A COMPLEX TOOLBOX FOR THE 21ST CENTURY ECONOMIST

UNA CAJA DE HERRAMIENTAS COMPLEJA PARA EL ECONOMISTA DEL SIGLO XXI

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Abstract

The Great Recession showed the limits of the models used to make economic policy, especially those of the dynamic stochastic general equilibrium (DSGE) model and computable general equilibrium (CGE) model. This paper presents a discussion of the limits that DSEG or CGE models have in the design of economic policies; it also shows the advantages that the theoretical and methodological framework of complexity economics could bring to macroeconomic analysis. This paper is divided in three sections. The first does a critical analysis of the DSGE and CGE models used in policymaking. The second section is focused in the fundamentals of complexity economics and the learning process in complex environments. In the last section, it will be discussed the advantages that complexity economics can bring to the design of public policies and the need to explore new methodologies that give policy designers greater freedom to achieve their objectives.

Keywords: General equilibrium models, neoclassical thought, complexity economics, financial crises, policymaking.

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Resumen

La gran recesión mostró los límites de los modelos utilizados en política económica, especialmente los modelos de equilibrio general dinámico estocástico (EGDE) y de equilibrio general computable (EGC). Este documento presenta un debate sobre los límites que los modelos EDGE y EGC tienen en la formulación de políticas económicas; también muestra las ventajas que el marco teórico y metodológico de la economia de la complejidad podrían traer al análisis macroeconómico. Este documento se divide en tres secciones. La primera hace un análisis crítico de los modelos EDGE y EGC. La segunda sección se centra en los fundamentos de la economia de la complejidad y en el proceso de aprendizaje en entornos complejos. En la última sección, se discuten las ventajas que la economia de la complejidad podría traer al diseño de políticas públicas y la necesidad de explorar nuevas metodologías que permitan a los diseñadores de políticas alcanzar sus objetivos.

Palabras clave: modelos de equilibrio general, pensamiento neoclásico, economía de la complejidad, crisis financieras, formulación de políticas.

Introduction

In my view, a good economist is a good economist; he or she is neither heterodox nor orthodox. He or she is always questioning, willing to consider new approaches, and trying to see whether he or she can gain a little more insight into what is going on by using this method or that method or by structuring the organization of the facts in a slightly different manner (Colander, 2003b, p. 79).

The Great Recession showed the limits of the models used to make economic policy, especially those of the dynamic stochastic general equilibrium (DSGE) model and computable general equilibrium (CGE) model. Policies validated by the DSEG and CGE allowed an excess of leverage and confidence in the US financial market. During the 2008 financial crisis, agents thought in unison: this time is different; “Everything is fine because of globalization, the technology boom, our superior financial system, our better understanding of monetary policy, and the phenomenon of securitized debt” (Reinhart & Rogoff, 2009, p. 20). These conditions, combined with poor financial regulation, caused the US financial system to fall, and along with it, most of the world's stock markets. On November 5 of 2008 Queen Elizabeth II asked to the professors of the London School of Economics “Why did nobody notice it?” (Chorafas, 2013, p.

15). One of the best faculties of economics in the world had no answer to that question. The only explanation for this debacle is that the best economists in the world failed to understand the risks of the system as a whole. Moreover, the roots of this failure are found in the theories and methodologies used as a metaphor for reality.

Behind every economic policy recommendation, that a model gives, there are the theoretical and methodological structure on which it is based. In the first place, the used theory gives the impression of being scientific and, at the same time, clean and easy to learn with guaranteed laissez-faire-type pieces of advice (Solow, 2008). Traditional theory ignores the social dimension of human activity and quasi-rational emotional humans (Screpanti & Zamagni, 1997; Thaler, 2000), which means that the agents are independent, autonomous, completely rational and without emotion. The general equilibrium model is based on methodological individualism and in a general equilibrium conception of the economy. These two characteristics are explained below.

On one hand, according to methodological individualism, there are only individual agents, and social relations only exist within the market; there is no other institution where individuals can interact. Thus, the process of individual decision is studied in relation to the way the individual assigns an order of priorities to the use of its income and time. However, if economics maintains the fundamental individualistic approach to construct economic models, it will not build a scientific theory with empirically falsifiable propositions (Kirman, 1989). On the other hand, regarding the vision of equilibrium in the economy, this is just an analytic technique or characteristic of a model; it is non-existent in the real world (Colander, 2003b).

The process of comparative statics is used by economists to explain the meanings of economic variables; due to this, the uniqueness and stability of equilibrium are fundamental problems for the theory. The analysis of comparative statics is equal to comparing different unconnected islands to each other; it has no causal explanation capability. Complexity economics aims to overcome these limitations of macroeconomic theory; interactions between individuals are the focus of this approach, and not individual behavior.

This paper is divided in three parts. The first part does a critical analysis of the DSGE and CGE models used in policymaking. These general equilibrium models are based upon the process of intertemporal maximization of utility in competitive markets (Prescott, 1995; Stiglitz & Gallegati, 2011). To understand what Complexity Economics can bring to economic analysis, the second part is focused in its fundamentals and the learning process in complex environments. In the last section, it will be discussed the advantages that the economy of complexity can bring to the design of public policies and the need to explore new methodologies that give policy designers greater freedom to achieve their objectives.

A critique to DSGE and CGE policymaking

All modeling process require simplifications of reality that become the assumptions of the models; but these assumptions became an arbitrary suppression of clues merely because they are inconvenient for cherished preconceptions (Solow, 2008; Berlin & Solow, 2009). The stronger the assumptions, the farther the resulting model will be from reality. Practical men and policymakers have justified their economic recommendations with unwarranted appendages and preconceptions (Kirman, 1989). However, society is not interested in knowing the assumptions of the model used by the minister of finance in its country, it demands policies and programs from economists, without knowing that there is no common answer between the profession to many questions. Economic policy designers consider many theories and models when making important decisions, but the possibility of incurring in some error is high among this tangle of concepts and relationships. In consequence, it is easier to assume something as true and defend it at all costs. The self-evident truths in public policy have been at the center of the recent academic and political debates (Ostrom, 2000). Economists must overcome these self-evident truths to answer the most important questions of society.

Policymakers use models that allow them to estimate the effect of a certain policy or external shock from a set of economic data. Computable general equilibrium (CGE) and dynamic stochastic general equilibrium (DSGE) models are the most commonly used for macroeconomic policy process. Both are constructed from the data of the economy that is to be modeled; which is usually taken from a social accounting matrix (SAM). The first models allow only static comparative analysis, while DSGE models allow to see how the economy changes over time incorporating a stochastic element into the analysis.

In both models the agents are the families, the companies, the government and the rest of the world within markets: of goods and services, of factors of production, money, credit and foreign exchange. Within each market every agent takes decentralized and autonomous decisions, which are theoretically based on their microeconomic behavior and are the result of an optimization process. Solow (2008) defines the dynamic stochastic general equilibrium model as the “model in which a single immortal consumer-worker-owner maximizes a perfectly conventional time-additive utility function over an infinite horizon, under perfect foresight or rational expectations, and in an institutional and technological environment that favors universal price-taking behavior" (p. 243). The economy of the model arrives at an optimal level or is pareto optimal if the property rights are well defined, the goods do not present externalities and the marginal rate of substitution is equal to the marginal rate of technical substitution for any good or service. On the other hand, the computable general equilibrium model represents an economy in a program through econometric calibration, this process is described through the relationships of economic agents in markets that behave according to the principles of microeconomic optimization. Monsalve (2017) shows that the calibration estimates the parameters of the model using certain economic and statistical criteria, then the parameters obtained are compared with empirical observations. Now, it is fair to move on to the limitations of general equilibrium models as a policy tool.

The behavior of the companies is not the same in Colombia and the United States; the African social protection policies do not have the same level as the European ones; or a public policy implemented in Southeast Asia will not have the same results as one implemented in Central America. Due to the fact that every nation has its own structure and internal institutions, a model as general as the DSGE or CGE cannot capture the existing relationships in any economy. Context does matter. Sims (1996) argues that "dynamic, stochastic, general equilibrium models have not been produced at a scale, level of detail and fit that allows them to be used in the actual process of monetary and fiscal formation" (p. 116). Because reality is a succession of surprises and processes in disequilibrium, models like the DSEG or CGE cannot have the level of detail or efficiency required for their effective use in monetary and fiscal processes; its scope is limited despite giving the impression of understanding the whole economy as a whole.

Economic policies inspired by general equilibrium models have considerable success when it comes to homogeneous and very competitive markets. But they are overcome by problems of production and provision of public goods and management of common-pool resources (Ostrom, 2002). The difficulty that general equilibrium models have in handling the situations mentioned above is due to a pair concepts: marginal cost and externalities.

Pure public goods have the quality of being non-rival; that is, they have a marginal cost equal to zero. In order for the private sector to maximize its benefit, the price of the good or service it sells must be equal to the marginal cost of providing it. Considering that the marginal cost of a pure public good is zero, private agents will not have incentives to produce it; in other words, the state will have the responsibility of proving this good or service and managing their externalities. General equilibrium models do not provide an effective tool to deal with related problems (free riders) of public goods and services, typical of a modern democracy.

The second difficulty mentioned by Ostrom is the management of common resources, this situation cannot be modeled in a competitive general equilibrium model. Common resources are rival goods, but they are non-excludable; that is, a community has free access to them. The complexity with shared resources is commonly as follows: “each user benefits directly from its use but shares the costs of its abuse with everyone else” (Meadows, 2009, p. 191). The tragedy of the commons happens when the excessive use of the resource causes it to end. The formation of a price vector for common resources cannot be done because property rights are not well defined, this impossibility exceeds the limits of DSGE or CGE models. Then, economists must look to the evolution of the institutions for collective action, in other words the advantages that it brings auto-governance.

Most economic policy models (DSEG or CGE) inspired by competitive general equilibrium models use the representative agent (RA) approach in which individuals are taken as units that think identically, make decisions with the same method, have similar initial endowments, and are totally rational and selfish; in this way, it will be enough to analyze the behavior of a person, the representative agent, to analyze them all together. Thus, the representative consumer has preferences equal to all other consumers in the economy and the representative firm optimizes a common production function for the whole economy. The financial system has the quality that the information is distributed asymmetrically, and the agents have heterogenous endowments. The RA approach has series consequences in the regulatory framework of a financial system. (Stiglitz & Gallegati, 2011) show that “economic theory based on the RA model has nothing to say about financial crises, bankruptcies, domino effects, systemic risk and any pathology in general” (p. 6). Considering the above, the agents take different decisions and try to take advantage of others. A model that thinks that everyone is equal and has such underlying extreme assumptions, cannot be used to make economic policy in an environment characterized by moving around its financial market.

One of the most widespread opinions on modern macroeconomics is that it has microfoundations in its construction; and due to this, macroeconomics is considered a scientific and robust theory. However, this premise is a mistake. Lorente (2018) argues that "the search for microfoundations in a model with representative agents constitutes a fallacy of composition; because it attributes to the aggregate what is only valid for one of its parts" (p. 10). In addition, this search excludes all possibilities of feedback processes, imitation, emulation or mutual compensation of decisions. General equilibrium models fail to understand that in the macro-economic aggregates, there are emergent properties and behaviors that are exclusively macroeconomic without a microeconomic representation. The problem of economics is embodied in treating individuals as acting independently of each other (Kirman, 1989).

Moreover, the greatest justification to use the hyper-rational, self-interested agent in most macroeconomic models was that it satisfied a set of strict microfoundations (Colander, Howitt, Kirman, Leijonhufvud, & Mehrling, 2008); but the Sonnenschein-Mantel-Debreu (SMD) theorem weakens this premise. The models that use the agent representative approach, face have another serious inconvenience when making macroeconomic analysis. The SMD theorem showed that hypotheses that guarantee a good behavior at the microeconomic level do not transfer a good behavior at the macroeconomic level (Monsalve, 2017). It cannot be said that the SMD theorem invalidates by itself the entire neoclassical theory of the competitive general equilibrium model that uses methodological individualism as a technique; but it limits its power of analysis at the macro level. New models that integrate more realistic dynamics to their conceptual framework will be better tools in the process of macroeconomic policy. Because of this, the profession of economist must move to a multidisciplinary plane to design better tools that incorporate models with heterogeneous agents, agent-based modelling, statistical dynamics, multiple equilibria (or no equilibria), endogenous learning, sociological and institutional theories.

Complexity economics: a system dynamics approach

"Scientific progress is difficult when the phenomena of interest are perceived as incomprehensible" (Ostrom, 2000, p. 34). That is why analyzing something as complex and incomprehensible as society, economists must move to methodologies that allow them to see the bigger picture. In that sense, systems dynamics would be an accurate option due to the fact that it allows the analysis of complex social systems, and complex systems in general. This approach shows that something as complex as the aggregate economy must not be analyzed by its structural simplicity but by the study of dynamics and iterative processes (Colander, 2000; Haldane &

Turrell, 2017). The quantity of agents and active elements within the economic system create patterns of complex interactions; data mining becomes elemental to discover relationships between agents and variables. Sterman (2002) describes systems dynamics as "grounded in control theory and the modern theory of nonlinear dynamics (p. 503). To understand what this approach does, this section will be divided in two: first, the fundamentals of systems thinking are explained, and second, learning in complex systems is introduced as a determining characteristic for complexity economics.

The fundamentals of Systems Thinking

Science requires its practitioners to develop and understand which concepts lie beneath the surface of the methodology that is being used to solve a research question, for this reason, if twenty-first century economists want to move from the neoclassical approach of economics to the systems thinking approach, that allows "the ability to see the world as a complex system" (Sterman, 2001, p. 9), they must start by understanding its key concepts: stocks and flows, feedback loops, and delay are the core concepts of systems thinking (Raworth, 2017).

Both flow and stocks are the basic building units in any system. A stock is the tendency that a system has to accumulate material or information over time. This accumulation assimilates the way society has "memory". Meanwhile, a flow is "the material or information that enters or leaves a stock over a period of time" (Meadows, 2009, p. 187). For example, in the financial system of an emerging economy the flows will be capital inflows and capital outflows, while the stock will be the trend in its behavior. Reinhart & Rogoff (2009) argue that "capital flows in emerging markets are pro-cyclical and have the ability to refocus the trend towards pro-cyclical policies in these countries" (p. 31). Then, any financial regulator should keep in mind that the system has a tendency or memory at the time of an intervention.

In policymaking and managerial context, no one knows the current rate of production, the exact output gap, or the price elasticity of demand of certain good, there are only estimates of these data. These estimates introduce delays, distortions and errors that can be identifiable or not; a system selects only a fraction of the real world (Sterman, 1994). From the systems dynamic point of view, the main issue in measurement are delays, these are "the lengths of time relative to the rates of system changes" (Meadows, 2009, p. 194). A typical example of this is measurement of output gap, the potential output and the output gap are not directly observable, they are only approximations, with a tendency trend and a cyclical one. No matter which method of measurement is used, there is always a non-negligible degree of uncertainty in the process, the data will always contain substantial variation, regardless of the theory chosen to perform economic analysis (Sims, 1996). The errors of measurement and delays must be considered when making economic policy and to understand how a complex system works.

Moving on to feedback loops process, (Meadows, 2009) defines a them as “a closed chain of causal connections from a stock, through a set of decisions or rules or physical laws or actions that are dependent on the level of the stock, and back again through a flow to change the stock.” (p. 189). This concept looks deceptively simple but is not; feedback means a change in the environment and the conditions of choice caused by the decisions of the agents in the past (Sterman, 1989). These changes in the environment and conditions of choice suppose a step forward in the generation of macro behavior from micro behavior, the introduction of limitations of human rationality, nonlinearities, and the determination of the effects of exogenous systematic and stochastic forces.

Positive and negative feedbacks are iterative processes present in the financial market. Bankruptcy cascades are a typical example; “an avalanche of bankruptcies is because of the positive feedback of the bankruptcy of a single agent on the net worth of “neighbors” linked to the bankrupt agent by credit links of one sort or another” (Stiglitz & Gallegati, 2011, p. 9). So, the structure of the financial system gives rise to the behavior and relationships of its agents; complexity economics takes this structure into account when making policy advice, unlike the general competitive equilibrium approach. An avalanche of bankruptcies shows that an agent´s decision or behavior may influence directly other set of agents whom the original does not know (Ormerod, 2010).

Economists understand that the real-world economy does not have mechanisms entirely transparent. There are markets for goods or for services, competitive or monopolized, symmetrically or asymmetrically informed agents, and so on (Solow, 2004). So, it is their task to develop models that resemble reality; instead of creating a “parable” of reality. It is too pretentious to say that a model will show society exactly as it is, since model’s representations of reality are just tools to deal with real problems (Colander, 2003a). Thus, how do stock, flows and feedbacks fit in a model that tries to assimilate the world? Colander et al (2008) argue that “any meaningful model of the macro economy must analyze not only the characteristics of the individuals but also the structure of their interactions (p. 237). It is in this realm that stock, flows, feedbacks and delays take importance because they offer a way to characterize the structure of the interactions among different individuals. Therefore, economists must learn how to better analyze complex systems to govern them within some ecological and technical boundaries (Ostrom, 1999).

The fact that economics in not an experimental science shows up that economists face a great amount of problems with data inference. These issues take the form of opposite theories been validated from the same data set by skilled econometricians. This results in the practice of blending objective data with certain assumptions or opinions to reach a wanted conclusion (Sims, 2010); and, in one theory to serve both normative and descriptive purposes (Thaler, 2000). It seems that the test of any econometrician model is very weak, it only asks if simulations with some disturbances can reproduce certain characteristics of an observed time series such as ratios of variances (Solow, 2008). So, a 21st century econometrician should be able to characterize patterns in the data and allow richer interpretations that can characterize the structure of interactions between agents; but she or he must not fall into the error of confusing correlation (a symmetric relation) with causality (an asymmetric relation).

Learning in Complex Environments

The introduction of learning in most economic models is ignored because agents are assumed to solve the relevant problem correctly on their first attempt (Thaler, 2000). This conception of learning and decision making has tried to resemble the vision of the study of the laws of magnetism, however the study of human choice is much more complex; and it requires a broader point of view. The procedure of endogenous learning in general equilibrium models is determinant to achieve the construction of macro behavior based on micro behavior. But, because complexity economics does not seek to find theorems of broad generality but has a holistic view of society, one must first have a holistic view of the learning process.

According to Sterman (1994), learning and decision making follows a negative feedback process:

> The loop is a classical negative feedback whereby decision makers compare quantitative and qualitative information about the state of the real world to various goals, perceive discrepancies between desired and actual states, and take actions that (they believe will) cause the real world to move toward the desired state (p. 293).

Clearly, the learning process is not perfect and is full of difficulties (Sterman, 1989; Meadows, 2009); however, it captures the importance of environmental and cognitive factors in decision making (Ormerod, 2010). With an informational and material flow, the mental model is responsible for organizing how we believe that the system operates, that is, it says which the implicit causal maps are within a system and its time horizon. Because mental models are created to understand how a system operates, they can be "contaminated" by our beliefs, opinions, environments and self-evident truths. The overwhelming complexity of any economic system forces policymakers to categorize and limit mental maps, this has as its refusal to learn new perspectives and knowledge. After all the information has passed through the mental model, it must be decided what it will be done with it, decision rules or heuristics play a decisive role in this decision

A heuristic is a simple and efficient rule to guide decision making. But the heuristics commonly used to judge causal relationships ignore feedbacks, nonlinearities, time delays, and other elements of dynamic complexity (Sterman, 2001). In addition to the mentioned limitations, delays do not become endogenous with the use of heuristics since the structure of the heuristic thinks that causal relationships have no temporal or spatial distance. The limitations not only of the heuristics but of the strategies and rules that economists and any administrator follow are the result of the limited mental model built by any subject. The addiction to look for solutions too simple for complex problems must be overcome (Ostrom, 2002; Ahn, Ostrom, & Walker, 2003). If 21st century economists want to improve the quality of their mental models and decision rules, training under simulations and in controlled environments will be fundamental. The current computational capacity allows the construction of economies in any computer; and if it is applied in the complexity approach to the economy, these virtual environments could provide the most valuable tools to future policymakers. Students would not find themselves more drawing demand and supply curves and learning to set marginal rates but experimenting with a virtual society built on the foundations complexity economics.

From DSGE policymaking to complex policymaking

The degrees of freedom within the economic policy are determined when deciding which objective will be met and with which instruments. Certainly, policymakers cannot have it all, they have to prioritize the objectives to ensure the effectiveness of the instruments used. In this process, the objective that has less relevance to the theoretical framework used will remain as a residual in economic policy (Hernández, 2005). The theoretical and methodological framework of complexity economics will give any policy modeler much more freedom to work. But this greater freedom cannot be converted into a new way of validating any theory with any data set, the theory must be guided by the data and not the other way around; as a result, the theory based on data is scientific despite the feeling of some economists to believe the opposite (Thaler, 2000). Because complexity economics does not seek the derivation of theorems or laws for society, macro policy must rely more than ever on econometrics. It must be accepted that economists can and should look for relationships between macroeconomic variables without worrying about the behavioral foundations of these relationships (Janssen & Ostrom, 2006; Colander et al., 2008; Haldane & Turrell, 2017; Lorente, 2018). If these key relationships are identified, only a small number of people should be pressured to obtain a much larger result.

The policymakers that use DSEG or CGE models as a tool for formulating economic policies, think that only the government or benevolent social planner have the capacity to avoid undesirable situations; usually it is never considered what people could do by themselves (Ostrom, 2010). Theoretically, this benevolent social planner has an objective function that wishes to maximize or minimize as the case may be. It is assumed that the benevolent planner can do and know everything, however reality is far from this. This actor is part of the representative agent approach, which gives policy makers an answer to a specific problem in the form of do A to get to B; though, doing A may lead to C, an unexpected event. In complexity economics, this situation is called Policy Resistance. It happens very often, the objectives of the policy designer may not be aligned with the objectives of the agents of the system, then there will be a constant struggle between both sides to see who the imposed is. Systems dynamics give a simple but effective solution. Policymakers and Society must define bigger, more important and common objectives among them to work together (Meadows, 2009). This way of carrying out projects is a step forward in the autonomy of the communities, where each social group has the right to order its priorities and govern itself.

In the first section of this essay, it was mentioned that DSEG or CGE models cannot understand the difficulties that the management of common-pool resources brings. The solution in the context of the formulation of complex policies is based on the learning of the system agents involved. Policymakers should educate and encourage users to understand consequences of abusing the resource (Meadows, 2009). If this strategy does not work, the use of the resource should be regulated. With this regulation, users will learn that they must change their behavior; the entire process will take the form of a negative feedback process, that is, the same way as learning.

Conclusion

This paper presented a discussion of the limits that DSEG or CGE models have in the design of economic policies; it also showed the advantages that the theoretical and methodological framework of the complexity economics could bring to macroeconomic analysis. Complexity economics is an expansive field of study that needs at least a book to be explained fully, and many more books to explain the whole complexity approach to sciences in general. Besides, complexity does not reject all the existing economic theories, it has the capacity to adapt them under a more real and scientific methodological framework. It is in the study of the structure of social relationships between individuals and not in the individual study that the economy advances. This process requires the realization that economics is a multidisciplinary science. This process requires economists to accept that economics is a multidisciplinary science. In this way we can go from models in equilibrium to models in constant disequilibrium, from theories of individual psychology to group sociological theories, from the isolation of agents to permanent interaction, from optimization to constant learning; and from parables to reality.

Economics would be much better if economists spent more time in reading each other's' work and less in thinking up grand excuses for ignoring it (Sims, 1996). This thought and the epigraph at the beginning of the text describe the intention we had at the time of writing, economists should not become dogmatic and closed to new ideas or approaches, it is in the variety of thoughts and positions that any branch of science advances.

And it must be remembered that society expects economics to solve important questions such as how to achieve sustainable development? Can a more equitable society be made? o Can the world economy supply everybody? The fundamentals to answer these questions are made in investigations focused to understand and solve a situation at a time, researchers focus on gaps and asymmetries of information, long-term contracts, imperfect competition, and so on. The critical energy of the scientific community is the ultimate guarantor of objectivity in any field of study (Solow, 2004). It is this energy that will finally make economists overcome self-evident truths and understand economic system as a whole.

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