" ceases to have a function as a record of B's indebtedness. (This point is important.) My choice of the same letter *m* serves to illustrate that when B comes up with "*m*" (as an individual or institution), the interpersonal quality of the

concept of *debt* is reified, that is, transformed into an impersonal thing that attracts anyone's altruism (including B's!)

As I discuss in the next sections, this reification can be facilitated by the token's physically relying on money or being made as an imitation, for example, by issuing a limited number of tokens and declaring their destruction illegal. The tokens continue to circulate primarily thanks to the norms that stimulate their use and create a network effect, namely: if B ought to accept "*m*" and be altruistic toward C, then A has an incentive to *want it* in order to exchange it for C's altruism. This encourages B to issue more credit in an odd mixture of duty and desire, utility and compulsion. This symbolic 'creation of value' corresponds to the modern activity of banks. It is supported by more altruism, for example, by adding a partner D who can provide additional resources. It is what makes *credit* a formal token of reciprocal altruism, yet one that inevitably succumbs to the incentive to cheat that is inherent in the Prisoner's Dilemma.

### 3.3. Credit-money

The concepts of money and credit overlap due to the influence of morality. Morality can itself be seen as a cognitive conflation of natural concepts (e.g. gold) and social concepts (a gold-backed currency), or as the confusion of societal laws with natural laws that is characteristic of myth [10,21]. In this way, morality biases cooperative investment toward an ingroup, thereby making it altruistic. This view not only accounts for a well-known phenomenon in social psychology [22]; it highlights the fact that the concept of morality is illogical, as it refers to norms that are at once universal and discriminate against outsiders. Through this cognitive conflation, group members are somehow rationally required to cooperate, rather than simply expected to cooperate because it is in their best interest to do so. The ingroup may be a family, clan or peer group, an ethnic or an ideological group. These 'relatives' are valued primarily for their partnership, so their non-cooperation (see the appendix) is perceived as a defection that inflicts a cost ( $-b$ ) greater than the benefit of cooperation ( $b'$ ).

This psychological projection changes the type of interaction: A and B see themselves in a P-D, where non-cooperation means defection and cooperation means altruistic actions that risk a possible lack of reciprocity. As anthropologists note, B's reciprocal action is often delayed indefinitely. Indeed, in terms of economic value, A has made an investment, that is, given B something it can afford to lose; but A actually seeks to create a debt obligation in B. Humans

project this ‘dilemma’ also on potential partners, strangers, who are seen either as belonging to one’s group or to a competing group. In other words, from a sociocentric perspective, nobody is free, everyone ought to be ‘giving to us’ as their creditors or ‘allowing us to give to them’ as their debtors, otherwise they are enemies (or gods).

This central feature of our nature probably dates to the beginnings of *homo sapiens*. It explains why humanity would evolve to consist of antagonistic tribes that restrict the cooperative ability of individuals to an exclusive subset of the species. Yet as Cheal writes, ‘it may not be winning or losing that is important so much as playing the game’ [23] (p. 139). Consider the Kula ring of the Trobriand Islands, the famous example where primitive people exchange what Szabo [24] has called *collectibles*. These people must realise that their bracelets and necklaces enable long-distance trades that would not otherwise be possible, but at the same time, strict customs require that these objects be altruistically given away. Thus, it is not enough that the objects circulate, as they do, as a result of their demonstrable value; they must also favour the particular lineage that originated them, who become creditors of those who hold them. This involves the requirement that objects go back to their owners, the famous ‘paradox of keeping while giving’ [25], which may be compared with the more general ‘paradox of the non-cooperating defector’ to which I have alluded. Who has not been frowned upon for not helping around the house. Indeed, Trobrianders are keen to give because it creates those debt obligations, but they do not insist that debtors return exactly the same things that were given away. This happens due to the *monetary* nature of the Kula collectibles, which is probably why these items are often, anyway, held without their holders knowing who their owners are [26].

Other traditional societies are equally bound by ‘spheres of exchange’ that obey a traditional system of marriage and kinship [1] (p. 59). These reproductive systems can resist the ‘impersonal’ power of money, restricting it to short-term relations, or they can adopt it [7]. When systematic farming began in Mesopotamia, precious metals were similarly restricted, kept in religious temples along with the surplus. They were used in external trade only by the powerful, and internally to represent personal credits and debts [15]. However, the power of money was greater than those political restrictions, and it was used to fuel the ambitions of civilisation [27,28]. Because of the moral need to channel resources toward the ingroup, it seems plausible that token-money (credit) could buy encounters with ‘goddesses of fertility’ and participation in ritual feasts from Sumer to Greece [15,29,30] (Graeber, p. 181; Snodgrass, p. 282). According to Plutarch, these metallic

tokens were given the shape of cumbersome sticks in order to discourage the pursuit of wealth. So, when Greek city-states proceeded to give them the more practical shape of coins, they often ended up buried with the dead, lest they be used to buy sex. Coinage certainly allowed for more explicit measures of taxation [31], but also more explicit accounts of the services that could be bought [30] (p. 134).

In sum, the history and anthropology of money shows that indirect cooperation overlaps with altruistic customs that transform money into credit. Its recent evolution has been guided by expanding societies that sought to harness its power. From Alexander's empire to that of the Romans, soldiers were systematically paid with newly minted coins, essentially, to attack foreign people and conquer new land [32]. These unethical actions were surely moral at the time, justified by a belief in various divinities. They served to integrate other societies by introducing a money that would be progressively debased in order to feed a greater reproductive system. This tendency has, of course, continued up to this day. Our planetary-scale nations rely on a system of pure credit, and their central banks resemble mint-temples both in their appearance and functioning [29].

#### **4. The origins of money**

The possession of money signals the ability and willingness to invest in the future. This is why it tends to receive divine status and promote political interests. Biologically speaking, money is a proof of reproductive fitness. Obtaining it and holding it requires energy, and individuals and groups produce it as a means of investing energy for cooperative exchanges. Even if it has been obtained by chance, or stolen, any such party can only hold money if it is fit enough to preserve it as well as forgo the resources that money can be exchanged for.

All of the three main characteristics of money can be derived from this grounded definition. Firstly, money is a good store of value because it registers a previous investment. Money becomes a good medium of exchange because it is a store of value that people seek to possess. And money is a good unit of account because people want to keep it as well as exchange it, which means that they must divide it well. This measure of investment in the light of natural limitations (the scarcity of energy and resources) is the so-called thingness of money.

Economists in the tradition of classical liberalism mistake the thingness of money for the notion of utility or saleability in an attempt to reduce money to a commodity. Commodities certainly signal a previous investment because, like copper or coffee, they must be produced or

extracted. However, money does not need to be a commodity, or come from a commodity, because an item can fulfil such a signalling function without it being a resource (see Bitcoin below). As Szabo [24] has noted, human beings like to collect seemingly purposeless items that can function as tokens. Collectibles have been traded and used as records of past favours (even as mnemonics of stories and gossip) presumably because they can be trusted by human groups living very far away and experiencing great economic uncertainty. The basic component of this intergroup trust is cooperative. Only a successful and well-intentioned group would be able to produce elaborate items and offer them in exchange, even though it can also have altruistic intentions to give them away and ‘not expect them back’. Especially where the memory of past interactions is faint, any reliable proof of a cooperative intention would have been valued and circulated.

The word *money* comes from the latin *moneta*.<sup>1</sup> In roman mythology, moneta was a title given to the goddess of memory (identified with the Greek goddess Mnemosyne). Moneta was also an epithet of the goddess Juno, the protectress of funds in whose temple the mint of Ancient Rome was located. The words Juno and moneta are etymologically associated with the meanings of *remind, warn, the one, unique*, all of which suggest the idea of a reliable memory or record. Money performs this signalling function naturally, without the need for norms. This means that money always has a social function, in spite of its institutional use by the Romans and others. That is, money has a relationship to everyone else in the sense of human beings who would voluntarily give their property in exchange for it, not ‘everyone else’ meaning members of a society or country. This genuine social function remains elusive today due to the monetary monopoly of states throughout the 20th century.

#### 4.1. Bitcoin

Created in 2009 by Satoshi Nakamoto, Bitcoin is commonly called a decentralised digital currency. However, according to the present definition of money, Bitcoin is simply the first form of digital money, as opposed to credit that has been issued digitally. Both digital credit and digital money are accounting ledgers that are stored in networks of computers. In the case of credit, the network is centralised, meaning that the authenticity of the ledger is determined by a single authority, typically a nation-state. This authority decides what credit belongs to whom and how much of it

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<sup>1</sup> Graeber [15] supports an account of money as credit through his knowledge of ancient history and etymology. He notes that the word *pay* means to pacify or appease (p. 96), but does not mention the meaning of *money*.

can there be in circulation. By contrast, the authenticity of the Bitcoin ledger is decided by a cooperative process called proof-of-work [33]. Any computer is free to participate in the process by running a program that adheres to a certain protocol of communication, in the same way as connecting to the internet requires the TCP/IP protocol. The protocol rewards those ‘mining’ computers with new coins at a decreasing rate that mimics the scarcity of gold. At root, however, the proof-of-work is a mathematical solution to the problem of coordinating different computers on the internet, in the same way as money in general is a solution to the problem of coordinating different people in nature.

As discussed in section 3.3, the Trobrianders and their Kula ring are a classic puzzle in economic anthropology. These primitive people travel long distances across the ocean in order to give what, in the words of Malinowski, were ‘worthless trinkets’. Malinowski concluded that this was a political system of exchange motivated by reciprocity [34]. However, politics requires a means of enforcement that is simply not available to the Trobrianders, as it is not available in the wild of the internet. Szabo makes a convincing case that the collectibles used in this network, through which the men establish important bonds, are a form of what he calls proto-money [24]. In his view, these objects need to acquire value by circulating and enabling trades. However, as I have argued, these are unique handicrafts with an immediate potential for circulation. This must be why they are exchanged in a ceremonial act in which the donor talks down to the recipient [26]. And they go back to their owners not because the Trobrianders obey some law of ‘inalienable possessions’ [25]. Rather, there is a ‘giving-for-keeping’ [35] reflecting the cognitive overlap of altruism and cooperation to which I have alluded, and whose purpose is to secure partners for a reproductive or kinship system that works in a context of lifetimes.

Of course, one of the key features of bitcoins, as a form of cash, is that they cannot be claimed back by their previous owners (due to the extreme difficulty of modifying the ledger against the consensus of the network). Yet the owner of a Kula valuable would equally sever his relationships by claiming it back, and as I mentioned, it is often unknown who the owner is [26]. In the spirit of Malinowski, Szabo subscribes to a common conceptual confusion (section 2) by assuming that these partners are engaged in an individualistic system of reciprocal altruism [24]. Szabo speaks also of insurances and the division of labour as ‘cooperation’ in a Prisoner’s Dilemma. But it is unlikely that people who *really* play such a game, which involves dealing with a high risk of defection, will have the time and resources to make the kind of investments required by the Kula,

an insurance fund, or specialised labour. And if they do have the time and resources, then they are not being very intelligent.

Similarly, Krawisz [36] has likened the Bitcoin proof-of-work to an altruistic consensus. However, this system incentivises partnering computers to make a *joint* decision on the state of the ledger. It does not incentivise them to make *independent* decisions on the state of the ledger, which is what the so-called ‘temptation’ payoff represents in a Prisoner’s Dilemma (see the appendix). There is little benefit in detaching from the network and leading one’s version of the ledger in order to ‘sucker’ the others. On the contrary, there is an incentive to cooperate, and the proof-of-work functions as a reliable signal for a successful Stag Hunt (i.e., the so-called payoff-dominant equilibrium of the game). Some research explores this mechanism in the light of biology [37,38]. Krawisz and Szabo’s view depends on the signalling of handicap to ensure reciprocal altruism [39], but this costlier kind of investment applies to competitive situations that do not correspond to the ecosystem of the Bitcoin network.

## **5. The origins of credit**

The illusion that credit has a monetary basis is sustained by a network effect: one wants it because others want it. Thus, unlike money, credit is a medium of exchange primarily. It imitates money by turning a personal creditor–debtor relation into a thing that can be transferred, or even one that ought to be transferred. Only then does credit acquire the property of being a store of value, albeit one dependent on politics and the altruism of others. Because of this weakness, and the ease with which people get into debt (we already feel indebted to kin, god or flag), credit must also be a bad unit of account. That is, if one wants “*m*” mainly to give it away in exchange, then one will have a lesser incentive to accurately divide it. This is reminiscent of Gresham’s Law, which reminds us that ‘bad money drives out good money’ [32]. Credit can be seen as a money that people do not want as much, because it is a bad store of value, prone to economic miscalculation and inflation.

Credit can have a long life because the norms of exchange that sustain it are strong. However, it mainly survives thanks to a parasitic reliance on the value of money. Throughout history, credit has used money as a real basis, notably precious metals stored in temples or otherwise used for coinage [32]. Rulers have made credit from gold, silver or copper not as a whim, but because in an uncertain world, people cannot reasonably accept absolutely anything as valuable; people’s minds cannot be absolutely embedded in a normative context either. This is particularly true of the

military expansions of Ancient Greece and Rome, which needed strong money to create new markets in a context of lawlessness. It is also true of prehistoric times when the possibilities of bringing together separate human groups were minimal. In these situations of distrustful encounters, a strong monetary basis is key. This was the case of collectibles, which were probably the first form of money [24]. Objects such as cowrie shells, glass beads, and wampum have all served the same function. The adoption and devaluation of wampum by European colonists, in particular, is a good example of how money emerges and is subsequently transformed into credit due to the demands of a more ambitious society [32].

Pure credit has its expression in fiat money, which acquires value by decree. These eminently normative, moneyless tokens are favoured by strong government and/or the availability of resources. In their absence, the tokens fall out of favour through episodes of inflation. Fiat systems have thus appeared and disappeared at previous times in history [40]. Modern fiat money dominates the world's economy thanks to the marriage of banking and state. It originated in 17th Century England when goldsmith bankers began to lend their customers' deposits of precious metals as notes payable to bearer [41]. This meant turning a debt obligation (a relationship between goldsmith and depositor) into a thing that could be loaned and exchanged in the form of impersonal notes, just as the precious metals themselves could. Kim [41] refers to it as the fraudulent promotion of a legal hybridity between rights *in personam* and rights *in rem*, or as a double-ownership scheme. However, the tendency to make credit out of money is simply inherent in human societies and cannot be blamed on a single party (as section 3.2 shows, B can only produce credit together with A and C). In the English case, the scheme was supported by the ability of goldsmiths to honour demands of payment through what is called fractional reserve banking. It was also supported by law, in a novel legal context of individual rights 'against all the world' [42]. Through nationalisation, England finally stripped the debts of bankers of any personal connotations, along with a liberal notion of 'individual' that was political, as opposed to biological. Thus, current monetary theorists refer to all money as credit, and to credit as a claim against 'everyone in society', meaning an undetermined set of conspecifics who are trillions of dollars in debt at the time of writing.

## 6. Conclusion

Today banks continue to create credit in the form of numbers that they treat as property they can lend. This virtual experience of utility resembles the way drugs create an experience of achievement. Lea & Webley [43] explore this phenomenon by speaking of money as combining the qualities of a tool and a drug. Other theorists seem to agree. Orrel & Clupatý [44], for instance, ascribe a certain compulsion to the symbolic quantification of value, in a similar way as Kim [45] regards all property as a metaphysical fiction. Ever since the beginnings of civilisation, at least, there has been such a duality of usefulness and compulsion, as money was stored in temples that were centres of duty but also of ritual excesses. However, this does not mean that the concept of money must conform to such an anthropocentric view. Living organisms do happen to own the resources that they control against the possible interference of others, something they can achieve particularly by dispersing [46].

Nonhuman organisms appear to be incapable of performing indirect exchanges because they lack the faculty of language. Somehow being able to speak, to refer to things not immediately present, or to have symbols and tokens, comes together with the ability to coordinate behaviour over extended frames of time and space. This involves an increasingly voluntary control of actions, the ability to make intelligent decisions, and therefore the ability to play Stag Hunt instead of becoming a prisoner of a certain partner or partners. There is substantial empirical evidence supporting this ‘free market’ view of biological interactions [47,48], including the classic example of vampire bats [49]. Like the present article, the theory of biological markets emphasises the continuum between non-human and human behaviour by looking at economic activity as a proximate mechanism. This does not reject global notions of biological value (reproductive fitness) but criticises them as excessively abstract and therefore prone to an anthropocentric bias.

Money is a kind of property upon which we project godlike illusions of credit and power over others. This is because we have always believed in gods of all kinds, not because gods exist or the value of property is metaphysical. We believe in those things because others do, which they do in turn because others do, and there is a clear utility in it. However, like other animals, human beings are not completely bound by our relations to others, and we can perceive what is real regardless of what others say or do. Anthropologists often forget this and appeal to tradition, as if morality and symbolism were the only possible means of human association. Graeber [15] summarises it well: ‘We are all communists with our closest friends, and feudal lords when dealing with small

children' (p. 114). In other words, human existence is seen as a Prisoner's Dilemma in which one can only either share resources (reciprocal altruism) or dominate altruists. Like many biologists, anthropologists and social theorists tend to view any hierarchical mode of social organisation (which can involve the cooperation of specialists or mutualists) as a system of reciprocal altruism. In the tradition of Marx, this means confusing production with exchange, or labour with capital. But the fact that people report being engaged in altruistic actions (e.g. 'This is how we repay our mothers for the pain of having raised us', *ibid.*, p. 114) does not imply that each particular action is altruistic from a biological perspective. Indeed, if human economies are based on gift giving, it is because our species can afford it. In this sense, it would be more accurate to say that the topic of Graeber's book is *credit*.

Today a waiter could peacefully reject a customer who insists in paying in dollars, only to accept one who will pay in bitcoins. How are we to explain this phenomenon? These partners are not reproducing a pattern of behaviour set by a political authority, one that has issued some form of credit. They are also not interested in obtaining these coins due to some intrinsic utility. Yet their interaction is not an illusion; it is a biological game in which they cooperate. Now that internet money has been made a reality, there are hundreds of digital coins vying for users. Some coins are more like money, some less, as governments and social media giants begin to produce their own. Even in the case of a single cryptocurrency, there are issues of governance over the protocol that mirror traditional moral issues, such as whether the 'money' should be for the many or for the few [50]. In this case, though, there is no government to decide which policy should be obeyed for the next four years in an exercise of altruism. The cryptocurrency simply splits into two, and each team goes their own way like the crews of two different ships.

## Appendix: Cooperation in game theory

The tables below represent games where player A chooses one of the row actions and player B one of the column actions. In accordance with the present article, the letters C and NC stand for cooperation and non-cooperation. The cells contain the so-called ‘payoffs’ each player receives depending on their respective choice; I prefer to call them gains. The second game is the famous Prisoner’s Dilemma. It can be readily distinguished from the first in that the highest gains are zero-sum, which incentivises players to defect (D):

	C	NC
C	2,2	-1,1
NC	1,-1	0,0

	ND	D
ND	1,1	-2,2
D	2,-2	0,0

Interactions can also be sequential, so that if the first mover chooses to help, it runs the risk of not being helped back. The terms ‘cooperation’ and ‘defection’ are commonly used to refer to what I have called non-defection (ND) and non-cooperation (NC). This is because they are defined in terms of absolute payoffs: ‘reward’ (1), ‘temptation’ (2), ‘punishment’ (0) and ‘sucker’ (-2).

The tables below represent a generic view of these symmetric games. The term  $b'$  represents the non-additive value that A receives from an economic interaction. Hence, a Stag Hunt is defined by  $b' > b$  and a Prisoner’s Dilemma by  $b > b'$ :

	C	NC
C	$b'$	$-c$
NC	$b$	0

	ND	D
ND	$b'$	$-b$
D	$b$	0

As noted in section 2, acting without B’s cooperation may inflict a cost  $c$ . Correspondingly, a non-cooperating A may receive an additive benefit  $b$  from B’s action (e.g. a farmer’s surplus), but this gain is not comparable to the greater, qualitative benefit  $b'$  that is derived from fulfilling the cooperative action or exchange.

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