Technical or political? A reply to Lopes's (2021) account of the socialist calculation debate from complexity economics

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Abstract: This article challenges Lopes's (2021) view of the socialist calculation debate and his conclusions. In a recent paper, Lopes argues that Oskar Lange provided scientific proof of the feasibility of socialism, according to standard economics, that refuted Mises's theory. Moreover, he contends that the subsequent Austrian rebuttal in the debate diverged from standard economics, thus using unscientific language and political arguments. Following this analysis, Lopes concludes that socialism cannot be scientifically rejected but only politically. In response to Lopes, we maintain that mainstream economics is evolving into complexity economics, and a new scientific consensus points to the infeasibility of central planning and the rejection of Walrasian equilibrium, on which Lange's position is based. Therefore, we conclude that the Lange-Taylor socialism can now be considered unscientific, while the Austrian position can be regarded as a scientific interpretation of the debate, given the parallelism between complexity and Austrian economics. In this way, we reach opposed conclusions to those of Lopes and emphasize that any historical interpretation alluding to the scientific value of a theory needs to account for the evolution of science, since it can entirely change the historical interpretation itself.

Keywords: socialist calculation debate, history of economic thought, complexity economics, paradigm shift.

JEL codes: B10, B51, B53

INTRODUCTION

In a recent paper, Lopes (2021) presents a new analysis of the historical socialist calculation debate. His main thesis is that Oskar Lange demonstrated the technical feasibility of socialism following standard economic theory, which helped create a scientific consensus about this issue in favor of the viability of central planning. With this, Lopes claims that defenders of capitalism could not reject socialism on scientific terms, which led one of the schools participating in the debate, the Austrian school, to deviate from mainstream economics and create an own economic framework from which to oppose socialism. In fact, Lopes attempts to show that Austrian economics abandoned Mises's scientific challenge to socialism due to the superiority of Lange's argument and advocated Hayek's position based on political reasons. This ultimately means, Lopes argues, that late

Austrian arguments are mainly political, and thus the Austrian account of the socialist calculation debate cannot be uncritically accepted. Finally, he concludes that one of the accepted truths revealed by the debate is that "socialism cannot be scientifically rejected, but only politically by those whose economic interests are opposed by it" (Lopes 2021, p. 807). As we disagree with this analysis and conclusions of the socialist calculation debate due to interpretative and theoretical reasons, we shall devote this article to analyze and challenge Lopes's view.

We are aware that there is already a reply to Lopes's paper (Bylund, Lingle, and Packard 2022). However, although that article makes some significant contributions in terms of interpretation that significantly help address Lopes's view, and will indeed be used in this work, there is still room for further discussion on some relevant ideas from his paper. Concretely, the assumption that Lange offered an accurate demonstration of the feasibility of central planning according to the said "standard economics" and for the "scientific community and consensus". In this paper, we ask: what if a new growing scientific consensus in economics had shown that Lange and standard economics of that time were wrong about the feasibility of central planning, and in turn, that Austrians and their own paradigm were right? Precisely, as we shall develop below, this is what has happened with the development of complexity economics, which makes Lange's argument untenable, falling outside of what is deemed "scientific", while supporting Austrian arguments during the debate, including Mises's, as the now scientific position regarding central planning. In this sense, we will see how Lopes's "scientific" and "consensus" view of the socialist calculation debate may turn against his own conclusions.

The socialist calculation debate is a significant fact in the history of economic thought and is still alive. For this reason, we consider that any new interpretation of the debate, such as Lopes (2021), deserves profound analysis and discussion. This is the *raison d'être* of this article. That said, we will first present Lopes's analysis in section 2, to subsequently comment on his contribution and elaborate on our arguments in section 3. Section 4 concludes.

LOPES'S ANALYSIS OF THE SOCIALIST CALCULATION DEBATE

Lopes (2021) begins his article by noting the relevance of Ludwig von Mises's (1935) contribution to the socialist calculation debate, which is considered to have initiated the historical event. Before Mises (1935), Lopes remarks that, although economic planning had become an important topic in political economy, supporters of either capitalism or socialism had developed their arguments in political terms. Therefore, the dispute could not be resolved on technical or scientific grounds. In this context, Mises's great achievement was to attempt to address the matter in an objective technical way, in a genuinely scientific arena. That is to say, separating the economic analysis from the political argument. Thus, the Austrian economist showed that, if we want to determine which system is superior, we first need to ask whether an economic system without private property of the means of production is technically and rationally feasible. And this is precisely what Mises did. In his 1920 article, Mises (1935) showed that the absence of private property of the means of production prevents prices for those factors to appear, which means that the necessary information to attain a rational allocation of resources is missing. In turn, this makes rational central planning and socialism theoretically and technically impossible.

According to Lopes, one of the merits of Mises's contribution is the attempt to discuss the issue of economic planning according to the economics and scientific consensus of the time. Concretely, Lopes states:

> It is extremely important that Mises took pains to promote his cause based on what was universally accepted as sound economics (…) Therefore, he had to show, within the framework of economics of his time, that socialism is unable to achieve rational economic accounting (…) Based on what was then accepted as scientific economics, he argued that economic calculation in socialism would not drive society to an outcome of abundance, but to a scenario of scarcity and chaos and hence non-survival (Lopes 2021, p. 791).

His ambitious intention was to end that debate once and for all by showing that rational economic accounting under socialism is impossible. He did not seek to do this by developing a new branch of economic science or a parallel school of thought, but by using universally acknowledged economic science. He assumed every economist had to follow his idea since they all used the same framework. He aimed to have the final word on the issue: rational economic calculation under socialism must be excluded from the realm of the possible by the standard theory accepted by the entire scientific community of economists (Lopes 2021, p. 792).

The continuous reference to terms such as science, scientific consensus, or a standard scientific theory is central in Lopes's analysis of the debate. As it appears from the paper, the author attaches a special value to arguments built within the limits of science. It is not enough to hold objective or technical theories, devoid of value judgments. Additionally, it is necessary to develop scientific arguments, which means theories elaborated according to a common conceptual framework, a language, accepted and shared by what is considered science or a scientific community in a particular moment. In this case, Lopes does not refer to a scientific method, but mainly to an accepted theory or framework. That is, an argument is considered scientific insofar as it is based on concepts shared by a community of scientists. This is the very reason why Lopes regards Mises's article so relevant, because as we have just quoted above, "Mises took pains to promote his cause based on what was universally accepted as sound economics" (Lopes 2021, p. 791). Likewise, this focus on scientific arguments later leads Lopes to assert that Oskar Lange's (1936, 1937) rebuttal of Mises, as it was made scientifically according to standard economics, is superior to subsequent Austrian replies to Lange (Hayek 1940, 1944; Lavoie 1981, 1985) regardless of how technical they may have been, given that these replies were founded on a divergent economic theory from standard, scientific economics. Let us dig deeper into this.

After dealing with the thesis and relevance in scientific terms of Mises (1935), Lopes introduces the most famous reply to it. This is Oskar Lange's (1936, 1937) *On the Economic Theory of Socialism*. In these two articles, Lange managed to use the same neoclassical general equilibrium framework supposedly employed by Mises, based on an early work of Taylor (1929), to refute the Austrian hypothesis of the infeasibility of socialism. He argued that Mises was right in describing the phenomenon of economic calculation but erred in stating that it is impossible for central planning to carry it out. This is because the process of information gathering can be performed by the State through a "trial and error" method, which can be seen as a *tâtonnement* process in which planners adjust supply and demand constantly. Therefore, both the socialist and the capitalist system have the same equations to solve, which means that economic calculation can be performed in a centrally planned economy. Here, again, the virtue of Lange's contribution, according to Lopes, lies in showing that central planning is feasible, by using a common, scientific framework; that of standard, neoclassical economics. As the author puts it: "Instead of trying to elaborate his own methodological approach separate from the general outlines of orthodox economics, Lange simply pointed out where the standard economic theory contradicts Mises' claim (…) Lange was aware that failure to remain within what was recognised as orthodox economics meant defeat in the debate (Lopes 2021, p. 792). This helped to create a scientific consensus about the feasibility of socialism in mainstream economics, which constitutes the standard interpretation of the socialist calculation debate (Bergson 1948; Samuelson 1948; Schumpeter 2006). Thus, Lange's work proved that socialism cannot be rejected in technical nor scientific terms, contrary to what Mises attempted to do.

Several Austrian economists subsequently criticized Lange's theory, but they did it differently from Mises. Robbins (1934) and Hayek (1935) moved away from Mises's conclusion about the impossibility of rational economic planning and instead asserted that central planning is unfeasible in practical terms. There can be a purely theoretical solution, but the general equilibrium model assumes certain unrealistic conditions and requires particular dispersed information that is difficult to acquire. With this, these two Austrians implicitly conceded that Lange was right in defending that socialism is feasible according to general equilibrium, neoclassical economics, which parallelly implies a defeat for Mises (Lopes 2021). Having experienced how Lange scientifically demonstrated the superiority of his arguments, the Austrians were left

with two alternatives. On the one hand, they started to raise political reasons against socialism, as was exemplified by Hayek (1944). On the other hand, they needed to develop additional technical arguments out of standard economics, creating their own branch of economic science. These arguments underlined the dynamic character of the economy and the dispersed, tacit nature of knowledge (Hayek 1945; Lavoie 1985). Indeed, they gave rise to a reinterpretation of the debate done by Lavoie (1981), who in contrast to the "non-innocent reading" of the debate made by "neoclassical theorists" (Lavoie 1981, p. 72), argued in favor of a continuity between Mises's and Hayek's positions. Lavoie thus emphasizes that both Mises and Hayek criticized central planning based on a dynamic perspective opposed to the static general equilibrium theory. In consequence, this reinterpretation points out that Lange's response does not affect Austrian (Mises and Hayek) arguments, given that it rests on a different paradigm; that of neoclassical, general equilibrium economics.

According to Lopes (2021), the main problem with the new Austrian rebuttal is that it was entirely based on unscientific grounds: political arguments and an alternative economic branch that explicitly rejects standard economics. Lopes does not deny the relevance of a dynamic analysis and the role of tacit knowledge,[1] but he asserts that these points do not "address the essentials of what had been established by the debate during the 1930s and 1940s" (Lopes 2021, p. 800). He adds that these arguments:

> Arise in the later history of the debate (and of the Austrian School's development outside mainstream economics) and so cannot be retroactively inserted into the earlier history in order to force through a change to the standard interpretation. In the original historical context, there was no distinction between 'official economic science' and Austrian economics. Consequently, it is inadequate to argue that the then standard static equilibrium model could not have been used successfully against Mises. Since there was no clear position separating Austrian economics from the standard economic theory, the socialists were using the same tools as the anti-socialists in order to defend their cause (Lopes 2021, p. 803).

This means that when Austrian economists claim a victory in the debate, they do so "in the sense of their own school of thought" (Lopes 2021, p. 803), not in the sense of economic science "as it is studied and taught in the main economic institutions of the world" (Lopes 2021, p. 802). Contrariwise, as the author repeatedly asserts, standard economics already concluded that central planning cannot be rejected from a scientific perspective, demolishing Mises's attempt, and declaring a victory for Lange and the socialist side.

Lopes finally remarks that the Austrian reinterpretation fails since it reveals how the Austrians needed to build a separate branch in economics to criticize socialists, denoting a clear political purpose. He then concludes with a phrase we quoted in the introduction: "If I were to select one accepted truth revealed by the debate, it would be that socialism cannot be scientifically rejected, but only politically by those whose economic interests are opposed by it" (Lopes 2021, p. 806).

WHY CAN SOCIALISM BE TECHNICALLY AND SCIENTIFICALLY REFUTED?

As we discussed above, Lopes's analysis of the socialist calculation debate gives a central role to the issue of science; namely, that a theory is scientific, meaning that a community of scientists accepts it. Here, the author does not refer so much to following a scientific methodology as to using a shared conceptual framework. That is why he considers Lange's scientific arguments superior to the unscientific position of late Austrian economists such as Hayek or Lavoie. Yet, this focus on the scientific character of ideas as the source of theoretical validity may turn against Lopes's own conclusions. What if economics has developed and a new scientific paradigm regards central planning as unfeasible? Even more, what if there is evidence proving that Mises's first arguments pertained to an elementary form of this new paradigm? How can this affect the interpretation of the debate?

There are authors talking of a paradigm shift in economics, *à la* Kuhn (Beinhocker 2007). This is that, as Kuhn (1970) outlined, science evolves through revolutions, through abrupt changes in paradigms once anomalies appear in the predominant theory. Economics is no less affected by this process, which leads Beinhocker (2007) to stress that economics is undergoing a scientific revolution which he calls the "Complexity Economics revolution". At the same time, other authors have argued that economics is experiencing a fundamental shift, although not in a Kuhnian sense, but more from an evolutionary, Lakatosian perspective (Lakatos 1999). Unlike Beinhocker (2007), Colander et al. (2004) point out that what is occurring in economics today is not a sudden paradigm shift, but a cumulative, evolutionary process that will be seen as a revolution someday in the future. This process occurs gradually, and changes usually come from within the mainstream rather than from without, as the Kuhnian view tends to hold. In this sense, Holt et al. (2011) believe that new concepts and methods in economics are paving the way to a new era, which they call "the complexity era". Whatever the case, either abruptly or gradually, the truth is that a confluence of economists is indicating a change in mainstream economics. And, precisely, both perspectives point to the so-called *complexity economics* as the new face of mainstream economics.

COMPLEXITY AS A NEW PARADIGM IN ECONOMICS

In 1987, a group of economists, physicists, biologists, mathematicians, and computer scientists was assembled in a workshop at the Santa Fe Institute, New Mexico. The purpose of the meeting was to see how economics could benefit from the latest advances in the rest of the disciplines aforementioned. The group of economists, led by Kenneth Arrow, presented the state of the art in the economics of the time to the other group of physical scientists, led by Philip Anderson. Physical scientists at the workshop then were surprised by how unrealistic and restrictive the assumptions of mainstream economics were, which even led Anderson to ask: "You guys really believe that?" (Waldrop 1992, p. 142). The physicists were especially shocked at assumptions such as perfect rationality or equilibrium, which were central to mainstream, neoclassical economics.

Neoclassical economics assumptions reminded physicists of the classical, Newtonian paradigm, which basically described the world as a vast clockwork mechanism. Reversible and deterministic laws explain that world, and it is possible to anticipate any phenomenon with certainty since the universe is supposed to be in equilibrium. However, the revolutions of quantum mechanics and relativity, and later, chaos and *complexity theory,* proved that fundamental processes of the universe are irreversible and stochastic, and that the world can be in states far from equilibrium. Therefore, most phenomena are unpredictable, and so uncertainty gained a fundamental role (Nicolis and Prigogine 1977). From this new vision of the world, as it is logical, physical scientists were puzzled by mainstream economics, which was still largely based on outdated metaphors and parallels with mechanical physics[2] (Hodgson 1993). For instance, physicists strongly criticized the assumption of perfect rationality during the meeting, since it implies perfect foresight and certainty about the future, which is quite unrealistic, especially in chaotic phenomena and nonlinear systems (Waldrop 1992).

Hence, inspired by the new complexity paradigm in science, both groups of economists and physical scientists started to work on a first research paper series which was published in 1988 under the title "The Economy as An Evolving Complex System" (Anderson, Arrow, and Pines 1988). In this way, the scientific revolution that had taken place in physical sciences came to economics through the Santa Fe workshop. Here, *complexity economics* was born as a paradigm aimed to improve the unrealistic theories of the by then mainstream, neoclassical economics, as it previously occurred in science with mechanical physics.

The term *complexity economics* designates a wide movement integrated by diverse theories and methods from heterodox economics (Potts 2000). Complexity is not a theory, an ideology, or a research method; it is rather a new way of looking at the economy (Arthur 1999). Indeed, there is not a universally accepted definition of complexity. Yet, Holt et al. (2011) find it pertinent to mention three definitions. First, the general view of Simon (1991), who pointed out that a complex system is "one made up of a large num-

ber of parts that interact in a non-simple way. In such systems, the whole is more than the sum of the parts (…)" (Simon 1991, p. 267). Second, the computational complexity perspective, which is based on the Church-Turing thesis (Church 1936; Turing 1937), Shannon's (1948) information theory, and the algorithmic information theory of Kolmogorov, Solomonoff, and Chaitin (Chaitin 1987; Kolmogorov 1968, 1983). This approach attempts to define the complexity of certain models or phenomena in computational terms, determining whether a problem is computable indeed. And third, dynamic complexity, which focuses on the interaction of heterogeneous agents, out-of-equilibrium processes, and emergence (Rosser 2009). This is the most used concept of complexity in economics, and adopted Day's (1994) definition: "A dynamical system is complex if it endogenously does not tend asymptotically to a fixed point, a limit cycle, or an explosion" (Rosser 1999, 170). Complexity economics contrasts with neoclassical economics in several regards. Generally speaking, Arthur (2021) points out that the complexity approach relaxes the assumptions of neoclassical theory, especially those of homogeneous, representative agents; perfect rationality; optimal behavior; equilibrium; and well-defined situations. For its part, complexity economics tries to model agents realistically, assuming heterogeneity in their behavior, and bounded rationality. Equilibrium is not presupposed as in neoclassical theory, but there is a special focus on the emergence and the formation of economic networks and structures. In complexity economics, history and path-dependence matter, which can lead to increasing returns. The contrast with neoclassical economics is captured in this assertion from Arthur (1999, p. 109): "Complexity therefore portrays the economy not as deterministic, predictable, and mechanistic but as process dependent, organic, and always evolving". Consequently, in a sense, it could be said that neoclassical theory is a special case of the more general economics proposed by the complexity approach. And, interestingly, Arthur finally adds: "I see this shift in economics as part of a larger shift in science itself. All the sciences are shedding their certainties, embracing openness and process, and asking how structures or phenomena come into being. There is no reason that economics should differ in this regard" (Arthur 2021, p. 143).

Gradually, mainstream economics has incorporated many heterodox models and methods that form the complexity approach. Rosser (2021) mentions several of these types of work, also named in Colander et al. (2004) and Holt et al. (2011):

- Evolutionary game theory is reconceiving how to include institutions in the economic analysis.
- Ecological economics is shedding new light on how nature and the economy are interrelated from a transdisciplinary approach.
- Behavioral economics is reconceiving the concept of rationality.
- Econometrics is addressing the limitations of classical statistics and so it is affecting economists' thinking about empirical proof.
- Complexity theory is broadening economic understanding beyond general equilibrium, attempting to explain economic dynamics.
- Experimental economics is redefining how economists think about empirical work.
- Agent-based computational economics (ACE) is offering an alternative to traditional tools such as Dynamic Stochastic General Equilibrium (DGSE) models, through agent-based models (ABMs).

Indeed, from all those points, we could say that it is through computation and simulation, in the guise of ABMs, that complexity economics or ACE are changing the way economists model (Axtell and Farmer 2021). Since the Great Recession, which evidenced the failure of DSGE models to anticipate economic events, many voices within economics claimed for new tools such as ABMs (Farmer and Foley 2009; Colander et al. 2009; A. Kirman 2010). After several years, ABMs are becoming very influential in the economics literature (Chakrabarti, Pichl, and Kaizoji 2019).

Complexity economics' models and simulations have been helpful in studying the computability of important parts of neoclassical economic theory, concluding that many of them, such as Walrasian equilibria (Lewis 1992), Nash equilibria (Tsuji, da Costa, and Doria 1998), or general macroeconomic aspects (Leijonhufvud 1993) can be not computable. Moreover, they have allowed us to draw richer conclusions

beyond neoclassical theory with the analysis of increasing returns and path-dependence in technological lock-in contexts (Arthur 1989, 1994), spatial trading networks (A. P. Kirman 1997), bubble chaotic dynamics in financial markets (Brock and Hommes 1997), or a network, knowledge-based approach to economic development (Hausmann and Hidalgo 2011; Hausmann et al. 2013; Moreno-Casas 2021). In short, they have exerted a strong force in the direction of the paradigm shift, causing the use of concepts and tools of complexity to spread in the economics profession.

What does complexity economics say about central planning?

Having presented complexity economics as the new mainstream paradigm, or at least, as the most likely future mainstream economics, we now wonder what complexity economics can say about central planning and the socialist calculation debate.

If we go to the very features of the economy as a Complex Adaptive System (CAS), as described by the Santa Fe complexity (Arthur, Durlauf, and Lane 1997), we can find the following: (1) dispersed interaction among heterogeneous agents; (2) no global controller in the economy exploiting all opportunities, mechanisms of competition and coordination operate instead; (3) cross-cutting hierarchical organization with tangled interactions; (4) continual adaptation and learning; (5) perpetual novelty; and (6) out-of-equilibrium dynamics since "the economy operates far from any optimum or global equilibrium" (Arthur, Durlauf, and Lane 1997, p. 4). Note that there are at least two points that have to do with the issue of central planning. First, point 2 clearly states that there can be no global controller in an economy conceived as a CAS, which explicitly rejects the viability of central planning from a complexity view. In contrast, the economy works through decentralized processes of competition and cooperation. Second, point 6 excludes the possibility of attaining a global optimum. Precisely, central planning is claimed as a more efficient method than the market in that it can achieve an optimal point in terms of resource allocation. Moreover, central planning, in Lange's (1936, 1937) sense, is based on the Walrasian general equilibrium. This contrasts with the complexity position stating that the economy cannot reach a global equilibrium, but it is formed by out-of-equilibrium dynamics and emergence. Thus, just from the very features of the economy as a CAS, one can infer that complexity economics rejects the feasibility of central planning as based on the Walrasian general equilibrium, à la Lange.

Curiously enough, there are several complexity economists that have already drawn implications for the socialist calculation debate from their more general theories. This is the case of da Costa and Doria (1994), who deal with undecidability, incompleteness, and non-computability. They found that it may be impossible to compute Nash equilibria in finite non-cooperative games, which is formally equivalent to determining equilibrium prices in a competitive market, meaning equilibrium prices in competitive markets are not *always* computable. Still assuming that equilibrium will be reached, it cannot be computed beforehand in general. They apply this result to the socialist calculation debate, since Lange's argument is that equilibrium prices are *always* computable—even more so with the aid of powerful computers (Lange 1967)—, which leads the authors to explicitly conclude that "the main argument in favor of a planned economy clearly breaks down" (Costa and Doria 1994, pp. 38-39).

Likewise, Velupillai (2000), regarded as the most relevant figure of computational complexity in economics (Rosser 2009), makes a similar interpretation of the debate and argues that the fundamental points raised by Mises, Robbins, and Hayek can be interpreted in computational complexity terms. In this sense, Velupillai asserts that Austrian economists in the debate "were making the obvious point that certain processes were computationally intractable" (Velupillai 2000, p. 19). More explicitly, he adds: "I conjecture that the tools of algorithmic and computational complexity theory can be used to indicate the computational infeasibility of the institutions of so-called socialist market economies based on Lange–Taylor type arguments" (Velupillai 2000, p. 164). These conclusions have been reproduced and echoed in subsequent complexity works (Tsuji, da Costa, and Doria 1998; Koppl 2008, 2010; van den Hauwe 2011; Velupillai 2005).

As shown, the complexity paradigm not only rejects the idea of general optimum, on which Lange's socialism is based, but clearly concludes that central planning in the Lange-Taylor fashion is unfeasible. Therefore, if complexity economics is the new standard economics, or at least is on the way to becoming mainstream in the future (Colander, Holt, and Rosser 2004; Beinhocker 2007; Fontana 2010; Holt, Rosser, and Colander 2011), Lopes's (2021) analysis and conclusions are compromised. As we already described, Lopes advocates a scientific interpretation of the socialist calculation debate, meaning that the strength of an argument is determined by its scientific character, by being under a common framework accepted by a community of scientists. That is why he believes that Lange defeated Mises, and why the unscientific Austrian rebuttal is off-target. However, the current evolution of economics into a new scientific paradigm changes this conclusion. While the previous scientific paradigm backed Lange's theory, a new scientific consensus in economics is indicating that central planning is unfeasible (Tsuji, da Costa, and Doria 1998; Koppl 2008, 2010; van den Hauwe 2011; Velupillai 2000, 2005). Now, science does not back Lange and his Walrasian equilibrium. What does this imply?

First, contrary to Lopes's assertion that "socialism cannot be scientifically rejected, but only politically by those whose economic interests are opposed by it" (Lopes 2021, p. 807), now central planning can be and is indeed being rejected in scientific terms, separated from any political argument. Then, it could be said that Lopes bases his conclusion on an outdated—unscientific, to use his own preferred terminology—view of the state of economic science. This brings us back to a similar situation as at the start of the socialist calculation debate, when Mises attempted to conclude that socialism is technically and scientifically unfeasible. Moreover, apart from this relevant point, the paradigm shift also conditions the interpretation of the debate. Now, the so-alleged unscientific Austrian rebuttal by Hayek, Lavoie, and others can be regarded as scientific. Recall that Lopes criticizes Austrians for creating a new branch of economics, opposed to the standard, neoclassical equilibrium theory, to re-elaborate their critique of socialism after Mises. This new branch rejected the static equilibrium analysis, and advocated a dynamic view, clarifying that the problem of central planning is not static, but dynamic (Lavoie 1981, p. 1985). Apparently, the new Austrian branch resembles complexity economics and its critique of neoclassical theory.

According to Foss (1993), the Austrian rebuttal of Walrasian market socialism is broader than it looks at first. In reality, the Austrians rose up against "the emerging lock-in of unlimited rationality and equilibrium as the dominant economic tools" (Foss 1993, p. 154). Concretely, Foss names (1) the static character of Walrasian models, (2) the epistemological assumptions of those models, such as perfect rationality, and (3) the view of economic behavior as just maximizing. All those points coincide with complexity economics' critique of neoclassical theory sketched above, which ultimately supports the idea that the late Austrian reply in the debate was a complexity perspective. This hypothesis is confirmed insofar as computational complexity economists have pointed out how Austrian arguments in the socialist debate can be interpreted from a computational viewpoint (Velupillai 2000, p. 19), and also in light of the abundant works linking complexity and Austrian economics (Montgomery 2000; Koppl 2006, 2009; Rosser 2015; Barbieri 2013). In those works, Hayek and Lavoie are included in the complexity approach, specially Hayek, who is regarded as a forerunner of complexity theory in general (Rosser 2010, 2012). In this regard, Rosser (2012) mentions that Hayek managed to combine the *emergentism* of dynamic complexity with that of computational complexity in his argument against central planning, thus foreshadowing evolutionary-complex subsequent works of important figures such as Langton (1992), Wolfram (1984), Kaufmann (1993), and Mirowski (2007).

Applying Lopes's logic, the complexity paradigm shift in economics makes Lange's theory and Walrasian market socialism unscientific, while placing the Austrian reinterpretation in mainstream, standard economics. This exposes socialism to scientific criticism again, beyond mere political grounds. Actually, the fact that the Walrasian paradigm appears outdated in light of the complexity paradigm may be the reason why the new round in the socialist calculation debate is taking place away from the concept of general equilibrium. Two major current proponents of central planning, Cottrell and Cockshott (1993), elaborate their argument from a computational complexity perspective,[3] even rejecting Walrasian equilib-

rium and Lange's arguments (Cottrell and Cockshott 2007). This means that the new round in the socialist calculation debate is occurring in the complexity arena, in the new possible economics paradigm.

That said, an important question remains in this analysis of the socialist calculation debate. What about Mises's position from complexity economics? If we stick to Lopes's interpretation of Mises, we can say the same as with Lange, namely, that his arguments become obsolete due to the paradigm revolution, since Mises argued in the same scientific language as Lange. However, this is Lopes's account of the debate and of Mises's participation. In fact, Bylund et al. (2022) show that Lopes bases his interpretation only on Mises's *Economic Calculation in the Socialist Commonwealth* (1935), overlooking Mises's *Socialism: An Economic and Sociological Analysis* (2012), in which Mises expanded and consolidated his arguments. This leads Lopes to portray a wrong image of Mises by saying that he took part in the debate using the same language and framework as Lange. In reality, Mises held a dynamic view about the market process, stressing that economic calculation is only present in dynamic conditions, and that the problem of socialists was their static viewpoint. Bylund et al. (2022) support this with several quotations such as the following:

> As far as most socialists are concerned, recognition of these problems is obstructed, not only by their rigid adherence to the labor theory of value but also by their whole conception of economic activity. They fail to realize that industry must be constantly changing: their conception of the socialist community is always static (Mises 2012, p. 212).

Moreover, Bylund et al. go on to demonstrate that there was not such a thing as a retreat from Mises's position by Hayek. They prove this with another quotation from Mises, in which it is clear that Hayek's argument is not a retreat nor a development, but an alternative charge against socialism:

> Hayek has also pointed out that the possibility of using the equations describing the state of equilibrium for purposes of economic calculation presupposes a knowledge of the future scales of preferences of consumers. But here he has in mind only a complication of the practical task of applying the equations, and not a fundamental and insuperable obstacle to their use for any such process of calculation (Mises 2000, p. 30).

Even after the debate, Mises continued writing from this dynamic approach to economic phenomena, by emphasizing the promoter or entrepreneur as the driving force of the market *process* (not equilibrium), understanding that the market process can never be static; it does not cease to operate (Bylund 2018, 2020). Therefore, Mises's view can also be included with Hayek's and Lavoie's as a scientific complexity standpoint in the socialist calculation debate.[4]

CONCLUSIONS AND IMPLICATIONS

From what we have discussed, we can draw several conclusions. In the first place, we have seen how the new economic paradigm of complexity shows the infeasibility of central planning and the obsolescence of the Walrasian equilibrium as a theoretical framework. Taking this into account, Lopes's logic turns against his own conclusions. Thus, Lange's position and Walrasian socialism can be regarded as unscientific according to complexity economics. At the same time, Austrian arguments can be considered scientific insofar as they parallel the complexity charge against socialism and its general theoretical framework. Hence, the Austrian reinterpretation of the debate now becomes the standard interpretation, provided that complexity economics is understood as the new scientific paradigm, as several authors already do (Colander, Holt and Rosser 2004, 2011; Beinhocker 2007). This is precisely a conclusion opposite to Lopes (2021).

In contrast to Lopes's resounding assertion that socialism cannot be rejected scientifically but only politically, complexity economics paradigm presents scientific arguments against the viability of central planning. In fact, the socialist calculation debate is still open, and is taking place in the complexity arena. For

this reason, it would still be bold to claim that complexity economics completely rejects socialism in technical terms. However, recent works point out that there are inevitable problems that central planning faces from a complexity approach, such as the issue of self-reference (Moreno-Casas, Espinosa and Wang 2022), that socialist authors have not resolved yet. This may constitute a scientific, at least temporary, rejection of socialism –in the sense of a consensus among scientists–.

Furthermore, our analysis can have implications beyond the interpretation of the debate and a critique of Lopes's work. On the one hand, as we identify the Austrian position in the debate as a complexity standpoint, the socialist calculation debate may be seen as a clash of paradigms, concretely, the first clash between neoclassical economics and complexity economics, the latter in an elementary form through the Austrian position. Obviously, this idea needs to be expanded and elaborated in subsequent works, which means that this article may stimulate future research. On the other hand, on a more general level, we can draw the implication that any historical interpretation appealing to the scientific value of theories, beyond its technical or objective validity, needs to account for the evolution of scientific paradigms. What was scientifically true in the past may be scientifically rejected in the present. This, as shown in this article, may completely change any historical interpretation.

NOTES

1 Lopes does not disregard these non-standard Austrian arguments but rebuts them through three reasons. First, that it is possible to convert the traditional static equilibrium to a dynamic theory (Crookes and De Wit 2014). Second, that authors such as Adaman and Devine (1996) have already tackled the issue of tacit knowledge by proposing a model of participatory planning. And third, that the socialist theory incorporated the essentials of the neoclassical paradigm as developed since the Marginal Revolution, which leads Lopes to say that Lange's argumentative strategy fully absorbs Mises's (1998) magnum opus, Human Action.

2 In fact, many economists believe that neoclassical economics originated at the end of the 19th century as a metaphorical adaptation of the mid-19th century mechanical physics, concretely, energetics (Mirowski 1989, 1991).

3 They base several arguments on fundamental computational complexity theories mentioned above: the Church-Turing thesis (Cottrell and Cockshott 2007), Shannon's (1948) information theory (Cockshott and Cottrell 1997), and Chaitin's (1987) algorithmic information theory (Cottrell and Cockshott 2007).

4 It is worth noting that Mises (2012) is wrong when asserting that central planning is feasible under stationary conditions. As treated in this article, the non-computability of equilibrium prices in a competitive market equally applies to that Mises's assertion (Doria 2017).

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