

Summary of the treatise

Schumpeter's Evolutionary Economics

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Andersen's book *Schumpeter's Evolutionary Economics: A Theoretical, Historical and Statistical Analysis of the Engine of Capitalism* was in the summer of 2009 published by Anthem Press, London. The table of contents of the book, which has 493 pages, is reproduced at the end of the present summary. A related book will be published by Palgrave Macmillan in the Great Thinkers in Economics Series, edited by Anthony Thirlwall. This shorter and broader book is called *Joseph A. Schumpeter: A Theory of Economic and Social Evolution*.

Schumpeter's Evolutionary Economics is a treatise on the central contributions to the analysis of economic evolution by the Austrian-American economist Joseph A. Schumpeter (1883–1950). The background for the treatise is Schumpeter's importance for modern evolutionary economics and for similar fields within other social sciences. The exploitation of Schumpeter's contributions has, however, been constrained by the fact that some central parts of his work has not yet been analysed and that the understanding of other parts has been incomplete. The treatise tries to develop a more satisfactory analysis of his contributions to the theory of economic evolution. This analysis consists partly of a historical reconstruction of his development of a theory of economic evolution, partly of a rational reconstruction of the contents of his theory. Thereby, the treatise not only contributes to the study of the history of economic thought and analysis but also to modern evolutionary economics.

Although the treatise relates to Schumpeter's extensive work as a whole, its analyses are primarily built on his five most important books, of which one exists in two very different variants. The treatise analyses *Das Wesen und der Hauptinhalt der theoretischen Nationalökonomie* (1908), *Theorie der wirtschaftlichen Entwicklung* (1912), *The Theory of Economic Development* (1934), *Business Cycles* (1939), *Capitalism, Socialism and Democracy* (1942), and *History of Economic Analysis* [1954]. The treatise divides these books in three groups; and the structure of

the treatise reflects this division. The books from 1908 and 1912 are interpreted as Schumpeter's "two programmatic books", and these works are analysed in Part I. The books from 1934, 1939, and 1942 are combined under the heading "the evolutionary trilogy", which is the topic of Part II. A major topic of Part III is the posthumously published *History of Economic Analysis*—which together with other unfinished projects is treated as "works in progress". This phrase is also used to denote Schumpeter's evolutionary theory as a whole. The final chapter of the treatise uses the unfinished nature of Schumpeter's contributions to evolutionary theory as a way of relating explicitly to modern evolutionary economics.

The introductory chapter

The treatise starts by solving two terminological problems. The first problem is connected to the term evolution. Schumpeter wrote in the first half of his academic life in German. Here "Entwicklung" meant both "development" and "evolution". In the 1934 book the translation was "development"; but in the 1939 book and later the translation was "evolution". Although the first translation has become the predominant label of Schumpeter's theory, this theory does not concern a developmental process but an irreversible and unpredictable process of evolution. Therefore, Schumpeter's German word "Entwicklung" should nearly always be translated by "evolution". The second terminological problem concerns the words "statics" and "dynamics". These words are today used to denote, respectively, methods of equilibrium and methods that make essential use of the concept of time. However, this usage of the words "statics" and "dynamics" had not been established when Schumpeter started his work. Instead, he primarily used the words to denote equilibrium economics and evolutionary economics.

The solution to the two terminological problems serves to make clear that Schumpeter in 1908 formulated a research programme that is designed to complement equilibrium economics with evolutionary economics. Although he promoted the modernisation of equilibrium economics, the introductory chapter argues that his ambition to develop a complementary evolutionary economics has to be considered the pivot of his life-long scientific efforts. The chapter also emphasises that his evolutionary theory is formulated by a hierarchy of concepts. The starting point is a reinterpretation of equilibrium economics as reflecting the system of economic routines. The Schumpeterian evolutionary theory emerges by adding the innovative entrepreneur and special versions of the concepts of profit, credit, and capital. Thereby, Schumpeter reaches a description of the fun-

damental mechanisms of economic evolution and of the essence of capitalism. The first version of this analysis of economic evolution is found in his “two programmatic books” in German. Even though this version is relatively complete, Schumpeter obtained his relevance for modern evolutionary economics through the further development of his evolutionary analysis in “the evolutionary trilogy”. Actually, the modern interpretation of his work has hitherto primarily been derived from a few selected quotations from this trilogy. In contrast, his “works in progress” have been left to specialists, not least historians of economic thought. However, even his unfinished works are of significant importance for modern evolutionary economics.

Part I: Equilibrium Economics and Evolutionary Economics

The first part of the treatise analyses Schumpeter’s “two programmatic books”. This treatment has to overcome some of the misunderstandings that have emerged concerning his early efforts before World War I. Chapter 2 starts by pointing out that although evolutionary theory was on the research agenda of both Marshall and Veblen, Schumpeter’s strategy of developing an evolutionary complement to formalised neoclassical economic theory was unique. The background for his strategy is found in his untraditional academic education. His syllabus not only combined economic theory with mathematics, philosophy and law; it also combined studies of the German historical school of economics with those of the different variants of neoclassical economics. His evolutionary theory is interpreted as a synthesis of the historical school and neoclassical economics, with added inspirations from instrumentalist methodology, elite theory, and analytical Marxism.

Schumpeter’s first book on the essence and main contents of economic theory is the topic of chapter 3. *Das Wesen und der Hauptinhalt der theoretischen Nationalökonomie* of 626 pages was published in 1908, and it has not yet been translated to other languages (except Japanese). The treatise nevertheless demonstrates that it was in this book that Schumpeter developed his ambitious research programme. His programme builds, with inspiration from the American economist Clark, on the assumption that economic theory has two main branches: equilibrium economics and evolutionary economics. Schumpeter recognised that evolutionary economics had not been developed, but he demonstrated its necessity through an analysis of the impossibility of treating by means of Walrasian equilibrium economics the many crucial economic problems relating to economic evolution. In this way, Schumpeter developed his idea of evolutionary economics as a necessary complement to equilibrium economics. He developed this complement

by assuming that equilibrium economics studies a given system of economic routine while evolutionary economics studies the innovative transformation of this routine system. In this perspective, the Walrasian entrepreneur becomes the manager of incumbent firms; and the manager has to be complemented by Schumpeter's innovative entrepreneur. Furthermore, the S-entrepreneur becomes the starting point for a reinterpretation of core economic concepts like profit, credit, capital and business cycles as well as of the theory of economic distribution.

Schumpeter presented the first version of his evolutionary analysis on 548 pages in *Theorie der wirtschaftlichen Entwicklung* from 1912. The treatise demonstrates that the title of this book can best be translated as "The Theory of Economic Evolution", but the English translation of the shortened German edition of the book got the title "*The Theory of Economic Development*" (1934). Another problem with the English version of the book is that it simplified the originally very thorough treatment of the driving force of economic evolution: the innovative entrepreneur. A third problem is that the large concluding chapter is omitted. Here Schumpeter compared his theory of economic evolution in capitalist systems with what he considered unsatisfactory theories of economic evolution (by, e.g., Marshall). He also sketched how his theory of economic evolution can be generalised to cover evolution in all the sectors of society and how the co-evolution between these sectors can be analysed. This is part of the reason why the treatise spends three chapters (with the numbers 4, 5, and 9) to analyse the contents of what is normally considered a relatively simple book on *The Theory of Economic Development*.

Chapter 4 focusses on later omitted, or radically changed, parts of *Theorie der wirtschaftlichen Entwicklung*—especially the final chapter and the chapter on the fundamental phenomenon of economic evolution. The phenomenon that, according to Schumpeter, serves as the basis for economic evolution is innovation. In the original description of this phenomenon, Schumpeter's inspiration from elite theory is very clear. He describes the individuals in a society as divided into a mass, which follows routines, and an elite, which under certain conditions can innovate. This division was used by Nietzsche and many others (including Schumpeter's teacher Wieser), but it can most easily be interpreted in relation to the sociology of Pareto. Pareto interpreted the socially important characteristics of individuals as showing a normal distribution, and there is thus a gradual distinction between the mass and the elite (placed in the upper tail of the distribution). Similarly, Schumpeter described a gradual borderline between innovators and routinists. Whether an individual can become an innovator depends not only on its abilities and will, but also on the difficulty of the innovative task.

Schumpeter's analyses are, nevertheless, developed in terms of dichotomies like routine and innovation as well as mass and elite. The final chapter of his book sketches how these dichotomies can be applied in the analysis of the evolutionary process that takes place within each social sector, including the sectors of politics and culture. He also shortly discusses how the co-evolution between the different social sectors takes place and how this co-evolution produces the overall evolution of the socio-economic system. Although the mechanisms of this evolution can be analysed scientifically, its results cannot be predicted.

Chapter 5 analyses some of the basic questions of capitalist economic evolution that define the contents of *Theorie der wirtschaftlichen Entwicklung*. These questions were not only important for Marxism and the historical school but also for Schumpeter's Austrian-neoclassical teacher Böhm-Bawerk. To make the analysis of this scientific debate concrete, the treatise points at the seminar series that Böhm-Bawerk organised in 1905. Here the basic questions of capitalism were discussed in abstract form not only by Schumpeter but also by later leading members of the neo-Austrian school (Mises) and neo-Marxism (Otto Bauer, Hilferding, and Lederer). Böhm-Bawerk's main interest was the question of interest, and he related a positive interest on capital with any application of physical capital. Schumpeter's contrasting solution is that interest on "capital" is a phenomenon that is only related to economic evolution. If evolution comes to a halt, then the interest on capital disappears. Böhm-Bawerk considered crises as the result of random shocks while Schumpeter described business cycles as a necessary reflection of the evolutionary process. Innovative entrepreneurs operate on the background of a relatively undisturbed economic system, the finance of their investment creates an economic upswing, and the adaptation of the routine system takes place during the economic downswing. Böhm-Bawerk's theory made "capitalism" an eternal phenomenon by defining it as any economy that applies physical capital. Schumpeter agreed with the neo-Marxists and the historical school that "capitalism" is a historical phenomenon. Marx had described the drive to accumulate as the essence of capitalism and Max Weber had connected the origins of capitalism with the emergence of "the capitalist spirit" in the form of an increased propensity to save. Schumpeter preferred to reinterpret Marx by pinpointing the drive to economic innovation as the central characteristic of capitalism. Since the drive to innovate has existed in all human societies, he could not accept Sombart's solution according to which the origins of capitalism are connected to the emergence of a new spirit of entrepreneurship. Instead, capitalism emerged gradually by an orientation of the credit sector toward innovative projects. Schumpeter's system of concepts serves to clarify how economic evolution takes place in such a capitalist system.

Part II: The Evolutionary Trilogy

Schumpeter's implementation of the evolutionary research programme that he described in his "two programmatic books" is primarily found in "the evolutionary trilogy". Chapter 6 emphasises that this trilogy's coherence is due to the research programme and not from any overall design of the three books. The trajectory to *The Theory of Economic Development* from 1934 went through the radically revised edition of *Theorie der wirtschaftlichen Entwicklung* from 1926. Here the theory of crises and business cycles was a core element. Therefore, Schumpeter chose to develop his theory of evolution and to relate to historical and statistical data in *Business Cycles* from 1939. This large book covered 150 years of the history of capitalism and it contained considerations on the emergence of capitalism. Since the institutional framework had not been constant, the writing of this book emphasised the need of transcending the narrow theory of economic evolution through an analysis of the evolutionary processes in capitalist society as a whole. This analysis is found in *Capitalism, Socialism and Democracy* from 1942.

The treatment of these three books as a whole involves four challenges for the treatise. Chapter 1 has already confronted the first—terminological—challenge, which emerges because Schumpeter in the three books does not use the same words for his concepts. The solution of the treatise is to use the terminology of *Business Cycles*. The second challenge is that Schumpeter in *Capitalism, Socialism and Democracy* applies another model of economic evolution than in his two other books. The solution is to make explicit his Mark I and Mark II models of the "engine of capitalism". The third challenge is to find common characteristics of his two evolutionary models. The solution is to concentrate the analysis on the two central mechanisms of evolution: the mechanism of innovation and the mechanism of adaptation. The fourth challenge is that the last book of the trilogy couples the theory of economic evolution with sociological and political-science theories of evolution. An integrated treatment of "the evolutionary trilogy" makes possible that the related overall questions can be treated before turning to more specific questions of economic evolution. This solution influences the structure of Part II: the books of the trilogy are analysed in reverse order.

The 431 pages of *Capitalism, Socialism and Democracy* can be analysed in different ways. Chapter 7's strategy is to interpret the book as providing an analysis of the interaction between the economic evolution and the political and socio-cultural evolution. Schumpeter presents the "capitalist engine" as driven by large firms' own-financed innovative activities in their oligopolistic competition. The evolutionary mechanism of adaptation is part of the same competition: the

incumbent firms can to some extent avoid to be out-competed by adapting their routines to the conditions created by the innovations of other firms. These two mechanisms are the core of Schumpeter's Mark II model. In contrast, the incumbent firms are in the Mark I model considered as conservative upholders of given routines. In this early model it is thus the entry of new firms by innovative entrepreneurship that provides the core element of the mechanism of innovation; similarly, the out-competing of old firms is central for the mechanism of adaptation. The overall evolutionary process can thus be described as "creative destruction"; but Schumpeter also uses this term to describe the process of his Mark II model.

The socio-economic consequence of the real movement from Mark I to Mark II is that individual entrepreneurship becomes more or less obsolete and that increased governmental control of economic processes becomes possible. This control can be used to slow down the function of the capitalist engine. The great question concerns the actual use of its two "brakes": the brake on the mechanism of innovation and the brake of the mechanism of adaptation. Schumpeter's analysis of the use of these two brakes relates to his idea of "creative destruction". According to him, capitalism creates a "sociological trend" towards an emphasis on increased predictability and increased calculability. This means demands for increased public intervention against the social disturbances emerging from the "creative destruction" of capitalist evolution. At the same time, the transition from Mark I to Mark II implies that this intervention is easier to implement by government. To determine whether this intervention is actually implemented requires an analysis of political evolution, which Schumpeter however performs by means of an abstract theory of evolution within democratic political systems. Although this theory has been recognised by political science, its evolutionary structure seems hitherto to have been ignored. Schumpeter even here describes a transition from a Mark I model to a Mark II model. The driving force in the first model is innovative politicians, who with the help of other politicians routinise their policies. The driving force in the second model is incumbent parties, who participate in an oligopolistic competition for the votes of the people by means of innovation and adaptation. This second model seems well suited for translating the sociological trend to practical intervention in the capitalist process of economic evolution.

Chapter 8 analyses the 1095 pages of *Business Cycles*. This book is built on a pure Mark I model, where innovative entrepreneurs establish firms by means of borrowed money and where the incumbent firms have the choice between bankruptcy and enforced adaptation. Schumpeter's argument for the choice of this model is that it serves to expound the topic of the book that, as emphasised

by its subtitle, is *A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*. The capitalist process is produced by the Mark I engine. Therefore, the origins of capitalism is characterised by the spread of the establishment of innovative firms through innovative credit. Schumpeter's ultimate ambition was to perform a reasoned reconstruction of the history of capitalist economic evolution. For this purpose, he carried out a stepwise development of the Mark I model. He started with an abstract model in which an economic equilibrium without evolution is followed by an innovative upswing and a downswing characterised by the adaptation to the innovative results. At this abstract level, economic history is characterised by a sequence of equilibrium states punctuated by evolutionary periods.

Schumpeter's "first approximation" to the real capitalist economic evolution consists in the description of the evolutionary mechanisms that can produce such a capitalist economic evolution. The core of the innovative mechanism is a "swarm" of innovative projects, where the "swarming" builds on imitation and easier access to innovative credit. From these core investments the upswing spreads to the non-innovative parts of the economic system. The functioning of the adaptive mechanism becomes clear when the innovative projects have been carried out and when the repayments of the innovative loans begin. During the economic recession the routine system is changed through bankruptcies and through the internal adaptation of incumbent firms. These mechanisms suggest that Schumpeter's, relatively unspecified, wave indicator can best be expressed as the statistical variance of evolutionarily relevant economic behaviour.

The "second approximation" consists in adding the secondary macroeconomic effects of the Keynesian type to this model. Thereby, Schumpeter arrived at business cycles with four phases: prosperity, recession, depression, and recovery. The addition of depression and recovery is explained by the fact that the previous prosperity period is not only characterised by innovations but also by what, in an evolutionary perspective, must be called erroneous investment.

The "third approximation" to the real capitalist process consists in the addition of different types of business cycles: the short Kitchin cycles, the ordinary Juglar cycles, and the long Kondratieff waves. The Kitchin cycles can hardly be connected directly with the evolutionary process. Therefore, the treatise concentrates on the Juglar cycles and the Kondratieff waves. It is especially the long waves that were used by Schumpeter in his reasoned reconstruction of the waveform evolution of the capitalist economy. This historical reconstruction seems most convincing for the period 1843–1897, which Schumpeter called the age of "railroads, steel, and steam" or "the Bourgeois Kondratieff".

Chapter 9 returns to the analysis of *The Theory of Economic Development*, which

has already been covered by chapters 4 and 5. Three reasons are given for the renewed treatment. First, this book of 255 pages is very different from *Theorie der wirtschaftlichen Entwicklung* of 548 pages. Second, it is appropriate to end the treatment of Schumpeter's "evolutionary trilogy" with a thorough analysis of the Mark I model and its limitations. Third, this model is not only described in *Development* but also in the first chapters of *Business Cycles*. The chapter's analysis concerns Mark I's description of the basic mechanisms of economic evolution. Although Schumpeter concentrated his exposition on the innovative mechanism, it is, in a sense, the adaptive mechanism that is most fundamental. His analysis of the adaptive mechanism is hidden in his reinterpretation of the Walrasian equilibrium model to a model of the circular flow of economic life. The literature on Schumpeter has mainly interpreted the circular-flow model as a timeless description of an economic system without innovative entrepreneurs and profit—and with a zero interest on capital. However, in relation to his evolutionary analysis, the crucial part of the model is the process that leads from an innovatively provoked disequilibrium to a renewed equilibrium. Schumpeter de-emphasised the description of this process because it involves nearly unsolvable analytical difficulties. If we apply a statistical description of the relevant aspects of economic behaviour, it becomes clear that the adaptive mechanism concerns the reduction towards zero of statistical variance with respect to every evolutionarily relevant characteristic.

Schumpeter's assumption that the routinised behaviour of incumbent firms shows a significant degree of inertia means that the process of adaptation is time consuming and implies serious social costs. His mechanism of adaptation also means that certain forms of economic evolution can be driven by exogenous factors instead of directly by innovative entrepreneurs. Schumpeter's Mark I analysis of the innovative mechanism has been criticised as being strongly simplified. However, it seems clear that his simplifications were motivated by the analytical difficulties that relate to the more realistic Mark II model, which not only is related to modern analyses of Schumpeterian competition but also to the neo-Marxist models that he met in his youth. The Mark I model is designed to introduce the innovative entrepreneur into the circular-flow model in the simplest possible way. Therefore, it is not primarily to give a realistic description of the S-entrepreneur that Schumpeter distinguished sharply between the entrepreneurial function and the related functions of credit creation, risk taking, and inventive activity as well as the subsequent function of managing incumbent firms. Schumpeter's removal of much of the colourful description of the innovative elite from the exposition of *The Theory of Economic Development* can be interpreted in the same way. By focussing on the pure innovative function

in relation to a given routine system, his analytical task became simplified significantly. He upheld an opening toward a more comprehensive understanding of the evolutionary process by emphasising that his analysis did not only cover process innovation and product innovation but also organisational innovation, the opening up of new geographical regions and innovation with respect to economic inputs.

Schumpeter's Mark I model involves even larger difficulties than the related Walrasian model when it comes to the description of the economic process and the determination of its equilibrium state. Schumpeter's mathematical training and his understanding of the limitations of equilibrium models implied that he was aware of these problems. His attempts to find solutions led him to the interface between monetary theory and evolutionary theory. It was at this interface that he found the best possibilities for developing the analysis of the engine of capitalism as consisting of a combination of the innovative mechanism and the adaptive mechanism. He actually wrote a, posthumously published, treatise of monetary theory (*Das Wesen des Geldes*), which among its purposes had a solution of this task. The result is not convincing, however. Instead, his other works demonstrate that his Mark I model provides a family of relatively loosely defined models of the capitalist engine of evolution. The final section of chapter 9 reconstructs these models in terms of an economic system in which production solely takes place by means of knowledge and labour (*AL* models). The reconstruction of the Mark I model emphasises that the conservatism of incumbent firms is the result of two related characteristics. First, the productivity of firms becomes fixed after they have been established. Second, all surplus is used for the personal consumption of their owners. Schumpeter did not emphasise these inflexibilities of his Mark I model—probably because they give difficulties for the analysis of the movement towards the circular flow. His Mark II model involves even larger difficulties. However, he presented it in *Capitalism, Socialism and Democracy*, where he had no ambition of presenting a formal description of the evolutionary process as a whole. Nevertheless, the Mark II model can be described as having a feedback from the surplus of a firm to its investment. Under oligopolistic competition, parts of the funds for investment will be used for innovative and adaptive projects. Thereby, we arrive at an evolutionary analysis that apparently is very different from that of the Mark I model. If we add feedback from the payment of wages to aggregate demand, we obtain an evolutionary growth model. It seems probable that Schumpeter had envisaged such a model from the beginning of his academic career. The evolutionary growth model, however, has very strong constraints on the behaviour of incumbent firms. It is, furthermore, a model that has nothing to do with “economic growth” in the

traditional sense since it emphasises what Schumpeter in the last book of the evolutionary trilogy called “creative destruction”. Mark II is thus an evolutionary model that encompasses the same elements as the Mark I model—but in a complex manner that makes full analytical treatment very difficult.

Part III: Works in Progress

This part of the treatise analyses Schumpeter’s evolutionary theory in relation to the history of economics. One of the purposes of this analysis is to move the focus from Schumpeter’s concrete results to the Schumpeterian research programme. Chapter 10 emphasises that Schumpeter was placed centrally in the development of the science of economics in the period 1926–1939, which Shackle has characterised as “the years of high theory” and which Louçã has also characterised as “the years of high econometrics”. In the beginning of this period, Schumpeter resumed his academic career after his functioning as Austrian minister of finance and Viennese banker. He actually emerged as a symbol for the reconstruction of economic theory in Germany after its eclipse during the reign of the historical school; and he played a crucial role for the creation of the international Econometric Society in 1930. He then moved to Harvard University, which he helped to become the world’s leading producer of PhD degrees within economics. Even though these developments primarily supported the modernisation of equilibrium economics, Schumpeter hoped that his evolutionary economics would also be promoted. He actually had many important helpers, like Frisch, Georgescu-Roegen, Samuelson, Sweezy, Marschak, and Goodwin, but the results were disappointing. The treatise points out that collaboration with his helpers was not least hindered by Schumpeter’s “principle of indeterminateness” for economic evolution. The lack of real help meant that he launched his personal project of treating “the theoretical apparatus of economics”. No clear results emerged—although he gradually reduced the task to the description and development of the theoretical apparatus of evolutionary economics. Nevertheless, until his death in 1950, he emphasised that the main task of ambitious economists is to produce what he in the subtitle of *Business Cycles* had called *A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*. Actually, he provoked the ambitious generation of young economists by stating that it lacked “the historical sense”. As a partial solution to this problem, he proposed to produce a large series of historical monographs of the evolutionary process in selected industries and geographical localities.

The fact that Schumpeter tried to collaborate with the younger generation on his evolutionary research programme serves as a partial explanation why he en-

gaged in the study of the history of economic analysis from Aristotle to Keynes. This study is the topic of chapter 11. The chapter builds on the 1260 pages that, after Schumpeter's death, were published as *History of Economic Analysis*. Although the very rich information that is contained in this book has made it a central handbook for historians of economics, the book has also been used by economic theorists. The book is relevant for modern evolutionary researchers for three reasons. First, the book contains a theory of the evolution of the science of economics that helps to understand the difficulties of evolutionary economics. Second, Schumpeter found room for discussing some of the central concepts of evolutionary theory—although he systematically excluded his own work from the exposition of the history of economic analysis. Third, the book contains a theory of the co-evolution of the fundamental fields of the science of economics that seems to be of special importance for evolutionary economics. Chapter 11 starts by demonstrating how Schumpeter used his theory of long waves in the evolution of the science of economics to provide the overall structure of *History of Economic Analysis*. Each wave of scientific evolution takes its starting point in a “classical situation”, where a relatively stable synthesis has emerged between the elements of economic analysis. On this background, scientific innovators develop new analytical tools that give rise to a creative but confusing period before a new classical situation is again established. This theory has similarities with Kuhn's theory of “normal science” and “scientific revolutions”, but Schumpeter does not describe “normal science” as an important force of scientific progress.

Schumpeter's theory of scientific evolution is based on his definition of science as producer of tool-based knowledge. This definition suggests that each science is characterised by an evolutionary process that concerns the renewal and improvement of the tools of scientific analysis. There are several “brakes” on the evolutionary process. An important brake is provided by the scientific synthesis that has become established as a “classical situation”. Other brakes consist of the scientific schools, the influence from ideologies and practical policies, and the influence from philosophy and from other social sciences. Schumpeter's theory on the brakes of the scientific process led him to emphasise the importance of the promotion of pure science, but he recognised that applied science had in many fields contributed to the development of the fundamental fields of economic analysis. Since any science has an empirical content, these fundamental fields do not only include economic theory but also economic statistics and economic history. As an afterthought, Schumpeter added economic sociology as a fundamental field. Thereby, he suggested that economic analysis has to be founded in a systematic treatment of evolving economic behaviour and of the

evolving institutional framework. This conclusion seems, together with his emphasis on the writing of economic history, to be of special importance for the evolutionary part of the science of economics. Another implicit conclusion in *History of Economic Analysis* is that the underdevelopment of evolutionary economic analysis is due to the lack of operational tools.

Chapter 12 is the final chapter of the treatise. It applies Schumpeter's theory of the fundamental fields of economics to analyse how we today can move beyond his evolutionary economics. The idea is that evolutionary economics has four fundamental fields: evolutionary economic theory, evolutionary economic statistics, evolutionary economic history, and evolutionary economic sociology. It is emphasised that a viable evolutionary economic analysis not only presupposes an interaction between works in these four fundamental fields, but also an interaction between these four fields and applied evolutionary economics. To simplify the analysis of the chapter, evolutionary economic sociology is presented briefly in relation to the other fundamental fields, and applied evolutionary economics is only mentioned very briefly at the end of the chapter.

Evolutionary economic theory is the topic of two sections. The first of these sections discusses why a cumulative theoretical tradition has been missing and it emphasises that the main explanation is the missing analysis of the basic mechanisms of economic evolution. The second section points out that the treatment of the innovative mechanism and the adaptive mechanism, which has dominated the treatise, has to be complemented by analysis of the mechanism of inertia and the mechanism of segregation. The existence of a mechanism of inertia is necessary for any evolutionary process, and the localisation of the basic causes of behavioural inertia defines the nature of the concrete evolutionary theory. It is actually primarily the differences with respect to the mechanisms of inertia that explain the very different evolutionary processes in Schumpeter's two models of the capitalist engine of evolution. On the other hand, the specification of the mechanism of segregation is crucial for explaining the emergence of complex economic systems. But the understanding of the "industrial ecology" also requires analytical tools for the study of the co-evolution between the many industries and sectors of the economic system. Schumpeter's Mark I model seems to function well as a first approximation to these analyses. In contrast, the Mark II model seems presently rather inadequate for the analysis of complex evolutionary processes. In any case, it seems important to combine the two very different research traditions that, independently of each other, have explored and developed each of Schumpeter's two models. More specifically, there seems to be a need of developing collaboration between Nelson and Winter's Mark II tradition and the Mark I-like tradition that, under the label of "organisational ecology",

has been developed by organisational sociologists like Michael Hannan.

Although statistics and history has normally been described as two of the auxiliary disciplines of economics, they are central for the development of evolutionary economics. The section on evolutionary economic statistics emphasises that it was not least the important statistician R. A. Fisher that saved Darwinism from the eclipse that it faced in the beginning of the twentieth century. Actually, it became clear that the core concepts of biological evolutionary theory cannot be defined precisely without the help of statistical concepts like mean, variance, and covariance. One might think that Schumpeter's engagement in the econometric movement would have led to a similar solution for the conceptualisation of economic evolution—but this was not the case. Even today, we need the development of an economic econometrics that can serve to complement standard econometrics. This econometrics can be used to operationalise and analyse the core mechanisms of economic evolution. The relatively simple Mark I model can be studied in terms of an entry effect and a selection effect, which also includes the exit effect. The more complex Mark II model can be studied in two steps. We begin by studying the part of evolution that relates to the entry effect and the exit effect. Then we divide the residual evolution into a selection effect (caused by the covariance between firm growth and evolutionary characteristics) and an "innovation effect" (caused by changes within firms). When this two-step analysis has been specified, new tasks emerge for the statistical offices and the research groups that produce and analyse statistical data.

It is clear that the process of economic evolution includes so many characteristics that are difficult to quantify that evolutionary economic statistics must necessarily be complemented by evolutionary economic history. Actually, one of Schumpeter's last ambitions was to promote the production of a large series of historical monographs of the evolution of industries and localities. He emphasised that these monographs should be developed according to a common plan; but he died before he was able to specify this plan. However, the best way of developing his own analyses in *Business Cycles* seems to be to relate to the railway-related evolution in the nineteenth century. Actually, several economic historians have related to Schumpeter in the study of railroadization, but it is also here that a counter reaction has emerged in the form of Fogel's "new economic history". This type of study emphasises quantitative methods and counterfactual analysis in a way that is far removed from the analysis of the mechanisms of economic evolution. First, it simplifies the problem of the effects of the railway innovation and ignores qualitative issues. Second, counterfactual analysis raises very difficult problems in an evolutionary context. Therefore, broader analyses of railway-related evolution seems necessary—both of the type that fo-

cusses on individual firms (like Alfred Chandler) and of the type that analyses the general connections between technological change, institutional change and crises (like Freeman and Louçã). The treatise also emphasises that the development of evolutionary economics depends strongly on contributions from its many applied fields. Actually, it can be expected that a significant part of the core contributions to general evolutionary economics will come from fields like evolutionary organisation science, evolutionary finance, evolutionary industrial dynamics, evolutionary economic geography, evolutionary development studies, evolutionary environmental economics, and so on.

Appendices

Appendix A contains a reconstruction of Schumpeter's curriculum vitae, while Appendix B summarises the interpretations of his efforts that are found in the Schumpeter biographies and in similar material.

Appendix C presents solutions to the problems of accessing and grouping Schumpeter's works, with special emphasis on his 200 papers. Since the world of economics is increasingly an Anglophone world, it is a major problem that he primarily wrote in German in the period 1905–1932—and that a part of his papers are printed with old-fashioned German fonts. Therefore, the appendix develops a system of citation that uses existing English translations and otherwise refers to the collections of the papers, which are often found in journals that are today difficult to access. The appendix also presents a rough classification of his work according to topic.

Finally, Appendix D relates to the, in the treatise frequently mentioned, problem that evolutionary economic analysis of missing adequate tools. This appendix focusses on two areas of analysis. First, Schumpeter had difficulties in analysing the evolutionary interactions in the complex "industrial organism". This problem has been treated by evolutionary biological ecology. The appendix selects tools from this field, and it is demonstrated who these tools can be adapted to develop a refined classification of different types of innovation. Second, the treatise has emphasised the need of making the analysis of the mechanisms of evolution operational by means of statistical concepts. The appendix concentrates on the development of R. A. Fisher's evolutionary analysis that is represented by George Price's formula: $\bar{w}\Delta\bar{z} = \text{Cov}(w, z) + E(w\Delta z)$.

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