Compatibility or Incommensurability: IR Theory and Complex Systems Analysis

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ROBERT W. GLOVER, JUL 21 2012

A recent New York Times op-ed, written by a professor of political science no less, lambasted the discipline for consistently failing to predict both international and domestic political outcomes. It boldly proclaimed "…[c]himps throwing darts at possible outcomes would have done almost as well as the experts."[1] To add insult to injury, the article featured a picture of a primate armed with darts taking aim at circular boards marked with regions of the world, possible outcomes, and likelihoods. The upshot of the article was that political science simply shouldn't be in the business of prediction. Stevens quotes Karl Popper, stating "[l]ong term prophecies can be derived from scientific conditional predictions only if they apply to *systems which can be described as well-isolated, stationary, and recurrent.* These systems are very rare in nature; and modern society is not one of them."[2]

Though such indictments of our intellectual enterprise may be painful to hear, they are also correct in many senses. Political science, and by extension international relations (IR), has had difficulties in predicting future events with any accuracy or specificity. The guiding principles of "traditional" or "mainstream" approaches to IR have generally held that there is observable order in world affairs, from which we can offer explanations and make predictions. It is the great hope of our discipline that "there is an external world of which we can have knowledge…" and the notion that IR is "grounded in lawlike regularities that allow the possibility of making claims about how the 'international' operates."[3] Yet if this were the case, surely we'd be doing a better job at forecasting international outcomes.

The invocation of Popper reminds us why our best laid plans have gone awry. Social systems, from the most basic to the most intricate, almost invariably involve the complex interface of many variables, opaque interaction effects, and elements of chance and human variability. As Jervis states, "…[t]he result is that systems often display non-linear relationships, outcomes cannot be understood by the adding together of units or their relations and many of the results of actions are unintended. Complexities can appear in even what would seem to be simple and deterministic situations."[4]

Beyond prediction, even our attempts at post-hoc explanation tend to rely upon reductionism. That is to say we reduce the irreducibly complex to pithy "cause and effect" relationships. The 2008 war between Russia and Georgia was caused by a dispute over South Ossetia. The 1997 economic crisis was triggered by currency instability in Southeast Asia. The recent political upheaval in Egypt stemmed from technologically savvy young people angered with the corruption of Mubarak's regime and a stagnant economy. These are the types of concise explanations we offer for events of enormous, *systemic*, complexity.

However, IR theory has been grappling with a new set of tools which originate in the study of the natural world, specifically physics and biology. We call these tools "complex systems analysis" or in its more conceptual variant, "complexity theory."[5] Complexity is not a unified theory as such, but rather an "emerging approach or framework" drawn from a variety of sources.[6] Proponents argue that IR can achieve better understanding of the world utilizing conceptual lenses attuned to the interaction of large numbers of variables and actors, interacting in a non-linear (and hence, less predictable) fashion. The remainder of this article will examine the rudiments of complexity theory, as well as its promise as a conceptual tool in understanding international relations. In particular, I will focus upon whether complexity theory constitutes a framework compatible with existing IR theories, or a fundamental and

incommensurable challenge to the present theoretical landscape of IR.

The Basics of Complexity

By now, we have some sense of what complexity means in relation to social and political phenomena. However, we need to lay it out a bit more precisely. As a preliminary, complexity theory holds that phenomena such as international politics or evolutionary biology exist as part of a "complex system." The system encapsulates and is constituted by the various sub-systems which exist within it. For example, the global economy constitutes a kind of "meta-system" yet we could imagine various constituent parts which would constitute a system as well: the IMF, the European Central Bank, consumers in China, agricultural lobbies in the United States. Kavalski notes that "…complex systems are identified by the multitude of their components, and the numerous interconnections among the subsystems of a complex system."[7]

However, to understand a complex system we cannot simply turn our attention to the parts that we deem to be the most important or relevant. We call this analytical move reductionism. For simple systems, with few variables and limited interaction, such an approach may well be sufficient. For complex systems, the characteristics of the constituent parts may not lead us to any determinative conclusions about the system as a whole. As Jervis writes, "…the whole may be symmetric, peaceful or stable only if the parts are not; and a reliable system can be formed from unreliable components."[8] Rather, our "unit of analysis" becomes interactions, relationships between the subsystems.[9]

Cudworth and Hobden identify four defining features of complexity theory: *self-organization*, *non-linearity*, *openness,* and *co-evolution*.[10] Let us examine each. In complexity theory *self-organization* refers to the features of a system which become apparent at a certain level of complexity—modes of organization and operation which produce and re-produce themselves as "emergent properties" of the system itself. That is, patterns emerge out the relatively mundane interactions of parts of the system and these parts. Think of the global market economy. Prices for certain commodities rise or decline, but only through an inconceivably large system of feedback loops, individual and actions, perpetrated by actors often scarcely aware of the effect that they are having on others within the system.

An equally essential part of complexity theory is *non-linearity.* Complexity theory argues that systems invariably oscillate between patterns of linearity and non-linearity. In a "linear" world, we ought to expect a "proportionate and non-varying relationship between cause and effect."[11] Thus, if a certain amount of foreign aid resulted in the growth of a developing economy, we ought to expect that doubling that amount of foreign aid would produce further economic gains. However, as we've often seen this is not always the case. Relationships between causes and effects vary widely. The output produced by our actions often does not adhere to proportionality, due to the vast numbers of actors and interactions which shape and constrain our interventions. Edward Lorenz depicted this disproportionally eloquently with what he deemed "the butterfly effect," the notion that a butterfly flapping its wings in Brazil could produce a tornado in Texas.[12] Or, to use a more IR-centric example, the self-immolation of a humiliated fruit seller in Tunisia can set in motion a wave of protest and revolution, unseating brutal tyrants who have clung to power for decades. If such seemingly insignificant events really can produce such volatile, system-wide reverberations, we need to rethink our ability to predict anything.

Contemporary mainstream IR often revolves around the idea of order; there are regularities to detect, states of equilibrium and maximum utility to be achieved. Complexity theory knows no such state. *Openness* refers to the fact that a complex system and its various sub-systems maintain a constant state of dynamic flux between order and chaos, and must necessarily do so in order to adapt to challenges that threaten the system. As Geyer and Pickering write, "…from a complexity perspective, humans must constantly seek the appropriate *balance* between order and disorder in their symbiotically evolving environment."[13]

Lastly, it is this openness that enables the system to adapt to changes in its environment, i.e. with other systems. This is the principle of *co-evolution*. The various parts of the system (the state, international organizations, individuals, leaders, etc.) do not follow regimented patterns but are in a continuous state of adaptation and change. The "environment or landscape that each system faces is altered as a result of all the changes in the various other

systems that collectively constitute the landscape."[14]

What Does Complexity Theory Mean for IR?

It is customary to see one's own historical epoch as characterized by extraordinary sophistication and advancement. However, one would not be taking a great intellectual risk to suggest that the complexity of our world is unprecedented: the proliferation of international organizations and law to regulate global affairs, instantaneous internet and satellite-based communications, the ability to transfer billions of dollars halfway across the globe with the click of a mouse, global supply chains which result in manufactured goods assembled across a host of countries, unprecedented human mobility. If ever there were a time where international affairs could be understood as a complex system it is now. However, if complexity theory arguably offers a more apt orientation for thinking about our world, what challenges might we encounter as we attempt to think about international relations as a complex system? At least five such challenges merit mention.

1) Understanding international relations as a complex system is hard work.

If we accept the notion that our world is a complex system, characterized by the attributes above, much of the conceptual vernacular in existing IR theory must be rethought. The world which complexity theory presents to us is one of "…fluid and open assemblages…systems without any necessary propensity to equilibrium or stasis…open to transformative change and metamorphosis."[15] Modelling such a world will be complex, to say the least. Gone will be the law-like regularities posited by realists, who assert that states constitute conflict-prone unitary actors, or liberals who see institutionalized cooperation as being in the rational self-interest of states. Integrating complexity theory into IR means, as a starting point, we must accept that there are no overarching laws to the international system.

2) We cannot expect linear relationships in complex systems.

International relations theory is often framed as a series of "great debates:" idealism v. realism, behavioralism v. traditionalism, positivism v. post-positivism, etc. According to Emilian Kavlaski the contemporary debate in IR theory is that of "linearity v. nonlinearity."[16] Thus, rather than thinking of linear relationships where independent variable (cause) A produces dependent variable (effect) B, we need to figure out ways to formalize a myriad of possible influences in non-linear webs of interaction. Incidentally, Freidrich Hayek, writing about complex systems in the 1950s, thought that such an endeavor was very nearly beyond the reach of the human mind. At best, he said such an orientation would produce "pattern predictions" rather than deterministic cause and effect relationships.[17]

3) We need to abandon reductionism.

If we accept the perspective of complexity theory, we also must accept that the "whole" is quite different than the sum of its parts, at least in international relations.[18] As stated above, our attempts to interact with the system unleash a tidal wave of systemic interactions, interaction effects, and feedback loops. This has always been the case. For instance, the availability of a new vaccine may result in a healthier population with a longer life expectancy. However, such a declining death rate may also increase competition for scarce resources, provoke civil unrest on the basis of ethnicity, set in motion a flood of refugees into neighboring countries, and imperil regional stability. As Jervis says, "…we can never do merely one thing."[19] A reductionist approach to understanding international relations, which aims to understand the constitutive units and their relationships with one another, often fails to grasp the unintended systemic consequences of any action. Thus far, work which explicitly introduces the non-reductionist approach of complexity theory has been patchy.[20] Our ability to computationally model such interactions is improving via a tool known as "agent-based modeling" and similar innovations, however the prevailing perspective in IR research is a reductionist one.[21]

4) We need to re-think our unit of analysis.

In international relations theory we tend to think in terms of autonomous agents—individual or collective actors who

intervene in the world and shape its outcomes. Theorizing and analyzing the world must start at the level of *networks* rather than *actors* (and eventually proceed up the chain of complexity to interactions between networks, and the ways in which constellations of networks interact with the system).[22] Conceptual hierarchies based on the preeminence of the state, the path-defining effect of specific influential world leaders, the tendencies of "great powers," or the behavioral impacts of international institutions must fade. We must develop language to capture the fluidity and dynamism of contemporary global affairs. IR theory rooted in complexity will mean analyses of world affairs that focus on the patterns of interactions occurring within and between networks, rather than specific "agents" of world politics.

5) Long term prediction is nearly impossible but subtle regularities and trends can be uncovered.

This is shift that will no doubt face resistance as those who study IR face increasing pressure to make their studies "policy-relevant."[23] However, the take-away insight from propositions such as the "butterfly effect" should not be understood as enhanced prediction. Paying better attention to seemingly insignificant causes of international change will *not* be a means to better predict the future. Rather, the intricate feedback loops and sub-systemic interactions which characterize a complex system are so multifarious, we'd be foolish to attempt long-term prediction at all.

Here, the model of weather forecasting is appropriate. Based on recurrent patterns and a huge number of data-points, meteorologists can make reasonably accurate predictions within a compressed time horizon (usually 2-5 days). However, through the lens of complexity theory, the grandiose designs of IR theory which aim to predict international outcomes years in advance seem about as absurd as your local weatherman trying to tell you if it will rain ten years from today. There is simply too much complexity within the system to make such forecasts with any accuracy. This is not to say that we limit our attempts to understand IR to only what occurs in the next few days, only that our emphasis should be on detecting patterns and their probability of recurrence within a near time-horizon.

Concluding Thoughts: Compatibility or Incommensurability?

As the cautionary points above suggest, taking the insights of complexity theory and complex systems analysis seriously in IR will require a substantial "re-boot" of much of the discipline's theoretical apparatus. This type of epistemological re-orientation is precisely why Kavlaski identifies complexity theory as the source of the next "great debate" in IR theory. Thus far, attempts to systematically develop complexity theory into a research paradigm akin to liberalism or constructivism have occurred only on the margins of IR scholarship. Furthermore, as some scholars have attempted to shift upward to consider international political phenomena at the level of the system, a vacuum has developed whereby "power, authority, and hierarchy" have remained under-theorized.[24]

As noted earlier, complexity theory is less of a coherent theoretical paradigm and more a collection of tools and perspectives. Complexity theory can supplement existing approaches to understanding international relations. However, it can't replace them. Obviously, theoretical perspectives in IR that aim for the law-like certainty of the "hard sciences," or the agent-based parsimony of macroeconomic theory will have a hard time integrating such tools into their analysis. Theoretical orientations such as structural realism or neoliberal institutionalism might find little common ground with a complex systems perspective. However, more flexible models such as constructivism or critical theory might be well poised to integrate complexity theory's holistic, non-linear approach. International relations theory has undergone fruitful regeneration by adopting ideas from other disciplines in the past. Perhaps the next major interdisciplinary point of cross-fertilization will be the tools used to explain complex systems in the biological and physical sciences.

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[1] Jacqueline Stevens. Political Scientists are Lousy Forecasters. *New York Times.* June 23, 2012. Available from: http://www.nytimes.com/2012/06/24/opinion/sunday/political–scientists–are–lousy–forecasters.html?_r=1.

[2] *Ibid.* Emphasis added.

[3] Erika Cudworth and Stephen Hobden. The Foundations of Complexity, the Complexity of Foundations.*Philosophy of the Social Sciences.* 42(2012): 164.

[4] Robert Jervis. Complex Systems: The Role of Interactions. in *Coping with the Bounds: Speculations on Nonlinearity in Military Affairs.* Ed. D.S. Alberts and T. Czerwinski (Washington D.C.: Department of Defense Command and Control Research Publication, 1998), 235-236.

[5] For a general discussion of how complexity theory/analysis have been employed in the social sciences, see Erica Cudworth and Stephen Hobden. More than a Metaphor? Complexity in the Social Sciences.*International Journal of Interdisciplinary Social Sciences.* 4(2004): 59-70.

[6] Sylvia Walby. Complexity Theory, Systems Theory, and Multiple Intersecting Social Inequalities.*Philosophy of the Social Sciences.* 37(2007): 456.

[7] Emilian Kavalski. The Fifth Debate and the Emergence of Complex International Relations Theory: Notes on the Application of Complexity Theory to the Study of International Life. *Cambridge Review of International Affairs.* 20(2007): 438.

[8] Robert Jervis. "Complexity and the Analysis of Political and Social Life." *Political Science Quarterly.* 112(1997-1998): 570.

[9] For an early formulation of this idea, see Ernst Haas. Is there a Hole in the Whole? Knowledge, Technology, Interdependency and the Construction of International Regimes. *International Organization.* 29(1975): 827-76.

[10] Erika Cudworth and Stephen Hobden. Anarchy and Anarchism: Towards a Theory of Complex International Systems. *Millennium: Journal of International Studies.* 39(2010): 399-416.

[11] *ibid.* 404.

[12] James Gleick. *Chaos: Making of a New Science.* (New York: Penguin, 1987).

[13] Robert Geyer and Steve Pickering. Applying the Tools of Complexity to the International Realm: From Fitness Landscapes to Complexity Cascades. *Cambridge Review of International Affairs.* 24(2011): 13.

[14] Cudworth and Hobden 2010, 404.

[15] Antoine Bousquet and Simon Curtis. Beyond Models and Metaphors: Complexity Theory, Systems Thinking and International Relations. *Cambridge Review of International Affairs.* 24(2011): 58.

[16] Kavlaski 2007, 445.

[17] Friedrich Hayek. The Theory of Complex Phenomena. in *Studies in Philosophy, Politics and Economics*. F. Hayek, ed. (Chicago, IL: University of Chicago Press, 1967).

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[18] For critical perspectives that argue even complexity theory cannot escape reductionism, see Murray Bookchin. *The Philosophy of Social Ecology: Essays on Dialectical Naturalism.* (Montreal: Black Rose Books, 1995); Takis Fotopoulos. Systems Theory and Complexity: A Potential Tool for Radical Analysis or the Emerging Social Paradigm for the Internationalizes Market Economy? *Democracy & Nature.* 6 (2000): 421-446.

[19] Jervis 1997-98, 570.

[20] Lars-Erik Cederman. *Emergent Actors in World Politics: How States and Nations Develop and Dissolve.* (Princeton, NJ: Princeton University Press, 1997); James N. Rosenau. *Turbulence in World Politics: A Theory of Change and Continuity.* (Princeton, NJ: Princeton University Press, 2003).

[21] Robert Axelrod. A Model of the Emergence of New Political Actors. in N. Gilbert and R. Conte, eds *Artificial Societies: The Computer Simulation of Social Life.* (London: Routledge, 1995), 19-39; Lars-Erik Cederman. Computational Models of Social Forms: Advancing Generative Process Theory. *American Journal of Sociology.* 110 (2005): 864-93; Nigel Gilbert. *Agents-Based Modeling.* (Los Angeles: Sage, 2008).

[22] See for instance, Manuel Castells. *The Rise of the Network Society.* (Cambridge, MA: Blackwell, 1996); Margaret Keck and Kathryn Sikkink. 1998. *Activists Beyond Borders.* (Ithaca, NY: Cornell University Press); Daniel Nexon *The Struggle for Power in Early Modern Europe: Religious Conflict, Dynastic Empires, and International Change.* (Princeton, NJ: Princeton University Press, 2009).

[23] Joseph Nye. Scholars on the Sidelines. *The Washington Post.* April 13, 2009.

[24] Cudworth and Hobden 2010, 406.