Commentary

From General Equilibrium to Algorithmic Equilibrium

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Based on the Algorithmic Thinking Theory, this essay introduces the concept of "Algorithmic Equilibrium," which can really exist and be used to replace, re-interpret, and/or synthesize all other kinds of equilibria, and to allow the coexistence of equilibria and various dis-equilibria in a unified, dynamic, and developmental panorama, thus exhibiting a grand synthesis of economics.

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1. Introduction

Equilibrium means a position in economics where human intelligence has reached its maximum. "Perfect rationality" implies that information transfers frictionlessly and humans think or calculate costlessly, at infinite speed, or with zero time. In this sense, equilibrium must be only "general" (Walras, 1969; Arrow, 1951 & 1954; Debreu, 1951), namely, no equilibrium can be tenable solely unless all people and all factors reach the equilibrium simultaneously, and all "partial equilibria"[2], if any, must integrate with the equilibrium into an embracive wholeness and thus are not independent. This logic forced economic theory into an aggressive and unstoppable trajectory that has been attempting to cover everything; hence, Robert Lucas had to deliberately revamp the concept of "rational expectation"[3] to illustrate that general equilibrium would contain the future, despite it being ridiculous in common sense.

Then, cannot equilibrium be actual? Or, how should economists realistically identify, describe, and analyze equilibrium? The essay introduces a solution to these questions, which also brings a new scheme of a unified economics.

2. Algorithmic Equilibrium

Common sense tells us that equilibrium, as a statics, can really exist discretely, or in multiple units, and can also coexist with many dis-equilibria in the world, mixedly. We need to consider this synthetic scenario and explain why. The spatiotemporal properties of thinking, or of thoughts, can be some of the reasons: information, data, or thoughts as entities are distributed in the brain (and in space), and their gathering and interaction mean "thinking," which consumes time and other resources, like physical economic activities; then, the heterogeneity and marginal economic effects lead some thinking activities, with diminishing marginal returns, to converge into equilibria, whereas others remain active or diverge into dis-equilibria, maybe from some extant equilibria. Space and time can separate different entities, different thinking processes, and different equilibria and/or dis-equilibria, making them coexistent at different locations, temporarily or permanently. In order to describe this scenario, Algorithm Thinking Theory (ATT, or Algorithm Framework Theory, AFT; Li, 2009-2023) as a minimal theory is needed, which says that humans use finite, innate, and universal "Instructions" in the brain to serially, selectively, roundaboutly[4], and economically process informational pieces to think, at a finite speed (thinking = computation = [Instruction + information] × speed × time). One operation of computation or thinking means that one Instruction (e.g., "Add," "Multiply," "And," "Move," "Search," "Randomize," "Halt") works on no more than two pieces of data (information), getting no more than one result.

The "combinatorial explosions" happening between instructions and data illustrate the expansive, infinite, and endless procedures of knowledge development. However, one must stop or close their thinking somewhere in order to make decisions in time and to act. Providently, one must exert their best efforts to have a decision containing as much knowledge as possible, despite their limited thinking speed and capacity. How to do this? From empirical observations, we learn that one uses various methods other than deduction, such as induction, assumption, analogy, approximation, omission, and negotiation, to reach rash, rough, or vague conclusions about a part or the whole of the world. These conclusions, as cognitions, beliefs, attitudes, or strategies, cover wide domains, but only in limited depth or correctness, and in concise forms. In other words, they are in principle "makeshifts" or "stopgaps." Philosophical ideas, habits, traditions, common sense, and all taught knowledge can be examples of them. They are broadly, repetitively, and maybe implicitly invoked as parameters for enormous computations to reach specific equilibria; thus, an equilibrium achieved in this way would be "general," more or less; it can be a smaller and special "general equilibrium": containing thoughts relating to the globe; emphasizing something while neglecting others; resulting from the finite and affordable workload of computations; with various methods more subjective than neoclassically objective; possibly appearing flawed and arguable, etc. It may represent psychological states such as satisfaction, desperateness, or confusion while further computing attempts are deemed economically unnecessary, hence the actor chooses to stop here, despite many other problems remaining unsolved. According to the terminology of ATT, this equilibrium can be called "Algorithmic Equilibrium," different from, but relating to, neoclassical partial or general equilibrium.

3. The Coexistence of Equilibria and Dis-equilibria

Since computing time and costs are certainly real, any statics in the real world can be seen as an Algorithmic equilibrium that exists relatively independently and coexists with other equilibria and/or disequilibria. This independence and coexistence can be explained further. The decisive cause is the feeble capacity of a "thinking," or a computational operation, which confines any computational task within its limited scope and depth. One cannot carry out many or all tasks concurrently. It is far from the case that all variables are allowed, neoclassically, to change simultaneously and accordingly. Instead, one must invoke certain ready-made knowledge stocks that have been assumed relatively reliable and not subject to further change, to support current computations. One must choose from enormous stocks of knowledge, even purblindly. Since the stocked knowledge is one's historically accumulative results, endogenously, one can neither precisely examine their reliability for the time being nor revamp them all to adapt to current circumstances. Even if one determines to do so, he or she can only do it marginally, and perhaps very slowly. Moreover, due to scale or scope economies, the current computations should be intensive in certain domains to some extent, lasting a certain long period of time until an equilibrium is obtained; then it can be economically rational to turn to another task. And, while undertaking other tasks, the same limitations also apply to them.

The above logic suggests that in most cases, one must tolerate both the independence and coexistence of many equilibria, even without knowing their exact relations. From this perspective, we can comprehend the relationships between Nashian equilibria (Nash, 1950 & 1951) and other Non-Nashian ones. There must be explicit or implicit conflicts among various equilibria since they just arose from their specific contexts, respectively. Moreover, there must be abundant disequilibrated phenomena occurring beside the equilibria – no matter how a disequilibrium is defined. While confining equilibria locally, theorists should also admit the possibility and reality of the local existence of disequilibria, to make the concept of

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equilibrium falsifiable and hence methodologically meaningful. Then, we will find out that equilibria, as invoked knowledge, mean patterns, modules, or “anchors” that use fixed modes and output fixed responses upon certain stimuli from their diverse and changing contexts; in this way, equilibria are used to deal with disequilibria, or certainty is used to deal with uncertainty -- tight relations are juxtaposed or mixed with loose or unknown relations or irrelevance. Therefore, current computations are stratified as: some variables applicative to invoked knowledge + the rested variables assigned at one’s discretion. Both actors and researchers must face and tolerate the mixedness and plurality herewith.

Since it is an arbitrary, subjective, vague, and coarse conclusion of the objected world, an Algorithmic equilibrium embeds innovations as its possible negation or improvement. Then, some extant equilibria may collapse, computations return active, and other new equilibria may establish themselves again. History is neither a procedure of linear accumulation of knowledge nor a “random walk” without a diachronic continuum. Every decision means both a destination and a start. On the one hand, humans must “make mistakes” to conclude computations, to decide, and to act, thereby forming a specific edition of knowledge; on the other hand, they will have the opportunity to correct the mistakes and to make new knowledge marginally, thereby forming a new edition of knowledge; in this way, the loop recycles. This is like the structure of an onion: a small layer of leaf is covered by a bigger one, then by an even bigger one … thus the bulb grows. From this angle, we can obtain an appropriate outlook on history: accumulative, expansive, divergent, innovative, even progressive, but also kind of chaotic, conflictive, destructive, devious, and even retrogressive. Thanks to humans’ intentional selection, the former positive aspects overwhelm the latter negative ones at the macro level, leading to overall, continuous, and quite stable economic growth as a prominent social phenomenon.

4. The Grand Synthesis of Economics

Apparently, all economic branches or schools have been essentially and critically included in the above panorama. Communicational costs and time make actors prefer their own businesses to social ones. However, interpersonal conflicts give rise to institutions and organizations that are used to coordinate and simplify social interactions and hence bring about additional benefits. People act in the institutional infrastructure as if a person computes with knowledge stocks. Price, as a kind of quantitative information, sensitively but limitedly coordinates behaviors, whereas other kinds of data guide various behaviors besides transactions. Thoughtful entities endogenize money and financial phenomena. All goods are unnecessary to instantly sell out because assets, inventory, innovation, and many other

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measures can be taken to mitigate the necessity and difficulty of market clearance. This all-factor-inclusive approach can, surprisingly, make economic analysis easier and more effective than that of neoclassicism. Nonetheless, the market, running with subjectivities, flaws, mistakes, failures, innovations, and wastes, will never appear perfect or "generally" equilibrated, as supposed by neoclassical microeconomists; thereby, macroeconomic issues and policies competitively arise. In the long run, all factors, including institutions and cultures, may be changing at their respective different speeds, and the Algorithmic discovery of infinite knowledge development will enlighten actors and researchers.

The longer an equilibrium lasts, the more economical the computations with it will be. Hence, both actors and researchers often strategically pursue high-quality and longstanding equilibria. However, equilibria need not be the only contents or ends of all analyses. An analysis can start or end anywhere as long as it is competitive in explaining or predicting realities, or in advising actions. In this boundedly rational and endogenously heterogeneous framework, social researchers compete, cooperate, or trade with real actors, and theoretical explanations can be occasionally but reasonably superseded by predictive or advisory work, or by empirical studies.

Footnotes

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[2] A realistic concept of "partial equilibrium" was proposed and properly used by Alfred Marshall (Marshall, 2013); however, its basis needs to be interrogated and rebuilt, as in this essay.

[3] See Lucas, 1971. Under the logic of "rational expectation", any changes in the future can be divided into two parts: the predictable, and the "random walk".

[4] For the roundabout method of production, see Böhm-Bawerk (1923), pp.17-23.

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