

# Evolutionary Economic Theory

Evolutionary economics explains change over time with respect to economic development.

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**How to cite:** Michael, K. & Abbas, R. (2023) *Evolutionary Economic Theory: A review*. In S. Papagiannidis (Ed), [TheoryHub Book](#). Available at <https://open.ncl.ac.uk> / ISBN: 9781739604400

## Theory Factsheet

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**Proposed By:** Nelson & Winter, 1982

**Parent Theory:** Evolutionary theory, General Darwinism

**Related Theories:** Neoclassical Economic Theory

**Discipline:** Economics

**Unit of Analysis:** Organisation, Institution

**Level:** Meso-level

**Type:** Theory for Analysing

**Operationalised:** Qualitatively / Quantitatively

## Introduction

Economic theory is the study of how economies work. Evolutionary economics is broadly concerned with how economic change occurs, and is focused on innovation and entrepreneurship, industrial and institutional dynamics (as opposed to profits), and on patterns and trends as they relate to economic growth and development (Hodgson, 2019). Fundamental to the ideology of evolutionary economics is that innovation and economic change are intertwined (Ayres, 2000; Ayres, 1953). Theorists employing an evolutionary economic approach are typically concerned with economic growth, productivity, and stakeholder interactions. Planners that adopt principles of evolutionary economics are concerned with infrastructural, structural, and institutional changes and impacts over time. Practitioners, on the other hand, most of whom manage technology development, focus on innovation processes and systems of innovation and technological change as it might impact on economic development (Nelson, 2008; Schot & Steinmueller, 2018). Central to evolutionary economics is the notion that the world is complex and dynamic. Accordingly, Metcalfe (1998:8) proclaims: “*innovation-driven economic processes are open-ended with the economy never in equilibrium, or even close to equilibrium... Outcomes are to be discovered, not presumed in advance of an event*”. Thus, evolutionary economics is said to be non-directed, lacking predetermination to a given endpoint (i.e., it is not teleological). As innovation (i.e. technological change) is considered on a

continuum over time and as a phenomenon that is unfolding, stakeholders are engaged in a practice of co-evolution where they are building together a knowledge program through the exchange of thoughts and imagination (Witt, 1998; Dopfer, 2001).

In this innovation environment, technologies impact the way supplies are procured, and goods are produced, and consequently, organisations and citizens have to co-evolve in larger processes to observe technologies in continuity (or discontinuity, if fit is not achieved). Co-evolution comes into practice when several evolving domains or areas within a socio-economic system reciprocally impact one another's innovation, reproduction and/or choices. In effect, co-evolution can be analysed as a process at a global level, demonstrating dynamic co-determination toward shared agreement between stakeholders (Almudi & Fatas-Villafranca, 2021). The interdependencies and interconnections between "clusters" of stakeholders yield the creative ability to co-create (Potts et al., 2008; Pitelis, 2012).

Evolutionary economic theory has made possible the reinterpretation of microeconomics and macroeconomics using evolutionary concepts and ideas (Dopfer, 2001). It proposes that economic and industrial processes emerge over time, driven by humans who assemble into communities within society at large and for the greater part they self-organise (Andriani, 2001). It is humans who together are able to conceive of new innovations that can be designed and implemented (Witt, 2001). The study of evolutionary economics is wide-ranging and may be located in any number of disciplines or schools, e.g., within business, sociology, innovation studies, science and technology studies, demonstrating its interdisciplinarity and reach in terms of influence and inspiration. It is closely related to other social sciences where economics may feature as a joint focus, such as in the study of economic sociology, economic anthropology, and the political economy.

## Theory

### Background: Evolutionary Theory Basis

The parent theory of evolutionary economic theory is evolutionary theory, attributed to Charles Darwin, who published *On the Origin of Species* in 1859, focused on natural selection (Cordes, 2015:431-432). General Darwinism (GD), also known as universal Darwinism or universal selection theory (Cordes, 2015; Witt, 2008), is when the Darwinian concept of natural selection is applied outside of the biological sciences, for example, in the fields of economics, psychology, medicine and culture (Hodgson & Knudsen, 2008). Many fundamental principles of GD were applied to the field of economics toward the end of the 1800s.

Relevant to evolutionary economic theory, Thorstein Bunde Veblen (1857-1929) is widely considered the founding father of the evolutionary-institutional paradigm (Elsner, Heinrich & Schwardt, 2015; Lewis & Steinmo, 2012), and to whom can be attributed the first coining of the term "evolutionary economics" in English (Hodgson, 1994). Veblen did not believe that neoclassical economics could be considered a modern science, since it pre-dated Darwinian thinking (Elsner, Heinrich & Schwardt, 2015). Neoclassical economics is concerned with the production function (Solow, 1957), viewing advances in technology (i.e., a fixed capital factor of production) as fuelling economic growth "by lowering the cost of making an output" (O'Neill, 2001:1526). Veblen recognised that the fundamental weakness of neoclassical economics was that "only prices and volumes matter" (Edquist, 1997:48). He applied evolutionary biological concepts to economics and noted that the process of change, in the definitive formulation of knowledge, was a gradual one (Veblen, 1898). Veblen was considered a radical economist by many for his views on the "predatory business culture" (Elsner, 2014:329), which he believed caused major inefficiencies and waste in the economy due to vested interests (Veblen, 1898).

Unlike traditional economics, which used rational choice theory, Veblenian evolutionary economics argued that human nature, namely anthropological and psychological factors, were the key drivers of the economy (Elsner, Heinrich & Schwardt, 2015). Veblen had determined that the industrial process had been usurped by individual financial investors and financial organisations, and the very wealthy, who sought to maximise profits for short-term gain, even at the expense of provisioning for society at large (Elsner, Heinrich & Schwardt, 2015). Veblenian evolutionary economics today is an interdisciplinary paradigm in the social sciences with great influence on the study of complexity in economics (Elsner, Heinrich & Schwardt, 2015; Frenken, 2006).

## Definition of Evolutionary Economic Theory

Scholarship in the field of evolutionary economic theory emanated from Simon (1955), Cyert and March (1963), and Penrose (2009), among others (Cordes, 2015). Evolutionary economic theory is defined in the seminal work of Nelson and Winter (1982), and is now part of mainstream economics (Friedman, 1998), developed as an alternative to neoclassical theory, which was strongly inspired by Schumpeter's *Theory of Economic Development* (Schumpeter, 1934; Nelson, 2008). Nelson and Winter claimed that *"firms are not profit maximizers but follow rather rigid rules or routines, and agents, including managers, are only boundedly rational"* (Cordes, 2015:432).

In the context of innovation, evolutionary economic theory views technical change as something other than an attempt to maximise profits and is characterised by the concepts of reproduction, variety and selection (Edquist, 1997). Technological advancement is considered a key driver in evolutionary economic theory, co-evolving through the interaction of firms and industry structures and supporting governing institutions (Hall & Rosenberg, 2010). It is also about the manner in which technological development can lead to assimilation, as countries lagging behind the frontier attempt to catch up to achieve fundamental wellbeing for all, as opposed to being preoccupied with investments and human capital leading to accumulation (Nelson, 2008). The advantage of evolutionary economics over neoclassical economics is in its level of analysis, whereby the key players, i.e., the agents, are not individual persons but groups of people, identified as *"firms"* or other *"organisational units"* at the level of *"industries, sectors, branches, markets or whole economies"* (Vromen, 2012: 738). Evolutionary economics *"acknowledges heterogeneity within industries between firms. But it seems to pay considerably less attention to the heterogeneity within firms between firm members"* (Vromen, 2012: 739).

Evolutionary economic theory is characterised by three underlying pillars: (1) system dynamics, typified by a continuous process of innovation, where conditions emerge from within the economic system endogenously; (2) time (as in the historical element), which indicates a given irreversible path dependency (lock-in); and (3) the process of innovation, from invention to diffusion (Witt, 1987). The first pillar of evolutionary economics notes that innovation is not a matter of *"chop and change"* but is related to the *"very structure and function of the object"* (Sahal, 1981:64). It is not about measuring discrete events to identify how change happens, but change is a continuous process (Sahal, 1981). Due to the randomness and time-consuming nature of innovation processes, evolutionary models of technological change are more realistic when it comes to understanding innovations than the models provided by neoclassical economics, thus overcoming an obvious limitation (Nelson, 1981). The second pillar of evolutionary economic theory pertains to the element of time and the historical choices that determine a particular way forward. Edquist (1997:6) affirms that *"...technological change is an open-ended and path-dependent process where no optimal solution to a technical problem can be identified"*. The third and final pillar of evolutionary economic theory pertains to the process of innovation (Metcalf, 1998:3). In effect, it is the activity of organisations and associated actors or agents, coming together to learn, share, and produce knowledge that may lead to an innovation that will have an impact on the economy and on humans

as they adopt technologies (i.e., products and processes). Technical change was thus declared an evolutionary process in the 1980s (Nelson, 1987) and supported by well-known evolutionary economists and several journal publication outlets dedicated to the field (Vromen, 2012), among them the *Journal of Evolutionary Economics*.

## Foundational Concepts

Evolutionary economics is typified by the distinguishing principle of selection (Knudsen, 2002). Humans demonstrate goal-directed behaviour, which renders selection, variation, and inheritance as interdependent mechanisms. Economic agents thus choose between alternatives, products, ideas, in one off selections, according to a criterion of preference (Cordes, 2007). According to Lindley (1997:25), *“(t)he selection environment acts to influence the path of innovation and the rate of diffusion generated by any given innovation, and at the same time generates feedback to strongly influence the direction and type of R&D programs that firms might invest in”*. Importantly, the selection environment does not discount technologies co-existing, mutating or recombining to form new products through processes of innovation (Michael, 2003).

Another fundamental concept of evolutionary economics is that of technological trajectories, also known as natural trajectories, defined as a pattern of innovation (Dosi, 1982). Citing von Hippel (1988), Breschi and Malerba (1997:144) defined technological trajectories as the *“continuous improvements of products in terms of performance and reliability and in the tailoring of products to specific users’ needs, within specific application contexts”*. Each firm follows a technological trajectory in search of continuous improvements to their existing products (Edquist, 1997), in pursuance of *“a single technical option... committed to a single technological trajectory”* (Saxenian, 1996:112; Murmann & Frenken, 2006).

Path dependency is closely associated with the concept of technological trajectory. Ontologically, individuals produce knowledge by self-organising with one another, forming informal and formal groups, and creating new entities by enacting change (Mueller & Cantner, 2000). When these groups interact, in a path-dependent sequence of economic changes, temporal events can influence outcomes by chance rather than being driven by what is known as “systematic forces” (David, 1985:332). The basic design of a technological innovation acts as a guidepost charting the course of future innovation activity along a dependent path (Wijnberg, 1994; Nooteboom, 1999). One or two early models of a product or process usually stand out above all the others in the history of an industry and their design becomes the foundation for the evolution of many other innovations (Sahal, 1981). Following on from this, the concept of creative symbiosis is the case where *“two or more technologies combine in an integrative fashion such that the outline of the overall system is greatly simplified... when it happens, totally new possibilities for further evolution present themselves”* (Sahal, 1981:75). The related notion of creative destruction is that which fuels economic change via the introduction of new patterns of behaviour, be it technological, organisational, or social, which are particularly linked to decentralised and distributed practices that are regenerative, away from the former centralised models (Metcalfe, 1998; Raworth, 2018).

The above-mentioned presentation of the foundational concepts in evolutionary economic theory revolve around technical change, at the heart of which is the historical element (Saviotti & Metcalfe, 2020). Firms innovate along a given path, making use of guideposts, and over time a single dominant design develops on a technological trajectory. When there is more than one choice of innovation, a selection environment exists whereby stakeholders provide feedback to influence the direction of research and development. Technologies can also combine toward creative symbiosis.

Understanding systems phenomena demands knowledge of the interactions at the component level as product and service innovations emerge. When new patterns of innovation form, causing a shift in the way things are done from a variety of perspectives, creative destruction is said to take place,

giving birth to new ways (practices and procedures in production) and new things (products and services in application).

## Theory Updates/Extensions

Extensions to evolutionary economics can be theoretical and methodological in nature (Witt & Chai, 2018).

### Theoretical

Until recent times, evolutionary economics has been concerned predominantly with supply side economic activity (Nelson, 2013). However, the *“new evolutionary economics”*, as it has been touted, has sought to rebalance this endeavour by emphasising the importance of those factors affecting the demand side (Schlaile et al., 2018). In posing the question *“where do we go from here?”*, there is a need for *“better treatment of how households respond to an economic world that is constantly changing around them, as they themselves change”* (Dopfer & Nelson, 2018:216). The challenge for evolutionary economists is: *“to construct a theory of demand and supply and their interaction on markets that are not changing too erratically that is consistent with the basic tenets of evolutionary theory”* (Nelson, 2013:19).

An important focus is the study of consumer reaction to a growing choice of goods and services, which heavily influences a pattern of evolution. This emphasis to theory opens up new horizons for evolutionary economics (Nelson, 2013). To be concerned with the supply and demand sides alone, as we generally conceive them, is not enough. We require the incorporation of an *“adequate theory (that) needs to recognize the rich mix of institutions that are involved in economic activity”*, inclusive of the various roles of government, beyond the firm, households and markets, toward co-evolution of technologies in use and associated institutions that regulate these (Nelson, 2008). One such study investigated the social and cultural demand side factors within the context of the development of automatic identification and location-based services (Michael, 2009). Additionally, the study incorporated the role of public research institutions and auxiliary actors in propelling innovation at the technological level. Successful economic development involves the co-evolution of technologies, appropriate firm and industry structures, as well as broader economic institutions. In addition, government policies and programmes are essential to this process of change (Nelson, 2008).

### Methodological

In methodology, early studies typically gave verbal descriptions of national innovation patterns, while the number of utilized indicators of innovative activity was small (Balzat & Hanusch, 2004). These studies have been largely characterised by descriptive and policy-oriented research with the development of analytical models to accomplish more comparative capabilities between nations, despite attempts at numerical performance comparisons, such as the calculation of index numbers (Balzat & Hanusch, 2004). Simulation models may also be helpful in the future, especially through formal evolutionary models that run in parallel to empirical work (Nelson & Winter, 2002:39). These simulation models offer formal methods that are explicit as well as analytical toward proofs that may help to shed light on dynamic systems, explaining economic growth with a focus on the size distribution of firms. Closely linked to the evolutionary modelling efforts described here is a class of formal models at the level of the individual organization, typically focused on *“related issues of structure, coordination and organizational learning”* (Nelson & Winter, 2002:41).

One reason found in the literature for a somewhat retracted adoption and application of evolutionary economics has been the lack of simplified and abstract “formal” methods, in

comparison, for instance, to neoclassical treatments of price theory. Nelson's hope was to raise awareness of the benefits of what he calls "appreciative" theory to lay the foundations for knowing "what is really going on" before developing *"an evolutionary-economics-compatible price theory built on the same set of assumptions about economic behavior and economic contexts that characterize the rest of evolutionary theory"* (Nelson, 2013:19). The difference between "appreciative theory" (i.e., mostly expressed verbally) and "formal theory" was that the latter was closer to empirical details of the subject matter, which are often abstracted in the form of a mathematical model for logical exploration and manipulation (Nelson, 2008:19). Nelson and Winter (2008:19) *"argued that in economics most of the empirical research and interpretation of empirical phenomena was structured by appreciative theory"*. A great deal of evolutionary economics has dealt with empirical observations, though this has not been the case for all researchers in this domain, some more aligned with pragmatic realism (Dopfer & Nelson, 2018). Modern evolutionary theory provides a framework that is helpful in the analysis of economic dynamics (Nelson, 2008:19). It is in this regard that there is a stark distinction between the scholars who have held strongly to neoclassical theory, without acknowledging the contributions of the evolutionary economists.

Nelson (2008:13) wrote that theory should be able to take advantage of both qualitative and quantitative approaches, such as those found in the accounts of economic historians, also maintaining that *"a satisfactory theory needs to specify correctly the basic processes driving economic growth"*. Both deductive and inductive research is performed by evolutionary economists (Boschma & Frenken, 2006) and empirical studies take the form of varied approaches, including social network analysis, chain-link modelling, distributed process modelling, development block theory, agent-based modelling, evolutionary game theory, among others. Further, existing analytical techniques have been applied to evolutionary economic studies in novel ways (Edquist & Hommen, 1999; Carlsson et al., 2002; McMaster & Watkins, 2012). While rigorous mathematical models have their place in economics, evolutionary economists prefer scalable design questions that would enable ways forward using historical analysis.

## Applications

One stand-out characteristic of *"modern evolutionary economics"* has been its attempt to be a bridge builder across the borders of an organisation, across disciplines, across generations, and across societies, particularly because history matters (Nelson & Sampat, 2001:1). This has meant that interdisciplinarity has been increasingly embraced by theorists working in the evolutionary thinking space, particularly in the field of evolutionary economics. Take for example, how evolutionary economics has been a catalyst for bringing aspects of sociology, psychology, network science, evolutionary biology, nonlinear dynamics, and chaos theory together, among other areas (Schlaile et al., 2018). When evolutionary economics is adopted, *"(t)he particular intellectual barriers attributable to differing rationality assumptions are lowered significantly (although many other barriers remain)"* (Nelson & Winter, 2002).

In its essence, evolutionary economics was an evolutionary mechanism of systems, organisations, and technology, requiring a transdisciplinary approach for evolutionary controversies to be better understood (Japan Association for Evolutionary Economics & Aruka, 2001). The result is significant levels of interdisciplinary engagement (Nelson & Winter, 2002). The advantages that evolutionary economics offers begin with interdisciplinary dialogue, as it *"has open frontiers, lives with other disciplines in what is recognizably the same intellectual world and has much to offer and to gain from trade"* (Nelson & Winter, 2002:42). However, the field to date has suffered from specialisation, and to an extent fragmentation (Hodgson & Lamberg, 2018). A unified theory of evolutionary economics should be presented to demonstrate the superiority of the approach over neoclassical economics (Shiozawa, 2004).

Methodologically, studies in evolutionary economic theory have varied widely in terms of approaches. Some evolutionary economists utilise evolutionary theory analogously, borrowing from the core concepts in metaphor (Nelson & Winter, 2002), while others directly apply concepts and models from the theory (Metcalf, 1994). This has led to vastly different approaches to data collection, depending on the goal of the research. A great number of national innovation systems studies, for example, utilise empirical data through survey instruments, or factual descriptive statistics, or even pragmatic sources of evidence (Foster & Hözl, 2004). This is not to say that some evolutionary economic studies were not also in some instances wholly exploratory, conceptual, and appreciable by nature (Sharp, 1985). A mixed methods approach using case studies containing quantitative and qualitative data is also common, especially when related to presenting national innovation systems.

*National Systems of Innovation: A Comparative Study*, edited by Nelson and Rosenberg (1993), was a seminal contribution propelling innovation thought and application forward. A case study methodology to investigate the national systems of innovation of fifteen countries was used. The book was intended to emphasise empirical evidence first and confirm theory second. Findings from the case studies suggested that thinking of systems of innovation at a national level was appropriate, although there were challenges with identifying national borders (Nelson, 1993), with varying economic and political circumstances. As noted in the literature possible directions were to extend the national innovation systems (NIS) approach with a future research focus toward both sectoral and regional perspectives, inclusive of cluster theories (Balzat & Hanusch, 2004; Geels, 2004). Systems of innovation have become central to “*shifting the research agenda*” asking “*what does history mean in relation to (envisaged?) future options? How can the system itself be informed reflexively with respect to its self-organizing capacities?*” (Leydesdorff, 2001:13753; Leydesdorff, 1995 :296). A selection of readings is provided in Table 1, representing innovation systems conceptual and empirical cases at the national, regional, sectoral, technological, and local innovation systems levels.

**Table 1: Levels of Systems of Innovation**

Source	Level of Innovation System	Location	Industry Type
(Carlsson, 2012)	Technological	N/A	Factory automation
(Capron, Meeusen & Muller, 2000)	National	Belgium	Any
(Chung, 2002)	National, regional	General	Any

(Cooke & Morgan, 2014)	Regional	Baden–Württemberg, Germany	Automotive, optics, software, mechanical engineering
(de la Mothe & Paquet, 2012)	Local, regional	General	Any
(Dodgson et al., 2008)	National	Taiwan	Biotechnology
(Doloreux, 2002)	Regional	General	Any
(Edquist, Eriksson & Sjögren, 2000)	Regional	East Gothia (Sweden)	Product innovation with emphasis on manufacturing firms
(Franco & Mani, 2009)	Sectoral	Developing countries	Actors, structure, evolution
(Grubler et al., 2012)	Technological	N/A	Energy sector
(Herstatt et al., 2008)	National	India	Corporate
(Intarakumnerd, Chairatana & Tangchitpiboon, 2002)	National	Thailand	Any
(Leydesdorff & Strand, 2013)	Regional, national	Sweden	Knowledge economy
(MacDowall, 1984)	Technological	Japan	Product innovations
(Motohashi, 2005)	Technological	Japan	Technology firms
(Mowery, 1992)	National	USA	Any
(Nelson, 1993)	National	Comparative	Any



(Niosi, 2000)	National	Canada	Any
(Sun, 2002)	National	China	Any
(Lall & Urata, 2003)	Technological	East Asia	Technology sector
(Wieczorek et al., 2013)	Technological	N/A	Wind innovation
(Zhu & Tann, 2005)	Regional	Zhongguancun, China	Any

## Limitations

From the very start, evolutionary economics was oriented to the “*system level (or the ‘population’ level)*” (Winter, 2014:629). Two paramount aspects when studying innovation systems that require further research are: (1) complexity; and (2) the incorporation of non-market institutions (e.g. university and public research systems, scientific and technical societies and government programmes) (Nelson, 2008:12). The “*lack of a system view*” is a significant problem, and not just for evolutionary economics but for society at large (Winter, 2014:639). For Winter, looking at the economy through the lens of a “system” usually equated to sound economic policy, even though the economics discipline in general required an intervention. One of these interventions came in the form of an “*analytical framework for evolutionary economics with a micro–meso–macro architecture*” (Dopfer, Foster & Potts, 2004:263). The micro was defined as the “*individual carriers of rules and the systems they organize, and macro consists of the population structure of systems of meso... The upshot is an ontologically coherent framework for analysis of economic evolution as change in the meso domain... and a way of understanding the micro-processes and macro-consequences involved*” (Dopfer, Foster & Potts, 2004:263). Another complementary intervention beginning in the early 1990s was how evolutionary economic themes were brought together in the concept of a (national) system of innovation; “*that set of distinct institutions which contribute to the development and diffusion of technologies and which provides the framework within which policies are implemented*” (Metcalf, 1994:940). Consider also that there are a variety of theories of change, and evolutionary economic theory captures only one of these; other basic theories of change in organisations include dialectical, life cycle, and teleological (van de Ven & Poole, 1995).

One of the strengths of evolutionary economic theory is arguably one of its weaknesses. The new breed of evolutionary economists are revolutionaries and not merely revisionists like those practising “evolutionary theorizing”, taking a radically different stance to “*standard theoretical approaches in economics*” (Vromen, 2012:739-740). Not all economists perceive the theory favourably, although it is considered “*mainstream economics*” (Friedman, 1998; Hodgson, 1999; Hodgson, 2007). For example, evolutionary economics has continued to migrate between “*departments of economics to business schools, institutes of innovation studies and elsewhere*” (Hodgson, 2019:1). It is not a single discipline with a single disciplinary location within academia, which, depending on perspective, can be perceived as a limitation, despite the fact that today interdisciplinary and transdisciplinary research is encouraged. To critics of evolutionary economic

theory, there is an acknowledgment that the theory has greatly inspired a variety of fields in business and social sciences but that it is too specialised. According to some, evolutionary economics *“lacks a sufficiently-developed core theory that might promote greater conversation across these fields”* (Hodgson, 2019:1). It is time to develop the field of evolutionary economics further, so that a more unified and integrated research community emerges with *“shared conceptual narratives and common research questions, to promote conversation and synergy between diverse clusters of research”* (Hodgson & Lamberg, 2018:167).

## Concepts

**Path Dependency** (Concept): The process of technological change that is open-ended, where no optimal solution to a technical problem can be identified, and where historical events/ decisions may impact future events/ decisions in the development of an innovation. (Nelson, 1987)

**Technological Guidepost** (Concept): The basic design of a technological innovation that acts as a sign charting the course of future innovation activity. (Sahal, 1981)

**Technological Trajectory** (Concept): Also known as natural trajectory. A pattern of innovation and the continuous improvement of products in terms of performance and reliability. (Dosi, 1982)

**Selection** (Concept): Distinguishing principle whereby humans demonstrate goal-directed behaviour which renders choice, variation, and inheritance as interdependent mechanisms. (Cordes, 2007)

**Selection Environment** (Concept): The choice between a number of innovations in the same firm/industry which acts to influence the path of innovation and the rate of diffusion generated by any given innovation. (Lindley, 1997)

**Creative Symbiosis** (Concept): Two or more technologies combining in an integrative fashion such that the outline of the overall system is greatly simplified. (Sahal, 1981)

**Creative Destruction** (Concept): The introduction of new patterns of behaviour that determine winners and losers at the organisational level while positively propelling an economy forward through innovation. (Schumpeter, 1943)

**Emergence** (Concept): The phenomenon whereby the complex interactions of subsystems form an observed system. (Herrmann-Pillath, 2001)

**Systems of Innovation** (Concept): A holistic and interdisciplinary approach that explains the process of innovation as a complex and dynamic phenomenon. Explains how innovation comes about, and includes organisational, institutional, political, cultural, historical, cognitive, and economic determinants. (Nelson & Winter, 2002)

**Complexity** (Concept): A dynamic state of interaction between one or more actors in the economy. (Dopfer, 2011)

**Stakeholder Clusters** (Concept): Also known as agent groups. These include stakeholders who are brought together through a high degree of intersecting interests. (Duggan, Farnsworth & Kraak, 2013)

**Co-evolution** (Concept): A practice involving stakeholders building together a knowledge program through exchange of thoughts and imagination. (Witt, 1998)

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**How to cite:** Michael, K. & Abbas, R. (2023) *Evolutionary Economic Theory: A review*. In S. Papagiannidis (Ed), [TheoryHub Book](https://open.ncl.ac.uk). Available at <https://open.ncl.ac.uk> / ISBN: 9781739604400

*Last updated: 2023-09-29 20:33:44 - Exported: 2024-02-22 13:12:47*

*ISBN: 978-1-7396044-0-0*

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