DISCUSSION PAPER

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EXECUTIVE SUMMARY

A COMPLEXITY APPROACH FOR PUBLIC POLICIES[1]

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Complex systems can be defined in a broad manner and embrace concepts from different fields of science, from physics to biology, to computer and social sciences. Complex systems' methodologies emphasize interactions, diversity and dynamics within a system. By considering that public policies are employed in a number of sectorial issues which are intertwined, asynchronous, and spatially superposed, it can be argued that most objects of public policies – be them of economic or urban nature, be them of environmental or political consequences – can be viewed as complex systems. In this sense, complex systems' perspective enables public policies to be considered comprehensively and simulated in all their multiplicity of sectors and scales, of cause and effect.

Complex systems' methodologies have been applied to different aspects of science, but less frequently to public policies analysis. Therefore, it is of great interest to bring about the complex systems' perspective into the public policy arena; to present how and why public policies can be viewed as complex objects; and to discuss the possible benefits of this approach to the policy-making process.

Complex systems definition is usually attached to a specific context; however, some parts of the definition seem consensual: *i*) the idea that interaction among parts from and across scales, space and time is relevant; *ii*) that interaction among parts can lead to self-organization of the system without the need of central control, implying that local interactions can generate bottom-up emergent behavior; and *iii*) that complex systems can experiment feedback. These characteristics of complex systems seem to be useful to the study of public policies.

The relevance of viewing objects of public policies as complex systems is that the associated methods and methodologies available for the study of such systems could be applied to public policies, helping improve their analysis. Such methodologies include network analysis, agent-based modeling, numerical simulation, game theory, pattern formation and many others within the realm of complex systems. Besides, there have been advances coming from computer science, along with the availability of detailed, micro, spatially-precise data. This abundance of data is fertile land for the use of methodologies such as data mining, machine learning and artificial intelligence, which are collections of techniques that can be put together to help simulate complex systems and which are likely to improve insightfulness.

The paper describes the complex nature of objects of public policies, such as social, economic, urban and environmental systems. Cities, for example, are said to have five typical properties: *i*) heterogeneity (of people, places, institutions, and offer of services); *ii*) interconnectivity; *iii*) scale; *iv*) circular causality, feedback; and *v*) they evolve. Considering these properties, attempts to change the city – and occasionally even inaction and omission on policies on the city – have to be made with clear view of its consequences across all aspects and layers of the city. City planning calls for integrated, connected, nonlinear, dynamic approaches. As those attributes are typical of complex systems, it may be of interest to apply them to the study and policy applications of cities. The paper also highlights some applications on transport planning, on the study of the legislative process and on education, and provides a brief panorama of some of the existing applications in Brazil.

1. This paper summarizes the contents of the book of the project "Modeling complex systems for public policies".

The main contribution of the paper is to bring the theoretical and methodological advances used within complex systems research into the public policy perspective. Complexity concepts can prevent an oversimplified view of the objects of public policy. When thinking of public policy, one has to consider that agents are heterogeneous, that everything is interconnected, and that policies do not work with clear, linear or immediate cause and effect. In this sense, complexity methods and methodologies can help take into account the complex features of the system under analysis.

A main tool used to specify systems is computational modeling. Modeling, not only enables a better understanding of how a system works, but it also permits the simulation of scenarios, presenting itself as a decision-support tool to inform policy-making. Modeling therefore stimulates a forward-looking, prospective view of policy, by allowing scenario building and testing. A further insight is that, complexity methods allows for the use of data to its best extent.

In sum, the paper suggests that public policies may benefit methodologically if studied within the complex systems' approach. Modeling and simulation can be used to investigate public policies, which is especially relevant in areas of public policies where experiments are usually not simple, cheap or even viable. Complex systems methods have the potential to inform public policies effects, effectiveness, direct and indirect costs. The formal modeling framework, the adequacy of its data treatment and the communication facilitated by modeling together may help the emergence of more sensible, insightful, and full-scope policy-making.

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