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Another Look at the Mengerian Theory of Money

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Abstract. This article examines Menger's theory of money in the lens of the philosophical concept of emergence. While Menger's theory of the emergence of money is well known, the precise nature of this process has been relatively unexplored. The article begins by situating itself within philosophical debates to understand the meaning, scope, and implications of emergence. Section 2 demonstrates that the Mengerian approach is based on an ontology, epistemology, and methodology that differ from those of his contemporaries, particularly Walras. In this approach, the concept of emergence becomes legitimate and even attains the status of an epistemic concept. Finally, we categorise the type of emergence associated with the monetary phenomenon in light of the typology presented in the first section. As a result we argue that money is a weak case of diachronic and epistemological emergence involving a top-down, selective causal effect.

Keywords: Emergence, Money, Menger, Complexity

JEL codes: B13, B41, B53

The concept of emergence remains a challenging notion to define consistently in philosophy. In economics, it is only since the 1990s, with the rise of the broader complexity approach, that it started to become an epistemic concept in the sense of Ian Hacking (1975).[1] The founder of historical epistemology drew a distinction between epistemic objects and concepts. The former are the entities or phenomena that are studied by science, while the latter are the methodological or theoretical tools that structure scientific activity and enable the construction and analysis of the objects. However, as early as the end of the 19th century, Menger (1871) already treated money as an emergent phenomenon, moving away from the framework of general equilibrium theory that was developing at the time. In such a framework, reliance on the mechanical analogy excludes any notion of emergence and equilibrium is rather the central epistemic concept. While Menger's theory of the emergence of money is well-known, the precise nature of this emergence remains underexplored. This omission is not confined to the Mengerian theory but is more broadly symptomatic of the place of the concept of emergence in economics, which, beyond rhetorical usage, remains poorly documented and riddled with contradictions.[2]

This paper is organized into three parts. First, it begins within the context of philosophical debates to grasp the meaning, scope, and stakes of the concept of emergence. The objective is to revisit the definition of emergence in philosophy—a concept that continues to elude precise definition despite rigorous attempts. It involves clarifying an ancient idea dating back to Aristotle, summarized by the

[1] The complexity approach encompasses evolutionary theories, Hayekian thought, institutionalist perspectives, new economic geography theories, and the Santa Fe approach.

[2] With a few notable exceptions, in particular, Ioannides (2016), the JEBO special issue on emergence edited by Harper and Lewis (2012), or Brisset (2016).

well-known slogan that "*the whole is greater than the sum of its parts."* What emerges is simultaneously dependent on its foundation, contiguous to it, yet novel. The challenge lies in defining a coherent concept of emergence that reconciles continuity and novelty. This guiding thread is reflected in successive definitions of emergence from J.S. Mill (1859) to contemporary thinkers like J. Kim (2006). This historical review of the concept reveals multiple versions of emergence: strong, weak, epistemological, ontological, diachronic, synchronic, supervenience, etc. The ultimate goal of the article (Section 3) will be to specify, in these terms, the emerging phenomenon of money according to Menger. Before that, Section 2 will demonstrate that the Mengerian approach is built on a distinct ontology, epistemology, and methodology compared to his contemporaries, and particularly Walras. In this approach, the concept of emergence becomes legitimate and even attains the status of an epistemic concept. Analyzing money as an emerging phenomenon is, ultimately, consistent with Menger's overall approach.

Section 1 Philosophical background on Emergence

Emergence is an old idea dating back to Aristotle. In his *Metaphysics*, the greek philosopher writes: 'For everything that has a plurality of parts, and whose totality is not a mere juxtaposition, but whose whole is something other than the assembly of its parts, there is a cause of unity' (Ross, 1924 ed., book Z (VII), 17, 1041b 11-33).

The whole is therefore composed of its parts, just as a syllabe is composed of letters; there is continuity in matter, the monistic or physical idea is maintained: the whole arises from a nascent basis. This physicalism can be substance, property or predicate physicalism. In the first case, this implies that all natural entities are exclusively composed of elementary physical particles; in the second case, it means that all properties of natural entities are exclusively the result of the combination of elementary properties; and a physicalism of predicates implies that all natural science predicates are exclusively defined in terms of combinations of physical science predicates.

Continuing the Aristotelian reflection, however, the whole is not the mere juxtaposition of its parts: an anti-reductionist position is confronted with the previous physicalist position; there is a 'law of unity', something new, different from the sum of elementary causes. And this anti-reductionism can also concern substance, properties or predicates: substance anti-reductionism means that there are natural entities which are not exclusively composed of elementary physical particles; the second type implies that there are properties of natural entities which are not exclusively the result of the combination of elementary properties; finally, predicates anti-reductionism means that there are natural science predicates which are not exclusively defined in terms of combinations of physical science predicates. So what emerges is both dependent on its base and new. The challenge is to define a coherent concept of emergence that reconciles both dependence and novelty, that reconciles physicalism and anti-reductionism. Of course, it would be incoherent to link substance physicalism with substance anti-reductionism and so on, but the different ways in which these two sets of features could be coherently linked to each other lead to different conceptions of emergence (Saertenaer, 2018). This is the thread that runs through the various definitions of emergence that have followed

one another from JS Mill to the present day, giving rise to different versions of emergence (strong, weak, epistemological, ontological, diachronic, synchronic, occurrence, etc.).

Let's take a moment to look back at J.S. Mill's exposition for two reasons: firstly, his presentation lays the foundations of the classical emergentist current which dominated debates until the 1920s and against which modern thought was built; secondly, it is interesting to note for our purposes that it was an economist who was among the firsts to examine this concept. J.S. Mill was one of the most influential English philosophers of the 19th century. He dealt with emergence in his 1859 book, *System of Logic*, in the chapter entitled 'On the Composition of Forces'. The author distinguishes between two modes of composition of forces. This distinction will turn out to be of decisive importance in that it leads Mill to a division of knowledge into deductive and inductive sciences.

On the one hand, the vast class of mechanical phenomena follows the principle of composition of forces commonly known nowadays as the homopathic mode: 'the joint effect of several causes is identical with the sum of their separate effects' (Mill, 1859, p. 427). When combined, the various causes act in the same way as when taken in isolation and the final effect is predictable apriori.

On the other, rarer side, there are phenomena that follow a heteropathic mode of composition of causes. Here, the combined effect of the causes is heterogeneous. Mill gives the example of a chemical reaction where the combination of two substances with particular properties gives rise to a third substance with properties different from those of the two initial substances. This effect was unforeseeable a priori, that is based solely on knowledge of the properties of the two initial substances. This knowledge can only be acquired through experience.

Heteropathic effects are characteristic of emergent effects, although the term comes later, being introduced by the philosopher Henry Lewes in 1875. Lewes contrasts emergent effects with resultant effects but the distinction is the same: the homopathic effect results from the simple addition of causes taken in isolation, the result is expected, predictable without surprise; the heteropathic effect emerges from simple causes as something other than their sum, as something unexpected, new, and only direct experience makes it possible to know the effect to which the starting point gives rise.

This interpretation of emergence is the literal interpretation of the classical maxim 'the whole is more than the sum of its parts': the combined effect of causes is different from the sum of the effects that each would have had if taken in isolation. Combined, the different causes bring new laws into play. If there were only homopathic phenomena, everything would be predictable by deduction from a restricted set of axioms, themselves derived from induction or introspection. But the existence of heteropathic effects means that something other than deduction has to be used to gain knowledge of laws, induction remaining thus to that extent unavoidable.

Mill, well aware of Hume's problem of induction, points out that this division of sciences is not immutable and that even disciplines dealing with non-mechanical phenomena might one day become deductive. Later, Hempel and Oppenheim (1948) developed the idea that emergence is not an ontological property, but reflects the state of knowledge available at any given time. Emergence is therefore relative, and scientific progress leads to the disqualification of phenomena previously considered emergent. From this perspective, emergence, as a property that cannot be deduced in principle, is epistemological rather than ontological. A phenomenon is emergent as long as we do not know the laws and principles that explain the macro-phenomenon from its parts. Although Mill specifies that the heteropathic mode is not limited to chemistry alone but also concerns political, social and mind phenomena, it is interesting to note that paradoxically, in the field of political economy, the author remains attached to a deductivist approach; there is no place for emergent

phenomena in his *Principle of Political Economy* throughout the various editions that ran from 1848 to 1871, after the publication of *System of Logic*; Mill stuck to a Ricardian hypothetical-deductive approach, which derived the movement of the economy towards the stationary state from a limited number of initial axioms (the law of diminishing returns in agriculture, the iron law of wages, the search of economic agents for the greatest individual utility), with no scope for emergence.

Mill, Lewes, then Alexander, Lloyd-Morgan and Broad formed the core of the group of British emergentists. Their discussions took place in the context of the debate that had been raging between reductionists and vitalists since the 19th century. For the former, the whole can be explained, at least in theory, as the result of the properties of its parts; for the latter, a living organism is not explained by the physical or even chemical arrangement of its constituent elements, but by the presupposed existence of an 'entelechy', a term given by Aristotle to the soul or vital function of living organisms. The entelechy enables what is to actualise its potential. In this ontological division, emergentism offers a third way. For classical emergentists, the whole is neither the result of the parts, nor the product of the external intervention of a mysterious force. Once again, the challenge is to develop a coherent concept of emergence that reconciles continuity and rupture, dependence and novelty. Classical emergentists focus on what will later be described as a strong form of emergence. Strong emergence concerns global properties that cannot be deduced, even in principle, from properties of lower orders. Emergent phenomena would therefore be unpredictable even in the eyes of a Laplacian super-being, 'an intelligence which, at a given moment, would know all the forces by which nature is animated and the respective situations of the beings of which it is composed' (Laplace 1814, p. 5). The concept of weak emergence concerns new properties that are unexpected but deducible, at least in principle.

Ontologically, the question arises of the very existence of a phenomenon of strong emergence. Chalmers (2006) for instance argues that only the phenomenon of consciousness could claim this status. Scientific advances in biology and quantum physics have marked the decline of classical emergentist thinking centred on a strong version of emergence. The resurgence of the concept of emergence, which has been flourishing since the 1990s, covers a wide range of disciplines, from biology, philosophy and neuroscience to the social sciences and economics in particular. Evolving into its weaker version, the concept has lost the sense of mysticism that was once associated with it. Emergent properties are unexpected and new compared to those of the components of the whole, but can be deduced from them. For example, the regular patterns emerging from cellular automata depend entirely on the rules and initial conditions. Similarly, multi-agent models are, by construction, tools for explaining weak emergent properties.

Beyond the lessons of classical emergentist thinking, against which this renewal is being built, the concept of emergence remains a complex one. One of the leading figures in this renewal, Kim (2006) combines the requirements of continuity and novelty by associating emergence with supervenience. Supervenience indicates that the same property emerges systematically from the same microconfigurations, or to put it differently, that there can be no difference to the whole without a difference to the base, linking emergence to inductive knowledge and characterising a weak version. However, supervenience is necessary but not sufficient for emergence. In fact, if survenience captures quite well (too well) the continuity requirement associated with emergence, it does not satisfy the novelty dimension. Thus, for a supervenient phenomenon to be emergent, the additional condition of top-down causation is required. This condition refers back to Alexander's dictum that for something

to exist it must have causal powers. Therefore, to establish the existence of an emergent property, it must be shown that it in turn has causal power over the world. Without top-down causation, emergent properties remain mere epiphenomena. The question is to identify the nature of the action - if any - of the whole on the parts. In its strong version, macro properties directly cause changes in laws at a lower level. There are as many doubts about this possibility of strong top-down causation as there are about the existence of strong emergence in the sense that the laws of nature are immutable. In a weaker version, it is possible to affirm the existence of emergent properties through their influence as constraints on lower-level entities. In biology, cultural traits do not modify DNA - no strong top-down causation, but the environment can contribute to altering the functioning of DNA by activating or deactivating certain genes - a weaker version.

It is not certain, however, that the concept that allows this type of compromise is coherent. Kim, to whom we owe the notion of supervenience, and the definition of emergence as the association of the conditions of supervenient and top-down causation, also highlights the tensions between these two requirements through the causal exclusion argument. According to this argument, there can be no systematic causal overdetermination and the base cannot therefore be determined by both top-down causation and the rules associated with its level. However, philosophers have not given up on the concept of emergence. The solution is to retain both occurrence and downward causation by weakening one or other of these two conditions. On the one hand it is possible to consider epistemological emergence: it retains the condition of occurrence intact, but considers downward causality not to be reflexive (the whole can act at a lower level, on a basis that is not necessarily its own) but selective. Descending causality is understood here as a mechanism for selecting global properties by virtue of the function they fulfil for the base. Cultural selection of institutions is a typical instance of selective top-down causation. On the other hand, it is possible to consider ontological emergence: it retains a reflexive form of downward causation but consider surpervenience as a mere empirical relation between the whole and its basis, with no identifiable determination between them. Contemporary debates about emergence in philosophy centre on these two versions of emergence, epistemological and ontological, each with its own limitations and challenges. The intention is to see how these questions translate into the field of economics in general, and the Mengerian theory of money in particular.

Section 2 Specificities of Menger's approach and the relevance of emergence

In what follows we show that the theoretical environment in which Menger's approach is embedded is consistent with the concept of emergence. His approach is characterised ontologically, epistemologically and methodologically by features that make the concept of emergence inescapable. We examine these three dimensions one by one.

2.1.The ontological dimension: economy as an open system and emergence

Thinking about emergence requires a particular ontological prerequisite. The idea of emergence would make no sense in a Walrasian framework where the whole is the sum of its parts because of an ontology defined around the mechanical analogy. The concept of equilibrium is the unifying

epistemic concept of this approach. Menger's representation of economic reality is quite different and, as we shall show, makes it possible to conceive of the idea of emergence as an alternative epistemic concept.

The economic agents who populate Menger's world are very different from the optimising agents of Walrasian economics. In his attempt to dehomogenise Menger and Walras (and Jevons), Jaffé (1976) perfectly expresses the gap that exists between their respective conceptions of the *homo economicus*.

> Man, as Menger saw him, far from being a « lightning calculator », is a bumbling, erring, ill-informed creature, plagued with uncertainty, forever hovering between hopes and haunting fears, and congenitally incapable of making finely calibrated decisions in pursuit of satisfaction. (Jaffé, 1976, p. 521)

This distinction in the nature of economic agents has its origin in the fact that, in the Mengerian world, time matters, actions take place in real time. It is not a logical conception of time like it is in the walrassian logic but a bergsonian conception of time (O'Driscoll and Rizzo, 1985) that allows for the introduction of two fundamental factors in the analysis: uncertainty and knowledge. Consider for instance the decision to produce a good. Agents need to anticipate the demand they will face and choose the best current ways of implementing this production process. Production activity therefore depends both on agents' knowledge of how to transform higher-order goods into first-order goods (consumer goods) and on their anticipation of future needs. However, during the production process, these two elements may change: agents may discover or imagine new ways of doing things, and the future needs that guided their choices may seem different from those on which they based their choices in the first place, leading them to modify their plans. Agents can thus make mistakes and modify their actions as time goes by and they acquire more knowledge. The uncertainty within which agents are forced to make their decisions, as 'an attempt to *provide in advance* for meeting their requirement in the future' (Menger 1871, 1950, p. 79), is a matter of radical uncertainty in the sense that the future is not predetermined but in constant formation. Agents have to decide today whether to set up a production process to meet future needs without being able to know today the true nature of these future needs or the true nature of the causal relationships between goods of different orders; this type of uncertainty is '... one of the most important factors in the economic uncertainty of men' (Menger, 1871, 1950, p. 71). The passage of time influences individual actions by allowing agents to acquire new knowledge that enables them to modify their plans.

> If it is generally correct that clarity about the objective of their endeavors is an essential factor in the success of every activity of men, it is also certain that knowledge of requirements for goods in future time periods is the first pre-requisite for the planning of all human activity directed to the satisfaction of needs… The second factor that determines the success of human activity is the knowledge gained by men of the means available to them for the attainment of the desired ends. Wherever, therefore, men may be observed in activities directed to the satisfaction of their needs, they are seen to be seriously concerned to obtain as exact a knowledge as possible of the quantities of goods available to them for this purpose. (Menger 1871, 1950, p. 89-90)

Moreover, individuals do not all have the same capacity to gain new knowledge as the economic process progresses. Some are better able than others to learn from their experiences. Menger (1892, p. 254) describes them as 'the most effective' or 'the most intelligent bargainers', who try to find new processes or new tools for improving the working of the market economy. This difference in the

respective agility of individuals will be crucial, as we shall see, in explaining the spread of the use of money across the population.

To conclude this brief ontological overview of the Mengerian approach, it remains to consider the nature of economic interactions. While it is indeed the principle of economizing that guides individual actions (*bedürfnissbefriedigung*), interaction between individuals can lead to unexpected consequences that go beyond their respective individual interests. In particular, organic institutions are the unintended social result of individually teleological factors (Menger, 1883 **[1985],** 158). The aim of social scientists will be to understand these unexpected phenomena, of which money is the most famous illustration.

The re-emergence of the concept of emergence in the 1990s was mainly driven in economics by the Santa Fe approach, and it is interesting here to compare the nature of the economic reality underlying the Mengerian approach with that of complexity economists. According to Arthur (2013, p. 2) complexity economics '[…] is a different way of seeing the economy. It gives a different view, one where actions and strategies constantly evolve, where time becomes important, where structures constantly form and re-form, where phenomena appear that are not visible to standard equilibrium analysis […]' and, in a letter to Shubick (2003, p.11) he adds that '[i]n short, Santa Fe economics had an unmistakable theme, an approach that instead of assuming homogenous agents allowed heterogeneous agents; instead of assuming deductive-making allowed inductive decision making; instead of assuming equilibrium allowed out-of-equilibrium. In this context, standard equilibrium economics became a special case, and we often use it for a benchmark'.

The economic reality depicted by Menger is just as much populated by heterogeneous economic agents, endowed with limited rationality, liable to make mistakes, to learn and to adapt in an uncertain environment, and whose interaction is non-linear insofar as it leads to unexpected consequences which are thus akin to emergent phenomena.

2.2. Epistemological dimension: causal-genetic approach and emergence

Adopting such a social ontology has epistemological consequences that relate to the nature of what is considered a correct scientific explanation.

The late nineteenth-century debate on the foundations of mathematics is interesting for present purposes because it teaches us that ontology and epistemology are linked. Bourbaki, for example, who advocated the extreme version of formalism followed by Debreu in economics, makes this link explicit. Formalism as a philosophy of mathematics is linked to Plato's realism, supporting the idea that mathematics does not create, invent objects, but discovers pre-existing objects in the intellect. The power of axiomatisation rests on the belief in a pre-determined adequacy between the structure of mathematics and reality, precisely because the 'discovery' of a formal system makes it possible to explain various real phenomena.

> From the axiomatic point of view, mathematics appears thus as a storehouse of abstract forms – the mathematical structures; and so it happens without our knowing how certain aspects of empirical reality fit themselves into these forms, as if through a kind of preadaptation. (Bourbaki, 1950, p. 231)

This view of reality is in contrast to constructivism, the view that a mathematical object exists only through its elaboration. In the course of this debate, two alternative explanatory criteria - formalism

and constructivism - have thus emerged from two different conceptions of the nature of physical reality. Economists have adopted the specific explanatory canons of the former since the formalist revolution of the 1950s (Blaug 2006, 2009). For the formalists, a phenomenon is explained if it is possible to identify the initial conditions under which that phenomenon is in existence. In fact, a phenomenon is explained by showing that it would imply a logical contradiction not to exist. From a constructivist point of view, explaining a phenomenon takes on a completely different meaning: a phenomenon is explained if it is possible to identify the process that leads to it being created.

In his analysis of economic phenomena - whether markets, money, prices, States or production processes - Menger adopts a constructivist methodological stance. For the Austrian founder, understanding a phenomenon means something very specific: it goes beyond cognition, that is beyond being able to draw a mental image of it; it means identifying ' …the reason for its existence and for its characteristic quality (the reason for its *being* and for its *being like it is* » (Menger 1883, 1963, p. 43). The analytical method is the appropriate way to come to such an understanding. It consists in breaking down a phenomenon into its simplest constitutive elements and to identify the law by which these various elements are organised to give rise to the phenomenon under analysis (Menger 1871, 1950, p. 46-7). If the phenomena under investigation are of a pragmatic nature, i.e. they are phenomena whose origin is known to have been designed by men, there is no point in such an investigation. On the other hand, there is another category of phenomena, organic phenomena, which are not the deliberate fruit of human will, and the whole point of scientific research is to *explain* them in the Mengerian sense, i.e. to reconstruct them starting from the simplest explanatory elements, namely the principle of economizing. His central theoretical objective, set out in chapter 2 of the *Untersuchungen*, is then to understand the nature of economic organic institutions:

> The solution of the most important problems of the theoretical social sciences in general and of theoretical economics in particular is thus closely connected with the question of theoretical understanding the origin and change of 'organically' created social structures. (Menger [*1883*], 1963, p. 147)

These organic structure emerge without intentional planning, and the essential challenge for economics lies in studying their genesis and their dynamic transformations. More precisely, Menger wonders: 'How can it be that the institutions which serve the common welfare and are extremely significant for its development come into being without a common will directed toward establishing them?' (Menger [1883], 1963, p. 146).

This epistemological perspective, described as 'causal-genetic', is radically opposed to the functionalist approach developed by marginalist theorists. As Mayer ([1932] 1995, p. 57), a disciple of Menger, points out, functional theories of prices are content to describe the correlations between prices in equilibrium (cognition of prices), whereas genetic-causal theories seek to elucidate the historical and processual mechanisms that produce these prices (understanding prices). The divergence thus concerns the very nature of economic explanation: understanding the laws of becoming rather than formalising static states.

More recently, Joshua Epstein (2006) presents the generativist stance as an option to formalism, and his approach is reminiscent of Menger's causal genetics: the slogan of generativist explanation is 'if you haven't constructed it, you haven't explained it'. Being able to generate a macro regularity from a given micro specification is a necessary condition for understanding it. Generative explanations are constructivist evidences in the sense of outlining a procedure, a systematic method

to be followed in order to generate an object. A phenomenon exists not because it can be shown to be a contradiction if it does not exist. It exists because it is possible to generate it systematically by following an acceptable algorithm. The generativist position has two consequences for the nature of emergence: (i) emergence in this framework occurs in its weak version, i.e. novelty is entirely determined by an identifiable process, and (ii) in this way the emergent property is 'explained' in the generativist sense, thus distancing the concept of emergence from the mysticism that has long been attached to it.

Generativism holds that in order to understand a phenomenon, one must be able to reproduce it. If theorists can identify a micro-configuration that leads to its emergence under plausible conditions, then a macro-phenomenon can be explained. In the same way, Menger explains money by studying the process that leads to its emergence.

2.3. methodological dimension: mathematical tools and emergence

As far as formal tools are concerned, it is well-known that Menger refuses the use of mathematical techniques. This rejection however seems to us to have more to do with the incompatibility between the mathematical tools then available and the nature of the author's approach than with any opposition in principle to the use of mathematical tools. New constructivist tools, it will be argued, are indeed compatible with Menger's particular ontological and epistemological positions. These tools allow for the resolution of models through the exhibition of emergent patterns or properties.

Menger does not use formal tools and his rejection of functional mathematics is made explicit in his correspondance with Walras.

> The object of my research is to bring the complicated phenomena of economics back to their true causes, and the search for the laws according to which the said complicated phenomena of political economy reproduce themselves. The results of my research can be clothed in mathematical formulae. Mathematical representations can contribute to their demonstration: however, the mathematical method of representation is in no way essential to the task I have set myself. (Our translation, letter from Menger to Walras, June the 1st, 1883 in Antonelli 1953, p. 272)

This aversion to formalism is often presented as a typical feature of Austrian thought. However, as Garrouste (1994) also points out, the reluctance to use mathematical tools may also reflect a deeper concern: Walras's mathematical method is simply not suited to Menger's goal of determining the essence of complicated economic phenomena.Since the aim of the theoretician is to understand the process by which a phenomenon comes into being by breaking it down into its simplest elements, formalising it in terms of simultaneous equations is inadequate in that it disregards the sequence leading up to the phenomenon and focuses exclusively on the properties of the final result of the process, the state of equilibrium. For Menger, understanding a phenomenon means being able to reproduce the process that leads to its existence, to design it. For Walras, understanding a phenomenon means demonstrating its logical consistency with its environment.

In this way, and by losing its anecdotal character for good, the Austrian rejection of formalisation takes on a new dimension. It arises out of uncompromised support for a conception of social reality which defies formalisation into deducible and continuous functions. These mathematical tools are not compatible with the ontological foundations of Mengerian analysis and the causal-genetic approach

that follows from it. On the contrary, these tools are perfectly appropriate to the functional approach, again in Mayer's terms, to which Walras's followers will remain faithful. It is natural that theories built on two such different starting points should be irrevocably far apart. This does not mean that the Mengerian vision cannot be formalised. As we have seen, within mathematics there are philosophical currents connected with specific and distinct ontological positions. In particular, two families of mathematical tools can be distinguished, formalist tools and constructivist tools, the former being associated with the social ontology related to deductivism, while the latter would fit the Austrian vision of dynamic open systems. In particular, it is striking how close the Austrian approach is to the multi-agent approach presented by one of its most prominent advocates, Epstein ([2006], p. 1587).[3] :

> To explain a macro-x, please show how it could arise in a plausible society. Demonstrate how a set of recognizable— heterogeneous, autonomous, boundedly rational, locally interacting— agents could actually get there in reasonable time. The agent-based computational model is a new, and especially powerful, instrument for constructing such demonstrations of generative sufficiency.

In the words of Tesfatsion [2006], multi-agent simulation enables a quantitative study of the aspects highlighted by the Austrian tradition from an exclusively qualitative point of view. In these models, the global logic is compatible with the Mengerian approach: the market is analysed as a continuous process resulting from the interaction of heterogeneous agents with limited rationality evolving in an uncertain and constantly changing environment. Individuals base their decisions on the development of end-mean plans (the achievement principle); these plans are formed on the basis of the local information available to them, the knowledge they develop on the basis of their experiences and observations, and the anticipations they imagine about the future. When the comparison of individual plans reveals coordination problems, errors or unfulfilled plans, these are revised on the basis of the new information and knowledge available, according to behavioural rules which are themselves adapted from past experience. The 'resolution' of a model takes a different form from traditional acceptance, since the outcome of the simulation is not (or very rarely) a situation of equilibrium, but the emergence of a few regularities or stable patterns that make the market process viable.This a posteriori reconstruction, which aims to show the compatibility of numerical simulations with the approach of the Austrian founder, is tantamount to boldly suggesting that Menger would have qualified his position of categorical rejection of the mathematical method if the tool of simulation had then been available. This seems to be precisely the path explicitly suggested by Menger when he provides this description of the approach that would make it possible to solve the problem he assigned to the social sciences and to economics in particular: « If you could follow the contracting parties through the thousand vicissitudes of the market, rigorously analyse their positions, weigh their needs, so to speak, you would have the real solution to the problem. »[4]

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[3] Vriend (2002), Nell (2010) and Seagren (2011) also address the compatibility between the Austrian approach and multi-agent tools. More generally, the affinity between the Austrian school and complexity economics is not a new argument. However, most of the time it is either about finding in Hayek almost exclusively the premises of an economic theory of complexity (Caldwell [2004]; Kopl [2006 and 2009]; Lewis [2012]) or about having very general considerations that put complexity as the central feature of the Austrian tradition; Rosser [2010] makes a finer distinction between Austrian authors who develop an approach that incorporates complexity premises (Menger and Hayek) and those who have no such concerns at all (Böhm-Bawerk).

[4] Handwritten note on the facing page of p. 108 of Menger's *Grundsätze der Volkswirtschaftslehre*, in French in the text, found by Campagnolo (2005, p. 804) as a follow-up to his archive work.

Keeping track of the thousand vicissitudes of the market is precisely what multi-agent models allow, enabling the theorist to approach Laplace's demon in an attempt to explain unexpected but deterministic phenomena. It is not surprising, therefore, that the Mengerian theory of the emergence of money is one of the main sources of inspiration for evolutionary search models, based on the use of classification systems, genetic algorithms and multi-agent simulations (Alvarez, 2004).

Section 3 The nature of emergence in the mengerian theory of money

The Mengerian approach is compatible, on the ontological, epistemological, and methodological levels, with the concept of emergence. The objective of this section is not to offer a new presentation of the Mengerian theory of the origin of money but rather to qualify the type of emergence associated with the monetary phenomenon in light of the typology presented in the first section. More precisely, this section aims to present the Mengerian theory from a specific angle that highlights the following series of propositions:

Proposition 1. Money is indeed an emergent phenomenon

It is tempting to assimilate organic institutions, as defined by Menger, to instances of emergent phenomena. But to what extent does this assimilation make sense? Are these strictly emergent phenomena, or is emergence merely a metaphorical process?

Since the resurgence of the concept in the 1990s, emergence has been associated with complex phenomena. It is one of their essential characteristics. Testfatsion (2006), for example, defines complex systems as (i) systems composed of heterogeneous units (ii) whose interaction leads to emergent properties. There are different types of complex systems depending on whether these units can react to variations in their environment, adapt to it, or even control it. However, the nature of their interaction remains nonlinear, making emergence an essential characteristic of these systems in all cases.

Holland (1988, p.117) provides one of the first detailed characterizations of what constitutes a n economic nonlinear adaptive network, a characterization that later served as the foundation for defining the economy as an adaptive complex system within the Santa Fe approach. In his characterization, Holland describes economic reality as the product of the interaction of numerous dispersed, heterogeneous, and interdependent agents with bounded rationality and incomplete information, who interact locally while striving to adapt to their environment without centralized control. Menger's organic institutions align with this characterization; he emphasizes their unplanned nature and the fact that they emerge from a multitude of individual economic agents pursuing their own interests: '[…] [organic] social phenomena come about as the unintended result of individual human efforts (pursuing *individual interests*) without a *common will* directed toward their establishment » (Menger 1883 [1963], p. 133)

Money, in particular, arises from an emergent foundation composed of *heterogeneous individuals* who, while striving to pursue their own interests, inadvertently give rise to an *unexpected phenomenon*—one that is unplanned by the state, does not result from legislation, and is not the product of convention or any form of human deliberation. Menger's objective is to *understand* this phenomenon in the specific sense he attributes to the term: namely, to identify the process that leads to its emergence. « It is clear, rather, that the origin of money can be truly be brought to our full understanding only by our learning to understand the *social* institution discussed here as the unintended result, as the unplanned outcome, of specifically individual efforts of members of a society » (Menger 1883 [1963], p. 155).

Regarding its unplanned nature, Menger repeatedly emphasizes the spontaneous origin of the monetary institution. It would be 'unhistorical' to consider it as the result of a legislative act (*ibid.* p. 241). Such an event, Menger explains(*ibid.* p. 241), would have remained forever in memory as a significant historical moment in the history of societies. The intervention of the state does not occur at the moment of money's emergence but rather later in the process to improve the mechanism. By affixing its seal, the public authority facilitates the verification of authenticity, the degree of fineness, the weight, and the division of raw metal materials, for example (Menger, 1871 [1950], pp. 280-1).[5] Yet, as Menger states, '[…] money has not been generated by law… by state recognition and state regulation, this social institution of money has been perfected and adjusted' (Menger, 1892, p. 255).

With regard to the heterogeneity of the agents, it is of crucial importance in Menger's theory. The author distinguishes between two categories of individuals, which can be described as a group of innovators and a group of imitators. As for the first group, some agents are 'the most discerning and most capable economizing individuals' (Menger, 1871 [1950], p. 261). These particular individuals initiate the process leading to the emergence of money, doing so *'without any agreement, without legislative compulsion, and without regard to the public interest'* (*ibid*., p. 260). While a non-monetary economy presents an insurmountable obstacle to economic progress due to the problem of the double coincidence of wants, these more alert individuals adapt to environmental constraints by adopting a new behavior: the indirect exchange. This new behavior is a true innovation. It consists of exchanging goods not for their use value but because the agent anticipates that these goods will later allow them to acquire the goods they actually desire more easily. Menger stresses that indirect exchange is far from self-evident: 'It is a procedure so opposed to the ordinary course of things' (Menger, 1892, p. 239), '[...] which seems to conflict with the nearest and immediate interests of contracting individuals' (ibid., p. 240). The 'more intelligent bargainers' (ibid., p. 254) are the most likely to learn that indirect exchange is ultimately in their best interest. This learning process is gradual and not uniform across all agents: 'It is only in the first instance a limited number of economic agents who will recognize the advantages of such a procedure' (ibid., p. 249). Thus, heterogeneity prevails not only between the two categories of agents but also within each group itself.

With regard to the (heterogeneous) group of imitators, behaviour is more routine-oriented. Imitation allows indirect exchange to become the new norm.

[5] Ikeda's (2008) article initiates a debate regarding the role of the State in Menger's theory of money. The author moderates the radical liberalism of Menger's successors, who view the emergence of money as an example of a Hayekian spontaneous order, leaving no room for State intervention.

> Media of exchange originally emerge and eventually, through progressive imitation, became generally used not by way of law or agreement but by way of custom, that is through similar actions, corresponding to similar subjective impulses and similar intellectual progress, of individuals living together in society' (Menger, 1909, 202, p. 33).

These individuals learn to practice indirect exchange through a twofold process:

(i) Observation of the innovators' success encourages them to adopt the same strategies. Indeed, according to Menger (1892, p. 249) '[…] there is no better method of enlightening anyone about his economic interests than that he perceives the economic success of those who use the right means to secure their own'.

(ii) The process is self-reinforcing, and the commodity (or group of commodities) initially selected by innovators becomes increasingly attractive to all agents. In modern terms, commodity money represents the focal point of a pure coordination game (Selgin and Klein, 2002). Due to intrinsic differences between various goods and specific historical circumstances, goods exhibit varying degrees of 'saleableness' and '*[t]he theory of money necessarily presupposes a theory of the saleableness of goods*' (Menger, 1892, p. 245). The innovation of indirect exchange lies in the fact that innovators trade their goods for commodities with higher saleableness. As a result, the selected commodities see their saleableness increase further due to imitators, since the likelihood of obtaining any good in exchange for these commodities rises as more people use them as a medium of exchange. In other words, the most saleable goods benefit from network effects, making them increasingly attractive as the number of individuals using them in indirect exchange grows: 'When the relatively most saleable commodities have become 'money,' the event has in the first place the effect of substantially increasing their originally high saleableness' (*ibid.*, p. 250).

Thus, during the imitation process, where more and more individuals adopt highly saleable goods, an increasing differentiation between their degree of saleableness and that of all other goods takes place. This process is not continuous; there is a threshold effect, where the gap between the saleableness of the selected commodities and all others becomes so significant that a commodity suddenly attains absolute saleableness (*ibid.*, p. 252). At this point, it is no longer distinguished merely quantitatively by its degree of saleableness but qualitatively as the generalized medium of exchange. Ultimately, '*Pecuniam habens, habet omnem rem quem vult habere'*[6] (*ibid.*, p. 250).

Proposition 2: Money as a weakly emergent phenomenon

Money is indeed an emergent phenomenon, but its nature must be further specified. Unlike strongly emergent phenomena, which must be accepted with 'natural piety' (Alexander, 1920, II, pp. 46–47), Menger does not consider money to be a brute empirical fact. While it does not arise from explicit agreement, legislation, or even convention, this unplanned institution is not, for that matter, the mere result of chance either (Menger 1871 [1950], p. 271). Instead, it is a deterministic phenomenon, dependent on specific historical and physical circumstances.

> All these circumstances, on which depend the different degrees of, and the different local and temporal limits to, the saleableness of commodities, *explain why* it is that certain commodities

[6] 'He who has money possesses everything he wishes to have'

> can be disposed of with ease […] while the saleableness of other commodities is confined within narrow spatial, and again, temporal limits' (Menger, 1892, p. 247, emphasis added).

It refers therefore to a weak form of emergence: money does not arise by magic; the theorist has the ability to understand the phenomenon, meaning she can identify the causal process leading to its establishment. Weak emergence is closely tied to the causal-genetic approach: 'We can only come fully to understand the origin of money by learning to view the establishment of the *social procedure*, […], as the spontaneous outcome, the unpremeditated resultant, of particular, individual efforts of the members of a society' (*ibid.*, p. 249, emphasis added).

Similarly, since the 1990s, the generativist perspective has placed weak emergence at the center of analysis. Multi-agent models, drawing from Mengerian insights, specifically aim to identify this *social procedure* leading to the emergence of a generalized medium of exchange, tracing the thousand vicissitudes of the market.

proposition 3: Money as a phenomenon of diachronic emergence

Another distinction, far from being anecdotal, concerns synchronous and diachronic emergence.[7] The first approach relies on a stratified conception of reality, with different levels in interaction. It highlights the simultaneous presence of new, more complex objects or properties alongside those found at a simpler or more fundamental level. The second one emphasises the appearance of emergent phenomena across time. In philosophy of mind, where the synchronic version dominates, emotions coexist with their physical basis, and time does not intervene. Money, on the other hand, is conceived as a progressively realised institution that can be modelled by multi-agent simulation, where ticks represent the passage of time.

The links between novelty and continuity vary considerably depending on the type of emergence considered: from a synchronic perspective, dependence can be explained by supervenience, whereas from a diachronic approach, it can be explained by causality. Menger's whole approach consists of making this causality explicit. Instead of a multi-agents model, Menger uses history to explain the specific forms taken by the commodity-money selected by the interaction between innovators and imitators. Menger's use of history is extremely detailed, establishing the universalism of the monetary phenomenon and its determinism. Through his extremely erudite illustrations, Menger (1871 [1950], p. 263-71) shows that cattle systematically emerge from nomadic and agricultural economies; that furs are selected by hunting economies; that copper emerges, followed by precious metals and gold, from more diversified economies. The historical examples on which he draws are as relevant to the Old World as they are to the Americas or older civilisations.[8] Everywhere, the economic thinking that drives people to act in order to satisfy their needs as fully as possible leads to similar phenomena. More precisely, history teaches us that money systematically emerges from a situation of barter as individuals learn to adapt over time and discover the possibility of indirect exchange; that the particular form that commodity money takes depends on the intrinsic characteristics of the goods and

[7] In particular, Kim's causal exclusion argument mainly affects synchronic versions, as shown by Humphrey (2008).

[8] In note 9, p. 666 of his French translation of Menger's *Principles*, Campagnolo tells us that Menger's library contained a good third of all the accounts and reports on what was then known about the life of the peoples of the world.

the particular historical and economic circumstances. Each illustration could be interpreted as the simulation of a multi-agents model whose initial conditions and procedural rules are specified (the different degrees of saleableness initially associated with each good; the degree of aptitude of each agent to perceive or imitate the best possible strategy over the course of interactions). The author identifies the causal process that leads from the initial barter situation to the monetary economy through the interplay of interactions between the various categories of agents.

Proposition 4 *Money exerts a selective downward causal action*

Downward causation (DC) is as essential as it is problematic in any discourse on emergence. Global properties only exist if they exert an effect in return on their emergent base, but DC, which can also take several forms, may also give rise to problems of causal overdetermination that jeopardise the entire theoretical edifice on which the concept of emergence is built (Kim, 2006). In its strong version, DC modifies the laws of lower levels; in its weak version, DC can be non-reflexive: it refers to all the effects exerted by higher-level globalities on lower-order units that do not necessarily constitute the emergent basis of these globalities (for example, any action by a living being on the physical world falls into this weak category).

Generally speaking, Menger (1883 [1963], p. 147) explicitly recognises the existence of feedback effects from the whole to the parts. He uses the term 'reciprocal causality' to designate ' […] the fact that the parts of a whole, and the whole itself, are at the same time reciprocally *the cause* and *the effect* (that there is *a phenomenon of reciprocal causality* on their part), which is a conception that has frequently conquered its place in the organic direction of social science research'. The task of the social scientist is precisely to make us aware of this reciprocal conditioning of social phenomena. Economic processes are inscribed in a kind of *recursive loop*, to use an expression central to Arthur (2014) when he characterises the economy as a complex adaptive system, where agents are influenced in return by the globalities that they themselves have helped to shape. The interaction of heterogeneous agents leads to the spread of indirect exchange, which in turn, as we have already mentioned, reinforces the degree of saleableness of the commodity currency initially favoured by the innovators and facilitates exchanges for everyone as a widespread intermediary of exchanges. More precisely, the monetary institution that emerges from the base of individual agents exerts a feedback effect on agents that can be described as reconstitutive DC. This term is proposed by Hodgson (2006) to describe an intermediate type of DC in which higher-level entities are binding conditions for the emerging activity of lower levels. This particular type of DC, also known as selective DC, acts as a selection mechanism for certain properties of the emergent by virtue of its functions for the base, whatever the nature of the base: the most saleable goods are selected first by innovators, but this leads to a further increase in their attractiveness which results in their qualitative transformation into money.

If we call B1 the ontological level made up of people and goods, E1 emerges from B1, E1 representing indirect exchange through the use of a specific good. Note that B1 is characterised by a double heterogeneity: a heterogeneity of agents with different capacities to adapt to their environment and to discover or implement the strategy of indirect exchange; and a heterogeneity in the *absatzfähigkeit* of goods. E1 exerts a selective DC effect on B1, which is transformed into B2, through the modification of the degree of saleableness of goods on the one hand and the modification of agents' perception of their interest in adopting the new indirect exchange strategy on the other. The

material cause for the emergence of money is to be found in B1 and rest in the existence of the double heterogeneity we described, in a situation where agents are facing the problem of the double coincidence of needs; however, the recognition of the existence of a selective DC allow to explain the realization of money through the function it fulfills.

Proposition 5. Money as an epistemologically emergent phenomenon

There is no single definition that allows to distinguish between ontological and epistemological emergence. On the one hand, it is possible following Sartenaer (2018) to distinguish ontological emergence as the association of a substance physicalism and a property anti-reductionism from epistemological emergence as the association of a property physicalism and a predicate anti-reductionism. On the other hand, following Kim (2006) we have already distinguished between the two by considering ontological emergence as the articulation between brute supervenience and selective top-down causality and epistemological emergence as the articulation between traditional supervenience and strong top-down causality.

Whatever the definitions chosen, it seems that Menger depicts an epistemological emergence for money. Regarding the second type of definitions, the descending causality is indeed, as we have just argued, of a selective type and supervenience is not brute insofar as the author's aim is to explain in causal-genetic terms the relationships between the socio-historical conditions of society and the occurrence of a particular commodity as a generalised means of exchange. On the other hand, if we now base ourselves on the first type of distinction, it also happens that emergence is indeed of an epistemological nature; physicalism is indeed of properties in the sense that the properties of money as an institution, a generalized medium of exchange, is exclusively the result of the combination of the properties of the more saleable goods; and anti-reductionism is indeed of predicates, in the sense that the *concept* of money is not definable exclusively as a combination of concepts identifying commodities.

Conclusion

The analytical framework within which Menger analyses the monetary phenomenon is compatible with the concept of emergence. Money appears to be a phenomenon of weak emergence: although unpredictable ex ante, it can be explained in retrospect by the properties of its components (individual rationality, preferences for liquidity) and the laws of social interaction (imitation, positive reinforcement). There is no strong downward causality: money does not alter basic individual motivations, but acts as a facilitating constraint, reducing uncertainty and structuring expectations.

If money is the most celebrated instance of analysis of organic institution in Menger, it is not the only one. The author explain that langage, the State, markets are other instances of organic- emergent-phenomena. As regards markets, Menger also provides an analysis of their emergence and a quick look at it seems to indicate that the nature of emergence is of a similar kind than that which is involved in his theory of money:

In his *Principles*, Menger (1871 [1950], pp. 236–9) describes how economies evolve from the 'isolated household' to the 'organized market economy'. The role of 'middlemen' is central to understand the evolution to market economy. It is a special category of agents who learn to take advantage of the difficulties of isolated households economies and whose interaction leads to an unplanned improvement of the organization of markets according to a self-enforcing process. If this intuition is verified it would be then possible to refer to a *mengerian* type of emergence.

This investigation in the nature of emergence in the work of Menger ultimately allows to emphasize the modernity of this author. The Austrian founder was aware that he was developing analyses that were at odds with the approaches of his contemporaries. He broke with the German historicists, as expressed in the *methodenstreit*, and with Walras, as can be seen from their correspondence. Menger put forward themes that were resolutely ahead of his time. Such is the case with the idea of reciprocal causality, […] a view so vague and inadequate for our laws of thinking that we will scarcely err if we designate it as eloquent testimony that our age in many respects still lacks a deeper understanding of the nature of natural organisms as well as of that of social phenomena' (Menger 1883 [1963], p. 133].

But modernity is a criterion that can be understood from various perspective as Gloria, Ragni and Sturn (2023) suggested in their introduction to the special issue on the modernity of Carl Menger. Our contribution suggests that the author's modernity does not consist in one or several of any analytical elements taken per se or isolated from one another. His modernity rather lies in the organisation of these originals elements into a coherent framework. This was precisely the strength of Walras 'writings: to provide a coherent theoretical pattern. The same holds true for Menger in that he offers an alternative pattern based on a specific ontology which in many respects sees the economy as a complex adaptive system; this particular ontological position is associated with the causal-genetic approach; the tools available to the theorist can only be constructivist in nature, and within this framework the concept of emergence acquires the central role of an epistemic concept.

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