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Rational order from 'irrational' actions

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Abstract
Rational outcomes of a social system do not necessarily require its individual participants to be rational. In macro systems, aggregate properties distinct from the behavior of their micro level components can emerge through complex interactions. Caution in building social sciences on assumption of methodological individualism seems appropriate.

Keywords Complexity · Social systems · Rationality · Zero intelligence · Methodological individualism

A fundamental societal economic problem is not that often we fail to choose the best course of action by intuition, or even by deliberation; instead, the problem is what we do, can do, and how, to achieve relatively efficient outcomes despite the limitations of our cognitive capabilities. Throughout history, humans have devised social mechanisms—norms, laws, and institutions—to help govern these shortfalls and their respective outcomes. In economics, the price or market system of private goods is one of these mechanisms.

People acquire information not only when they seek it, but also from just existing in the world—e.g., noticing a pothole while driving home and remembering to avoid it in the future. In the price system, bits of information that people have influence their actions. Markets can aggregate this dispersed information from the participants, and disseminate it among all the participants for their use. In other words, rational order can *emerge* from interaction among individuals, each possessing limited cognition and only small bits of information about the total picture.

At first glance, the creation of a rational order may not appear to be a major challenge. It should be straightforward to gather relevant information in one place, such

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as human or computer memory, and use it to arrive at a decision before implementing it to attain a rational outcome. However, each step in achieving a rational order faces serious obstacles. First, as Hayek points out, when information is widely dispersed, there is no good way of reliably sharing it with others—especially with a central authority—because distortions occur from people anticipating and fearing that the information provided will be used to harm them. (Also, finding competent but benign central planners who can be trusted not to use their privileged position to make self-serving decisions is difficult.) Second, as Simon (1957) and Gigerenzer et al. (2000) point out, when guided by intuition alone, individual behavior often deviates from a rational standard in important ways, and people resort to either bounded rationality or heuristics efficiently, but only satisfactorily to attain their goals. The derivation of a rational order from rational behavior (e.g., in mathematical models exemplified in the approach of Paul A. Samuelson and Robert E. Lucas) can fail to correspond to the observed world if either the relevant information is not available in one place, or if individual behavior does not correspond to the chosen axioms of what is assumed to be rational.

Complexity theory in physics suggests that a distinct macro order can *emerge* from interactions among micro-level components of larger systems. In other words, the properties of the macro order can be quite different from the properties of the micro order. Natural science and social science are replete with examples: the properties of a crystal of common salt have little in common with the properties of its sodium and chlorine atoms; macro properties of water sloshing in a jug or waves moving across the ocean surface, have little in common with the water molecules executing rapid three-dimensional Brownian motion in random directions.

Social norms such as marriage, school and markets are examples of continuing evolution through which macro order emerges from individual activities, and yields very different social outcomes. Scholars of Scottish Enlightenment recognized this phenomenon, as reflected in the words of Ferguson (1767): "… the result of human action, but not the execution of any human design…", and Smith (1776): "… he intends only his own gain, and he is in this, as in many other cases, led by an invisible hand to promote an end which was not part of his intention."

Recent studies of price systems take us another step by further weakening the need for pursuing individual gain on which Ferguson and Smith base their argument. Gode and Sunder's (1993, 1997) studies of price systems find that even with extremely weak forms of "striving" (labeled zero- or minimal-intelligence (ZI/MI) on the part of individuals), price systems can yield near perfect order—one hundred percent allocative efficiency—at the macro level. These simple artificial agents have become spelunkers to current and potential explorations of the properties of complex social systems such as markets, regulation, elections, hierarchies, villages, and schools. The following paragraphs briefly describe some of these findings.

Plott and Sunder (1982) reported the first scientific evidence for the popular "efficient markets hypothesis" from their controlled laboratory experiment in which human traders faced uncertainty and asymmetric distribution of information (some traders were informed while others were not). When traders attempted to earn money, information in the hands of the informed traders became incorporated into market phenomena observable to all traders in such a way that even the

(initially) uninformed traders began to behave as if they were informed, and the market yielded efficient outcomes as if information was disseminated to all the participants throughout the experiment.

Plott and Sunder (1988) examined the ability of price systems to execute Hayekian aggregation of dispersed bits of information among market participants. In order to aggregate information (and achieve high levels of efficiency), the markets must be either complete (so traders can take positions on any possible combination of contingencies) or have identical preferences. Obviously, when both conditions are fulfilled, markets aggregate diverse information more easily. We now know that markets can produce rational order from the participation of profit-motivated human traders who have randomly dispersed information. The Hayek conjecture has been shown to have support in data.

Even as we observe aggregation and dissemination of information in certain kinds of markets, we still do not understand how and why this happens by assuming methodological individualism, as Arrow (1994, p. 8) points out:

> In the usual versions of economic theory… it is necessary to base all accounts of economic interaction on individual behavior… under the name of *rational-actor* models. … In fact, every economic model one can think of includes irreducibly social principles and concepts … social variables, not attached to particular individuals, [which] are essential in studying economy or any other social system.

Gode and Sunder (1993) replaced human traders in their double auction market experiment with simple computer algorithms or robotic traders. When these algorithms generated uniformly-distributed random numbers as bids (an offer to buy) and asks (an offer to sell) subject only to their budget constraint—do not bid a price above what the object is worth to you, and do not ask a price below the cost of the object (in other words do not propose a trade that could results in a loss)—the markets are nearly 100% efficient allocatively. In economics terms, the total of all traders' profits achieves its maximum possible value. This rational order emerges at the aggregate (or market) level from the chaos of individual traders' random actions when a simple no-loss constraint is imposed.

Rational order is achievable in simple price systems, even in the absence of Ferguson and Smith's "striving" by individuals. Some three decades before Gode and Sunder (1993), Becker (1962) had shown that the downward slope of demand functions arises from random consumer choice from their budget sets, and diminishing marginal utility is not necessary. In the same year and journal, another future Nobel Laureate Vernon L. Smith (1962) reported that a handful of profit-motivated student traders could achieve near perfect market outcomes in double auctions under far-from-perfect market conditions. Gode and Sunder had, in effect, replaced Smith's human traders by Becker's random choice and added Smith's market institution to discover rationality as an aggregate-level property of social institutions (price systems in this case) largely independent of an individuals' micro-level behavior.

During the past three decades, the idea that simple or random behavior can generate complex and rational order at an aggregate level has been applied in

many other contexts outside economics to fields such as other social sciences, computer science, ecology, energy networks, and electrical engineering. Convergence to Bayesian prediction (Jamal and Sunder 1996), non-binding price controls (Gode and Sunder 2004), learning competitive equilibrium (Crockett et al. 2008), minimal market institutions (Huber et al. 2010), monetary theory (Angerer et al. 2010), and stock markets (Farmer et al. 2005) are a few examples of this expanding research field.

Logically-derived equilibrium outcomes from assuming unrealistic rationality (and cognitive ability) assumptions about individuals can be observed in markets populated by minimally-intelligent algorithmic traders. Limitations of human cognition are well known, but it does not mean that rational social order derived by ignoring such limitations are necessarily wrong. Social outcomes depend not only on individual behavior, but also on the structural properties of the institutions that define their interactions. The fundamental lessons of complexity theory and emergence apply to social science just as they do to natural science.

How does the price system help create a *rational order* in spite of the imperfections and limitations of "irrational" individuals who participate in it? To quote Hayek:

> Civilization advances by extending the number of important operations which we can perform without thinking about them. This is of profound significance in the social field. We make constant use of formulas, symbols, and rules whose meaning we do not understand and through the use of which we avail ourselves of the assistance of knowledge which individually we do not possess. We have developed these practices and institutions by building upon habits and institutions which have proved successful in their own sphere and which have in turn became the foundation of the civilization we have built up. (1945, para 25).

Rational order can arise without rational decisions. Design can emerge without a designer.

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