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Cigarettes, dollars and bitcoins – an essay on the ontology of money

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Abstract. What does being money consist in? We argue that something is money if, and only if, it is typically acquired in order to realise the reduction in transaction costs that accrues in virtue of agents coordinating on acquiring the same thing when deciding what thing to acquire in order to exchange. What kinds of things can be money? We argue against the common view that a variety of things (notes, coins, gold, cigarettes, etc.) can be money. All monetary systems are best interpreted as implementing the same basic protocol. Money, i.e. the thing that we coordinate on acquiring in order to lower our transaction costs, is, in all cases, a set of positions on an abstract mathematical object, namely a relative ratio scale. The things that we ordinarily call 'money' are merely records of positions on such a scale.

Introduction

Two questions need to be answered when investigating the ontology of money. First, what does being money consist in? Call this the individuation question. Second, what kinds of things can be money? As the choice of a currency is uncontroversially a matter of interpersonal coordination, call this the question concerning the objects of coordination.

Section 1 answers the individuation question. It is argued that something is money if, and only if, it is typically acquired in order to realise the reduction in transaction costs that accrues in virtue of agents coordinating on acquiring the same thing when deciding what thing to acquire in order to exchange. Section 2 answers the question concerning the objects of coordination. It is argued that money, i.e. the thing that we coordinate on acquiring in order

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to lower transaction costs, is, in all cases, a set of positions on an abstract mathematical object, namely a relative ratio scale. The things we ordinarily call 'money' are actually mere records of positions on such a scale. In Section 3, two objections to these views are considered and dismissed.

Two clarifications are in order. First, the topic of this paper is social ontology. No pretense will be made that answering the question as to the ontology of money exhausts the interesting questions we can ask about money. Such questions, for instance about the history of money, or optimal monetary policy, belong to social sciences like sociology and economics and are not at issue here. Matters properly belonging to economics cannot entirely be avoided, but the assertions concerning economics made within will not be claimed to be novel.

Second, social ontology is not social psychology. When explanations are given within, they will not be psychological explanations in any strong sense of the term. Rather such explanations are of the type commonly found in game theory. Consider the fact that our practice of driving on the same side of the road in a given country is very stable. This is well explained by the fact that deciding what side of the road to drive on is a coordination game and, in such games, there is typically no overriding incentive in favour of unilateral deviation.

Making such a claim does not amount to claiming that the actual drivers are well versed in game theory and conceive of their situation (*de dicto*) in terms of 'coordination games', 'incentives', and so on. Rather such an explanation just states that, given the preferences of road-users, there is an overriding reason to drive on the side that others do. It is this non-psychological fact, namely that, given certain common sense assumptions about preferences, the structure of interaction is such that it rewards acting as others do and punishes deviant behaviour, that is well expressed by saying that choosing which side of the road to drive on is a coordination game. The explanations offered within will be of the same kind, i.e. explanations in terms of incentives arising in virtue of common sense assumptions about preferences and the structure of interaction between economic agents.

1. The individuation question

The Searlean view

Contemporary philosophical discussion of institutional reality is dominated by Searle's theory of institutional facts (1995, 2005). On Searle's view, some brute object is an institutional object if, and only if, it is the object of a collective attitude of the form '*X* counts as *Y* in *C*', where the *X*-term denotes the brute object, the *Y*-term is the institutional characterisation of the object and the *C*-term characterises the context in which the object denoted by the *X*-term functions in the appropriate way. In this way, some piece of paper counts as money in the USA, just like some laminated piece of plastic counts as a driver's license in the state of California, and so on.

On Searle's view, an object is money if it is collectively counted as money among a group of agents. Such a definition cites the *definiendum* in the *definiens* and so is not terribly informative. Searle acknowledges this and answers that, where institutional reality is concerned, we cannot do much better (1995: 52). Institutional reality is irreducible to non-institutional reality and so we cannot account for money (or driver's licenses, borders, etc.) in non-institutional terms. The problem is mitigated in that we can define institutional notions in terms of other institutional notions, even if we cannot ever break out of the circle of mutually interdependent institutional terms (1995: 52–53). In this way, we can define money in terms of 'media of exchange, repositories of value, payment for debts, salaries for services rendered, etc.' (1995: 52) even if the matter of what counts as an 'exchange', a 'payment', a 'debt', etc. in a society remains irreducibly institutional.

This paper concerns money, not institutional reality as such, and so we will remain agnostic as to the correctness of Searle's general claim that institutional reality is irreducible to non-institutional reality.[1] Searle's view, however, needs to be fleshed out, as it does not help us to determine whether something is money or not. This can be illustrated by considering the recent rise of cryptocurrencies like bitcoin.

Are bitcoins money?

Background

Bitcoin is the most famous of the cryptocurrencies recently created. The bitcoin network consists of a series of computers running bitcoin software that operate in order to create a decentralised consensus as to how much bitcoin each user of the system owns. This consensus takes the form of a 'blockchain', a decentralised account ledger that keeps track of each transaction that has ever taken place in the system. Bitcoins have no 'intrinsic worth', at least not in the sense that gold does, and are not issued by a government. Rather new bitcoins are issued in accord with an algorithm which guarantees that the amount issued is limited and the rate at which they are issued remains predictable.

It is disputed whether bitcoins are money and here Searle's view is of little help. Bitcoins do get used as 'media of exchange, repositories of value, payment for debts, salaries for services rendered, etc.' (Searle, 1995: 52), if on a relatively small scale. Yet this has not convinced some that bitcoins are money. The obvious Searlean answer would be to say that bitcoin is money among those who count it as money and not among those who do not count it as money. This, however, is not very satisfactory. It seems to leave a basic theoretical itch unscratched and to miss the degree to which the people who dispute such things take themselves to differ on some substantive issue.

1 This claim is challenged in Darby (1996: 718) and in Smit *et al.* (2011, 2014).

A more compelling answer to whether bitcoins are money would be to identify some theoretically interesting, explanatory characteristic shared by those things we uncontroversially consider to be 'money' and to see if bitcoin has the characteristic in question. This, roughly, is the same basic strategy as is used to determine the extension of natural kind terms, i.e. to determine whether whales are fish, whether 'heavy water' is water, whether 'fool's gold' is gold, and so on. Note that Searle need not object to analysing money in this way; he can treat such an analysis as giving an explanation of what 'counting as money' consists in and as serving to develop his cursory remarks on the topic. What, then, is the theoretically interesting, explanatory characteristic definitive of money?

Medium of exchange, store of value and unit of account?

Money is traditionally defined in terms of three basic functions, namely that of a medium of exchange, store of value and unit of account. That money often does fulfil these three functions is beyond dispute, yet this is not sufficient to show that all three are definitive of money. Below we will argue that it is only the 'medium of exchange' function that serves to individuate money. Note that doing so does not amount to denying the importance of these functions, it is merely a matter of pointing out that being a store of value and unit of account are important empirical facts about money, but not constitutive or individuating.

First, however, a distinct issue needs to be resolved. Money is, undoubtedly, a medium of exchange, yet it is not immediately obvious what we are saying when we say that money is a 'medium of exchange. The notion of a 'medium' here is a metaphor; while air and water can literally be said to be media that serve to propagate sound, there is no literal sense in which money is a medium through which anything is propagated. Enquiry cannot terminate in metaphor; what does it mean to say that money serves as an intermediary facilitating exchange? It seems to mean that individuals typically acquire it, not for consumption, but in order to exchange it for something else later. This definition, while capturing part of the 'medium of exchange' metaphor, is still too broad to allow us to define 'money'. For there are plenty of things that are bought in order to resell at a later date that do not count as media of exchange (or money). Consider, for example, investments like shares in a public company or real estate bought in order to resell at a profit, etc.

We can differentiate money from investments by noting that money serves to lower transaction costs by bringing about a form of social coordination. Currencies are tools of social coordination for, all else being equal, the transaction costs incurred by an economic agent decreases as a function of the amount of agents that she transacts with that transact in the same currency. This fact is absolutely central to the nature of money; it explains why the choice for a given currency is a kind of coordination game,[2] 'which explains why the matter

2 A coordination game is a situation of interdependent choice with multiple equilibria.

of adopting a currency is subject to a strong network effect,[3] which explains why the choice for a given currency is generally stable,[4] and so on. Hence, we can refine the intuitive notion of a 'medium of exchange' as follows: something is money among a group of interacting agents if, and only if, it is typically acquired in order to realise the reduction in transaction costs that accrues in virtue of such agents coordinating on acquiring the same thing when deciding what thing to acquire in order to exchange. Note that we need not require that the agents in question understand their practice in such terms. The agents themselves may have all manner of false beliefs about their practice. Yet their practices are sustained, and their behaviour explained, by the fact that the adoption of a currency has such a coordinating function.

The above definition of money is consistent with the common view that money is a 'generally accepted medium of exchange'. It refines this view by explaining what being a medium of exchange consists in and also explains why it is conceptually required that it be generally accepted. What of the view that it is also a store of value and unit of account? Below we will argue that we need not view these as constitutive features of money. Rather it is merely a typical consequence of money being the general medium of exchange (as these notions were explained above) that it can be used as a store of value and unit of account.

The notion of a 'store of value' is, as was the case with 'medium of exchange, somewhat metaphorical. Value is not the kind of thing that can be stored in the literal sense, i.e. in the same sense that grain can be stored. We take the common use of the phrase 'store of value' to mean roughly the following: something is used as a store of value if, and only if, that thing is commonly acquired in order to resell at a later date and the most important consideration guiding such an acquisition is the exchange value of the object at the time of resale. On this definition, the matters of 'medium of exchange' and 'store of value' differ in the following way: while both concern the matter of a something being bought in order to be sold on at a later date, the main consideration guiding the acquisition of money is the reduction in transaction costs deriving from a network-effect, whereas the main consideration guiding the acquisition of an object *qua* store of value is its eventual exchange value. This is not to say that matters of eventual exchange value do not affect the acquisition of money, or that matters of transaction costs do not influence the acquisition of something *qua* store of value, for clearly all costs are relevant to all transactions. The point, however, is that these factors are not the main consideration guiding such acquisition. Simply put, I typically

3 There are many potential sources of network effects (Katz and Shapiro, 1986: 424), but for this discussion our attention is on the impact of the number of users of a particular currency on the utility of that currency for all the users thereof, i.e. a direct network externality.

4 The network characteristics of a payment mechanism predict that the use of particular monies will be stable (Storti and de Grauw, 2002: 10). The expectation is not complete 'lock in' for existing currencies. However, the success of an alternative money will depend not just on the technology by which it is created and delivered, but also the demand side where users enjoy the network externality (Van Hove, 1999).

acquire money despite the fact that it may become worth a bit less while I hold it and may acquire stock in a public company as a store of value despite the fact that selling such stock comes with significant (practical and legal) transaction costs.[5]

On the definition above it is plain that, while money can be used as a store of value, using it in this manner is not its typical use. In fact, fiat money is typically allowed to inflate at a rate that lowers its eventual exchange value, i.e. at a rate that actively discourages using it as a store of value and that makes other investment opportunities (stocks, bonds, real estate) much more attractive. Furthermore, while money can upon occasion be an attractive store of value, this is not conceptually required. If something circulates as medium of exchange, but everyone prefers using alternative financial vehicles in order to store value, then we would not hesitate to call it money. Also note that, if something becomes the medium of exchange, i.e. if it somehow comes about that we all coordinate on acquiring the same thing in order to resell it later in a way that minimises our transaction costs, then such coordination gives that item a non-zero value. In this way, the fact that something is a medium of exchange also explains why it has economic value and so can, upon occasion, be used as a store[6] of value.[7]

What, then, of the idea that money is a unit of account? If we frequently transact by using some item, then it also becomes an obvious candidate to be used for the denomination of contracts and pricing of goods. In this way, the fact that money is the medium of exchange explains why it is typically also the unit of account. It is, however, conceptually possible for something to be the medium of exchange, yet not the unit of account. If, for example, we were forced to transact in a fiat currency that inflates at a catastrophic rate, then it would be natural for sellers to avoid menu costs by quoting their prices using some other *numeraire* and simply calculating the cost in the inflating currency at the point of exchange. It would similarly be natural for people to think of their own wealth using this alternative *numeraire*. Yet, if this occurred, we would still call the

5 One may object by saying that this definition is too broad as all investments fall under this category. Aren't investments a matter of trying to maximise returns (relative to some risk-profile) and storing value more a matter of trying to safeguard what one already has? This may well be so, but we will not complicate the definition given above as any such putative distinction does not affect the argument here. The difference seems a mere matter of degree, i.e. 'storing value' is no more than a matter of making an unambitious, low-risk investment.

6 There is also a broader sense of the term in which everything which has kept some positive exchange value in some arbitrary time-period has served to store value. In this sense, money is a store of value. We think that the interpretation offered in the main text is the dominant one, but adopting the broader usage would not affect our argument. The fact that money is a store of value in this sense is, as was the case on the interpretation employed in the main text, again a consequence of it being the medium of exchange. (Note that on the broader interpretation most anything I own is a store of value and so the broader interpretation runs the risk of triviality.)

7 It may, of course, especially in the case of commodity money, also have value due to other factors.

item circulating as the medium of exchange money. Hence, it is not conceptually required that money be the unit of account.

We are now, finally, in a position to consider whether bitcoins are money. This question now becomes the question as to whether bitcoin is generally used as a medium of exchange, i.e. is mainly used in order to realise the reduction in transaction costs that arises in virtue of social coordination. The data is murky, but it is reasonably clear that the answer is no. At present, the vast majority of bitcoin is traded as a speculative investment, not as a means of lowering transaction costs. We could say that bitcoin may become money at some point, and we could say that bitcoin is already money among those who use it to transact. If asked, however, whether bitcoin as such is money at present, the least misleading thing to say is that it is not. Note, however, that such answer is not due to some constitutive fact about the nature of money that prevents a cryptocurrency from being money, but rather is due to a mere contingency concerning its present use.

2. The question concerning the objects of coordination

The problem of free standing Y-terms

The question as to the objects of coordination, i.e. the problem concerning which kinds of things can be money, may seem to have an easy answer. Is it not the case that any number of things can be money? In other words, given the right conditions, sea-shells can be money, as can gold, cigarettes, tins of mackerel,[8] paper bills, and so on? Fiat currencies, however, introduce a problem, as first noted by Smith and Searle (2003: 287).[9] While some fiat currency exists in the forms of physical notes and coins, most of it does not. Central banks typically only mint some small fraction of the currency in circulation; the rest merely 'exist' as entries in the account ledgers of financial institutions. This raises the following problem for Searle: if money is a matter of some group collectively regarding some brute object as money, what is it that the relevant group regards as money when no physical bills and coins exist? In other words, does the *X*-term in '*X* counts as *Y* in *C*' denote anything when electronic fiat money is considered?

Searle originally claimed that the entries on the account ledgers of various institutions are the relevant objects, i.e. that those entries count as money (1995: 56). Smith rightly objects that such entries are not money, but representations of money (2003: 287). If some copy of these records is destroyed, no money has been destroyed, the copy can be recreated from other copies. Searle, in response, admitted that the records are not money, but merely a representation (Smith and Searle, 2003: 307). This difficulty, and related problems concerning things like corporations, subsequently became known as 'the problem of free-standing

8 As used in US prisons (Scheck, 2008).

9 Recently discussed in Smith (2014).

Y-terms', i.e. the problem created in virtue of the fact that there seem to be no object such that the *X*-term in '*X* counts as *Y* in *C*' denotes it. Searle eventually claimed that his '*X* counts as *Y* in *C*' is merely 'a useful mnemonic' when thinking of the nature of institutional reality (Smith and Searle, 2003: 301); he later characterises institutions as having the form 'We (or I) make it the case by Declaration that *Y* status function exists in *C*' (2010: 101). This, while much less intuitive than '*X* counts as *Y* in *C*', avoids the problem of free-standing *Y*-terms by dropping the *X*-term altogether.

This paper is not about the general problem of free-standing *Y*-terms. Our interest is in the ontology of money; we will defend the view that, where money is concerned, there is a non-institutional object such that we can interpret Searle's *X*-term as denoting it. Or, to use the terminology adopted here, there is some object such that agents coordinate on using it to lower their transaction costs. The first part of my case depends on the claim that notes, coins and electronic records can all be interpreted as records.

Notes and coins as records – a useful analogy

We normally think of chess notation as being a record of positions on an actual board. We do not, however, have to conceive of chess notation in this way. What a system of chess notation and play on a board has in common is the rules governing both have the same mathematical structure, namely the structure of a specific game tree. This structure is definitive of a game being chess;[10] if we encountered some set of agents with prodigious memories who have no notion of a chess board, but play chess by writing out some notation according to rules that map onto such a game tree, then they are playing chess, even if they treat the notation as an uninterpreted set of formal symbols. Hence, we can treat a written list of all such moves up to a given point in time, not as a representation of a board, but as a representation of a node on a game tree.

Note, crucially, that a position on an actual chess board also marks a node on the game tree definitive of chess. Hence, we can apply the same interpretation to a position on a physical chess board; we can interpret it as representing a node on a game tree. In this way then, both a written list moves up to a certain point and a position on a board can be interpreted as being records of a position on an abstract mathematical structure. In fact, we should go further and not only say that a position on a board and a list of moves can be interpreted as marking positions on game tree, but that they straightforwardly do mark such positions. For it is only with recourse to such a game tree that we can at all explain in what sense people playing chess by using a board and people playing chess by using notation are both playing chess, i.e. playing the same game. That the positions

10 While most chess engines do utilise formal representations of the board (typically using a bitboard, specifically a conjunction of 64 integer binary numbers plus values indicating whether castling has occurred, etc.), some do not. Yet we would consider a game against such an engine to be chess.

on a board and the written list of moves mark nodes on a game tree is a necessary feature of playing chess.[11] This is so despite the fact that the players of any such game need not conceive of chess in terms of game trees.

The above analogy suggests the following possibility. We can think of physical notes and coins as being like chess played on a board and think of electronic records as being like chess notation. In this way, transacting electronically is like making a move by employing chess notation and transacting with notes and coins is like making a chess move using physical chess pieces. More importantly, the states achieved by updating a financial ledger or exchanging notes and coins can both be interpreted as being records of some abstract fact. The question is: which abstract fact?

The object of coordination of fiat currencies and bitcoin as a position on a relative ratio scale

Conceptual background

The key to the ontological status of money lies in the difference between the expressions '5 meters' and '5 dollars'. Meters are a paradigmatic example of what is commonly called a ratio scale measure[12] as any measurement expressed in meters is a ratio of a defined unit, i.e. if something is five meters long, its length is five times a fixed quantity. The fact that the meter is a ratio scale measure also implies that the '5' in '5 meters' is a real number, i.e. capable of addition, subtraction, divisible into fractions, and so on. The situation is different in the case of dollars. If someone owns five dollars, then there need not be anything such that the person owns five of these things, i.e. owning five dollars does not literally mean I have five dollar bills. I may simply have a single five dollar bill or, in the case of electronic money, there need not be any bills at all.

Meters are units, i.e. a concretely defined quantity which allows for measurements to be expressed as multiples of it. Dollars, however, are not units. If we multiply all measurements of length by some constant, we need to multiply our unit by the reciprocal of the same constant in order to leave the measurements unchanged, i.e. 10 meters is the same length as five double-meters, where a 'double-meter' is twice as long as a meter. If we multiply all dollar amounts by some constant, we do not need to make any compensating adjustment concerning units, i.e. if we multiply all dollar amounts by 10 by adding a zero to our currency, nothing has really changed. In this way, 'US Dollar' and 'bitcoin' are not units, but the names of distinct monetary regimes.

The '5' in '5 dollars' is a real number, i.e. capable of being divided into fractions and allowing for addition, subtractions and so forth. How can this be,

11 But of course it is not sufficient; the players must also (typically) understand themselves to be acting in accord with the rules defining the game tree, be trying to get to the end-node definitive of 'winning', and so on. See Smith (2008).

12 The terminology is from Stevens (1946).

i.e. why is it the case that 1 dollar + 1 dollar = 2 dollars? In the case of ratio scales like meters, this is easily explained by the fact that there is an underlying unit with a defined physical meaning so that amounts are ratios of this unit. No similar explanation is available in the case of the dollar. Dollar amounts are real numbers, not in virtue of being ratios of a fixed unit, but because our practices (legislation and custom) treats these numbers as real numbers. The fact that dollar amounts are real numbers consists in nothing over and above these practices. If I have five one-dollar bills, then any trade that can be entered into in virtue of this can, by law and custom, also be entered into with one five dollar bill, or with four one-dollar bills and four quarters. Similarly, if I have a five dollar bill and a one dollar bill and offer it in payment of a six dollar debt then, by law and custom, my obligation is discharged.[13] If our practices were different, it would not make sense to add these numbers together, i.e. the numbers stamped on notes and coins would not function as real numbers. The same holds for electronic currency and bitcoin. When a bank, or the bitcoin network, is instructed to credit or debit an account (or a bitcoin address), it does so in accord with the rules defining real numbers; i.e. if I have 100 dollars and instruct them to debit my account by 1.2 dollars, I have 98.8 dollars left, and so on. Such practices make these numbers real numbers. It is also, presumably, these practices that may mislead us into thinking that there must be some unit, i.e. the dollar, that underlie our practices and that all amounts are some ratio of.

The above reasoning provides an obvious candidate for the abstract mathematical object that could serve as the denotation of Searle's *X*-term, namely the real number line. Mathematically, there is no difference between a real number and the corresponding point on the real number line; hence we can say that notes, coins and electronic numbers represent positions on the real number line in the same way that a position on a chess board or a written list of moves can represent a position on a game tree. This would render notes, coins and electronic fiat records of positions on the real number line in the same way that a chess board and chess notation both serve as records of nodes on a game tree.

The above proposal is tolerable in that it would seem to solve Searle's problem. It also makes it clear that money, like chess, is 'software', not 'hardware', i.e. modern monetary systems all implement a basic protocol that partly involves assigning real numbers to individuals and then using record-keeping devices like notes, coins and electronic records (or the blockchain) in order to keep track of such assignments. Note, again, the analogy to chess. The gain from introducing an abstract object like game trees into our understanding chess was that it allows us to see why chess using a board and chess using only notation are the same sort of activity, namely playing chess. The gain from introducing an abstract object

13 Of course, the transaction costs may differ. In extreme cases, I may have to take my pennies to the bank to exchange for larger denominations before a store will accept them for large purchases.

as the object of coordination in our monetary practices is similar in that it allows us to see that using notes, coins, electronic records (or the blockchain) are also the same sort of activity, namely record keeping.

There is, however, a more elegant alternative to treating points on the real number line as the abstraction that notes, coins and electronic records are records of. The fact that assigned numbers in a monetary system are real numbers allows us to construct a scale that measures the fraction of the sum of all amounts that each specific economic agent owns. Given that the assigned numbers are real numbers, such a scale will be mathematically equivalent to a typical ratio-scale, i.e. it has a natural zero point and addition and subtraction (and hence multiplication and division) are meaningful operations. Hence, in virtue of some ownership-relation and assignments mechanism specific to the particular monetary regime, we can say that each economic agent that owns money also has, i.e. owns, some position on the relevant ratio scale and that trade in the currency is a matter of surrendering and gaining some interval on this scale. Call any such ratio scale measuring the fraction of some total assigned to an entity by an underlying mechanism a relative ratio scale and call any ratio scale arising in virtue of a unit with a concretely defined unit (as with meters) an absolute ratio scale. Below we will argue that the object of our monetary coordination, i.e. the thing that gets traded when we buy and sell using bills, notes and electronic records are positions on some particular relative ratio scale.

Arguments in favour of the relative ratio scale view

The problems with treating positions on the real number line as the object of coordination are all due to the fact that dollars are not units and so treating the ratio scale as the relevant object better carves economic reality 'at the joins', i.e. doing so is conceptually useful. If I merely know that something is 5 meters long then, provided I know what '5' means and I know how long a meter is, I know something substantive. If, however, there is a currency called the 'geo', and I know that someone has 70 geo, I know nothing similarly substantive. Amounts expressed in meters are meaningful relative to a concretely defined unit, whereas amounts expressed in geo are only meaningful relative to other amounts expressed in geo. For example, I need to know how the geo is denominated before I know if 70 geo is a lot of geo or not. If the sum of all geo in existence is 100 geo, then 70 geo is a lot of geo, but if the sum of all geo is 90 trillion geo, then 70 geo is a trivial amount of geo. (Note that we are not here talking about the value of the geo, but of a notion that occurs at an even more basic level; if the geo becomes a universal currency, then a trivial amount of geo can still be worth a fair bit.) The actual real numbers assigned to economic agents by some monetary regime are meaningless except in the context of all other real numbers assigned to agents via the same system; the relative ratio scale defined above discards the meaningless real number in favour of the much more meaningful 'fraction of total assignments' assigned to each individual.

By the same logic, the relative ratio scale also allows for a clear sense in which someone can have 'more' or 'less' money. For example: if someone is assigned the number 5 in some particular monetary system at time t, and then assigned the number 6 at time $t+1$, then we want to be able to say that she has a greater amount of currency at time $t+1$ than at time t. But this will not be the case if the system has experienced monetary inflation of over 20 per cent in the interim; if such a situation occurs, then the person actually has less at time $t + 1$ than at time t. What fundamentally increases when someone has more currency is not that the real number assigned to them increases, rather such an increase consists in an increase in the interval assigned to them on the relative ratio scale expressing the fraction of total currency assigned to each economic agent. Hence, treating the ratio scale as the object of coordination allows for a clear statement of the non-trivial sense in which we can have 'more' or 'less' money. This way of looking at things yields a conceptually neat tripartite distinction between the numbers assigned to individuals, the amount of currency that they own in virtue of such assignments and the value of such currency. Consider the case where a government drops a zero from its currency. In such a case, the real number assigned to each individual is an order of magnitude lower, but there is a sense in which 'nothing really changes'. The above concepts allow for a clear statement of the sense in which 'nothing really changes'; this consists in the fact that the position occupied by each person on the ratio scale is entirely unchanged. This, of course, is a distinct thing from the economic value of money and the price level; people are strange creatures of habit and such a change may, at least in the short run, cause a change in the economic value of some interval on the relevant ratio scale.

Another point in favour of treating the ratio scale as the object of coordination is that it allows the mathematical rule that someone's gain is someone else's loss to always come out true. Consider a form of cryptocurrency that assigns real numbers to addresses but where the software treats re-assignments in a mathematically deviant manner, for instance by making it so that if A assigns 10 to B, B gains the 10, but A loses 15. The 'missing' 5 are not re-assigned in any way; they just go out of existence. This would be odd, but not impossible. In theory, all that is required of a functioning system is that there is some degree of scarcity, that the sender ends up with less after sending, and some way of positively influencing the balance of the receiver, i.e. that they end up with more.

We can imagine all kinds of crazy implementations that violate the 'one-for-one' property that someone else's loss is someone else's gains on the level of real numbers.[14] On the level of the resulting ratio scale, however, the 'one-for-one' property would be preserved. It deals with fractions of a total, and in the above case the 5 going out of existence would simply decrease the total, thereby

14 Note that the numbers themselves would still be real numbers as they allow for addition and subtraction in the normal manner, i.e. if I have 7 and lose 5 I have only 2 left.

increasing the fraction owned by all parties in the system and so preserving the 'one-for-one' property. In fact, on the level of the ratio scale, the '5 going out of existence' would simply be the functional equivalent to of a sales tax distributed across all those with a positive balance. This may sound esoteric, but it is not. In any realistic economy, 'money' is always being created, lost or destroyed. Currencies are constantly in a flux of such redenomination; the ratio scale measuring the fractions assigned to individuals gives us a meaningful grasp on the conceptual content of such redenomination prior to the economic question of the dynamic effects of such redenomination on the value of some amount of the currency.

If the above is correct, then Searle's *X*-term can be taken to refer to a brute object, namely a position on a ratio scale. Of course, Searle's typical examples of brute objects are physical, not abstract, but that is not a problem here. Any account of institutional reality will have to pre-suppose abstract objects like numbers in order to account for social security numbers and so on; using such objects to account for money does not complicate our ontology beyond what we are already committed to. In fact, note that Searle has explicitly acknowledged that an abstract object can be the denotation of the *X*-term when writing that an abstract line, i.e. the sequence of extensionless points separating Colorado and Utah, counts as the border between them (Searle, 2003, 308). Of course, the theorist may ultimately wish account for such *abstracta* according to realist, nominalist or fictionalist scruples, just like they may ultimately account for physical objects in various ways. But such broader issues are orthogonal to present concerns, nothing in the theory of institutions forces a specific commitment in these areas.

The money protocol

The view defended implies that notes, coins, electronic records (or the blockchain) implement the same basic protocol. The view that money is 'software', i.e. a protocol that can be implemented in various ways, is implicitly recognised in the writing of most economists and others who have written about money. The task here is to spell out the detail of what is required of such implementation. Once we focus on this topic explicitly, we find that, in each case, there is some method, particular to each monetary system, that assigns real numbers to individuals and in virtue of which can say that someone owns *X* amount of some specific currency. These real numbers represent points on a ratio scale and it is these points on the ratio scale that is the object of coordination, i.e. the things we coordinate on using as a means of exchange in order to lower our transaction costs. Of course, people do not think of themselves as gaining and ceding intervals on some abstract object. We are not, however, here interested in social psychology; chess players don't typically think of themselves as trying to reach certain nodes on a game tree either.

In order to make the basic idea seem less strange, we will run through a basic example and then contrast it to present practice. Stipulate that five honest people with perfect memories are stranded on a desert island and that the transaction costs of barter become prohibitive. They are in need of a monetary system; they launch one by agreeing that 'everyone has 2' and further agree that all trades have to occur in the presence of all five people. The first trade occurs by A publicly receiving some consumer item from B and, in payment, A publicly declaring: 'I hereby assign 0.23 to B'. Everyone now knows (and remembers) that A has 1.77, B has 2.23 and everyone else still has 2. When A makes a subsequent purchase, the amount assigned by him now gets subtracted from 1.77; and so on for all the people on the island. They can continue using this extremely basic system indefinitely, subtracting the assigned amount from the total assigned to the buyer of a good and adding it to the seller of a good, all the while updating their mental records of trades in accord with the relevant declarations.

It may well be asked why anyone would accept such a system, i.e. why anyone would trade goods and services in return for having a higher number, and hence, all else being equal, an improved position on the ratio scale assigned to them. There are any number of mechanisms that could make this happen. In the above case, it was done by credible agreement, but it could also have occurred by one powerful entity making a credible commitment to do so, which incentivises all other parties to do similarly. Once such a situation is up and running, however, it is sustained by the same logic that makes us all drive on the same side of the road, i.e. by the fact that there is no incentive in favour of unilateral deviation. If any party unilaterally opts out, then all that happens is that they lose whatever money they may have and forego the savings in transaction costs afforded by transacting via this system.

Note that, in the above case, the question as to unit ('2 of what?') simply never arises. This again demonstrates that, when dealing with fiat money, we not dealing with a ratio scale defined in terms of some concrete unit. Initially, the maximum that anyone can have is 10, but monetary inflation can occur if any party can have an assignment exceeding what was assigned to them generally accepted by the other parties. This means that it is most elegant to view the assignments as ways of assigning positions on a ratio scale that make the conceptual possibility and consequence of such 'redenomination' immediately clear.

Our main claim is that modern monetary systems can, and should, be viewed as implementing the same basic protocol as on our island example. Of course, monetary systems will differ in how assignments are made, i.e. how it comes about that you own *X* amount of currency (and so can be said to have a certain position on the relevant ratio scale). On the island, this is a matter of public declaration. With fiat money, it is a matter of either handing over notes and coins with the relevant number stamped on them or instructing a financial institution to debit your account, and credit the account of someone else, with the required

amount. In the case of bitcoin, assignments are done by publicly broadcasting an instruction to debit one address, and credit another, with some required amount. Systems will also differ in what constitutes ownership of currency. On the island, ownership consists in others being willing to update their mental records in accord with your public declarations. With fiat money, ownership consists on being the legal possessor of the relevant notes and coins or financial institutions being under the legal obligation to update their records in accord with your instructions. In the case of bitcoin, ownership is not (primarily) a socio-legal relationship at all, rather one owns a certain amount of bitcoin if one knows the private key required in order to broadcast a message instructing that a specific address be debited in favour of another address. Yet, despite these differences, it should be clear that all the cases above implement the same protocol.

'Commodity-money' as records of positions on a relative ratio scale

The elimination argument

The above analysis may naturally push us towards pluralism about the object of coordination. On such a view, the object of coordination can be a position on a ratio scale, but the object of coordination can also, as is the case with commodity-money, be a kind of physical object like cigarettes, sea-shells, gold, and so on. We will argue against such pluralism and in favour of the view that all the things we ordinarily call 'money' are best interpreted as records marking positions on a relative ratio scale, so that money, i.e. the 'things' bought and sold, just are positions on such a ratio scale.

Consider cigarettes used as a currency in a prison.[15] In a cigarette economy, people are assigned real numbers based on how many cigarettes they own. These real numbers reflect an absolute ratio scale (with cigarettes as unit), but can also be used to define a relative ratio scale of the fraction of all cigarettes owned by each person. Positions on this latter ratio scale can be re-assigned by trading cigarettes, and then the cigarettes themselves then function as a record of the position of their owner on such a ratio scale. In this way, the cigarette-economy straightforwardly implements the money protocol; there is an ownership-condition that assigns real numbers to agents, a method of re-assigning such numbers and a method of keeping track of such assignments. This raises the question: should we interpret a cigarette economy in this way? What is gained in talking of people in a cigarette economy as trading positions on a ratio scale, as opposed to simply trading cigarettes?

The reason why it is better to talk of the relative ratio scale that arises due to cigarette trade, as opposed to the actual cigarettes, is that, *qua* items in a monetary system, the cigarettes only matter inasmuch as they assign positions

15 An instructive historical example is in Radford (1945).

on a relative ratio scale to individuals. Consider a prison with unusually honest inmates, all with prodigious memories, that have a cigarette economy. Suppose a guard wishes to punish some inmate by stealing five cigarettes from him. The prisoners are in uproar at such blatant injustice and decide to treat the inmate as if the cigarettes have never been stolen. If this prisoner wishes to trade, he makes some public, verbal declaration like 'I give 2 cigarettes to Bob', and then all simply remember that Bob now has two more 'cigarettes', and the unjustly treated inmate two less. Intuitively, if the prisoners all accede to this system, then they have foiled the evil intent of the guard; the prisoner did not lose any money. This may seem puzzling, but the current theory neatly explains how this can be. While the inmate may have lost five cigarettes, he did not lose his position on the relative ratio scale that serves as the object of coordination.

We can make the example more extreme by removing all the cigarettes from the 'cigarette' economy, yet their monetary system can remain unchanged. If we can remove the cigarettes from the prison economy, yet the monetary system can remain unchanged,[16] then the actual cigarettes cannot have been the object of coordination. Call this the elimination argument. It shows that the cigarettes merely functioned as record-keeping devices, which is why they could be replaced by record-keeping devices of a different kind.

Note that the elimination argument not only applies to commodity-money, but also to government issued fiat currencies. In principle, we can eliminate any one of notes, coins or electronic records. Nothing needs to change, provided that one of the remaining methods picks up the slack by, for instance, printing the relevant notes when the electronic records are abandoned. All three function as records, and, as is typical of records, can simply be replaced by records in a different medium.

Note that the elimination argument does not claim that, if we remove the commodity from so-called 'commodity money', the monetary system will always remain unchanged. This will rarely be possible; all prisoners are not scrupulously honest and people typically do not have prodigious memories.[17] What the elimination argument shows is that the relevant commodity solves a practical problem of record-keeping, not the problem of providing an object of coordination. In most practical cases, of course, the relevant people won't have the means or economic ingenuity to simply replace the system of record keeping with an alternative system if the commodity disappears. This, however,

16 One may object that removing the cigarettes is, in itself, sufficient to amount to the adoption of a new currency. Such an objection straightforwardly conflicts with historical practice; e.g. if a currency abandons the gold standard, we consider it a matter of changing something important about that currency, not a matter of abandoning one currency and adopting another.

17 Compare the emphasis on honesty and memory in this example with the role imperfect enforceability and imperfect record-keeping as two crucial social frictions that explain the emergence of money in Kocherlakota (2002).

is irrelevant to the functional role that the commodity plays in their monetary system.

The purchasing power argument

One may object to the view that the commodities involved in commodity money serve as mere records by claiming that the relevant commodity also plays the role of guaranteeing the value of the currency. Is it not the case that the value of the cigarettes *qua* consumables determines their purchasing power *qua* currency, in much the same way that the exchange value of gold *qua* commodity backs the purchasing power of gold-backed currencies?

The idea that the use-value of a backing commodity determines the purchasing power of it *qua* currency is a myth. Stipulate that some kind of commodity *X* circulates *qua* 'money'[18] in a monetary regime among a group of economically rational agents. Under standard assumptions, the fact that some agent parted with some amount of *X* implies that she revealed a preference for the objects exchangeable for that amount of *X* to using or consuming the amount of *X*. If this were not the case, then she would have used or consumed the amount of *X*, and the specified amount of *X* would have ceased to be a part of the monetary system. This logic generalises; a commodity can only circulate *qua* 'money' between agents who place a higher value on it *qua* currency than they do *qua* commodity. This means that the use-value of the commodity is no longer determining whether it is bought or sold. Hence, the use-value of a commodity used as currency does not determine its price, as expressed in some arbitrary *numeraire*; it merely places a lower limit on what that price could be.[19] An alternative way of making the same point is that, once a commodity is adopted as 'money', a group of people who previously had no reason to acquire it suddenly do have a reason to acquire it. Hence, such adoption raises demand above the demand due to its intrinsic nature and must, all else being equal, lead to an increase[20] in price.[21]

18 We insert scare quotes here as, on the present theory, the item themselves are not money, but a record of money.

19 As is the case with all commodities, the higher limit is set by the cost of reproducing the commodity, i.e. obtaining cigarettes from outside prison, gold mining, etc. In the case of fiat, this amounts to the cost of counterfeiting. After the Somalian government collapsed in 1991, the pre-1991 Somali shilling still circulated, but its purchasing power was constrained by the large amount of accepted counterfeit notes in circulation. Inflation stabilised once the value of the currency hit the cost of counterfeiting (Powell *et al.*, 2008: 667–668).

20 The value of a commodity used as money can rise in this manner as it is not consumed, but passed on to someone who will pass it on, and so on indefinitely. If the relevant commodity is durable enough to keep being passed on, and no agent knows that she happens to be the final agent in such a chain, then there is no end user who is such that the exchange value of the commodity needs to be a function of the use value of the commodity for that user.

21 The idea that, when a commodity is adopted as 'money', this constitutes a new use over and above its intrinsic usefulness and so affects its marginal utility (and hence price) is, of course, not novel. See, for instance, Schumpeter (1908: 287–288).

The purchasing power of the commodity *qua* 'money' can vary independently of its purchasing power *qua* commodity. This is another reason for distinguishing the commodity from the relative ratio scale to which it gives rise, and treating the latter as the monetary phenomenon, i.e. the object of coordination. Call this the purchasing power argument.

3. Two objections considered and dismissed

Does the government decide whether something is money?

We have defended the view that something is money if it is the object of social coordination used to minimise transaction costs. What however, about the role of governments? A United States federal judge has recently ruled that bitcoin is money while prosecuting someone running a bitcoin Ponzi scheme.[22] Does this make bitcoin money?

Note that government declarations cannot be necessary for the creation of money, as shown by all the non-state currencies identified by economists.[23] Can it, however, be sufficient? The answer is no. The very idea rests on a confusion due to an ambiguity between the legal use of terms and the non-legal use of such terms. There any number of terms that have a legitimate legal use that is distinct from its non-legal use. In this way, the government may declare Microsoft to be a 'person' or ketchup to be a 'vegetable', but this has no relevance for psychology or biology. The interest of the law is regulative; legal terms serve to commit the government to some action, not to describe reality. The same goes for the legal use of the term 'money'. Declaring bitcoin to be 'money' is a way of legally bringing bitcoin under the auspices of a specific regulatory regime, not the formulation of an economic theory. Government action can, of course, serve to create an object that is especially suited to being an object of coordination that serves to minimise transaction costs. In this way, they can create something that is almost guaranteed to become money.[24] Strictly speaking, however, it is the coordinating behaviour of the agents in an economy, not government behaviour, which is constitutive of the object that is of interest to monetary theory.

22 See Hill (2013).

23 The numerous examples of non-state commodity 'currencies', such as cigarettes in prisons, show that state sanction is not a pre-requisite for money. The point extends to non-state fiat currencies, for example the *slagters briefjes* (butcher's notes) which functioned as a fiat currency, but was issued by the Brothers van Reenen at the Cape of Good Hope in the 18th century. While the experience with privately issued monies was not uniformly positive, privately issued fiat money in Canada and Scotland seems to have worked well in the 19th century (Williamson, 1999: 469).

24 Governments can act as a kind of 'choreographer' promoting the coordination of action. See Gintis (2009).

Do some currencies merely mark a position on an ordinal scale?

Yapp stone money is odd in ways that have intrigued economists.[25] The interesting issue from our perspective is that the worth of the stones that the Yapp use in their monetary system is not a simple function of some physically comparable property of the stones like weight or volume. Rather the value of a stone depends on a variety of factors, including weight, appearance, how hard it was to obtain, and so on. Hence, the stones do not generate real numbers, or an economically relevant ratio scale in virtue of their physical make-up. At best, they generate an ordinal scale definable only in terms of what the different stones can be traded for.

At first blush, this may not seem to be a problem. Modern economies use a heterogeneous mix of notes, coins, and electronic records; these do not generate a relevant relative ratio scale in virtue of their ordinary physical properties. The relevant ratio scale is generated in virtue of the numbers assigned electronically or stamped on the notes and coins. Yapp money would be similar if each stone is assigned a value which remains a constant ratio of the value assigned to each other stone. Alternatively, if three subsets of stones are assigned a value which is a constant ratio of each other stone in the subset, but which varies against members of different subsets, then we have a situation similar to the relation between dollars, euros and pounds, i.e. we have three currencies that map onto distinct relative ratio scales and a variable exchange rate between them. The ethnographic data, however, does not serve to decide the question. So let us assume the worst and assume that the value of any stone can change relative to any other stone. Call this quasi-hypothetical scenario the extreme Yapp case.

Note that all the arguments offered in favour of viewing the object of coordination as an abstract entity straightforwardly apply to Yapp stones. First, we can eliminate the stones without eliminating any money. Secondly, the purchasing power of the stones cannot be determined by their use-value, for otherwise they would cease to be used as currency. The Yapp, in fact, seem to recognise these points, treating the stones more like records than objects of value. There is a famous case where the boat bringing a stone to the island capsized and the stone was lost to the ocean, yet the stone still 'counted' – in a manner analogous to the hypothetical cigarette example mentioned earlier – as money among the Yapp (Furness, 1915).[26] Furthermore, most Yapp stones are too heavy to conveniently transport; the stones typically remain in place subsequent to a transaction and the Yapp simply remember who it now belongs to.

How, then, should we think of the abstract entity that serves as an object of coordination in the extreme Yapp case? Each stone must be interpreted as determining a unique relative ratio scale, expressible by, for instance, assigning

25 See Furness (1915).

26 Goldberg (2005) has disputed whether the stone really remained currency.

the number '1' to its owner and '0' to everyone else. In support of this claim, note that, especially since the stones themselves rarely move, nothing stops the Yapp from trading parts of stones, e.g. surrendering one's claim to a third of a stone, without having to decide which sections of the physical stone each party owns. On the present view, this makes perfect sense; all that happens is that the party who owns the stone changes the assignment so that he is now assigned the number '2', the trading party is assigned '1' and everyone else remains at '0'. This is all that surrendering a third of the stone *qua* 'money' consists in and requires no reference to the actual, physical parts of the stone itself. This possibility would be unintelligible if the relevant abstract entity was only definable in terms of ordinal numbers as ordinals cannot be divided into fractions.[27]

4. Conclusion

It has been argued that, for all currencies, the object of coordination that is exchanged in order to minimise transaction costs is a set of positions on a relative ratio scale. The physical objects that serve to implement a specific currency are mere records of positions on such a scale. These objects can vanish overnight and yet no money is lost. In practice, of course, the physical objects matter. Cigarettes, fiat coins and the blockchain serve as way of keeping everyone honest and, sometimes, as a credible supply constraint or determinant of the minimum value of the currency. But no such extra-mental physical stuff is required by the very nature of money. While there are practical reasons for having such things, they are ultimately not what our practices are about.

References

Darby, D. (1996), 'Review of "The Construction of Social Reality"', *Mind*, **105**(420): 716–719.

Furness, W. H. (1915), 'The Island of Stone Money', *The Economic Journal*, **25**(98): 281–283.

Gintis, H. (2009), *The Bounds of Reason*, Princeton, NJ: Princeton University Press.

Goldberg, D. (2005), 'Famous Myths of "Fiat Money"', *Journal of Money, Credit and Banking*, **37**(5): 957–967.

Hill, K. (2013), 'Federal Judge Rules Bitcoin is Real Money', *Forbes*, available at: http://www.forbes.com/sites/kashmirhill/2013/08/07/federal-judge-rules-bitcoin-is-real-money/

Katz, M. L., and C. Shapiro (1986), 'Network Externalities, Competition and Compatibility', *American Economic Review*, **75**(3): 424–440.

Kocherlakota, N. R. (2002), 'What's the Question and Why Should we Care About the Answer?', *American Economic Review*, **92**(2): 58–61.

27 In the same way, our practice of only dividing monetary units up to a point (typically down to cents) does not refute the claim that the numbers in question are real numbers. Nothing beyond practicality prevents us from trading fractions of a cent (or even officially subdividing cents if our currency undergoes massive deflation).

Powell, B., R. Ford, and A. Nowrasteh (2008), 'Somalia After State Collapse: Chaos or Improvement?', *Journal of Economic Behaviour and Organization*, **67**(3–4): 657–670.
Radford, R. A. (1945), 'The Economic Organisation of a P.O.W. Camp', *Econometrica*, **12**(48): 189–201.
Scheck, J. (2008), 'Mackerel Economics in Prison Leads to Appreciation for Oily Fillets', *The Wall Street Journal*, available at: http://www.wsj.com/articles/SB122290720439096481
Schumpeter, J. A. [1908] (1980), '*Der MethodoIogische Individualismus*. Chapter VI of Joseph A. Schumpeter (1908)', English translation by M. von Notten (ed.), *Methodological Individualism*, Brussels: Institutum Europaeum.
Searle, J. R. (1995), *The Construction of Social Reality*, London: Penguin Books.
Searle, J. R. (2005), 'What is an Institution?', *Journal of Institutional Economics*, **1**(1): 1–22.
Searle, J. R. (2010), *Making the Social World: The Structure of Human Civilisation*, Oxford: Oxford University Press.
Smit, J. P., F. Buekens, and S. du Plessis (2011), 'What is Money? An Alternative to Searle's Institutional Facts', *Economics and Philosophy*, **27**(1): 1–22.
Smit, J. P., F. Buekens, and S. du Plessis (2014), 'Developing the Incentivized Action View of Institutional Reality', *Synthese*, **191**(8): 1813–1830.
Smith, B. (2008), 'Searle and de Soto: The New Ontology of the Social World', in B. Smith, D. Mark and I. Ehrlich (eds.), *The Mystery of Capital and the Construction of Social Reality*, Chicago: Open Court, pp. 35–51.
Smith, B. (2014), 'Document Acts', in A. Konzelmann-Ziv and H. B. Schmid (eds.), *Institutions, Emotions, and Group Agents. Contributions to Social Ontology*, Dordrecht: Springer, pp. 19–31.
Smith, B. and J. R. Searle (2003), 'The Construction of Social Reality: An Exchange', *American Journal of Economics and Sociology*, **62**(2): 285–309.
Stevens, S. (1946), 'On the Theory of Scales of Measurement', *Science*, **103**(2684): 677–680.
Storti, C. C. and P. De Grauw (2002), *Electronic Money and the Optimal Size of Monetary Unions*, London: Centre for Economic Policy Research, Discussion Paper No. 33.
Van Hove, L. (1999), 'Electronic Money and the Network Externalities Theory: Lessons for Real Life', *Netnomics*, **1**(2): 137–171.
Williamson, S. D. (1999), 'Private money', *Journal of Money, Credit and Banking*, **31**(3): 469–491.