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Ontological Analysis of Money

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Abstract. Money is enigmatic. Despite extensive investigation to date, conflicting theories persist regarding its nature. Examples include views that "Money is a physical object," "Money is an abstract concept," and "Money is institutional status," among others. This paper aims to unravel this mystery by engaging in an ontological discourse on the essence of money and constructing a three-layer model that comprises (i) the representation (legitimacy) layer, (ii) the role layer, and (iii) the property layer. In the representation layer, official state-issued objects such as banknotes are examined through the lens of the representation theory. In the role layer, these objects act as monetary role holders, referred to as monetary objects, by playing the monetary role which is inherently social in nature. The three fundamental properties/functions of money—serving as a unit of economic value, being exchangeable with commodities, and capable of being stored—are inherent in monetary role, and hence in monetary objects. However, these properties/functions remain latent until they are possessed by agents. The property layer elucidates that money is a contingent property of the owner of monetary objects, who can engage in economic activities by harnessing/actualizing these three properties/functions. In summary, our ontological theory of money posits *Money* as a property, *Monetary objects* holding the *Monetary role*, whose player is the *Legitimate representing thing* issued by the authority. For instance, a freshly minted 20 Euro banknote is a legitimate representing thing, transitioning into a monetary object upon holding the monetary role within the economic context. Its institutional/causal power becomes operative upon ownership by an agent. Our theory adopts a monistic perspective rather than a dualistic one, facilitated by the above nuanced distinctions made among entities pertaining to "money." Discussion about how our theory works for resolving some of the current issues is presented together with a justification for the observation that money virtually has *use value* in addition to *exchange value*.

Keywords. Ontology of money, money as property, monetary object, monetary role

1. Introduction

The reason why a banknote, which is just a piece of paper, has economic value and is used as money has attracted researchers' interest for long time. Answers to this issue are still lacking and further analysis is needed. Even though in the case of convertible money the issue is fairly understood, for contemporary non-convertible money the question remains problematic. Despite the long intensive discussion, there exist quite a few different views and claims about what money is [9,11].

For example, John Searle [19] argues that money is an institutional status that is imposed on physical objects. Commodity theory [4] is explicitly based on the notion that money means physical objects such as banknotes and coins. Guala [5] proposes that money is a concrete object in some cases, and an abstract object in others. J.P. Smit, et al. [24] argue that money is always an abstract object. Mäki claims 'money is a bundle of causal powers [11]. The last alternative is that money is a concrete object in some cases, and a property

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of an agent in others [7,8]. Although Hindriks proposes money is a property, his claim is based on dualism rather than monadism. This paper defends the monadic view and proposes a theory in this sense.

People do not distinguish banknote and money, and this has been one of the causes of fundamental confusion. We suspect that many of the theories that claim money is a physical object are strongly influenced by this confusion. The theory we present in this paper explains both the ontological status of a banknote as well as that of money, without conflating the two.

In our journey into the ontological investigation of money, the main focus is the explanation of what money is in the contemporary world. In other words, we do not discuss how money emerges but what money is. This is like discussing what a mountain is versus how it emerges, the first is significant in ontology, the second in geology. Similarly, the problem of how money emerges should be left for social scientists and economists.

Mäki, U. lists 12 core questions about money in his work [11]:

> *"(1) What is money? (2) What does money consist of? (3) Does money have an essence? (4) What larger worldviews are revealed by different conceptions of money? (5) How does money originate, and how does it persist? (6) Is money an institution or a convention? (7) What is the precise relationship between the material and the social in money? (8) How do particular items of money relate to money as an institution? (9) Why are certain things that are easily mistaken for money, not money? (10) How does money exist? (11) Is money real, and if so, in what sense? (12) Does money exist just in virtue of people believing that it does, or is more involved? These are questions about the ontology of money."*

Here, we set a theory that answers 10 of these 12 questions, excluding #4 and #5 for the reasons just stated.

Our theory is outlined as follows. We first focus on banknotes referred to as "money" in daily life. Following Searl's view: "Money is an institutional status that is imposed on concrete objects" [19], we refine his constitution rule (CR) using the role theory developed in the FOIS community [10,12,15] to introduce the concept of *monetary role*, which is a social role defined in the economic society with three well-known fundamental characteristics, namely, (i) the unit of economic value, (ii) exchangeability with commodities, and (iii) storability. The issue is to correctly identify the player of the role, for which we need a finer resolution than what proposed in today's theories. Note here that a banknote is physically a sheet of paper with (fancy) images. According to the ontology of representation [17], it is a representing thing realized on the medium of the sheet of paper consisting of form and content. The form consists of number symbols as well as images, that take care of the legitimacy of the monetary object, and the content is the (unit of currency and the) quantity of money. Such a representing thing is the player of monetary role. According to the role theory, when a representing thing plays monetary role, it thereby becomes monetary-role-holder, which is referred to as a monetary object. Concretely put, when a banknote with the authentic images printed by the authority of EU plays the monetary role of Euro, it becomes a Euro currency, say, 20 Euro bill.

At first sight, monetary role may seem to be a solution to the question of what money is. Monetary role (hence a monetary object) has the money status function, but cannot perform the function by itself. That must be done by an agent who owns the monetary

object. This fact suggests that money is not the monetary object itself but a *property of the owner* of monetary objects. That is, when an agent owns a monetary object, he/she inherits the fundamental three properties/functions from it and can perform the status function in the relevant economic society. The above rather complex entities and relations are organized in a three-layer model: representation, role, and property layers.

This paper is organized as follows. Section 2 presents three theories of representation, physical entity and role used for supporting the ontological analysis of money. The theory of physical entity is used for defending the claim that electronic money[2] is a physical entity refuting the criticism made in [26] against Searl's theory and contributing to the revival of his original position [19]. Sections 3 provides the definitions of monetary object, monetary role, and money together with the three-layer model of money and a preliminary formalization of the proposed ontology. Section 4 discusses money as quantity in the context of value analysis of money. In particular, the view that money virtually has *use value* besides *exchange value* is defended employing the existence of the amount of money roughly equivalent to the amount of value of commodities. Section 5 discusses related work in the light of the entities proposed in the paper, including our answers to the 10 questions listed by Mäki. Section 6 concludes the paper.

2. Theoretical background

The theory builds on three theories, namely, an ontology of representation, a role theory and a theory of physical objects which have been developed within the FOIS community.

2.1 Representation

A banknote is made of a sheet of paper with a numeral indicating the quantity of money and authentic images that guarantee it is an official product issued by the authority. To ontologically identify what it is, we first need a theory of representation to reveal the fundamental status of banknotes as a representing thing[3].

The YAMATO ontology [18] includes a theory of representation which was presented in [17]. The central idea is that a representation consists of a form, typically an expression in some language, and a content. A representing thing is composed of a representation and a representation medium (a support where the expression is cast). The form and content of a representation can be realized in different media. For instance, a musical score (representation) consists of a sequence of musical notes (the representation form) and the specification of the sound sequence (the content); and a music book (the representing thing) is composed of some musical scores (representations) and some pieces of paper (representation media) where the musical scores is depicted. The form of a representation is realized on a physical continuant: e.g., a sequence of musical notes is realized when it is written on a piece of paper (referred to as form-realization). The content of a representation is realized by some process (typically by an action) when it is a specification, i.e., a detailed description of how something is, or should be, designed or made (referred to as content-realization). Examples of representations whose content is a specification include an algorithm, a recipe and a plan. To continue our previous

[2] Bitcoin and the similar are out of scope of the paper.

[3] Our theory of representation is not representation of anything. It is just composed of representation form and its meaning called content which could mean fake, imaginary entity or whatever. Although the identity of a representation is determined by both the form and the content, the form is discriminating more than the content.

example, a piece of music is realized when somebody plays it.

2.2 Physical objects

The following is an excerpt from [9]:

> *"John Searle [19] has struggled with the issue. Initially, he argued that money is an institutional status that is imposed on concrete objects. As a consequence, the relevant objects can be said to be money. However, Barry Smith [26] pointed out that this idea makes little sense when it comes to electronic money. After all, in that case, there is nothing on which the status is imposed. In response, Searle [20] has conceded that, in the case of electronic money, there is no concrete object that has this status. But this leaves open what exactly its ontological standing is".*

In our view, the claim about electronic money in [26] misses the point: electronic money is a physical object. A bitstring on a computer disk of a bank is a physical object and not a mere record of cash. Note that when one deposits some cash in a bank, the bank can use it as it wants under the constraint that the bank has to allow her to withdraw the deposit whenever she requests, and she can buy something using it by bank transfer. Even worse to Smith's claim, the percentage of cash in circulation to the monetary base (the total amount of money in the market of a country) is only around 20% in Japan and 3% in UK nowadays [13], that is, the majority of the money (as quantity) in the market is the amount of current account deposits at banks. (Commercial banks create money, in the form of bank deposits, by making new loans.) That is, a bit sequence on a computer disk of an account itself is effectively money rather than a mere record.

Both banknotes and electronic money are representing things of money (or, better, are monetary objects). A bitstring representing $10 on a computer is a realization of a $10 representation, whose *form* is a bitstring and *content* is $10 as quantity. In the same way, a $10 bill is a realization of a $10 representation whose *form* is the decimal representation printed on the bill, and whose *content* is the $10 as quantity. Although there are differences in the representation *media* between the two, such as a sheet of paper and a magnetic disk, and the representation *form* is decimal or bit expression, they are the same in that they are representing things and have a ten-dollar amount as content.

Another difference is that the former lacks the legitimacy image that the latter has. But the legitimacy images have nothing to do with the concreteness of either one, nor they are the only way to establish the legitimacy of the entity. The legitimacy of electronic money is guaranteed by the information system of the bank and the bank account.

2.3 Role

The Searle's constitution rule (CR): X counts as Y in C, has been largely used to explaining social entities. Although it applies well to money as well, it is not very effective because Searle does not analyze closely the nature of Y in this context. We insist that CR should be refined by a deeper application of the role theories developed by the FOIS community [10,12,14,15].[4]

In YAMATO, roles are anti-rigid, dynamic, and externally grounded [12]. The core of the

[4] Role in DOLCE and YAMATO is different from role in other ontologies like, e.g., BFO (https://basic-formal-ontology.org). There exist two meanings of role in the sense of either one of the following two: (i) The role of a teacher is teaching, and (ii) A teacher is a role. BFO role means the first one, while our role the latter.

YAMATO conception of roles can be summarized in the schema: "A potential player for a role is a role-holder when it actually plays the role." Every role depends on a context, that is, on one or more entities relatively to which the role is defined. Hence a role is a dependent continuant. In the school example, the roles of student and of teacher are defined within a school system, which is the context. A role is an entity to be played, a potential player is an entity that can play a role, and a potential player becomes a role-holder in playing a role. The sharp distinction between a role, a role-holder and role-player helps to conceptualize the change in players and the vacant roles, i.e. roles which at the moment are not played.

Interpreting the CR in terms of the modern role theory like [14,15], Y refers to two distinct things: a role and a role-holder. In the case where CR is applied to money, Y refers to both Monetary role and Monetary-role-holder.

3. Three-layer model of money

Exploiting the above theories of representation, physical object, and role, we provide the core characteristics of Monetary object, Monetary role, and Money, and a three-layer model in which related entities are organized. Several domain notions, like those of economic system, economic value, and commodity, are here taken as primitive and used without characterization. These notions are central for a theory of economy where money has its niche. Nonetheless, we assume that they are ontologically less relevant for understanding money itself and, thus, fall outside the scope of the paper.

3.1 Definitions

Definition 1: Monetary role
A *Monetary role* is a social role [10, 12] in the context of an economic system and is characterized as follows:

(i) A Monetary role is associated with a **unit** (which provides a reference system for the economic value of commodities).
(ii) The role-holder of a Monetary role satisfies the **exchangeability relation** with any other role-holder of a Monetary role and with any commodity.
(iii) The role-holder of a Monetary role has **storability quality**, i.e., it is an enduring entity that maintains exchange value over time (the latter is provided by property (ii)).
(iv) A Monetary role depends on the **trust** of a community and on the guarantee provided by the community (and related institutions, e.g., state).

Note that exchangeability only means that role-holders and commodities *can be compared* (they are commensurable) in terms of their economic values in the given unit.

Definition 2: Legitimate representing thing
A *representing thing* is a physical object called the *medium* enriched with a *form* (ontologically, a feature of the object), a *content* (ontologically, an information object or meaning), and an *encoding method* of the content into the form. Informally, a form is a pattern which, in a suitable social system, is associated with a meaning (which, in turn, is encoded into that form). Form, content and encoding together are a representation. More information on representing things, forms and contents can be found in [17]. A representing thing is *legitimate* if the medium and the representation satisfy the

constraints set by the social system of reference, which in our case is an economic system.

Definition 3: Monetary object (Currency)
A *Monetary object* is a Legitimate representing thing holding a Monetary role, thus a role-holder. A legitimate representing thing for a Monetary role is a medium whose *form* includes numerals and other patterns that identify the economic system and the unit, i.e., property (i) of the Monetary role, while the *content* is an amount of quantity. Monetary objects are usually called *currency*. An example of Monetary object (or currency) is a legal 10 Euro banknote in your wallet, i.e., an artefact (with suitable features) that is the role-holder of a Monetary role.

Definition 4: Money
Money is a (non-intrinsic) property of the owner of monetary objects. Money provides the owner of a Monetary object (currency) with the capacity to perform economic activities in the community. Money is a deontic/social property. The value of the money-property is the amount of quantity specified in the content of the monetary object.

From our characterization of money, there is no money (capacity to perform economic activities) without an owner of a monetary object. It follows that monetary objects without ownership are not economic entities: a lost 10 Euro bill on the street is a valid banknote but, not having an owner, no money-property depends on it. Thus, the lost 10 Euro bill is a banknote but it cannot perform its economic functions by itself. When someone takes it as its own (whether it uses it or not), it becomes money for the value of 10 Euro because at that point the ownership is established, and thus the money-property (the capacity to engage in an economic exchange) is established. Note that it is irrelevant whether the ownership is legitimate or not.

3.2 Three-layer model

The ontology of money is composed of the following three layers.

(1) Representation layer (with legitimacy constraint) layer
The issues discussed in this layer include what makes a 10 Euro banknote a legitimate object. The solution is found in the theory of representation presented in sect. 2.1. A 10 Euro banknote as a representing thing is legitimate if it satisfies the constraints set by the EU authority which includes the presence of special images printed on an object of a given size and material. Being a representing thing with the given form on a suitable representation medium is essential to be a *legitimate representing thing*. In the economic context, the content of the legitimate representing thing called banknote specifies the amount of money in each economic system.

The legitimacy of electric money in the computer files of a bank system is guaranteed by the bank institution, which is an agent endorsed with the capacity to guarantee legitimacy in the community. Electric money lacks the legitimate images specified by the form of the banknote, yet the form is guaranteed by the information system (as context) which also encodes the numeral to denote the amount of quantity (content). Images are patterns used to encode meaning in paper-based objects. Electronic monetary objects encode the same content via other kinds of (digital) patterns. In this way, the theory delineated in this paper equally applies to physical and electronic monetary objects.

This is the first (bottom) layer, in which a *legitimate representing thing* is defined in terms of entities such as *Representation, Representing-thing, Form, Content,* and

Medium (see [17] for details).

(2) Role layer
A *legitimate representing thing* is a genuine monetary object when it plays the Monetary role in the context of, say, Euro economy. The Monetary role has been the primary focus of most analysis of the ontology of money. It is a social entity built using the Searle's constitution rule (CR): "X counts as Y in C", which can be refined by introducing the notions of player, and role-holder. We interpret this CR in terms of the modern role theory as: X (a legitimate representing thing with a pattern '10 Euro') is the player of role Y (a Monetary role of 10 Euro) in the context C (the European economic system). X playing Y is a Monetary object which is a role-holder for Y. Thus, we separate Y as Monetary role and Y as Monetary role-holder. The monetary role is a social entity with three functions/properties and a dependence relation as described above. The Monetary object is a *role-holder* of the Monetary role played by a *representing thing,* and hence it inherits the three properties as well as the dependency relation from Monetary role.

This is the second layer, on top of the first layer, in which Monetary role is defined in terms of role-related entities such as *Role, Context, Role-holder,* and *Player,* and relations such as *Play* (see [14,15] for details). The *Play* relation connects the representation layer to the role layer.

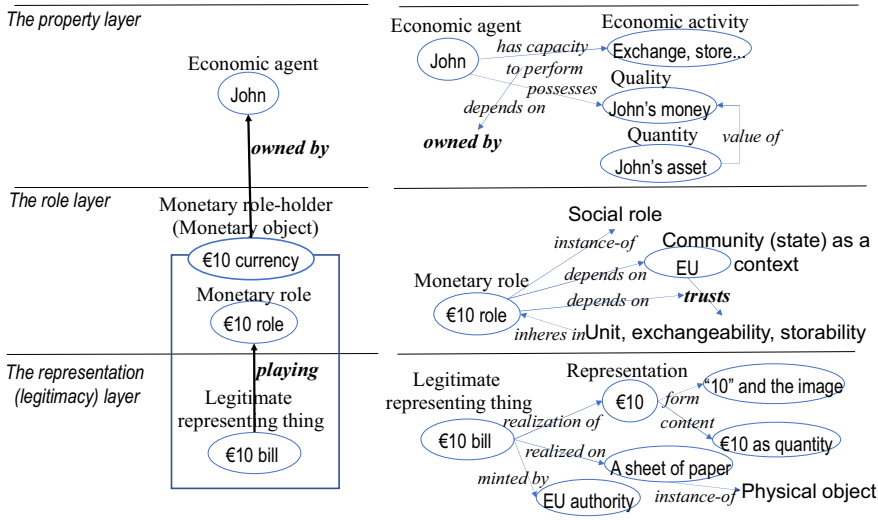
(3) Property layer
A genuine 10 Euro banknote as a monetary object becomes effective only when it is owned by an economic agent. When the monetary object is owned by an agent, the agent acquires a (relational) property, namely, a capacity to perform economic exchanges. From the perspective of agents, money is a contingent property that agents enjoy when they own monetary objects. The ownership *(owned by)* relation connects the role layer to the property layer.

For a better understanding of the relationship between money as a property and its value (how much the agent has when owning a 10 Euro banknote), we can make an analogy with qualities. Consider a quality, say, the height of John. Addressing qualities and their measurement means to distinguish two entities: John's height and the value of John's height. The former is a ***quality*** and the latter a ***quantity***. The entity "John's height" denotes an entity that can be measured in a certain way. The appropriateness of a measuring methodology distinguishes John's height from, say, John's weight. The entity "John's 180cm high" denotes the value of the height, and so is a different entity than "John's height". Similarly, "John's money" denotes the monetary objects that John possesses. It does not denote the amount (the money as a quantity). To refer to the amount one must state a value, i.e., the quantification of the amount of monetary objects (currency) possessed by John. Again, these two are different entities. We say that 'John's money' stands for the plurality of John's monetary objects, and that 'John's economic value' (a capacity) stands for the content of John's money (a quantity). This observation is supported by the theory of quality employed in DOLCE [2] and YAMATO [18].

The underlying perspective taken by this theory is three-fold: (1) The separation between money (a property) and monetary object (a role-holder), (2) the separation between monetary object and legitimate representing thing (a medium with a representation), and (3) the observation that the ownership is key for the presence of money (a capacity). The first enables us to build a monadic theory of money, the second to identify the player of monetary role, and the third to identify money as property.

3.3 Basic setting for a formalization of money

As we have seen, given a social system, call it SSys, several ontological entities are defined by the very nature of the SSys with the help of the usual machinery of (social)



(a) Hierarchy (b) Associations

Fig. 1 Diagrammatic representation of the three-layer model.

role theory. In our case, the framework is an economic one, and the entities we focus upon (beside those brought up by the role theory like 'role', 'role-holder', relation 'plays' and so on), are stated below with a terminology that we think is self-explicative within the previous discussion of the theory.

Recall that our focus is on the organization of the conceptual framework for a given system SSys. It follows that an expression like Monetary_role(x), as used below, should be understood relatively to the given SSys. To be explicit, one could highlight in the syntax the dependence of the relation on the system by writing, e.g., Monetary_role_inContext(x,SSys). Given the generality of our theory, we do not fix a reference ontology and, thus, do not investigate the details of the formalization within a specific ontology. Furthermore, to keep this part simple, we ignore temporal considerations (temporal parameters are not shown). After all, the theory does not present interesting temporal aspects, the latter are inherited by the usual machinery of the role theory itself. Major entities of the three-layer model are depicted in Fig. 1.

Given the discussion in the previous sections and the work in [17], the following expressions should be now self-evident:

$\text{Monetary\_role}(x) \rightarrow \text{Role}(x)$ [Monetary role is a role]
$\text{EuroMonetary\_role}(x) \rightarrow \text{Monetary\_role}(x)$ [Euro is a Monetary role]

Analogously for the other currencies (Dollar, Yen, etc).

$$\text{LegitimateRepresentingThing}(x) \rightarrow \text{Physical\_object}(x) \wedge \exists y\,(\text{Pattern}(y) \wedge \text{Encodes\_pattern}(x,y) \wedge \text{Established\_by}(y,\text{SSys}))$$

[a Legitimate representing thing is a physical object which encodes a pattern established by the SSys. This is a simplified version. See [14] for details]

One can characterize the currency by substituting in the above formula suitable specifications of the pattern, e.g., EuroPattern(y), for Pattern(y).

$$\text{Monetary\_object}(x) \equiv \text{LegitimateRepresentingThing}(x) \wedge \exists y\ (\text{Monetary\_role}(y) \wedge \text{role-holder}(x,y))$$

[a Monetary object is defined as a legitimate representing thing which is a role-holder for a Monetary role]

$$\text{Money}(x) \rightarrow \text{Quality}(x) \wedge \exists y,z\ (\text{Monetary\_object}(y) \wedge \text{Agent}(z) \wedge \text{Onws}(z,y) \wedge \text{Quality\_of\_relativeTo}(x,z,y))$$

[a Money is a quality of an agent that owns a Monetary object]

The discussion of the pattern encoding, the pattern recognition as well as of the meaning of the pattern in a community is a complex topic which is part of a representation theory, see [17] for a general approach on these issues.

$$\text{Unit}(x,y) \rightarrow \text{Concept}(x) \wedge (\text{Monetary\_object}(y) \vee \text{Commodity}(y))$$

[a Unit is a concept (in a SSys) that applies to Monetary objects and Commodities]

$$\text{Exchangeability}(x,y) \rightarrow \exists z\ (\text{Unit}(z,x) \wedge \text{Unit}(z,y))$$

[Exchangeability is a relation holding among Monetary objects and/or Commodities with the same (economic) unit]

Recall that exchangeability of two entities means that these entities have the same economic unit, but they can have different economic value. It means that these entities can be compared in terms of their economic value in the given unit.

$$\text{Storability}(x) \rightarrow \text{Quality}(x) \wedge \forall y\ (\text{Quality\_of}(x,y) \rightarrow \text{Monetary\_object}(y))$$

[Storability is a quality of Monetary objects]

$$\text{Trust}(x,y) \rightarrow \text{EconomicCommunity}(x) \wedge \text{Money}(y) \wedge \forall z,v,w,u\ (\text{Monetary\_object}(z) \wedge \text{Quality\_of\_relativeTo}(y,v,z) \wedge \text{Unit}(u,z) \wedge \text{Unit}(u,w) \rightarrow \text{Exchangeability}(w,z))$$

[If a community trusts the economic capacity of a Monetary object owned by someone, then every monetary object or commodity with the same unit is comparable to that Monetary object][5]

4. Money as quantity

Despite quite a few papers about quantity theory of money are found in economic communities [3], there seems to be little discussion about money as quantity, while the separation between money and quantity is not explicit in the literature about ontology of money. What matters is how much money one owns, that is, the quantity of money. In the presentations of a theory of money as property, however, the literature does not directly address the value of the money-property, which we suspect is one of the reasons the ontological investigation of money remains problematic.

[5] The last four predicates are associated with Monetary object assuming it inherits those related properties from Monetary role.

4.1 Quality vs. Quantity

Quality and quantity are quite different. However, as we saw in section 3, the value of a quality is often a quantity, and without proper ontological analysis these two can be easily confused. Other issues are caused by the use of an ambiguous term like 'money'. Separating money as quality vs. money as quantity helps distinguishing the concepts at stake. This distinction is clearly done in foundational ontologies like DOLCE and YAMATO.

It is tempting to think, as supported by some upper ontologies, that quantity is an instance of quality because, e.g., the 15 cm length of my pencil seems to be an instance of length (quality). YAMATO nevertheless draws a marked distinction between quality and quantity. As a result, quantity is defined as a generically dependent continuant and, independently of quality, quantity has its own *is-a* hierarchy according to which there are four types of quantity based on Steven's theory of scales of measurement: *nominal, ordinal, interval,* and *ratio* [27]. Analogously, in DOLCE (individual) qualities and quality values belong to distinct branches of the taxonomy.

Although quality in DOLCE and YAMATO corresponds to determinable in BFO and quality value to determinate, the way of dealing with quality and its value is different. While quantity is a subclass of quality in BFO, we distinguish between quality and quantity by separating quality instance and its value. Therefore, John's height at his boyhood and that at current time denotes identical instance of his height quality despite it denotes different values. The notion of determinate is introduced in BFO to take care of many, say, 10cm long quantities in reality. We do not need such treatment thanks to the above-mentioned separation.

4.2 Use value vs. exchange value

One puzzling characteristics of money is that a banknote made of a piece of paper has *use value*. While the reason why it has *exchange value* is due to its exchangeability with any commodity, the reason it has *use value* has not been addressed. If we take *use value* to be inherent in the thing, like the function of an artifact, then a banknote cannot have it. When banknotes were convertible, the issue of *use value* was not problematic. But how can we explain the contemporary situation in which banknotes are non-convertible and yet have *use value*? Claim 1, below, attempts to provide an (indirect) answer to this question. The justification is based on the quantity of money.

Claim 1: Besides *exchange value,* money as property of an owner virtually has *use value* equivalent to the amount of labor invested by the owner of the corresponding monetary object to earn the wage.

Note here that it is critical to distinguish activities performed by consumers and manufacturers. Although either activity is an exchange between monetary objects and commodities, in the latter case, the amount of monetary objects spent are accumulated as the cost of their products, while in the former case, they are just consumption and have nothing to do with the cost of the products.

Definition 5: Labor
Activity at the physical and/or information level provided by an (intentional) agent which in exchange receives (or expects to receive) wage.

The cost of any product is the amount of labor invested to the production of all

parts/portions of it [25]. The cost amounts to all the wages paid for all the invested labor because what they paid for machines and materials necessary for manufacturing products is also reduced to the labor cost of those source manufacturers. All the agents who receive wages in the exchange for their labor gain the corresponding amount of money. This is how people come to own money (monetary objects), and why money itself is of value. The value is not "exchange value" but is virtually "use value" which is supported by such labor, which is also the reason why people have so-called purchasing power. Note that the total amount of values of all the existing commodity (product) is roughly the same amount of money for enabling the economy to work through exchanging between money and commodity[6]. Once again, the distinction between two kinds of *Agents* is crucial. Human agents provide labor and manufacturing agents purchase goods that are used for manufacturing products.

Note here that all existing natural things such as crude oil, metal, woods, etc. are free in principle. The prices of them are reduced to the amount of human labor invested to make them available. Note also that theories claiming "the price of any commodity is determined by the balance of the demand and the supply" are not totally correct. It is obvious by the fact that the difference between the prices of a car and a pen is caused mainly by that of the cost used for manufacturing the two even if the actual prices of them are dependent on the demand and the supply. What is true would be "The price depends both on the balance of the demand and the supply and on the production cost". The price of many of industrial products is dependent largely on the production cost.

Note the observation presented here is different from Marx's labor theory [22] of value. Marx's theory claims that the value common to all the exchangeable commodities is labor necessary for producing each of them. This has nothing to do with the *use value* of money or with the existence of some amount of money as purchasing power.

4.3 Identity

The de facto identity of money is derived from its owner. Money is inherently accompanied by changes in ownership. The distinction between money quantities depends on the ID of the owner's banknotes. This applies equally to electronic money (like an ordinary deposit in a bank account). In fact, the amount of 10 Euro written in a bank account is identified by the ID of the account, but we cannot specify which money the amount of money is. What "Mr. A's 10 Euro" denotes is certainly the amount of 10 Euro that his 10 Euro bill designates, but it is the same amount even if it is composed of 10 coins of one Euro. Economic transactions are perfectly validated in terms of how much money are transferred from whom to whom without the ID of the monetary objects.

5. Related work and discussion

5.1 Artifacts and functions

In modern societies, money is played by representing things which are intentionally created, i.e., they are artifacts. We do not enforce this as a fact in the theory since it is not enforced by the nature of money. Indeed, in past social systems natural objects have been used as money (e.g. salt, shells, etc.). More specifically, the player of the monetary role

[6] The global steady state is assumed where no growth of the economy nor that of companies. So, the balance sheets of companies are zero.

is an ontological artefact in the sense of being socially selected but need to be neither a technical nor an engineering artefact (see [1] for more information). In particular, the player of the monetary role has no inherent function but, while it is a monetary object, it has use-function, i.e., the status/deontic functions (of money). Those three characteristics of money role are qualities attributed by the community to the owner of a player of monetary role, and they enable the owner to perform actions such as exchange with commodities. In the economic community, those actions are taken to be manifestations of "functions", by which they seem to mean "goal-oriented interpretation of a behavior" (philosophically speaking, functions are more complex entities [16])

5.2 Related work with use case analysis

We now come back to Mäki's questions to see how our theory addresses them. First recall the core of the theory: Money is a property of the owner of a Legitimate representing thing when the latter is a Monetary-role-holder (also, Monetary object), i.e., an object that plays the Monetary role in a social system (See Fig. 1). Then,

(1) What is money? Money is a property.
(2) What does money consist of? Money exists when a Monetary object is owned by an agent. Money requires four entities: Legitimate representing thing, Monetary role, Monetary object and Agent.
(3) Does money have an essence? This is the three properties/functions inhering in Monetary role (which existentially dependent on the society).
(4) What larger worldviews are revealed by different conceptions of money? [Out of scope of this paper]
(5) *How does money originate, and how does it persist?* [Out of scope of this paper]
(6) Is money an institution or a convention? Money is a property that exists in institutional contexts but is not conventional. Legitimate representing things (currency such as banknotes and coins) are conventional.
(7) What is the precise relationship between the material and the social in money? The Legitimate representing thing, when realized on a sheet of paper, is material; the Monetary role is defined in institutional and social contexts.
(8) How do particular items of money relate to money as an institution? Institutional aspects are reflected in the Monetary role (see #6 and #7).
(9) Why are certain things that are easily mistaken for money, not money? Because the legitimacy of a banknote is heavily based on that of the printed images on it.
(10) How does money exist? The Monetary role exists as a social entity in an economic society. Money as a property exists in that society. When trust is lost, the monetary objects (currency), rather than the money-property, cease to exist.
(11) Is money real, and if so, in what sense? Money (a property) and Monetary role (a social entity) are both real.
(12) *Does money exist just in virtue of people believing that it does or is more involved?* The existence of money depends on the trust in a society on the three basic properties/functions. Trust is more fundamental than the belief of the existence: from the trust, the existence follows.

The variety of ideas about what money is can be appreciated by the (limited) list:

(1) The commodity theory of money assumes that "money" stands for **Monetary object**.
(2) Similarly for the Credit theory when talking about "pieces of paper as the certificate of the debt".

(3) *"...Searle (2003, 2010) has conceded that, in the case of electronic money, there is no concrete object that has this status. But this leaves open what exactly its ontological standing is."* [9]. As stated earlier, there is a serious misunderstanding of the ontological status of bit sequences in a computer disk. Each bit is determined by the state of the cell in terms of the voltage level in the same way as the written numeral is by ink on a sheet of paper. This misunderstanding is present in quite a few papers.
(4) Searle [21] regards money as a status function, this would be correct if money stands for **Monetary role** (in which the status functions inhere).
(5) Hindriks's "dual conception of constitutive rules (base rule and status rule)" [8] is part of our approach. His base rule corresponds to the representation layer, the status rule to the role layer.
(6) In *"Bills issued by the Bureau of Engraving and Printing (X) count as money (Y) in the United States (C). [19]", X* is a **Representing thing**, *Y* is a **Monetary object**, and money as a **property** is missing. *C* is a social system.
(7) "…money is a bundle of causal powers" [11] assumes that money is not a concrete object: the claim seems to refer to **Monetary role**.
(8) *"They conclude that money is a position 'on an abstract mathematical object, namely a relative ratio scale.' [24]"*, suggests that money here is a **quantity**.

6. Concluding remarks

A monadic theory of ontology of money has been proposed by employing FOIS-originated theories. In particular, ontology of representation and role theory play key roles in refining the Searle's idea that money is an institutional status/function imposed on physical objects. The proposed ontology successfully explains the distinction between money as a general entity, which is essentially institutional and currency as a specific entity, which is conventional.

Let us elaborate the issue of "object-property view" that is the underlying philosophy of our ontology of money taking up a car as an example. Although a car is not a property but a physical artifact, when we talk about whether people possess a car, ownership relation emerges between Person and Car in which the person who owns a car acquires a contingent property of ownership of a car. The ownership enables the owner to manipulate all the functions of the car and the car becomes a complete whole that can manifest all the functions equipped in it with the owner as a driver.

The car-analogy helps deepen the understanding of our theory. Any person in a country/community has a contingent property **Money** whose value at **t** is equal to the amount of **Monetary object** he/she owns at **t**. The value includes zero or minus. When he/she obtains new monetary object, the value increases by that amount. The consequence of the ownership of monetary objects is the same as that of the car-owning case. However, an interesting difference arises in terms of function-realization. The functions of the car are inherent in its physical make-up, and hence their realization is independent of trust. The functions of money are not, they are fully trust-dependent. This difference emphasizes the unique characteristics of money as a social entity.

The theory introduced in this paper is only a first step towards a better understanding of the different meanings that are attached to the term money. We believe that our approach has introduced an important distinction showing how puzzling aspects on how to

understand money can be clarified. A more comprehensive theory, including a proper formalization within foundational ontologies remains the aim for future work.

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