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Political Economy and the Work of Kenneth Arrow

Norman Schofield

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Abstract

This chapter contrasts two domains of human activity: LOGOS, the principle of enlightenment rationality and MYTHOS, the search for meaning through religion. LOGOS has created our modern world, and we have many successes as a result: the general equilibrium result for economics, general relativity, and quantum mechanics (but as yet no combined theory of the two). Even Newtonian mechanics has led to the notion of chaos. The Hilbert program to show the consistency and completeness of Mathematics has been invalidated by Godel's Theorem, while the attempt to extend the economics general equilibrium theorem fails because of Arrow's Impossibility Theorem. Darwinian evolutionary theory is another success of Logos, but even here, there are many difficulties, particularly how genes work Logos has allowed us to create our industrial society, but has also led us to climate change, without indicating how we can avoid the collapse of civilization. Here we suggest that we may be able to use Mythos, our collective beliefs in what we should do, to help us make a wise choice about the future. The greatest failure of Logos is that we have no understanding of the nature of consciousness. If we can develop such a theory, then perhaps we can construct a theoretical political economy. Without this, it appears likely that climate change could induce a Malthusian trap for us unless we pay heed to Pope Francis's call for us to "Care for Our Common Home." Since this presents us with a common goal, it is possible that we can make a wise choice over our future.

1. Introduction

The foundations of western science in the most general sense of the term were perhaps handed down by Thomas Hobbes (1588–1679) in his Leviathan of 1651 [78] and by Isaac Newton (1642–1727) in his Philosophiae naturalis principia mathematica of 1687. Newton's work, particularly the Optiks, as well as his underlying philosophy of science, was transmitted throughout Europe by Voltaire's (1694–1778) book on the Elements of Newton's Philosophy (published in 1738).

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The human sciences, and especially political economy and moral philosophy, were developed further in France by Condillac's (1715–1780) Essay on the Origin of Human Knowledge (1746) and Turgot's (1727–1781) Reflections on the Formation and Distribution of Wealth (1766), and in Scotland by David Hume's (1711–1776) Essays Moral and Political (1742) and Adam Smith's (1723–1790) Wealth of Nations of 1776. At roughly the same time, Condorcet (1743–1794) published his Essay on the Application of Analysis to the Probability of Decisions (1785) and the Esquisse d'un tableau historique des progres de l'esprit humain (1794). The former essay had little widespread impact at the time (although Thomas Jefferson, a friend of Condorcet, while in Paris almost certainly read it). The latter essay was used by Thomas Malthus (1766–1834) as the point of departure for his pessimistic book, the Essay on the Principle of Population [106], where he argued against what he saw as Condorcet's excessively optimistic, "Smithian," viewpoint.

Since then, of course, political economy developed apace in the work of Ricardo, Pareto, Walras and Marshall, culminating in the mathematical existence theorems for a competitive equilibrium (von Nuemann, 1935 (1946); Wald, 1935; [7]; McKenzie, 1954).

In contrast to the theoretical efforts on the economic side of political economy, almost no work on formalizing Condorcet's insights, in his Essay of 1785 on the political side of political economy, was attempted until the late 1940s, when Duncan Black and Kenneth Arrow published seminal papers on this topic.

In 1948, Duncan Black published his paper "On the Rationale of Group Decision Making," [20] specifically addressed to the question of existence of a voting equilibrium. He followed this in 1958 with his monograph on The Theory of Committees and Elections. The monograph emphasized the importance of Condorcet's work in voting theory but paid much less attention to the so-called Condorcet Jury Theorem. In contrast, recent research has suggested that this latter theorem gives a justification for majority rule as a "truth seeking" device.

Arrow's paper on "A Difficulty in the Concept of Social Welfare," [6] derives, I believe, from quite a different tradition of formal political economy, namely the work in welfare economics of Bergson (1938), Hicks (1939) and Lange (1942). (It should perhaps be emphasized that both welfare economics and political economy, viewed in the larger sense, became the arena for sometimes vigorous arguments in the 1930s and 1940s in the work of Schumpeter, Hayek, Popper and von Mises, etc.).

Arrow's famous paper of 1950 shows essentially that any social welfare function (that maps families of weak individual orderings to a weak social order) is either imposed or dictatorial. To obtain what Arrow termed this "possibility theorem," he assumed that the social welfare function had universal domain and satisfied a property of positive association of preferences. Reading this paper and a related one by Arrow on "Welfare Economics" [6], I infer that Arrow's realization of the applicability of the social choice paradox to welfare economics came about from his deep understanding of Scitovsky's "Note on Welfare Properties in Economics" (1942). A typical assumption in economics is that a move from a restricted trade situation, x, say, to a "free-trade" situation y is "welfare preferred." Even though not all

individuals may prefer y to x, nonetheless winners in y may compensate losers in y, so that the post-compensation outcome y*, say, is unanimously preferred to x. If this holds, then y is said to be "welfare preferred" to x, even when compensation is not implemented. Scitovsky observed that "welfare preferred" can be badly behaved, since y may be preferred to x, and x to y.

As Arrow commented in his paper, the negative result of the "possibility theorem" was "strongly reminiscent of the intransitivity of the concept of domination in the theory of multiperson games" as presented in von Neumann and Morgenstern (1947). Since intransitivity of domination occurs most obviously in constant sum voting games, I also infer that Arrow means that the "possibility theorem" was derived from the fact that all welfare judgments are implicitly based on transfers of wealth. In his 1950 paper, (on Social Welfare), Arrow also emphasizes that he views the theorem as relevant to a situation where individuals make value judgments rather than to the more typical economic context where agents make choices based on their tastes. Since all political choices are based, to some degree or other, on the aggregation of values, I further infer that the "possibility theorem" addresses not just the traditional questions of welfare economics, but the larger issue of the interaction between the political and economic realms. In other words, the relevance of the theorem is not simply to do with the Condorcetian question of voting cycles, or intransitivies, but concerns the larger questions of political economy that were discussed earlier by Schumpeter, Hayek, Popper, and so on in the period before World War II.

The formal exercise of proof of existence of an economic equilibrium (obtained between 1935 and 1954) leaves unanswered many questions. For example, can the existence proof be extended from the domain of private commodities to include public goods? More particularly, can democratic procedures be devised to ensure that preference information be aggregated in an "efficient" fashion so that social choice is welfare maximizing. Arrow's possibility theorem suggests that democracy itself may be flawed: indeed it suggests that democratic institutions may (as Madison foresaw in Federalist X) be perverted or turbulent. Thus, difficult questions of institutional design need to be addressed. Third, since Arrow's theorem required an ordering of social states, it implicitly brings into question the nature of the stability of price equilibria (even when they exist). The example of Scarf (1954) indicates that the dynamical system defined by tatonnement may be structurally unstable. This raises the possibility that both economic and political systems may be chaotic.

Since 1950, these issues have been discussed at varying levels of intensity. All of them come back in one sense or another to an interpretation of Arrow's Theorem. In the rest of this essay, I shall attempt to outline my sense of the current state of the debate, and the relationship with Arrow's Theorem, along the following lines:

- **1.** Extension of equilibrium theories in economics to the larger realm of political economy (neo-Smithian theories);
- **2.** Democratic institutions and the compatibility of economics and politics (neo-Condorcetian theories);

- **3.** "Chaos" in political economies, and recent notions of complex behavior in dynamical systems (from Newton to Laplace to Poincare);
- **4.** Large-scale prediction or "post diction," and macroeconomic history (neo-Malthusian theories).
- 5. The effect of climate change on these theories.
- **6.** The possibility that complex societies such as ours can reach a tipping point and collapse (as the Roman empire did).
- 7. Extension of equilibrium theories and much of economic theory emphasise the importance of economic growth. But after 200 years of growth, we now face the likelihood that climate change will make growth in the future impossible. Recent work by Stern [160, 161] suggests how we can estimate the costs of ameliorating the ravages of climate change. Ultimately, we need a new theory of economic externalities. Stern [162] goes on to suggest that we need a new theory of social welfare to indicate how we can structure a rational political economy. However Arrow's Impossibility theorem indicates that a social welfare function may not exist. Devising a social welfare function may necessitate incorporating the following themes:
- 8. Aggregation procedures: We can first mention the work of Don Saari [138, 139] who has shown how almost all aggregation procedures can give rise to counter intuitive or "chaotic" outcomes. In particular, the work of Sonnenschein [158], Mantel [108] and Debreu [46] made it clear that devising a method to translate rational consumer behavior into a price vector was anything but obvious.
- 9. Chaos: Philosophers such as Joseph Schumpeter, Friedrich von Hayek, and Karl Popper in the period around World War II were all involved in the debate about whether a social welfare function could be constructed. Arrow's Theorem gave a negative answer to this debate. In order to understand Arrow's theorem, it is necessary to set out the fundamental problem of political economy, namely, the nature and evolution of the social relationship between human beings. Since I understand this debate to focus on the possibility of equilibrium in contrast to disequilibrium (or disorder), I shall also mention what I judge to be a significant anti-equilibrium discovery of this century: "chaos." To do this, I think it appropriate to briefly comment on my perception of the main themes of this debate, going back to the time of the time of Hobbes. For Hobbes, society could fall into disorder in the absence of a Leviathan, able to maintain the peace. I understand this debate to focus on the possibility of equilibrium in contrast to disequilibrium (or disorder), I shall also mention what I judge to be a significant anti-equilibrium discovery of this century: "chaos." The idea of "deterministic" chaos only developed in the last 50 years and came about because of a better understanding of the solar system. "To illustrate, astronomers since the time of Pierre-Simon Laplace (1799) have believed that the solar system is structurally stable: In other words, small perturbations in each planetary orbit (induced by other planets) cannot dramatically change the nature of the orbit. Although Isaac Newton was aware of the problem of perturbations (Newton 1687), even Henri Poincare in his treatise of 1890 could not solve the differential equations." However, Poincare's work led to the beginning of differential topology and the work of Marston Morse, John Milnor, and Stephen Smale in this century. If the solar system were structurally

unstable, or indeed chaotic, then it would be impossible to predict its evolution. In fact, it is not chaotic, although subsystems (such as asteroids) are¹. As a result of popular books [60], we can conceive of natural phenomena (hurricanes) or even large-scale dynamic systems (such as climate) as potentially chaotic (Lorenz, 1993)². Although still a young science, human evolutionary theory suggests that chaotic transformations in weather may have had a profound effect on the human diaspora "out of Africa" (Boaz 1997; Calvin 1990; Stanley 1996). "Equilibrium"-focused evolutionary theory may also need revision (Eldridge and Gould 1972; Gould 1996). **Figure 1** shows the chaotic variation in temperature over the last 100,000 years.

10. Malthus and evolution: Malthus published his book on Population in 1798, arguing that population will tend to grow exponentially while resources are bounded arithmetically. This insight provided Darwin [44] with the logic of natural selection. Although Darwin favored the notion of slow evolutionary change, it has been pointed out that evolution has in the past been driven by cataclysmic extinction events when nearly all species go extinct (Eldridge and Gould 1972; Gould 1996). This notion of punctuated equilibrium has been applied at the level of the entire biosphere to suggest that the evolution of the climatic system can undergo dramatic transformations. Indeed Greer [59] suggests that the current episode of anthromorphic climate change will force on us such a transformation sufficient to destroy our civilization. Our civilization has depended on the availability of cheap energy, and as we use up this energy, we will face a neo-Malthusian catastrophe. Indeed as Diamond [47] pointed out many societies have in the past faced such a Malthusian collapse.



Figure 1. The effect of climate change on agricultural production [36].

¹ Chaotic phenomena can, of course, have profound consequences. A chaotic event, an asteroid collision, may have led to the extinction of the dinosaurs.

²See the discussion on theories of the solar system in Peterson (1993).



Figure 2. Climate 100KYBP to now: chaos from 90 to 10KYBP (source: Global-Fever.org).

Zhang [186] provided us with some estimates of the Malthusian effects of climate change. Indeed Tainter and Renfrew [166] argued that all complex societies, including our own, can or indeed will hit a tipping point after which they go into decline³. Ahmed [5] ties this tipping point to the combined effect of peak energy (the increasing cost of obtaining energy), food disruption (due to climate change) and social dislocation. To illustrate, **Figure 2** shows the estimated losses of agricultural production due to climate change.

- **11.** Collapsing political systems In recent years, we have become used to political disorder in the Middle East, Africa, the Ukraine, and we can expect more of the same (Pakistan?). The countries that have experienced such disorder have also been subject to climatic transformations and food disruptions, as can be seen in **Figure 2**.
- **12.** Limits to growth in 1972, Meadows et al. [111] published a book arguing that population growth would eventually give us a world where pollution and the boundedness of the world's resource would have to be faced. Now, 16 years later, the science of climate change has shown the validity of this argument. Hawken [74] covered some of the ways in which we can limit climate change. However, climate change induces a prisoner's dilemma in the behavior of nation states, since no state is willing to adopt costly behavior which will limit the effects of climate change.
- **13.** Markets as prisoners' dilemmas Cassidy [27] argues that markets involve prisoner's dilemmas, what he calls rational irrationality. Since a prisoner's dilemma is fundamentally chaotic, it is not surprising that we can have chaotic market behavior, like the recent turmoil in financial markets. The economic growth that we have experienced since 1945 can be related to the willingness of the United States to act as a hegemon in the creation of the Bretton Woods system of institutions facilitating trade, the protection of property rights and the rule of law.
- **14.** Complexity theory: The notion of chaos has also given rise to the idea of complexity, the possibility that dynamical systems can generate complex phenomena perhaps through evolutionary transformations [89]. A reason to believe this is because of the Godel [61]

³Schofield [147] offers the example of the decline and collapse of the Roman Empire.

incompleteness/inconsistency theorem that mathematics, able to include arithmetic cannot prove that it is both consistent and complete. In addition, Turing's Theorem [175] showed that Mathematics is a subject to a halting problem unable to determine whether an algorithm has or has not been completed, Penrose [132] uses these two results to argue that the mind is not algorithmic, and indeed is creative. We still have no general theory of consciousness, but without doubt we will probably have such a theory in the future that will allow us to construct a better theory of rationality and thus to construct a theory of social choice that will extend Arrow's Theorem [141].

15. MYTHOS As we have suggested, Logos provides humanity with a set of useful clues as to how to understand and thus manipulate the natural world. Knowledge, in the sense of the enlightenment, allowed for the innovations of the scientific revolution. For policy makers, the upshot of these innovations was an often-unstated belief that technology and science would explain and redress the crises that would come to confront humankind. However, thus far, the opposite is true. Even if there was general agreement regarding markets, political methods, and so on, our models are insufficient to capture the scope of these phenomena. Indeed, all our scientific riches put into relief just how defective our model of choosing is.

Therefore, it may be the case that our model of decision-making does not consider the influence of Mythos on human decision-making. Perhaps humans need something beyond rationality. It could be, therefore, useful to look to thinkers like Pope Francis who take Mythos as the starting point for their thought but have deep respect for scientific inquiry. As he writes in his encyclical Laudato [100], pp. 119:

Doomsday [regarding climate] predictions can no longer be met with irony or disdain. We may well be leaving to coming generations debris, desolation, and filth. The pace of consumption, waste, and environmental change has so stretched the planet's capacity that our contemporary lifestyle, unsustainable as it is, can only precipitate catastrophes such as those which even now periodically occur in different areas of the world. The effects of the present imbalance can only be reduced by our decisive action, here and now. We need to reflect on our accountability before those who will have to endure the dire consequences.

Succinctly this captures the quandary policy makers find themselves in. Our climate models indicate disaster on the horizon. On the other hand, our models of decision-making indicate that there is no way to rank policy outcomes in an orderly fashion without influence of a hegemon [Arrow]. However, obviously Francis's thoughts are from an ethical vantage point—the Christian is to be a noble steward of her habitat. Thus, perhaps a religious ideology sympathetic to science, like Francis's theology, can point the way to a better model of choosing.

Author details

Norman Schofield

Address all correspondence to: schofield.norman@gmail.com

Department of Political Science, Washington University, Saint Louis, USA

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