Journal of Economic Behavior & Organization 82 (2012) 352–367

Contents lists available at ScienceDirect

Journal of Economic Behavior & Organization

journal homepage: www.elsevier.com/locate/jebo

The anatomy of emergence, with a focus upon capital formation

David A. Harper[a,*], Anthony M. Endres[b]

[a] Department of Economics, New York University, 19 West 4th Street, New York, NY 10012, USA
[b] Department of Economics, University of Auckland, Private Mail Bag 92019, Auckland, New Zealand

ARTICLE INFO

Article history:
Received 27 August 2010
Received in revised form 23 March 2011
Accepted 27 March 2011
Available online 28 April 2011

JEL classification:
B52
B53
D21
D24
E22
L23
012
031
033

Keywords:
Emergence
Evolutionary dynamics
Complexity
Capital
Production
Innovation
Spontaneous order

ABSTRACT

Emergence is a unifying theme of both evolutionary economics and complex systems theory. In spite of this centrality, emergence in economics has not been subject to an extensive critical analysis. This paper remedies this deficit. We identify several conditions that economic patterns (i.e. rule-systems, structures) must satisfy to qualify as emergent: (1) material realization (emergent patterns are realized in physical structures and processes); (2) coherence (pattern is not a mere aggregate but a systemic whole); (3) non-distributivity (pattern possesses global properties absent from its parts); (4) structure dependence (systemic properties depend upon connective structure). These four core features are common to all forms of emergence in economics. Evolutionary economic systems also exhibit extra-strength versions of emergence, which require that patterns possess one or more additional features: (5) genuine novelty; (6) unpredictability in principle; and (7) irreducibility. We introduce three basic forms of emergence that occur in economic systems—minimal, diachronic and synchronic emergence—and apply these ideas to capital formation at all levels of economic order. The economy-wide capital structure exhibits strongly emergent properties (both diachronic and synchronic) that depend on its structural and functional organization; it is not a mere aggregate of capital goods. Within the realm of capital phenomena, we also compare the distinguishing characteristics of emergent and spontaneous (self-organizing) orders. We provide a case study of the iPhone as an emergent capital pattern to illustrate conditions (1)–(7) above and the different types of emergence.

> Add successively as many mail coaches as you please, you will never get a railway thereby.
> (Schumpeter, 1934, p. 64).

1. Introduction: why emergence matters

Economics is at the dawn of a new age, "the complexity era", which is organized around a vision of the economy as an evolving complex system (Colander et al., 2004, 2010; Beinhocker, 2006). Emergence is a key generic property of such a complex adaptive system; indeed, it is what makes economies become complex. (For now, emergence is tentatively defined as occurring when wholes (combinations of things) produce structural or functional effects that are qualitatively different from what the parts can produce alone (Corning, 2005, p. 51).) Economic evolution does not consist in just churning out

* Corresponding author. Tel.: +1 212 998 8959; fax: +1 212 995 4816.
E-mail addresses: david.harper@nyu.edu (D.A. Harper), a.endres@auckland.ac.nz (A.M. Endres).

0167-2681/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.jebo.2011.03.013

more and more clones of existing types of goods and services or mere quantitative variation in macro-aggregates. It does not fill up economic space with mass-produced replicas of the same original pattern (Boulding, 1966). Economic evolution is fundamentally a process of emergence that perpetually produces novelty—new routines, new capabilities, new technologies, new firms, new networks, new markets and new institutions.

Economists use emergence to address two key questions: (1) What is the nature of order in economic systems? (2) What is the nature of economic change? Applying emergence to tackle the first question involves studying patterns of ordered complexity at multiple levels in the economy and their structural features. It also involves examining the general qualitative characteristics of different types of economic order, including both "grown" orders (e.g. self-organizing markets) and "made" orders (e.g. business firms) (Hayek, 1973, p. 155). For instance, the newer complexity modeling uses emergence to study a range of self-organizing phenomena, such as the formation of markets, trade and financial networks, social structure, residential segregation, urbanization and complex patterns in financial markets, such as herding behavior (Arthur et al., 1997; Miller and Page, 2007). Economists use emergence to examine the way in which elements connect and interact to make larger structures and the multi-level processes that coordinate economic activities across space and time. Economic order is an emergent phenomenon that is brought about by the interplay of agents and rule-systems that economize on agents' knowledge of what to do and how to do it.

Emergence also bears upon fundamental questions about the nature of change in economic systems: the general characteristics of economic change, its sources, the conditions in which new kinds of patterns come into being, the interactions and processes that constitute economic change, and the effects that changes in patterns of connectivity can have on the economy as a whole. Emergence sheds light on discontinuities in economic processes, including those associated with "anagenetic moments" when a new level of ordered complexity arises for the first time (e.g. Rosser et al., 1994). Evolutionary economists in particular invoke emergence to explain endogenous change in economic systems over time. They use emergence to study the forces that propel economic evolution—the ongoing generation of novelty and variety upon which selection processes can operate and without which economies stop evolving (Hodgson, 1997).

In spite of its pervasiveness, emergence is elusive and nebulous, proving to be "a mysterious, almost paradoxical, phenomenon" (Holland, 1998, p. 2). Indeed, in a wide range of applications, economists often use the term "emergence" as a generic byword so that it becomes "more evocative than precise" (Ioannides, 2008, p. 1). They know that emergence is going on out there in the economy but they cannot pin it down. To add to the confusion, economists tend to mix ordinary and technical uses of the term and to conflate emergence as a process with emergence as a product. Moreover, they sometimes fail to make clear whether emergence is the phenomenon to be explained or whether it is included in the data of their explanations of some other phenomenon.

All in all, the economics literature seems to be an incomplete patchwork of fragmented notions of emergence. Scholars selectively pick out one or more characteristics of emergent phenomena and ignore other relevant dimensions of emergence. Formulations of emergence in different fields have been imprecise and not that consistent with each other. For instance, in agent-based models of complexity, emergence is the outcome of self-organizing, bottom-up growth. Emergent phenomena are generally recurrent and familiar patterns that are fully reducible to a few simple micro-rules governing individual behavior of heterogeneous agents (Epstein and Axtell, 1996; Rosser, 1999). Although novelty is a useful heuristic which complexity researchers use to spot potential instances of emergence, novelty itself is not a defining property of emergence in the newer complexity approach (Holland, 1998, p. 5). In contrast, according to evolutionary-institutional economics, genuine novelty is the single most important hallmark of emergence. Emergence is a process that generates new connections and qualitatively novel structures within the economy. Emergent phenomena, such as technological change and industrial clustering, are meso-economic in nature and are not reducible in an ontological or an explanatory sense (Dopfer and Potts, 2004; Elsner, 2010). In addition, emergent patterns and institutions may also exert downward causal effects at the micro-level through changing individuals' habits, purposes and preferences (Hodgson, 2002). The upshot is that even though emergence is a central unifying theme of different branches of economics, there is little consensus on what phenomena qualify as emergent and emergence itself has not been subject to extensive critical or systematic analysis.

Consequently, this paper aims to remedy this deficit. We provide a systematic elucidation of the nature of emergence by providing a comprehensive realist framework that maps out the full scope of emergent phenomena in economic life. We investigate what emergence really is, as it actually occurs "out there" in the world as an objective feature of the economy. In a real-world economy, how are the effects generated by new combinations of things different from what their constituent parts produce separately? The objective is to examine if and in what sense different types of economic entities can be considered to be emergent. Accordingly, by drawing upon Stephan (1998), Wimsatt (1997) and Bunge (2003), Section 2 specifies systematically the formal conditions for emergence that real economic patterns must satisfy to qualify as emergent phenomena. At the end of this section, we provide a case study of the iPhone to illustrate these conditions.

Sections 3 and 4 apply our framework to show how emergence can elucidate the nature of the capital order in real-world economies, how it is structured, and how capital forms and changes at various levels of complexity, thereby shedding light on deeper processes of capital formation. Capital is defined here broadly to include any resource—whether natural, artifactual or human—that yields a flow of services people desire over time (Fisher, 1906). Section 3 identifies three basic forms of emergence that occur in capital structures and other economic patterns—minimal, diachronic and synchronic emergence. In Section 3.1, we return to the iPhone case study to illustrate these types of emergent capital patterns. Section 4 compares the distinguishing characteristics of emergent and spontaneous orders of capital. Such an investigation is important because economists typically conflate these two kinds of patterns.