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Abstract. Over the past decade, historical institutionalism has emerged as one of the major research pillars of contemporary political science. However, most historical institutionalists seem to be unaware of the paradigmatic implications of this approach for political studies. The theoretical underpinnings of historical institutionalism, namely, the ideas of path dependence and the economics of increasing returns, are based on a new science called complexity science. The worldview of complexity science is largely inconsistent with the scientific foundation of current mainstream political science, namely, Newtonianism. The emergence of historical institutionalist analyses in political studies thus means serious paradigmatic challenges for the discipline.

Keywords: • Complexity science • Historical institutionalism • Increasing returns • Paradigm • Path dependence

Over the past decade, historical institutionalism has emerged as one of the major research pillars of contemporary political science. However, most historical institutionalists seem to be unaware of the paradigmatic implications of this approach for political studies. The theoretical underpinnings of historical institutionalism, namely, the ideas of path dependence and the economics of increasing returns, are based on a new science called complexity science. The worldview of complexity science is largely inconsistent with the scientific foundation of current mainstream political science, namely, Newtonianism. The emergence of historical institutionalist analyses in political studies thus means serious paradigmatic challenges for the discipline.

By "paradigmatic challenges," we mean disagreements on very fundamental issues related to the scientific foundation of a body of knowledge. In a recent symposium, some scholars suggested "two paths to a science of politics." They represented the latest investigation into the scientific status of political studies.

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Dissatisfied with the "limited utility of formal theory and ahistorical behavioralism" in the study of political identity, Smith (2004: 305) argues that political scientists should pay more attention to historical context and meaning. At a more general methodological level, Granato and Scioli (2004: 314) propose to improve the existing formal models, case studies, and applied statistical approaches by "building formal models that are connected to an empirical test." The two articles, according to Brady (2004: 299), "have different emphases," but are "complementary" as they "Both endorse a scientific approach that requires theory-building and theory-testing."

This article will argue that the above scholars have neglected the increasingly influential school of historical institutionalism, which may have very serious paradigmatic implications for political science. While Smith, Granato, Scioli, and Brady are consciously seeking *scientific progress* under the same paradigm, historical institutionalists are working, perhaps unconsciously, toward a direction that may bring about a *scientific revolution* in Kuhn's sense.

Smith's article begins with the comment that we cannot rely solely on the behavioralist and rational choice methods. Instead, the role of "historical contexts" and "political institutions" should not be neglected (Smith, 2004: 301). This should lead Smith to the huge literature of historical institutionalism. But surprisingly this is completely absent. In fact, historical institutionalism, along with behavioralism and rational choice theory, have been identified as "the three major research pillars" (Pierson and Skocpol, 2002: 718–21) or "dominant paradigms" (Burnham et al., 2004: 15–22) of contemporary political science. To examine also the scientific foundation of historical institutionalism will not only give us a more comprehensive picture of the present state of political studies, it will also draw our attention to the important Kuhnian paradigmatic challenges that this school may bring about. This leads us to Kuhn's theory of scientific revolution.

Kuhn's Theory of Scientific Revolution

The central argument of Kuhn's seminal work *The Structure of Scientific Revolutions* (1962) is that, contrary to conventional wisdom, knowledge is not cumulative.[1] Linear scientific progress through continuous new discoveries and refinement of old knowledge is a myth. Rather, the history of science is characterized by discontinuous, cyclical replacements of old knowledge by completely new and incompatible knowledge. Specifically, according to Kuhn, the rise and fall of a science displays the following pattern: "pre-science → normal science → crisis → revolution → new normal science → new crisis" (Chalmers, 1999: 108).

At the *pre-science* stage, scrappy ideas prevail. Research activities are conducted in a disorganized, diverse, and fragmented manner. This is due to the absence of a paradigm. Kuhn defines paradigms as scientific achievements that share two characteristics. First, the achievements are "sufficiently unprecedented to attract an enduring group of adherents away from competing modes of scientific activity." Second, they are "sufficiently open-ended to leave all sorts of problems for the redefined group of practitioners to resolve" (Kuhn, 1962: 10). In short, a paradigm is "an accepted model or pattern" (Kuhn, 1962: 23) that defines the fundamental theoretical assumptions, laws, and methodologies for conducting scientific research.

The pre-science stage comes to an end when a paradigm emerges. As this paradigm gains increasing acceptance and becomes dominant, scientists sharing

this paradigm produce a *normal science* by recognizing only knowledge that is compatible with that paradigm. It is the task of these "normal" scientists to develop the science by expanding its scope of analysis and application, based on the single, dominant paradigm. The more comprehensive and integrated the paradigm is, and the more knowledge so produced, the more mature the normal science. Such increase in knowledge based on the same, existing paradigm is scientific progress in the conventional sense.

Normal scientific progress is achieved primarily through solving theoretical and experimental puzzles. Failure to solve a puzzle is attributed to the limit of the wisdom of the normal scientists, but not to the problem of the underlying paradigm. For confident and committed normal scientists, unsolved puzzles, or anomalies, would eventually be solved. However, when a large number of anomalies striking at the very fundamentals of a paradigm remain unsolved for a long period of time, and when a solution to these puzzles become socially imperative, the science is in *crisis*. Increasing challenges to the prevalent paradigm appear, and normal scientists have to resort more to philosophical and metaphysical rather than to scientific arguments to defend their position.

As the crisis deepens, rival paradigms emerge, and the original consensus over fundamental assumptions, laws, and methodologies breaks down. When a new paradigm becomes dominant over others, a scientific *revolution* takes place, giving rise to a *new normal science* that is incompatible with the old one. Paradigms are incomparable (incommensurable) in objective terms, as each paradigm has its own rationality. Thus, the shift from an old to a new paradigm is not the outcome of logical reasoning; rather, it is similar to a "gestalt switch" or a "religious conversion." Like its predecessor, however, the new normal science will have to face its own set of anomalies, which eventually will produce a *new crisis*. Such a cyclical process, according to Kuhn, is the basic pattern of the history of science.

In short, paradigmatic shift is the core feature of scientific revolution. It involves a fundamental break with old assumptions, laws, and methodologies. Existing knowledge is replaced by a completely new worldview. This differentiates paradigmatic shift from the emergence of new approaches, perspectives, analytical frameworks, or models, which do not lead to epistemological and ontological ruptures. Paradigmatic shift is scientific *revolution* in its real sense. The transformation it brings about is so fundamental that, as Kuhn notes, "though the world does not change with a change of paradigm, the scientist afterward works in a different world" (1962: 120).

Political Science as a Newtonian Science

How normal, then, is political science? To put it another way, what is the paradigmatic status of this discipline? According to Kuhn, what caused him to study the pattern of scientific revolutions was the observation that there are many more "disagreements between social scientists about the nature of legitimate scientific problems and methods" than between natural scientists (1962: x). That is to say, paradigms are less established in the social sciences than in the natural sciences. A major elaborator of Kuhn's ideas also noted that "Contemporary examples of fields with no universal consensus can be found in most of the social sciences" (Hoyningen-Huene, 1993: 133). In political studies, a scholar recently wrote that "What have been, and are, commonly called theories in political science (systems

analysis, rational choice, decision theory, institutionalism, realism, and the like) are not constructions of the kind Kuhn posited ... We can assume, however, that there are theories and paradigmatic concepts conforming to Kuhn's characterization which are implicitly embedded in the 'facts' that political scientists adduce and which form part of their 'tacit knowledge'" (Gunnell, 2004: 48). No substantiation, however, is given to such an assumption.

We will argue below that, in political science, a general consensus on fundamental assumptions, laws, and methodologies does not exist. Such lack of a dominant paradigm makes the discipline not a normal science in Kuhn's sense. However, we may observe in the history of political science that over the past decades there has been a clear trend of effort to move the discipline toward the realm of a specific kind of normal science, namely, Newtonian science.

Newtonian science is not just about natural science. It is a huge framework of ideas that shape our modern perception of the world, and its emergence is an important part of the Renaissance and the Enlightenment. Through synthesizing the ideas of Copernicus, Kepler, Bacon, Galileo, and Descartes, Newton replaced the medieval belief in a spiritual universe with a secular, mechanistic philosophy. At the risk of oversimplification, the following will highlight the major features of the Newtonian worldview that are most relevant to our discussion (Capra, 1982: 37–52; Cohen, 1980: 52–68; Cushing, 1998: 93–4; Gulbenkian Commission, 1996: 2; Harris, 1990: 211–12; Toffler, 1984: xiii; Wallerstein, 1998: 321):[2]

1. The material world God created is a huge mechanical system comprising of homogeneous atoms out of which matter is made. As such, matter could be different in weight, density, and size, but not substance.
2. God also devised the immutable laws of nature according to which matter in the world operates. These laws can be reduced to some simple laws of motion, as Newton presented in his *Philosophiae Naturalis Principia Mathematica*.
3. The function of scientific knowledge is to reduce the complex to the simple, thereby making the world comprehensible and manageable to human beings.
4. Mathematics is of primary importance, as it enables the expression of the laws of nature as a mathematical system that is the parallel or analogue of nature.
5. Through mastery of the mathematical simulation of nature, human beings could not only understand, but also predict the world with absolute certainty, so certain that chance plays no part.
6. Human beings are able to acquire knowledge through scientific inquiry that is based on retroductive reasoning.
7. Scientific truth so established exists in an eternal present. There is thus no need to distinguish between past and future.

The Newtonian worldview, as summarized above, formed the paradigm of physics in the 18th and 19th centuries (Chalmers, 1999: 108–12). It also produced a "culture of Newtonianism" that spread around different fields of knowledge (Dobbs and Jacob, 1995: 78–95). In the study of politics, mechanistic thinking had begun to influence political philosophy even before the birth of Newtonian physics. Hobbes's *Leviathan* (1651), which treated human action as matter in motion, was published about three decades earlier than Newton's *Principia* (1687). But it was after the establishment of the mechanistic worldview in

the 18th century that Newtonian-type scientific knowledge began to enjoy a privileged status. Different branches of academic endeavor, whether they were about the natural world or human society, began to search for their own Newtons (Capra, 1982: 55–6; Cohen, 1985: 174–5; 1994: 101).

Within such an intellectual environment, the 18th-century philosopher David Hume attempted to make Aristotle's politics into a kind of Newtonian science by applying the experimental method to moral subjects. However, by the 19th century it was economics that had emerged to become the first Newtonian social science, and Adam Smith was found to be the Isaac Newton of economics. Based on Smith's *Wealth of Nations*, classical economics sought scientific rather than political principles to explain atomistic individual choices, thereby divorcing the discipline from traditional political economy (Collini et al., 1983: 14–15, 309–37; Deane, 1989: 12–50, 119–41; Gulbenkian Commission, 1996: 17–20).

After its separation from economics, the study of politics in 19th-century England returned to the use of historical approaches to identify political patterns. From the 1860s onward, efforts were made to develop a comparative method as the major scientific ground of politics. During the 1920s, Merriam and his students at the University of Chicago attempted to transform political studies in the USA, which still relied heavily on legal, philosophical, and historical approaches, into a "real science" by referring to the methodology being used by psychology at that time. Yet, it was the behavioral revolution in the 1950s and 1960s that gave major "scientific" content to today's science of politics. The movement called for a shift of research focus from the traditional formalities of the state, constitutions, and law to human behavior. Methodologically, there was a strong emphasis on quantitative and positivist approaches. The overall purpose was, as had been the case in physics, to search for grand theories from which political "regularities" could be deduced. At about the same time, political science began to feel the impact of Popper's and Kuhn's works on the philosophy of science. Students of politics were taught that scientific knowledge should be retroductive and falsifiable, and that the behavioral revolution would take political studies from a pre-scientific to a scientific era (Almond, 1996: 63–8; Collini et al., 1983: 16–18, 183–246; Farr, 1995: 201–4; Freeman, 1991: 20–9; Goldberg, 1963).[3]

Despite all the above efforts, however, the scientific status of political studies is regarded as not very satisfactory. As the American Political Science Association's Ad Hoc Committee on the National Science Foundation recently noted, political science is seen as "not very exciting, not on the cutting edge of the research enterprise, and in certain quarters as journalistic and reformist" (cited in Granato and Scioli, 2004: 313). More specifically, according to a popular political science textbook of the 1980s, the "scientific potential" of the discipline (measured in terms of its capacity to classify data into discrete categories, to observe and measure data, to replicate experiments, to develop theory, and to avoid controversy) is incomparable to the natural sciences. Within the social sciences, it is ranked below economics and sociology. The study of politics is only more scientific than humanity subjects such as history and philosophy. However, there are some variations among political science's sub-disciplines. In general, studies on voting behavior are regarded as being as scientific as economics and sociology, while political philosophy is less scientific than history and philosophy (Rodee et al., 1983: 4).

That is to say, political philosophy has been regarded as the sub-discipline that has averaged down the scientificity of political studies.[4] On the other hand, it is

the behavioral movement that has established the major scientific foundation of contemporary political science. However, the main ideological base of behavioralism (liberal pluralism) perceives the political system as comprising of individuals acting in groups for the pursuance of collective interests (Farr, 1995: 204–5). This allows the use of collective entities as the basic unit of analysis, making the behavioral approach not strictly atomistic in terms of methodology. In this regard, it is the rational choice school, which Almond (1996: 85) called "scientific maximalism" in political studies, that has gone further. Originating from economics, rational choice theories insist on methodological individualism, which holds that in all kinds of social behavior the ultimately relevant actors are individuals sharing the same utility-maximization desire, rather than any groups seeking common interests (Johnson, 1991: 22–6; Sproule-Jones, 1984: 168–9). By breaking down aggregative units into identical, atomistic, self-interest-seeking individuals, such an approach makes rational choice theory, among the other subfields in political science, the most Newtonian.

Hence, if we rank the various subfields in political science according to their Newtonian scientificity, we may find rational choice at the highest end and political philosophy at the other extreme. The current trend is toward an "abandonment" of political philosophy, on the one hand, and an "accelerated assimilation" of rational choice theory into political studies, on the other (Boron, 1999: 50). Indeed, the rational choice school, which emerged in the 1950s as a small subfield in political science, has now become one of the most popular approaches in the discipline. As recorded by Green and Shapiro (1994: 1–3), the percentage of rational choice articles published in the *American Political Science Review* grew from almost zero in 1952 to more than 35 percent in 1992. Through the impact of the rational choice school, "the effect of economics has been felt more strongly in political science than any other social science" (Miller, 1997: 1173). A critic even commented that, "in the world of social sciences, political science offers the most successful case of the 'colonization' of a discipline at the hands of neoclassical economics methodology" (Boron, 1999: 53).

As mentioned, modern economics is the first Newtonian social science. Its successful "colonization" of political science implies that political science has also been "Newtonized." Apart from the atomistic nature of methodological individualism, the rational choice school is also Newtonian in the sense that it aims at reducing the complex political world into a few simple laws. As Almond (1996: 86) noted, "[rational choice's] vision of the future of the discipline is of a cumulating body of formal theory, internally logical and consistent, capable of explaining political reality with a relatively small number of axioms and propositions."

In short, behavioralism and rational choice are the two major "scientific" approaches in contemporary political science. They share the Newtonian belief in discoverable regularities, testable theories, quantitative data, positivist methodologies, and retroductive reasoning. However, to a large extent such "scientificity" of political science is borrowed from other disciplines, mainly economics. Overall, this discipline "has not yet found its Newton" (Saatchi, 2001: 8).

Historical Institutionalism, Path Dependence, and Increasing Returns

At the time when behavioralism was revolutionizing political studies, and when rational choice theory was in emergence, there was a general neglect of political

institutions in the discipline, because earlier institutional studies had shown no attempt to develop any positive theory. It was not until the 1980s that the political importance of institutions was "rediscovered" (Rothstein, 1996: 139–42). Arguing that political phenomena could not be reduced to the sum of individual behavior, but must also be explained in terms of institutions, an article by March and Olson (1984) marked the "rebirth of institutionalism" (Burnham et al., 2004: 18). Since then, a huge literature concerning institutional analysis has emerged. Peters (1999) identifies at least seven versions of institutionalism in political science, namely, normative institutionalism, rational choice institutionalism, historical institutionalism, empirical institutionalism, sociological institutionalism, interest-representation institutionalism, and international institutionalism. They share the common central message that "institutions are the variable that explain most of political life, and they are also the factors that require explanation. The basic argument is that institutions *do* matter, and that they matter more than anything else that could be used to explain political decisions" (Peters, 1999: 150, original emphasis).

Among the various versions of institutionalism, historical institutionalism has emerged as one of the most influential variants (Burnham et al., 2004: 19). It consists of a coherent set of ideas that makes it a distinct approach in political science. First, whereas "old institutionalism" defines institutions mainly in terms of formal structures, historical institutionalism widens the concept to include both formal and informal procedures, norms, and conventions. Second, in contrast to rational choice and game theory's focus on equilibria, historical institutionalism's primary interest is in historical processes, legacies, and contingencies. Central to this is the idea of path dependence, which will be examined in greater detail below. Third, when analyzing institutions' effect on individual behavior, historical institutionalism blends the "calculus approach" (which focuses on utility maximization) with the "cultural approach" (which emphasizes moral and cognitive factors). Fourth, instead of assuming that everyone is on an equal footing when making choices, historical institutionalism highlights power asymmetry among individual actors. Fifth, rather than taking institutions as the single explanatory variable, historical institutionalism examines interactions between institutions and other factors such as socioeconomic changes, ideological flows, and actors' interests and strategies, thereby situating institutions in broader contexts. Sixth, while rational choice theory takes individual preferences as given, historical institutionalism goes further, to ask how such preferences are formed and constructed. Finally, when formulating research programs, historical institutionalism tends to be driven by "big" and "real-world" questions, such as the occurrence of revolutions and evolution of social systems. These features, taken together, give rise to a "recognizable historical-institutional approach." Scholars of this school "share a common theoretical project and a common research strategy" (Burnham et al., 2004: 18; Greif and Laitin, 2004: 635–6; Hall and Taylor, 1996: 938–42; Immergut, 1998: 16–25; Pierson and Skocpol, 2002: 696–713; Thelen, 1999: 381–4; Thelen and Steinmo, 1992: 2, 8–13).

Since the above-mentioned "rebirth of institutionalism" in the mid-1980s, historical institutionalists have produced a large and growing literature, covering major political issues such as "transitions to democracy, the emergence and demise of authoritarian regimes, the intersection of domestic and international politics, the origins and development of welfare states, social identities in politics, the

political dynamics of gender rights, the development of economic regimes, and the causes and consequences of social movements and revolutions" (Pierson and Skocpol, 2002: 694). According to a review of the state of the discipline in the mid-1990s, one of the major "recurring themes" of political science is "a renewed recognition of the importance of institutional factors in political life. With the rise of this 'new institutionalism' comes a renewed appreciation of history and happenstance, rules and regimes as constraining forces in political life" (Goodin and Klingemann, 1996: 17).[5] A more recent survey of contemporary theories and methods of political science also recognizes that, among various versions of institutionalism, historical institutionalism provides "the most extensive body of empirical work to date" (Lowndes, 2002: 96). Finally, a "centennial" review of the state of the discipline identified historical institutionalism as one of "the three research pillars in contemporary political science," alongside behavioralism and rational choice theory (Pierson and Skocpol, 2002: 718–21).

If political science is a normal science, then these "three research pillars" (namely, historical institutionalism, behavioralism, and rational choice theory) must share the same paradigm, because by Kuhn's definition each normal science can have only one paradigm. However, while behavioralists and rational choice theorists share the same Newtonian foundation, they regard institutionalism as lacking similar theoretical and methodological rigor (Marsh and Furlong, 2002: 23). What this article intends to argue is that this is not a matter of difference in scientific depth, but a matter of paradigmatic incompatibility between historical institutionalism and the Newtonian worldview of behavioralism and rational choice.

The source of such paradigmatic incompatibility is the idea of path dependence, which forms the theoretical core of historical institutionalism. While historical institutionalism cannot be reduced to path dependence, the two are so intertwined that the latter has been taken just as another way of describing the former (Peters, 1999: 63). Simply stated, path dependence refers to the situation in which "Outcomes at a critical juncture trigger feedback mechanisms that reinforce the recurrence of a particular pattern into the future" (Pierson and Skocpol, 2002: 699). This is not a deterministic view of history. The "initial conditions" produced at a critical juncture do not determine the outcome. "Rather, a system that exhibits path dependence is one in which outcomes are related stochastically to initial conditions, and the particular outcome that obtains in any given 'run' depends on the choices or outcomes of *intermediate events* between the initial conditions and the outcome" (Goldstone, 1998: 834, original emphasis). Despite the central importance of this idea to their analyses, historical institutionalists tend to take path dependence as given, without investigating what gives rise to such a phenomenon. In such a way, history becomes the ultimate explanation of all political choices and changes.[6]

It is a new branch of economics, namely, the economics of increasing returns, that goes further to explain the dynamics behind path dependence. Technically, increasing returns can be defined as "the economic principle that the change in outputs increases at a greater rate than a change in inputs along a range of outputs (i.e. exponential increase in outputs resulting from a linear increase in inputs)" (Rycroft and Kash, 1999: 263). When "the change in outputs" in this definition is understood as social change, the idea of increasing returns says that once a social process has started, it will produce its own law of inertia through which the cost of adhering to the original direction of change will decline, whereas the cost of switching away will rise, resulting in path dependence.

According to mainstream economics, diminishing returns are the norm, while increasing returns, if they ever exist, are the exception. The economist Brian Arthur, however, identifies four technological and social "self-reinforcing" mechanisms that regularly generate increasing returns: (1) large set-up or fixed costs which lead to diminishing average costs as output increases; (2) learning effects which produce the knowledge and skills for more efficient production; (3) coordination effects which make the environment more compatible with existing technologies or practices; and (4) adaptive expectations which create self-fulfilling anticipation (Arthur, 1988: 10).

Such an economic "discovery" by Arthur helps to explain the prevalence of path dependence as a general social phenomenon. With Douglas North's (1990) application of increasing-returns analysis to the study of institutions and institutional changes, the idea has won increasing currency in various fields of the social sciences, including political studies. However, there had not been any formal theoretical justification for the general application of the economic idea of increasing returns to political analyses until the publication of an article by Paul Pierson.

According to Pierson (2000: 257–62), there are four features of politics that make it even more conducive than economics to increasing-returns processes. First, while most economic activities are based on "flexible" and "fluid" individual choices, politics is largely collective in nature. As a result, one's political decisions are highly dependent on one's expectations of other people's political choices. For example, the likeliness of an individual to contribute to a political movement increases with the expectation that others will do the same. That is to say, a marginal rise in participation will produce increasing-returns processes, making the movement path dependent.

Second, unlike the availability of exit options in an economic market, political constraints are binding upon all. All individuals under a particular jurisdiction have to adapt to its political rules, voluntarily or involuntarily. Due to the adaptive expectation effect, political institutions are prone to increasing returns. Once installed, they become path dependent and are thus difficult to alter.

Third, political power is self-reinforcing. The more powerful group in a relatively balanced conflict can impose its preferences on others, produce anticipated reactions, and manipulate ideology in its favor, thereby transforming the originally small power difference into a large degree of political inequality. Once predominant power is achieved, it often does not need to be exercised openly. In other words, political authorities tend to generate increasing-returns processes that make power asymmetries less visible. Power relations are thus path dependent.

Finally, while price and profit serve as good signals of economic performance, there is no similar indicator in politics. This makes political errors less easy to observe and correction less likely to take place. Research in cognitive psychology and organizational theory has found that actors operating under such complex and opaque social contexts tend to filter information into existing "mental maps." Social interpretations of a political environment are thus conducive to path dependence.

In short, according to Pierson, the economic theory of increasing returns is largely applicable to political analysis. There are "compelling reasons to believe that political life will often be marked by dynamics of increasing returns. Tendencies toward positive feedback characterize four processes central to political environments:

collective action, institutional development, the exercise of authority, and social interpretation" (Pierson, 2000: 260). The most important theoretical implication of this, Pierson notes, "is the need to focus on branching points and on the specific factors that reinforce the paths established at those points." While political researchers have long been interested in "critical moments," increasing-returns arguments suggest that attention should be paid not only to "big" events, because "little ones that happen at the right time can have major consequences as well" (Pierson, 2000: 263).

Moreover, path-dependence analyses rest on a conception of "historical causes," and thus justify "a turn to history." The methodology thus required is different from social scientists' common practice of focusing on "synchronic causality – to try to understand how variations in current variables affect present social outcomes" (Pierson, 2000: 263). That is to say, instead of spending their entire energy on identifying relevant current variables, researchers should also trace the historical path of social outcomes. A related point is that timing and sequence are important, because "the same event ... may have a different effect depending on when in a sequence of events it occurs." Such an approach "can help political scientists think more clearly and explicitly about the role of time, and history, in social analysis" (Pierson, 2000: 264).

The idea of increasing returns also challenges the largely unquestioned functionalist explanations in political science. Functionalism assumes that an outcome exists because it serves a certain function. But the idea of increasing returns suggests that it may simply be a path-dependent outcome that has no particular purpose. More importantly, the outcome is not necessarily "superior" to its competitors. "*Rather than assume relative efficiency as an explanation, we have to go back and look*" (Pierson, 2000: 264, original emphasis).

No doubt, the idea of increasing returns brings important new insights to political studies. But does it mean just the emergence of another new perspective based on the same, existing paradigm or will it lead to a Kuhnian paradigmatic shift in the discipline? Pierson concluded his article by stating that "Since the rise of behaviorism, many political scientists have had lofty aspirations about developing a science of politics, rooted in parsimony and generalization and capable of great predictive power." Yet, despite more than four decades of efforts, the discipline still fails "to generate powerful generalizations that facilitate prediction." The reason for this, according to Pierson (2000: 266), may be unawareness of the existence of increasing-returns processes in the political world. Implicit in such statements is the hope that the idea of increasing returns will make political science more scientific along the current line of scientific inquiry.[7]

However, as will be argued below, path-dependence analyses are in fact based on a worldview that is largely inconsistent with the scientific foundation of current mainstream political science. The idea of increasing returns, if applied to political science, may move the discipline from the Newtonian tradition toward the realm of a new science, namely, complexity science.

Complexity Science and Increasing Returns

The Newtonian worldview, as summarized earlier, was dominant for most of the 18th and 19th centuries, and is still influential today. In the early 20th century, however, the emergence of relativity theory and quantum physics shattered the Newtonian "world-machine." More recently, growing skepticism from different

branches of science about the simplistic Newtonian belief in the certainty of certainty has given rise to a new science called "complexity science" (Capra, 1982: 62; Hawking, 1988: 60–2; King, 2000: viii; Wallerstein, 1998: 321).

There has been a proliferation of definitions of complexity. One physicist has distinguished more than 20 (Rescher, 1998: 2–3), while other commentators have identified more than 30 (Rycroft and Kash, 1999: 54). But it has been noted that complexity science is "so new and so wide-ranging that nobody knows quite how to define it, or even where its boundaries lie." This is so because "complexity is trying to grapple with questions that defy all the conventional categories" (Waldrop, 1992: 9).

Complexity science starts with the observation that the world is so complex that it is highly unpredictable. This has often been illustrated by the so-called butterfly effect: will the flapping of a butterfly's wings in South America set off a tornado in a city in the USA? It will under certain conditions, but not under others. The central message is that a minute difference in initial conditions and the subsequent intermediate events may lead to enormously different outcomes. This phenomenon, first discussed among meteorologists, is also found to exist in ecosystems, economic entities, developing embryos, and the brain. Studies of dynamic systems of this kind have given rise to a new science under a cluster of names, including "chaos theory," "complexity," "nonlinearity," "fractality," "self-organization," "irreversibility," "dissipative systems," "emergence," and so on (Gleick, 1987: 9–31; Lewin, 1992: 11; Lorenz, 1993: ix, 161–84; Turner, 1997: xi). While the meanings of these terms are not exactly the same, and there have been different understandings about their differences, this article will subsume them under the general rubric of "complexity science."

In the words of Prigogine and Stengers (1984: 209), complexity science is "the science of fire, chemistry," in the sense that "chemical structures are the creatures of fire, the results of irreversible processes." This distinguishes it from "classical physics," where "we can at least conceive of reversible processes." Due to such difference, "chemistry cannot be reduced to the idealization that lies at the basis of classical or quantum mechanics, in which past and future play equivalent roles" (Prigogine and Stengers, 1984: 137). Apart from neglecting irreversibility, Prigogine and Stengers (1984: 261–4) note, classical mechanics wrongly assumes the irrelevance of initial conditions. "It is obvious that we can no longer impose arbitrary initial conditions. The initial conditions must be the outcome of the dynamic evolution itself" (Prigogine and Stengers, 1984: 61). In our context, the importance of initial conditions, the subsequent intermediate events, and irreversibility imply that history matters.

According to Prigogine and Stengers, another important characteristic of chemistry lies in its complex relation between order and chaos: "successive regimes of ordered (oscillatory) situations follow regimes of chaotic behavior" (1984: 168). While there has been controversy about Prigogine and Stengers' contention that order will arise out of chaos through a process of "spontaneous self-organization" (Toffler, 1984: xv), the more common view in complexity science about chaos and order is that matter will not rest at either of these two extremes. Rather, complex systems are characterized by a special kind of balance between total order and total randomness. This balance point is where "the components of a system never quite lock into place, and yet never quite dissolve into turbulence" (Waldrop, 1992: 12).

What, then, is the cause of such balance between chaos and order? This question is so fundamental that some complexity scientists take it to be a "religious issue." For them, the transition between chaos and order is an "abstract" process brought about by "the mysterious 'something' that makes life and mind possible" (Waldrop, 1992: 293, 319). While in Newtonian science the ultimate creator is the Protestant God, complexity science seeks an explanation about the natural law governing chaos and order from the eastern religion of Taoism, hence Capra's popular book *The Tao of Physics* (1991). We will return to this important point at the end of this article.

In short, complexity science is the study of systems that are at "the edge of chaos" (Lewin, 1992: 44; Waldrop, 1992: 334). Its worldview is fundamentally different from that of Newtonian science. Whereas the Newtonian world is mechanistic, simple, synchronic, certain, and predictable, the complex world is organic, intricate, historical, uncertain, and unpredictable. When used as a paradigm, complexity science is some kind of "holism" considered to be applicable to systems that are unamenable to the Newtonian reductionist framework (Edmonds, 1999: 1). Complexity science, therefore, represents an important paradigmatic challenge to Newtonian science.[8] Now we can come back to the idea of increasing returns. Which kind of science does it belong to? In the following, we will follow Waldrop (1992) to situate the emergence of increasing-returns economics in the larger context of the rise of complexity science.

As mentioned, Brian Arthur is one of the most important proponents of the idea of increasing returns. His first article on increasing returns was written in 1983–84. It was flatly rejected by most of the top journals in mainstream economics, including *The American Economic Review*, *The Quarterly Journal of Economics*, and *The Economic Journal*. This is not surprising, given that the idea of increasing returns runs in direct conflict with a basic tenet of conventional economics, namely, the law of diminishing returns. For Arthur, increasing returns exist in economic reality not as an isolated phenomenon. It is particularly common in high-technology industries (Waldrop, 1992: 42, 49). However, his ideas were treated as heresy by mainstream economics.

Indeed, virtually all introductory courses to modern economics begin with the teaching of the law of diminishing returns. Why this is so central to modern economics can be explained in terms of the discipline's aspiration for making economics as scientific as Newtonian physics. According to Newton's first law of motion, an object at rest tends to stay at rest and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by a force. In the absence of any force, objects are in equilibrium. In economics, the existence of equilibrium (balance between demand and supply) requires convexity, which implies the absence of increasing returns. As Heal (1999: xiv–xv) noted, a "source of our intellectual weakness in dealing with increasing returns lies in the Faustian bargain made in adopting the techniques of convex analysis. They give us clean and powerful results, but at the cost of preventing the analysis of increasing returns ... The price is the inability of mainstream economic theory to address questions relating to increasing returns." Yet, the reward is the creation of a parallel between Isaac Newton in physics and Adam Smith in economics. While Newton reduced the physical world to a few laws of motion, Smith simplified economic activities to an "invisible hand." In both systems, nature works well by itself, and there is no need for external correction, which is a central belief of the Enlightenment (Waldrop, 1992: 22–3, 328).

The idea of increasing returns subverts all the above. It implies concavity, the nonexistence of a unique equilibrium, the inability of nature to restore order, and thus, uncertainty and unpredictability of economic activities.[9] Rather than aiming at reducing the complicated world into a simple, predictable system, the idea of increasing returns treats the economy as an evolving complex system. Such an approach distinguishes the idea of increasing returns from Newtonian science, and puts it in the realm of complexity science. When Arthur's arguments were still ignored by mainstream economics, they attracted the attention of complexity scientists in the Santa Fe Institute.

The Santa Fe Institute, founded in 1984, is a private, multidisciplinary research organization. Scholars attached to it include a number of Nobel laureates such as Murray Gell-Mann and Philip Anderson in physics, and Kenneth Arrow in economics. It has also attracted researchers in the fields of mathematics, computer science, and biology. Aiming at pursuing emerging science, the institute has been noted as a place "where no idea is too crazy," and is a bastion of complexity science.[10] In 1987, upon Arrow's invitation, Arthur presented his idea of increasing returns to a group of Santa Fe physicists and economists. In this and subsequent discussions, the idea of the possible absence of equilibrium in the economy was "transformed into a simple assertion that the economy is at the edge of chaos, where agents are constantly adapting to each other and things are always in flux" (Lewin, 1992: 9; Waldrop, 1992: 12, 52–3, 136–43, 254–5, 330).

In short, increasing-returns economics is not just another economic perspective. With support from complexity science, its emergence challenges the Newtonian foundation of conventional economic science. As the economic ideas of increasing returns and path dependence have gained increasing currency in political science through historical institutionalist analyses, it follows that they may also have a similar impact on the scientific foundation of political studies. This leads to the question of what paradigmatic implications this will have for political science.

Kuhnian Paradigmatic Challenges for Political Science?

As noted earlier, Kuhn's theory of scientific revolution begins with the observation that social scientists are more divergent than natural scientists on fundamental scientific problems and methods. We have also mentioned that, despite the efforts by behavioralists and rational choice theorists to make political science more Newtonian, a dominant paradigm is still absent in the discipline, making it not a normal science in Kuhn's sense. However, this does not mean that we cannot use the word "paradigm" at all in analyzing the scientific status of political studies. As a comparative political methodologist noted, while a "Kuhnian hegemonic paradigm" does not exist in political studies, there are plenty of theories, hypotheses, applications, and methodologies in the field that "have most of the other features Kuhn attributes to paradigms. They encompass a set of factual and explanatory knowledge claims, in other words, theories, that are widely accepted by adherents" (Geddes, 2003: 6–7).

Moreover, how essential is the idea of a "hegemonic paradigm" for the application of Kuhn's analysis to political studies? It is true that in political science there are a number of alternative and competing perspectives which do not seem likely to converge into a single paradigm in the foreseeable future. Many believe that such a "multi-paradigm status" is an essential and permanent characteristic of the social

sciences, and Kuhn's theory of scientific revolution is thus inapplicable in this realm (Delanty, 2005: 39). But there is also the view that the current absence of a dominant paradigm in the social sciences indicates only its scientific immaturity, but not impossibility. Flyvberg (2001: 31) has quoted political science as an example of this "pre-paradigmatic" argument: "even though political scientists may disagree as to what constitutes 'the political,' while physicists seem to be in more agreement as to what constitute physical phenomena, this state of affairs does not necessarily have to remain permanent. According to the pre-paradigmatic argument, there is nothing in principle which prevents political scientists from being able to reach agreement concerning the political domain."

The belief in the final acquisition of a paradigmatic status for political science can be seen in how a major behavioralist, David Easton, assessed the future trend of political science. According to Easton (1997), in the "postbehavioral phase" the discipline has become more fragmented and divided in terms of direction and methodology. "Postbehavioralism destroyed the central focus and sense of commitment provided by behavioralism ... [However, it] has been least successful, perhaps, in challenging the basic scientific methodology of behavioralism" (Easton, 1997: 26, 32). In his view, despite the post-behavioralist attack on systematic methodology, the scientific foundation of political science has been strengthened over the past few decades. "Few departments of political science around the world would now fail to provide students with basic training in rigorous techniques for acquiring, assembling, and analyzing data and for relating theories of various levels to such data. Rational and formal modeling's success in slowly suffusing throughout the discipline ... testifies further to the fact that, far from being dead, scientific research continues to grow as one of the major strategies for improving the reliability of our knowledge about the political world" (Easton, 1997: 41).

The philosophical base of the above "pre-paradigmatic" argument is naturalism, which holds that the natural world and the social world operate according to the same set of principles, and there should thus be no ontological and epistemological difference between the natural and social sciences (Delanty, 2005: 11; Williams, 2000: 49–50). This implies that the current plurality of theories and perspectives in political studies will ultimately give way to a single paradigm that is universally applicable in both the social world and the natural world. Such a perspective may lead to a rather "colonialist" argument that behavioralism and rational choice theory, with their Newtonian base, are superior to other approaches which lack a similar natural-scientific foundation. It is in this respect that historical institutionalism provides a real challenge to behavioralism and rational choice theory. As mentioned above, the theoretical underpinnings of historical institutionalism (namely, the ideas of path dependence and the economics of increasing returns) are based on complexity science. Like Newtonianism, complexity science is also based on observations of natural phenomena, and may also be presented in the form of mathematical equations. More importantly, according to complexity science, both the natural world and the social world consist of complex systems (Williams, 2000: 125–30), and a complexity-based science for social engineering is therefore possible (Byrne, 1998). That is to say, if the social sciences (including political science) are to acquire the same paradigmatic status as the natural sciences, the dominant paradigm need not be Newtonianism, but may be complexity science.

Hermeneutists may think that this is quite irrelevant. As the opposite school to naturalism in the philosophy of science, hermeneutics holds that the social

and natural sciences are fundamentally different in terms of method and subject matter. The two sciences have their own territory, and the permanent absence of a paradigm in social sciences is therefore possible. According to Peter Winch, a major hermeneutist (or intrepretivist), social phenomena could not be dealt with by the natural sciences, because the reactions of humans to their environment are more "complex" than those of other beings not only in "degree," but also in "kind." Here, "complexity" refers to the "irreducible diversity" of social objects, and is not about natural beings or phenomena (Delanty, 2005: 42, 57–8; Montuschi, 2003: 15–16; Winch, 1990: 71–5). But what complexity science has found today is that the natural world is as indeterminate, unpredictable, and irreversible as the social world. This lends support to the more aggressive version of hermeneutics (namely, the idea of the "universality of hermeneutics"), which Kuhn and other theorists have used to "relativize" the natural sciences. According to this view, not only human activity, but also the natural sciences are historically conditioned and are thus subject to hermeneutic interpretation. The distinction between the social and natural sciences is therefore weakening not because the social sciences have become as "epistemic" as the natural sciences, but because the natural sciences have been shown to be as "nonepistemic" as the social sciences (Delanty, 2005: 6–7, 143–5; Flyvberg, 2001: 28–9; Gulbenkian Commission, 1996: 60–9, 78). That is to say, it is an illusion to think that the natural sciences are "normal sciences," because a hegemonic paradigm is, in fact, as absent in the natural sciences as in the social sciences.

Issues for Reflection

Hence, from both naturalist and hermeneutic perspectives,[11] it makes sense to speak of important paradigmatic challenges for political studies due to the emergence of complexity science. We are facing a "complexity theory challenge" regarding whether political science is a science of linearity or complexity (Hoffmann and Riley, 2002). Before answering such a fundamental question, there are several issues that we need to consider seriously. The first is a methodological one. As Pierson (2000) noted, an important theoretical implication of the idea of increasing returns is that history matters. This should not be taken simply as a call for political studies to return to the traditional historical approach that attempts to make political explanations and predictions by identifying historical patterns. Instead, the idea of increasing returns holds that "small" historical events cannot be neglected because they may also have significant consequences given the right timing. Then, if "big" and "small" events alike need attention, how can we determine our focus of analysis? On what basis can we distinguish between the relevant and the trivial? How can we decide which historical events are important and which are not if all matters matter? In short, given infinite data on the one hand, but limited resources on the other, there is a question of methodological feasibility if a historical institutionalist approach based on complexity science is to be employed.

The second issue is about the power of knowledge. Newtonian science aims at producing knowledge that has both explanative and predictive power. In contrast, complexity science seems satisfied with explanation, and is not ambitious for prediction. According to it, the essence of science lies in explanation; prediction is just a bonus, but not a necessity, because the world is not always predictable.

Examples of natural sciences that are explanative, but not strictly predictive, include biology, geology, astronomy, and meteorology. Complexity scientists hope to show that this can also be the case in the social sciences (Waldrop, 1992: 39, 255).[12] Application of the idea of increasing returns to political analyses would incline the discipline toward such a position. Should this direction be welcomed? That is to say, should we be satisfied with political explanations that cannot be generalized for making predictions? While behavioralists and rational choice theorists would answer "No" to this question, a review of the state of political science in the mid-1990s argued that the discipline should not overload itself by taking on the task of making accurate predictions, because "The subjects of study in politics, as in all the social sciences, have an ontological status importantly different from that of billiard balls" (Goodin and Klingemann, 1996: 10). Political scholars in favor of such a position may find support from Roy Bhaskar, the leading philosopher of critical realism, who made a distinction between theories produced under "closed systems" and the application of these theories in "open systems." According to Bhaskar, positivist theories with predictive power are derived from observations under laboratory-type conditions of "closed systems" in which most variables are controlled. But in "open systems" where an unknown number of mechanisms are at work, only *ex post* explanations (not *ex ante* predictions) are possible (Bhaskar, 1975: 118–26; 1979: 124–32).[13] While there have been discussions about the application of critical realism to economic and sociological analyses,[14] the implications of this school of philosophy for political studies are yet to be explored.

The third issue concerns the purpose of science. Newtonian science aims at reducing the complex to the simple. Though this may not always be successful, its merit of making the world more comprehensible and manageable is undeniable. On the other hand, there is not much advice that is obtainable from complexity science about how life at the "edge of chaos" can be improved. According to Waldrop (1992: 331), "in a policy context, [the complex approach] means that you observe, and observe, and observe, and occasionally stick your oar in and improve something for the better ... You just observe. And where you can make an effective move, you make a move." He added that this is "not a recipe for passivity," but a "powerful approach that makes use of the natural nonlinear dynamics of the system" (Waldrop, 1992: 331). This is hardly satisfactory if we are looking for some concrete means for the betterment of life. But should this Newtonian mission be a necessary objective of science, whether it is feasible or not, or should science simply let us understand more of this world rather than improve it? In our context, how useful would historical institutionalism be if we are not contented with such conclusions as "No lesson is transferable" or "This is determined by the natural dynamics of evolution"? In the end, the question is, what should we expect from science?

Finally, and most fundamentally, there is the religious issue of the "First Cause." According to the "Newtonian settlement," God is the ultimate creator of the sun, planets, and comets. Once this was settled, physics began to divorce itself from theology (Buckley, 1988). Although Newton's fundamental concern was religious (to reveal the wisdom and providence of God), his works, however, showed that the world God created is so stable that it does not require God's further intervention. The laws of nature that Newton discovered have then been used to address earthly and utilitarian issues, and the questions of who set up the universe and who causes planets to turn have become irrelevant to all secular sciences (Dobbs and Jacob, 1995: 57–60). Moreover, Newtonian synchronism holds that questions concerning

the very origin of history are unimportant. The idea of increasing returns, however, is not contented with such a "settlement." The essence of the whole approach is to trace and to reveal "some original ordering moment [that] triggered particular patterns" (Pierson, 2000: 263). The religious base that complexity science offers for that "original ordering moment" is eastern Taoism (Waldrop, 1992: 330). In fact, there are major similarities between complexity science and Taoism. Both share the view that order and harmony emerge from chaos and confusion through some self-organization processes. While complexity science offers no explicit answer to the question of who is the "First Cause," Taoism holds that the very origin of our ever-burgeoning universe is emptiness, nonbeing.[15]

For Newtonians, complexity science's attempt to use Taoism as its "religious base" is a revival of premodern mysticism. Even within the circle of increasing-returns economics, there have been debates regarding whether any science, be it Newtonian or complexity, could accept the possibility of an event without a cause. The more conservative approach argues that to adopt the notion of an uncaused cause, which is basically a Darwinist perspective, would be an abandonment of the mission of science, making scientific inquiry "'dangerous' and corrosive of mystical or religious explanations of events" (Hodgson, 2002: 274).[16]

Political science may face similar criticism if more historical institutionalist analyses are employed. The problem is that we have no rational basis to judge whether such a potential paradigmatic shift is desirable or not. After all, as Kuhn noted, paradigms are "incommensurable," and a paradigmatic shift is like a "religious conversion" that cannot be explained by logical reasoning.

Notes

1. There is a huge literature on Kuhn's philosophy of science. The following summary of Kuhn's notion of paradigmatic shift is based mainly on Hoyningen-Huene (1993) and Von Dietze (2001).
2. For another summary of the Newtonian worldview, see King (2000: xi–xii).
3. According to a recent "recovery" of the history of political science, Merriam and the behavioral revolution's contributions in the making of modern political science have in fact been exaggerated. It is the works of two other political scholars, Catlin and Elliott, respectively an Englishman and an American, which made the earliest claims that the discipline should become more scientific. They represented an intense Anglicization and Americanization of political studies, after the discipline had been subject to the influence of German philosophy for almost a century. As such, they constituted a "paradigmatic shift" in Kuhn's sense (Gunnell, 2004, 2005).
4. On this point, see Kramer (1986: 12–15).
5. This review has been regarded as one that "provides probably the best overview of the discipline of political science, at least through the eyes of the mainstream of the profession" (Marsh and Savigny, 2004: 155).
6. As two critiques have argued, the idea of path dependence means nothing more than "history matters" if there is no clear specification about what social mechanisms are actually at work (Beyer, 2005) or if there is no "clear and convincing account of decision-making over time" (Kay, 2005: 553).
7. In his more recent work, Pierson (2004: 68) did note that the idea of "event sequences" in path-dependence analyses "begins to sound like chaos theory." But he did not elaborate on this. It is true that historical institutionalism and chaos theory are similar, as both involve unpredictability. However, there is a basic difference between the two. Historical institutionalism focuses on evolution of institutions over time and examines how unintended institutional changes may lead to unforeseeable results. In contrast,

chaos theory, when applied to analyze political behavior, shows how given institutions (such as a set of voting rules) may result in unpredictable outcomes (Brown, 1996: 131–4; Laver and Schofield, 1990: 119–29). That is to say, whereas historical institutionalism emphasizes the temporal dimension, chaos theory highlights individual and collective decisions under given "institutional incentives." The latter is more related to rational choice institutionalism than to historical institutionalism (Lecours, 2005: 9). While unpredictability under historical institutionalism is due to the nature of history, randomness under chaos theory is the result of institutional design.

8. For a discussion of different views about whether complexity theory represents a paradigmatic shift, see Morcol (2002: 194–6).
9. This is contrary to Thelen, who argued that "If positive feedback and increasing returns were the whole story, then prediction would be easy" (1999: 396).
10. Rycroft and Kash (1999: 262) thus defined complexity science as "a growing research program and body of literature commonly associated with the Santa Fe Institute that attempts to explain the phenomenon of increasing complexity through unconventional – typically nonlinear – models."
11. For a discussion of these two perspectives in political science, see Marsh and Furlong (2002).
12. There have thus been voices suggesting that it is biology rather than physics that should be the paradigm for the social sciences (Brady, 2004: 295–7; King, 2000: 13).
13. For a useful summary of Bhaskar's notion of closed and open systems, see Ozel (2003: 225–36).
14. Examples of these include Fleetwood (1999) in economics and Cruickshank (2004) in sociology. It is interesting to note that, in the view of a major advocate of critical realism in economics, the idea of path dependence may facilitate the overuse of history as a general variable for explanation and prediction, though it is less deterministic than contemporary mainstream economics (Lawson, 1997: 248–51).
15. For a detailed discussion of the relationship between Taoism and complexity science, see Clarke (2000: 63–89).
16. Brady (2004: 295–6) also suggests political scientists refer more to Darwinist ideas. While he briefly notes that Darwin is more "probabilistic" and Newton is more "deterministic," there is no further examination of the paradigmatic incompatibility between the two sciences. For a more general discussion of the application of Darwinism in political science, see Dryzek and Schlosberg (1995).

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Biographical Note

Shu-Yun ma is Head of Department and an Associate Professor in the Department of Government and Public Administration, Chinese University of Hong Kong. His research interests include comparative politics, political economy, and the politics of development. He has published articles in journals including *World Politics*, *Journal of Development Studies*, and *Problems of Post-Communism*. ADDRESS: Department of Government and Public Administration, Chinese University of Hong Kong, NT, Hong Kong [email: syma@cuhk.edu.hk].

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