CENTRAL PLANNING, COMPUTING TECHNOLOGY, AND ECONOMIC PROBLEMS

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1. **Introduction**

The contemporary development of computational technologies has led to a growing interest in the ideas of collective economic planning. Their modern proponents argue that the past failures of socialist systems were largely due to the lack of computational power available several decades ago. However, recent advancements in information and computational technology are expected to change this. Tools such as artificial intelligence, big data analytics, and machine learning are claimed to enable socialist economies to achieve a higher level of economic efficiency than market economies.

Proponents of these doctrines—collectively referred to here as cybersocialists—are often familiar with the arguments of Austrian economists, who, during the famous calculation debates, argued that collective economic planning is doomed to failure. They claim, however, that Austrian arguments have become outdated (Philips & Rozworski, 2019; Dapprich & Cockshott, 2022; Nieto & Mateo, 2023). Contemporary Austrian economists respond to various proposals put forth by cybersocialists (Wang et al., 2021; Boettke & Candela, 2023; Lambert & Fegley, 2023), yet it appears their argumentation could be strengthened by drawing on the

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achievements of contemporary philosophy and by emphasising issues that seem to have been overlooked.

My objective in this article is to contribute to the debate on cybersocialism by strengthening the foundations of the thesis that fundamental economic problems are inherently non-computational. Drawing on the work of Austrian economists, logicians, and analytic, I support my position with insights into the distinctions between computational and non-computational problems (Turing, 1950; Penrose, 1989), between semantics and syntax (Searle, 1980, 1984), as well as issues of subjectivism, uncertainty, entrepreneurship, value imputation, and the local nature of economic activities (Hayek, 1948; Buchanan, 1979; Mises, [1949] 1998; Huerta de Soto, 2009, [1992] 2010; Lavoie, 1990; Boettke & Candela, 2023). I argue that the fundamental economic problem—namely, the dynamic economic adaptation to unpredictable and local conditions—is not a computational problem and cannot be resolved at a centralized level.

In Section 2, I outline the general ideas of cybersocialism. In Section 3, I discuss the concept of computability and its limitations. In Section 4, I examine Ludwig von Mises's original calculation argument. In Section 5, drawing on the contributions of Austrian economists, I argue that the fundamental economic problem is non-computational in nature. In Section 6, I review selected new directions in argumentation against central planning. The article concludes with a brief summary.

2. Recent revival of socialist ideas

Proponents of planned economies argue that contemporary advancements in computational technologies are "changing the context, dimensions, and meanings of socialism, which need to be worked out" (Rajimwale, 2021, p. 91). The literature includes both new socialist and communist manifestos aimed at a broader audience (e.g., Bastani, 2019; King & Petty, 2021; Philips & Rozworski, 2019) and publications of a scientific or quasi-scientific nature (e.g., Dapprich & Cockshott, 2022; Dyer-Witheford, 2013; Laibman, 2020; Limas, 2018; Morozov, 2019; Nieto, 2023; Nieto & Mateo, 2020;

Samothrakis, 2021; Saros, 2014). While some advocates of collectivist economies argue that computational technology should primarily ensure appropriate incentive structures and communication (Saros, 2014; Morozov, 2019), many lean towards the thesis that computational technologies will enable planned economies to achieve greater economic efficiency than market economies by eliminating unused production capacities or by increasing economies of scale.

These ideas are referred to by various terms in the literature, including ‘digital socialism’ (Morozov, 2019), ‘digital communism’ (Dyer-Witheford, 2013), ‘technosocialism’ (King & Petty, 2019; Boettke & Candela, 2023), ‘cybercommunism’ (Nieto & Mateo, 2020; Nieto, 2023; Moreno-Casas et al., 2022; Wang et al., 2021), and ‘cybersocialism’ (Limas, 2018; Lambert & Fegley, 2023; Dapprich & Greenwood, 2024). For both historical and semantic reasons, it seems that the most appropriate term to describe the concept I intend to critique in this text is ‘cybersocialism.’ For Marx, communism represented the ultimate stage of history, characterized by the abundance of goods, social equality, and the absence of the state. Cybercommunists (Bastani, 2019; Dyer-Witheford, 2013) indeed argue that the scarcity of economic goods is artificially maintained today by “capitalist legal institutions,” including intellectual property rights, which hinder broad access to “intellectual goods” such as formulas, ideas, inventions, and technological or organisational knowledge. Although libertarian-leaning Austrian economists might agree with cybercommunists on the call to abolish or limit intellectual property rights, their rationale differs fundamentally. Cybercommunists suggest that knowledge is a factor of production, but in fact knowledge enables economic actors to comprehend how scarce factors of production can be combined to produce goods. Austrian libertarians maintain that knowledge, by its nature, is not a scarce good—and only scarce goods should be subject to property rights (Kinsella, 2001).

The term ‘technosocialism’ is sometimes used to describe an idea that is not strictly socialist. King and Petty (2019), for instance, propose a global economic organisation in which various governments collaborate and utilize modern technology to ensure *inter alia* broad access to education and healthcare. However, they do not advocate for the complete abolition of private property. The terms ‘digital socialism’ and ‘cybersocialism’ appear to be the most appropriate, but the latter is both shorter and better justified historically. In the 20th century, socialist projects such as ‘Cybersyn’ in Chile emerged (intended to support central planning by computers), and the discipline of cybernetics was intended to support central planning in the Soviet Union (see, e.g., Dyer-Witheford, 2013; Morozov, 2019).

Although the roots of cybersocialist ideas can be traced back at least to the time of Oskar Lange, who argued that central economic planning based on computational technology could fulfil “a function which the market never was able to perform” (Lange, 1967, p. 161), the current debate on this topic often references the book by W. Paul Cockshott and Allin F. Cottrell (1993). Some contemporary cybersocialists openly draw on this work (Dapprich, 2023; Dapprich & Cockshott, 2022; Nieto, 2023; Nieto & Mateo, 2020; Samothrakis, 2021). Among them, several argue that examples of large corporations such as Walmart demonstrate that large-scale collective economic planning is feasible. These companies employ modern computational technologies in logistics and production, and their scale—whether measured by the number of employees or economic value—exceeds that of many countries (Philips & Rozworski, 2019).

There are various cybersocialist proposals that deserve separate analysis; however, their common denominator is the belief that the fundamental economic problem faced by society can be made as manageable as possible through the collectivisation of the means of production and the application of computational technology to economic planning. Cybersocialists propose, for example, the use of an input-output matrix, which—based on data regarding available resources and methods of their processing—would show the possible combinations of final goods that could be produced. The choice of the final result would depend on democratically made decisions (which is meant to eliminate the issue of exploitation present in previous socialist economies, where rulers exploited the ruled). Income distribution, in turn, would not be based on strictly egalitarian principles (since such principles generate inefficient work incentives) but would be determined by the amount of time devoted to labor. Workers would receive non-circulating labor tokens, which could be used to purchase goods and services but could not be transferred to other individuals. Thus, cybersocialists rely on a labor theory of value. They believe that the value of final goods derives from the socially necessary labor time required for their production (Dapprich, 2023; Dapprich & Cockshott, 2023; Nieto & Mateo, 2020; Nieto, 2023).

They recognize, however, that a limitation of the input-output matrix is its static nature. Therefore, they propose that it should be subject to continuous, real-time adjustments. Simultaneously, they are convinced that machine learning can be used effectively to predict future demand for particular goods. The common economic unit, which is labor time, has practical application: calculations within the input-output matrix could, in principle, be carried out without any common denominator (such as monetary prices or labor time), but would then require significantly greater computational power (Dapprich & Cockshott, 2023).

3. **Computability and its limits**

Contemporary computational technology is largely based on the achievements of mathematical logic. At the beginning of the 20th century, proponents of so-called mathematical formalism sought to present an algorithm—a set of instructions within a formal system (a set of axioms and rules of inference)—through which all mathematically formulable problems could be solved. However, their research programme was quickly shown to be doomed to failure. Already in the 1930s, the Austrian logician Kurt Gödel presented his famous incompleteness theorems. In light of these theorems, in any formal system that contains natural numbers, there must exist statements that are true but cannot be proven using the axioms and inference rules of the system. Gödel thus demonstrated that even in mathematics and logic, there are non-algorithmic problems—that is, problems that cannot be solved through computational procedures (see Penrose, 1989).

The British mathematician Alan Turing contributed to the development of computational technology, notably through his formulation of the concept of 'computing machines' or 'digital computers,' now known as Turing machines. A Turing machine is not so much a concrete, tangible device, but rather an abstract mathematical concept: it is an abstract device that performs computational (algorithmic) operations within a given formal system (a set of axioms and rules of inference). Turing is also considered one of the pioneers of research into so-called artificial intelligence. He proposed a test, which he called the 'imitation game,' now known as the Turing Test. According to this concept, whether a given entity is intelligent is determined by whether it behaves (conducts a conversation) in a way that is indistinguishable from a human. If it passes the test (wins the 'imitation game'), it can be said to be intelligent. This is thus a strictly pragmatic and operational concept of intelligence, one that does not address the question of its essence (Turing, 1950).

Numerous arguments have been raised against such concepts. John R. Searle (1980, 1984) argues that genuine understanding is not reducible to algorithmic operations and that digital computers cannot truly be intelligent. He illustrated the difference between genuine understanding and performing computational operations with his famous 'Chinese Room' thought experiment. A person who speaks only English is locked in a room containing instructions on how to respond in Chinese to certain questions (also posed in Chinese). However, there are no translations. A person outside the room slides a piece of paper with a question written in Chinese under the door. The person inside the room responds in Chinese. The person outside might think that the person inside understands Chinese, but this is not the case. The individual inside is simply following instructions—performing algorithmic operations. Searle argues that his argument rests on simple and uncontroversial assumptions. First, imitation is not duplication. Second, meaning (semantics) is not reducible to symbols (syntax). It is possible to say that symbols *represent* meaning, but understanding meaning is not reducible to operations on symbols (Searle, 1980, 1984).

The contemporary mathematical physicist Roger Penrose believes that Gödel's theorems provide evidence that there must be a non-algorithmic component to conscious thought—otherwise, the human mind would be unable to recognize the truth of statements that are algorithmically unprovable. According to Penrose, this does not necessarily exclude determinism: even if the world is deterministic, this does not imply that it is entirely algorithmic. Nevertheless, the physicist argues that "the hallmark of consciousness is a non-algorithmic forming of judgements" (Penrose, 1989).

The above observations seem highly relevant to the social sciences. Economics, in particular, is a science of human action. Human actions, in turn, are based on judgments about reality. If these judgments are formed non-algorithmically (whether due to the existence of free will or for reasons such as the one Penrose describes), it implies that human actions and the complex socio-economic processes they generate do not unfold algorithmically. Moreover, as Austrian economists argue, to understand and explain the functioning of the economic world, one cannot limit oneself to observable phenomena. Instead, it is necessary to comprehend the meaning that acting individuals assign to the world and their actions. This explanatory principle, known as subjectivism, can be defined as "a research programme of the social sciences which aims at elucidating social phenomena in terms of their inherent meaning, i.e., in terms of their meaning to actors" (Lachmann, 1994, p. 237).

The operation of computers and all computational technology is based on data that can be articulated and processed through algorithms. With computational technology, one can create a list of physical resources and their possible combinations, but it is not possible to create a list of economic goods. A tangible object becomes an economic good only when it is assigned economic significance by an acting individual. However, different individuals may ascribe different meanings to the same object. A computer can be both a consumption good and a production good, depending on its function for a specific person. As Hayek emphasizes, data in the social sciences, in contrast to the natural sciences, is of a subjective nature. Consequently, "the objects of economic activity cannot be defined in objective terms but only with reference to a human purpose […] Neither a 'commodity' or an 'economic good,' nor 'food' or 'money,' can be defined in physical terms but only in terms of the views people hold about things" (Hayek, 1952a, p. 31).

Another issue with economic planning (in general) is that subjective data often resists articulation. The meanings that individuals assign to objects and their actions may be unclear and not fully expressible, yet they can still determine their course of action. In linguistics, the case of the ambiguity of the concept of 'soup' is well-known: although it cannot be precisely defined, this does not prevent people from understanding and practically using the term. Moreover, human beliefs, preferences, and expectations change depending on spatiotemporal contexts (circumstances of place and time). In addition, mental states that lead individuals to undertake specific actions are directly experienced only by their possessors, meaning they are not subject to external observation. All of this creates insurmountable limitations in collecting and algorithmically processing data about the social world.

4. The initial Austrian argument against central planning

The fundamental role in the debate on the economic viability of central planning was played by Ludwig von Mises, who, in 1920, published his famous essay *Die Wirtschaftsrechnung im sozialistischen Gemeinwesen*. What distinguished his argumentation, from many alternative critiques of socialism, was its strictly economic character. For Mises, the functioning of a socialist economy was not a psychological or ethical problem. According to his viewpoint, central planning would be economically unfeasible even if people were to abandon the pursuit of their own interests and wholly dedicate themselves to working for the good of the socialist community. Thus, Mises shifted the discussion of socialism onto the ground of economic theory. He argued that effective planning in socialism is unfeasible not only in practice but also in theory.

The essence of Mises's argument was the problem of economic calculation — that is, comparing the economic value of outputs and inputs through arithmetic operations. As the Austrian economist argued, in a market economy, economic calculation is made possible by the price system, which is based on private ownership of the means of production, money (a universally accepted medium of exchange and common denominator for diverse and incomparable goods), and markets, where goods are priced and exchanged. By adding and subtracting the prices of various goods, individuals can, under such conditions, assess which economic decisions will be most desirable for them. In a socialist economy, the aforementioned institutions do not exist, and thus there is no price system. Consequently, the socialist planner is condemned to "grope in the dark" — lacking the tool to judge which methods of production will be most economically efficient (Mises, [1920] 1990).

Mises's argument sparked significant interest in the 1920s and 1930s, with prominent economists such as Friedrich Hayek, Joseph Schumpeter, Oskar Lange, Abba Lerner, and Fred Taylor engaging in the so-called calculation debate. The argument continues to be appreciated even by contemporary cybersocialists. For example, some of them write: "Mises's argument […] is described to this day by his acolytes as his masterpiece. And not without reason: it is perhaps the strongest argument ever mounted against the idea of socialism" (Philips & Rozworski, 2019).

Unfortunately, it must be acknowledged that Mises's focus on the arithmetical problem of a common unit of account was a mistake[1]. Firstly, as noted by Mateusz Machaj (2007, 2018), some sort of economic calculation is possible not only in capitalist economies but also in what is known as market socialism (proposed by Oskar Lange in response to Mises's arguments). In this system, even though there is no private ownership, there are still prices (e.g., assigned to specific goods by a central planning board)[2] and competition for production resources among managers of state-owned enterprises.

Secondly, while a common unit of account is necessary for performing *arithmetic* operations, it is not required for carrying out *algorithmic* operations in general (arithmetic operations can be considered a subset of algorithmic operations). Through knowledge of production techniques and appropriately formulated algorithms, it

1 See an Austrian critique of Mises's original contribution in Kirzner (1988).

2 However, it must be admitted that these prices would not convey the same information as prices in a market economy, and therefore would not perform their functions effectively, see. e.g. Huerta de Soto ([1992] 2010).

is possible to determine which sets of goods can be produced from specified quantities of production factors. Therefore, it is difficult to deny the validity of the cybersocialists' argument that using labor time as a common unit of calculation serves only a practical function—without it, algorithmic operations would be significantly more complicated, but not inherently impossible (Dapprich & Cockshott, 2023).

Mises's original argument, therefore, suffered from certain shortcomings. However, the undeniable merits of the Austrian economist include shifting the debate on socialism to the realm of economic theory and highlighting the economic significance of social institutions such as private property, money, markets, and the price system. To do justice to Mises, it is worth mentioning that in his original essay, he also addressed the economic importance of entrepreneurship, innovation, and uncertainty (Mises, [1920] 1990). Unfortunately, he did not place them at the heart of his argument at that time. In his 1938 essay, however, he presented an interesting argument against the mathematical treatment of the market process, emphasizing its dynamic aspect. He observed that, by taking actions aimed at bringing the economy closer to a hypothetical equilibrium state, market participants change the market data, thereby altering that hypothetical equilibrium state (Mises, [1938] 2000). In *Human Action* ([1949] 1998), the Austrian economist further emphasized the economic significance of entrepreneurship in the dynamic market process, characterized by insurmountable uncertainty.

5. **Economic problem: dynamic and local adaptation**

Some contemporary Austrian economists have attempted to demonstrate that even if the problem of collective economic planning were purely computational (algorithmic), the computational power required to solve it would, in practice, be unattainable (Engelhardt, 2013; Cwik & Engelhardt, 2023). However, the dispute over the fundamental (rather than merely practical) feasibility of central planning revolves around the essence of the fundamental "economic problem which society faces" (Hayek, 1948, p. 77).

As Friedrich Hayek argued in his famous essay *The Use of Knowledge in Society*, first published in 1945, if we had access to all the data regarding technology, available resources, and human preferences, we would face a purely logical problem that could be solved through a system of mathematical equations. However, the real economic problem lies in the fact that economic data are not, and cannot be, fully known to anyone. People act within specific circumstances of time and place, and only they know the context of their actions. Only they know how important are resources at their disposal in relation to the alternative goals they wish to achieve. The economic problem, therefore, is how to make the most efficient use of subjective, dispersed, and impossible-to-centralize knowledge (Hayek, 1948).

Hayek (1935, 1952a) distinguished between technological (or engineering) problems and economic problems in this context. Technological problems can be seen as computational, meaning they are solvable using algorithms. Economic problems arise when we deal with the social world, constituted by the mental states of acting individuals. Social phenomena, by their nature, cannot be observed from the outside; they do not have a physical character. The socio-economic reality is shaped by human beliefs and valuations, which are inherently incommensurable and incomparable. A similar perspective is presented by James M. Buchanan, an economist inspired by the Austrian school. He argues that the economic problem faced by Robinson Crusoe would be "essentially a computational one, and all that he need do to solve it is to program the built-in computer that he has in his mind" (Buchanan, 1979, p. 27). The economic problem we refer to, therefore, has a strictly social nature.

The first significant element of Austrian economic analysis is, therefore, related to the subjective, dispersed, and local nature of human knowledge. Its second key component is the emphasis on time and uncertainty. The problem of uncertainty in economic processes was particularly highlighted by Mises ([1949] 1998). It was further developed by economists such as G.L.S. Shackle (1972) and Ludwig Lachmann (1986). These economists strongly opposed the assumptions of standard microeconomics about the completeness and constancy of human preferences. They argued that human preferences are, in fact, indefinite and incomplete. They are formed only in specific circumstances where individuals must make decisions. Hence, discussions about the optimal use of resources for given objectives are futile. Economic research should instead be based on the assumption that, as Buchanan succinctly puts it, "*not even* individuals have well-defined and well-articulated objectives that exist independently of choices themselves" (Buchanan, 1979, p. 111, emphasis in original).

In this perspective, the market process does not aim at a specific goal; "market organization is not a means toward the accomplishment of anything" (Buchanan, 1979, p. 31). Don Lavoie (1990), citing Hayek, argued that the fundamental cognitive function of the market is to discover the available means and the relative significance of the goals that members of society want to achieve. This problem—due to the indeterminacy of preferences and uncertainty about the future—cannot be solved by algorithms or computers. On the market, these discoveries occur as a result of social interactions. Peter J. Boettke and Rosolino A. Candela (2023) state that the task of economic calculation "is not to solve a technological problem of allocating given means to a single end, but the discovery of the means available to satisfy an undefined set of ends" (Boettke & Candela, 2023, p. 52).

We can therefore say that the essence of the economic problem is not the optimal allocation of given resources to specific goals (as assumed by the standard definition of economics formulated by Lionel Robbins), but rather the dynamic adaptation to unpredictable events in specific circumstances of time and place. This idea is clearly expressed by Hayek: "The solution of the economic problem of society is in this respect always a voyage of exploration into the unknown, an attempt to discover new ways of doing things better than they have been done before. This must always remain so as long as there are any economic problems to be solved at all, because all economic problems are created by unforeseen changes which require adaptation" (Hayek, 1948, p. 101).

The market addresses the problem of dynamic adaptation to unpredictable and local conditions through social institutions that Mises emphasized from the outset: private property, money, and exchange system. These institutions ensure social coordination.

Through the price system, resources are directed to those applications where the highest demand is expressed. What, how, and where will be produced ultimately depends on the decisions of entrepreneurs who own the means of production. These decisions, along with those made by the managers they employ, are made in response to changes in prices and emerging market information (Mises, [1949] 1998; Salerno, 1993, 1994).

Accepting the analytical framework outlined above, Jesús Huerta de Soto (2009) rejects static concepts of economic efficiency (which assume that goals and means are given) and proposes the concept of dynamic efficiency, which involves continuously adjusting resources to the ever-changing human goals[3]. The driving force behind this efficiency is the actions of entrepreneurs. The essence of entrepreneurship lies in creating and transmitting information about the market situation (*inter alia* through the price system), resulting in economic coordination (elimination of economic mismatches). However, due to the creative dimension of entrepreneurship (e.g., introducing product innovations or new organizational solutions), it does not make sense to speak of a final state of market equilibrium, as assumed in neoclassical economics. Huerta de Soto (2009) argues that the highest level of dynamic efficiency can be achieved in an institutional framework based on the absolute respect for private property.

William Hongsong-Wang and others (2021) criticize cybersocialism based on the concept of dynamic efficiency, further developing it by incorporating a judgment-based approach to entrepreneurship. According to this approach, the essence of entrepreneurship lies in taking responsibility for making judgments about the use of heterogeneous production resources in relation to the uncertain

[3] A similar idea of efficiency can be found in Douglass C. North, who introduces the concept of 'adaptive efficiency' and defines it as follows: "Adaptive efficiency [...] is concerned with the kinds of rules that shape the way an economy evolves through time. It is also concerned with the willingness of a society to acquire knowledge and learning, to induce innovation, to undertake risk and creative activity of all sorts, as well as to resolve problems and bottlenecks of the society through time" (North, 1990, p. 80). He also contrasts this type of efficiency with 'allocative efficiency', being the main focus of neoclassical economics, which studies conditions of optimal allocation of given resources to given ends.

future demand (Foss & Klein, 2012). Since private property does not exist in a socialist economy, the aforementioned entrepreneurial functions—creativity, market coordination, and asset responsibility for uncertain outcomes—cannot be realized.

Another important function of the market, especially in the context of the problems faced by socialist economies, is price imputation. This aspect of market functioning has been highlighted by some critics of socialism (Herbener, 1996; Machaj, 2018; Rothbard, 2011). Price imputation refers to the valuation of production factors based on the expected demand for the goods they help produce. According to this theory, the prices of production factors are ultimately derived from the prices of consumer goods, rather than the other way around, as suggested by cost-based value theories (such as the labor theory of value). Through the process of imputation, the prices of production goods reflect their relative economic value in relation to the consumer goods they produce. Consequently, "the market process can connect the value of factors to the value of consumer goods in a meaningful way" (Herbener, 1996, p. 158). It is important to highlight the local and non-computational nature of this process, which seems underemphasized in the literature: entrepreneurs form their subjective judgments in particular circumstances of place and time. A central managing authority (especially if based on the labor theory of value, as proposed by cybersocialists) thus faces the fundamental problem of linking the relative values of production and consumer goods.

As Hayek argued, the discussion about alternative methods of economic organization does not concern "whether planning is to be done or not. It is a dispute as to whether planning is to be done centrally, by one authority for the whole economic system, or is to be divided among many individuals" (Hayek, 1948, p. 79). The arguments presented above strongly support the thesis that "the economic problem which society faces" can be effectively solved when economic plans are formulated and implemented locally, within an institutional framework based on dispersed private property. Socialist institutions, by contrast, cannot effectively perform the functions fulfilled by market institutions. Therefore, it must be concluded that *static* and *central* planning is an inappropriate method for solving the problem of *dynamic* and *local* economic adaptation, regardless of available computational powers[4].

6. New directions in arguments against central planning

In the current literature on the subject, there is also criticism of central planning that remains consistent with the Austrian line of argument but develops it in new directions. Panagiotis Karadimas (2023) argues that economic models necessarily rely on scientific representations, developed based on preconceived formal criteria. As a result, these models must neglect aspects of reality that do not fit these criteria. People, on the other hand, act based on direct observations made in local conditions. Their knowledge often cannot be formalized or articulated, and does not fit the classificatory criteria assumed in theoretical models. As Karadimas states: "Scientific representations offer knowledge of the world at the cost of excluding aspects of it, while direct observation provides knowledge of particular circumstances, though not necessarily scientific" (Karadimas, 2023, pp. 9-10). Consequently, central economic planning must be 'elliptical', meaning that the planner is unable to account for all the economically relevant information. Karadimas (2023) calls this the epistemic impossibility of economic calculation in socialism.

[4] As one of the reviewers has kindly noted, proponents of cybersocialism could argue that thanks to the data generated by the users of social media, AI models can make relatively accurate predictions about consumers' choices. Indeed, there are papers supporting the latter thesis (e.g. Kaminski et al., 2013), and some proponents of cybersocialism raise the arguments to the effect that big data analytics can effectively utilize web data in forecasting, thus alleviating problems of central economic planning (e.g. Limas, 2018). However, this argument neglects more severe problems of non-algorithmic character of socio-economic processes and human choices: even though much of human activity is predictable, there is always possibility of unpredictable social events (e.g. connected with the generation of new knowledge or introduction of innovations). Moreover, as I have already mentioned, neither human knowledge nor human preferences can be treated as given and fully articulable. Finally, no forecasting and planning can replace the incentive structure generated by market institutional arrangement. At the end of the day, economic problems are not being solved by mere forecasting and planning (no matter how accurate) — they can only be solved by human actions, which depend on institutional incentives.

Another line of argumentation against the feasibility of collective economic planning is based on the theory of dynamic complex systems. Vicente Moreno-Casas and others (2022) argue that "the complete control of any complex system is impossible due to the problem of self-reference" (Moreno-Casas et al., 2022, pp. 574-575). This problem is well known in logic, where it generates famous paradoxes. For example, if we assume that the statement "This sentence is false" is true, it means that it is false. Since, according to classical logic, nothing can be both false and true at the same time, it follows that the statement must be meaningless. In the social world, the problem of self-reference involves reflexivity: no one who is part of a given complex system (such as an economy) can accurately predict the behavior of that system because his actions influence the processes occurring within it (see Soros, 2013). Therefore, since the economy is a dynamic complex system — one that not only involves a large number of variables but also the issue of self-reference or reflexivity — central planning cannot address its adaptive problems as effectively as the market can (Moreno-Casas et al., 2022)[5].

Another interesting way of arguing against technology-supported central economic planning refers to agency theory. This is a field of study that addresses the interactions between different types of agents and their environment. Agency consists of two components: broadly understood intentionality (as a direction toward a specific goal) and autonomy (as the ability to take action without external intervention) (Martinelli, 2024, p. 5). Agency can be active, reactive, or proactive. Activity involves both of the aforementioned traits (intentionality and autonomy). Reactivity refers to the capacity to shape an action path leading to a specific goal (a kind of rationality). Proactivity is a higher-order autonomy: it entails the capacity to generate new goals and pursue them (ibid.). Referring to theorists of artificial intelligence, Emanuele Martinelli (2024) argues that

[5] Interestingly, the idea of self-reference (or reflexivity) also underpins Gödel's theorem, which states that no formal system can be complete in the sense that its consistency cannot be proven using only its own axioms and rules of inference. Ludwig van den Hauwe (2011) even argues that there is a similarity between Gödel's theorems and Hayek's theory of the mind, according to which the human mind cannot fully explain its own functioning because "the capacity of any explaining agent must be limited to objects with a structure possessing a degree of complexity lower than its own" (Hayek, 1952b, p. 185).

computational devices may exhibit active and reactive behaviors, but not proactive ones. The same problem applies to collective actions such as running election campaigns, waging wars, or central economic planning: these actions are derivative of individual actions, as only individuals are capable of initiating new goals. Martinelli (2024) concludes that in a centrally planned economy, there is no room for proactive actions, which in market economies are undertaken by entrepreneurs. Consequently, "the problem of economic planning cannot be solved by simply enhancing a central planner's computational power or data-tracking capabilities" (Martinelli, 2024, p. 11). Market economies will always have an advantage over centrally planned economies because they have entrepreneurs who "exercise the characteristic human ability to navigate complex systems by creating goals that are not implicit in the environment. This is the main reason why economic planning is, in principle, impossible, even with the best foreseeable AI technology" (Martinelli, 2024, p. 9).

What seems to be worth mentioning in the context of agency theory is that apart from the aspect of proactivity, there are also other factors such as liability and incentive structures, that distinguish activities of central planners from those of entrepreneurs on the market[6]. As the socialist planners and managers — as opposed to private entrepreneurs — are not liable with their own assets, they can also lack proper incentives to incur costs of making responsible decisions. This poses another significant challenge for cyber-socialist projects: even the fastest computations together with the most accurate planning and forecasting do not replace the incentive structure generated by market institutions. Economic adaptation problems, in turn, can only be solved through actual human actions taken within definite institutional settings.

7. Conclusion

The fundamental economic problem—what I believe to be dynamic adaptation to local and unpredictable conditions (rather than the

[6] I am thankful to one of the anonymous reviewers for turning my attention to this point.

optimal allocation of given resources)—is non-computable (i.e., impossible to solve using algorithmic procedures) for at least two reasons. Firstly, the subjective valuations that guide members of society are incommensurable and incalculable, and the knowledge they use is impossible to fully articulate and formalize (see also Huerta de Soto, [1992] 2010). Therefore, it is not possible to completely collect and algorithmically process the economic data used by members of society in their local actions. Secondly, socio-economic processes unfold in a non-algorithmic manner. This claim can be substantiated by referring to theories that support the idea that the human mind is capable of non-algorithmic judgment formation, or to theories of complex dynamic systems.

Dynamic and local economic adaptation is a problem that is solved in the market process through entrepreneurial activities within institutional setting based on private property, money, and the price system. While computational technologies play a significant role in the economy, improving production and communication processes, collective economic planning cannot effectively replace market institutions in its functions. In other words, *decentralized* economic planning based on computational technology can enhance the functioning of the market, but *centralized* economic planning based on computational technology can neither replace the market process nor surpass its adaptive or dynamic efficiency.

Conflict of interest

The author declares he has no conflict of interest.

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