Introduction

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Without doubt, economics is the science which focuses on economic welfare and the means to its increase. This can be stated as a goal for all schools in economics, among the most important being the Classical, the Keynesian and the Neoclassical school, as well as the neo-Schumpeterian approach, about which this *Companion* deals. But the angle of analysis differs sharply among these various approaches. One of the decisive differences can be found in the emphasis which is put on the different levels of economic analysis and their particular interrelatedness.

Owing to the dominance of the Neoclassical school in the 20th century, the approach of a micro foundation of macroeconomics has wide appeal. The aggregation from micro to macro becomes possible because of the idea of representative households and firms. Although this approach may seem convincing thanks to its analytical stringency, its mechanistic design may lead to difficulties when it comes to the analysis of dynamic phenomena endogenously caused by the economic system.

Neo-Schumpeterian economics, by contrast, seeks to get a grip on these dynamic phenomena of economic reality. In order to do this, between the micro and the macro level of economic analysis the important meso level is considered (e.g. Dopfer, Foster and Potts, 2004). It is the meso level of an economic system in which the decisive structural and qualitative changes take place and can be observed.

To understand the processes driving the development at the meso level, neo-Schumpeterian economics puts a strong emphasis on knowledge, innovation and entrepreneurship at the micro level. Innovation is identified as the major force propelling economic dynamics. In this emphasis on innovation, the major difference in the neo-Schumpeterian approach with respect to alternative economic approaches can be identified. Generally, one may say that novelty, i.e. innovation, is the core principle underlying the neo-Schumpeterian approach. Innovation competition takes the place of price competition as the coordination mechanism of interest. Of course, prices are also of significance, but, concerning the driving forces of economic development, they are not central. Whereas prices are basic concerning the adjustment to limiting conditions, innovations are responsible for overcoming previous limiting conditions and – as in economic reality, everything has an end – setting new ones.

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The challenges for neo-Schumpeterian economics

The raison-d'être of neo-Schumpeterian economics is the prevailing transformations of economies, which persist at the macro, the meso and the micro levels. However, although the transformations are very visible at the macro level, they cannot be analysed or understood on this level (e.g. Carlsson and Eliasson, 2003). The sources of these qualitative changes instead can be found in the industry dynamics at the meso level (e.g. Saviotti and Pyka, 2004), yet the dynamic potential of industries is propelled by the creation of novelties and entrepreneurial decisions at the micro level of the economy.

Consider, for example, the transformation of economies with respect to employment shares towards service industries which has led to the so-called 'Fourastier Hypothesis'. This by no means can be explained by referring to the proportional growth of existing industries. Instead new industries emerge again and again throughout the history of capitalism, driving out existing ones or at least changing considerably their relative weights. The emergence of the new industries is driven by innovation and tested by entrepreneurial action.

Perhaps the most severe transformation the industrialized world has undergone is the current one, caused by the increased importance of knowledge, in particular scientific knowledge relevant for production activities combined with an increasing internationalization of business. For many years now, knowledge intensification and globalization have been widely considered to be the most important challenges with which industrialized and industrializing economies are confronted (e.g. Pyka and Hanusch, 2006). In addition, severe qualitative changes in the sectoral composition, in the relevant competences and in the institutional settings lead to catching-up and leapfrogging processes which affect the international competitiveness of nations and regions, and confronts established companies with major technological and organizational transformation processes.

These qualitative changes can immediately be traced back to developments going on at the meso or industry level. The underlying industrial dynamics are characterized by a crucial transformation of the nature of competition. Especially in technological intensive industries such as biotechnology-based industries and information and communication technologies, owing to the high degree of complexity of the underlying knowledge base, competition no longer takes place between single companies only, but often occurs between networks of actors, where new knowledge is created and diffused collectively. Most importantly, firms often no longer compete in a price dimension only, as competition in innovation has taken the dominant role.

Accordingly, competition and cooperation are simultaneously guiding the decisions of economic actors. Whereas traditional manufacturing firms

are forced by the ongoing globalization to become ever larger, either through own growth or by mergers and acquisitions on an international basis, and are acting in an environment of strong price competition, they are at the same time intensively engaged in a competition for innovation. To cope with the pressure stemming from complex modern innovation processes, they are obliged to search for possibilities of collaboration with small and new entrepreneurial and technological intensive start-up companies. In knowledge-intensive industries, we often observe the co-existence of small entrepreneurial firms, shaping technological development and contributing strongly to technological progress, and large established companies performing their business in routinized ways.

By emphasizing the decisive role of entrepreneurial business formation and the emergence of new industries, we are already hinting at the processes at the micro level of the economy underlying all these development processes. Innovations, affecting potentially the composition of sectors, are born at the micro level. New ideas paired with well developed absorptive capacities of entrepreneurs, who are well connected to their own financial and scientific/ technological networks, lead eventually to wide and fast diffusion of novelty and thus to new industries (e.g. Grebel, Pyka and Hanusch, 2003). As a prerequisite for a prolific creation of a new industry, of course, consumers also have to be aware of the new commodities and services offered.

Knowledge generation and diffusion processes stand behind innovation. Thus, an examination of knowledge in general and knowledge dynamics in particular is absolutely necessary in neo-Schumpeterian economics. The simplified treatment of knowledge as a public good, such as is a concern in neoclassical economics, is intellectually no longer profitable. Instead, the tacit, local, and complex character of knowledge are emphasized. This is the subject of many of the contributions to this *Companion*.

By focusing on the generation and dissemination of new knowledge, from the point of view of knowledge dynamics, severe non-linearities enter the neo-Schumpeterian economic system, decisively affecting the dynamics of the sectoral development as well as the sectoral composition of an economy. As a consequence, neo-Schumpeterian economics has rid itself of the concept of a representative agent. Heterogeneous agents with varying competences and capabilities, industries at very different stages of maturity, and institutional frameworks differing between sectors, regions and nations co-exist, enriching strongly the complexity of the economic systems under analysis. The changes going on at the macro level of the economy then are not only the aggregates of the changes at the meso level. Several emergent properties and non-linearities have to be considered, e.g. unbalanced growth processes, catching-up, leapfrogging as well as forging-ahead etc. become part of the economic reality.

The intellectual roots of neo-Schumpeterian economics

In order to analyse the innovation-driven development of economic systems, neo-Schumpeterian economics draws on several intellectual roots. Obviously, first and foremost we must consider the huge legacy of Joseph Alois Schumpeter (Hanusch, 1999). Schumpeter was among the first authors to stress the important role of innovation in his *Theory of Economic Development* (1912). There, he not only described economic development as the disruption of the regular circular flow caused by the introduction of novelties, but he also dedicated a large part of his presentation to the description of the entrepreneur, as the economic actor who kicks off economic development. In his later book, *Capitalism, Socialism and Democracy* (1942) – following the developments of his time – he updated his ideas of entrepreneur-initiated development with the consideration of large research and development (R&D) departments of industrial firms where innovation had become a routine occupation.

Only rarely considered in the postwar period, in the early 1980s Schumpeter's theories were rediscovered in *Evolutionary Economics*, which has to be considered as the second intellectual source of neo-Schumpeterian economics. Obviously, the scope of this introduction does not allow a sound appreciation of the important impact of evolutionary economics. Instead, the reader is referred to, among others, Dopfer (2001, 2005), Hodgson, Samuels and Tool (1994), Silverberg (1988) and Witt (2003).

Evolutionary economics deals with dynamic developments taking place in historical time and therefore allows for path dependencies and irreversibilities. The major focus of evolutionary economics lies in the emergence and diffusion of novelties which are driven by creation, selection and retention, the crucial forces of every evolutionary theory dealing with either biological or cultural evolution. The outcome of evolutionary processes is determined neither ex ante nor as the result of global optimizing, but rather is due to true uncertainty underlying all processes of novelty generation, and so allows for openness towards future developments, a feature of evolutionary theories which makes them ideal for analysing innovation processes. Not surprisingly, in evolutionary economic theories, learning and the cognition of economic actors are central. Boundedly rational actors learn and experimentally search in uncertain and permanently changing environments. The feature of path dependency corresponds well with the cumulative nature of building up competences. Additionally, innovation is considered as a process spurred collectively by many different actors. Heterogeneity of actors is an important source of novelty (e.g. Saviotti, 1996).

The emphasis on the interaction between agents in knowledge generation and diffusion processes in evolutionary economics relates to a third strand

of literature which has to be considered an intellectual root of neo-Schumpeterian economics, namely 'Complexity economics'. Pathbreaking work in this area has been done by, among others, Kirman (1989) and Arthur (1994). (For a review of most recent applications of complexity approaches in the domains of neo-Schumpeterian economics, see Frenken 2006.) Social systems share many commonalities with complex systems. Within the last 20 years, complexity sciences have developed tools to describe and analyse complex systems which are increasingly applied to socio-economic phenomena.

It is easy to show that innovation-driven neo-Schumpeterian economies are perfect examples of complex systems, as defined e.g. by John Casti (2001). On this approach, simple systems are characterized by few interactions and feedbacks, whereas complex systems show close and frequent interactions of components, combined with negative as well as prominent positive feedback effects. Whereas in simple systems one finds centralized and hierarchical decision processes, complex systems have strongly decentralized structures. Furthermore, simple systems are decomposable. Complex processes, on the other hand, are irreducible, i.e. neglecting a single part has severe consequences for understanding them. Finally, whereas the behavior of simple systems can be predicted, the behavior of complex systems is – owing to non-linearities caused by interaction and feedbacks – fundamentally unpredictable. It is clear that all features of complex systems can readily be found in neo-Schumpeterian economies. Most strikingly, the unpredictability of the complex system's behavior – with respect to innovation one can speak of truly uncertain outcomes – qualifies complexity approaches for the analysis and understanding of neo-Schumpeterian economies.

Another intellectual source for neo-Schumpeterian economics lies in those approaches dedicated to *change and development*. Although long run capitalistic development has been on the agenda of economics since the contributions of Kuznets, Clark and Schumpeter in the early decades of the 20th century, because of the strong dominance of short term equilibrium analysis of mainstream neoclassical economics this tradition went out of vogue until the early 1990s, by which time a new interest in the laws of motion and industry development re-emerged, formulating stylized facts of so-called 'industry life cycles' (eg. Utterback and Abernathy, 1975; Gort and Klepper, 1982; Jovanovic and McDonald, 1994; Klepper, 1997).

Finally, neo-Schumpeterian economics has an important source of inspiration in the mainly descriptive approaches of *systems theory*. Here, learning and the building up of competences is considered as an interactive and collective process. Besides economic actors – basically firms – institutional actors such as universities and other public research laboratories as well as

the institutional frameworks and governance structures shape the innovation process taking place in national (e.g. Nelson, 1993; Lundvall, 1988), sectoral (e.g. Malerba, 2002, 2005), regional (e.g. Cooke, 2002) as well as corporate innovation systems (e.g. Cantwell, Dunning and Janne, 2004) and are important in determining their performance.

The hallmarks of neo-Schumpeterian economics
What are the distinctive marks of the neo-Schumpeterian approach in economics? As already stated above, neo-Schumpeterian economics considers the introduction of novelties as the decisive characteristic of capitalistic organized economies. By its very nature, innovation, and in particular technological innovation, is the most important and visible form of novelty. Therefore, it is not very surprising that neo-Schumpeterian economics today is most appealing in studies of innovation and learning behavior at the micro level of an economy, in studies of innovation-driven industry dynamics at the meso level, and in studies of innovation-determined growth and international competitiveness at the macro level of the economy. The contributions of this *Companion* will deal almost exclusively with these areas.

From a general point of view, however, the future developmental potential of socio-economic systems, i.e. *innovation* in a very broad sense, encompassing technological innovation as well as organizational, institutional and social innovation, has to be considered as the *normative principle* of neo-Schumpeterian economics. Instead of allocation and efficiency within a certain set of constraints, neo-Schumpeterian economics is concerned with the conditions for and consequences of a removal and overcoming of these constraints limiting the scope of economic development. Thus, neo-Schumpeterian economics is concerned with all facets of open and uncertain developments in socio-economic systems.

What are the consequences of this normative basis in innovation for economic analysis in a neo-Schumpeterian spirit? Most scholars labelling themselves as neo-Schumpeterians probably would agree on the three constitutive elements following this normative commitment:

1. *Qualitative change* affects all levels of the economy, and so we must consider not only structural changes but also the removal of constraints inhibiting development under the status quo and allow for development under new circumstances.
2. Qualitative changes do not appear continuously in time but correspond to the idea of *punctuated equilibria* encompassing periods of smooth and regular development as well as periods of radical change.
3. Finally, these processes show strong non-linearities and positive feedback effects which are responsible for *pattern formation* and other

forms of spontaneous structuring, i.e. they are not completely erratic, even if the innovative success by its very nature is characterized by strong uncertainty.

Although very visible at the industry level, qualitative change is happening at all levels and domains of an economy. A comprehensive neo-Schumpeterian approach therefore also has to consider transformation processes on, e.g., the public and the monetary sides of an economy. In the concluding chapter of this *Companion*, 'A roadmap to comprehensive neo-Schumpeterian economics', we highlight the impact of the innovation orientation on other areas of economies. The bulk of contributions of this *Companion*, however, are restricted to neo-Schumpeterian economics of the real side, that realm of neo-Schumpeterian economics which without doubt has to be considered as the most developed.

The structure of the *Companion*
The final part of this introduction is dedicated to a brief presentation of the *Companion*'s structure and the various contributions of the particular sections. By compiling the topics of the subsections, we paid attention to a broad covering of the relevant fields and consciously allowed for some redundancies when the topics showed different dimensions. We are convinced that the contributions to the *Companion* give an informed and sophisticated overview on the stage of development in neo-Schumpeterian economics, as well as pointing to important directions for future research.

From Schumpeter's universal social science to neo-Schumpeterian thinking
Part 1 of the *Companion* following this introduction is entitled 'From Schumpeter's universal social sciences to neo-Schumpeterian thinking' and deals with the broad intellectual heritage of Joseph A. Schumpeter. The various contributions deal with different aspects of Schumpeter's impact on neo-Schumpeterian economics. Horst Hanusch and Andreas Pyka start with a short biography of Schumpeter, followed by Mark Perlman who introduces the intellectual sources which framed Schumpeter's ideas of economic methodology. Along this line, Yuichi Shionoya outlines the concept of Schumpeterian universal social science in his contribution. Kurt Dopfer reasons on the impact of Schumpeter on meso economics. In the English translation of Schumpeter's *Theory of Economic Development*, one chapter of the German version was excluded. John Mathews corrects this error. Zoltan Acs, also drawing on the lost chapter of Schumpeter's *Theory of Economic Development*, outlines a synthesis between entrepreneurship and philanthropy as a model for capitalistic organized societies. Matthias Weber in his chapter makes an important nexus between Schumpeterian

reasoning and the sociology of innovation, which has to be considered an important branch of modern innovation research. Part 1 closes with a chapter by Chris Freeman and his reflections on the Schumpeterian renaissance that has taken place in the last two decades.

Neo-Schumpeterian meso dynamics: theory
The following two sections introduce the major research program of neo-Schumpeterian economics of the real side of an economy, highlighting the most important concepts and approaches applied to the analysis of meso dynamics, both theoretically and empirically. Part 2 starts with contributions summarized under the heading 'Essentials of innovation processes', subdivided into subsections on the subjects of innovation processes ('Entrepreneurship, firms and networks'), the object of innovation processes ('Knowledge and competencies') and 'Innovation processes and patterns'.

Entrepreneurship, firms and networks   In Chapter 9, Thomas Grebel introduces the reader to modern approaches, allowing a profound discussion of the complex actor who plays such an important role in neo-Schumpeterian economics. In Chapter 10, Fritz Rahmeyer composes an evolutionary theory of the firm, allowing us to conceive firms as separate units between the entrepreneurial actor and the industry. Marc Gruber then takes a management perspective, analysing the processes of new venture generation. Mark Dodgson in his contribution highlights the important role of technological collaborations in modern innovation processes. The strategic dimensions of technological alliances are outlined by Nadine Roijakkers and John Hagedoorn in Chapter 13. Finally, David Audretsch and Roy Thurik introduce a model of entrepreneurial economics, which is better suited for knowledge-intensive economies than the widely used managerial approaches.

Knowledge and competencies   As already mentioned above, it is knowledge which stands behind innovation. The concept of knowledge accordingly plays an important role in neo-Schumpeterian economics and has generated a great deal of attention in the last few years. This is the focus of the section entitled 'Knowledge and competencies'. Dominique Foray introduces the concepts of tacit and codified knowledge, a subtle but important distinction with significant consequences for the analysis of knowledge generation and diffusion processes. Similarly, Cristiano Antonelli distinguishes between the concepts of global technological progress and the important notion of localized technological progress. Both concepts are responsible for a decisive difference in the treatment of technological

spillovers in neo-Schumpeterian economics. Whereas in Neoclassical economics, owing to the perception of knowledge as a public good, i.e. as codified knowledge which is globally applicable, technological spillovers are treated as incentive-reducing only, in Neo-Schumpeterian economics the idea-creating impacts of spillovers are emphasized because of the detailed consideration of the intricacies of the underlying knowledge. In Chapter 17, on competencies and capabilities, Mie Augier and David Teece show the consequences this changed view on knowledge has for understanding learning processes and the building up of competences in firms. In a similar vein, Brian Loasby applies these concepts to the important question of firm organization. Ernst Helmstädter then leaves the actor's and firm's perspective when highlighting the role of knowledge in a neo-Schumpeterian economy. Ulrich Witt and Christian Cordes outline the consequences of the cognitive framework of neo-Schumpeterian economics for the dynamics to be observed on the industry level.

Innovation processes and patterns The chapter of Ulrich Witt and Christian Cordes leads to the final subsection in Part 2, 'Innovation processes and patterns'. Giovanni Dosi and Mauro Sylos Labini open this subsection with a contribution on technological trajectories and technological paradigms. Although, because of the uncertainty inseparable from innovation, economic agents can no longer follow any optimal path in their innovation endeavors, this does not mean that innovation processes are erratic. Instead, specific patterns of technological evolution emerge as prevailing technological visions and concepts. The cumulativeness of learning processes guides innovative actions. In Chapter 22, Franco Malerba emphasizes the symbiotic nature of technological progress and firms' R&D strategies which leads to certain technological regimes. Another form of emerging structures is emphasized by Andreas Pyka's chapter on innovation networks. Innovation networks are considered as constellations which evolve thanks to the collaborative R&D strategies of the actors involved in innovation processes. The last chapter in this subsection, by Paul Stoneman, applies the concept of pattern formation and self-organization to the domain of the diffusion of innovation.

Modelling industry dynamics Not very surprisingly, neo-Schumpeterian economics relies on new tools when it comes to the construction of models. The section 'Modelling industry dynamics' deals with methodologies and instruments able to cope with the requirements of dynamic and innovation-driven processes. Chapter 25, by Witold Kwasnicki gives a broad overview on the development of different classes of economic models employed in modelling neo-Schumpeterian dynamics. In a similar

vein, the contribution of Paul Windrum introduces the important classes of simulation models in the neo-Schumpeterian context. As the phenomena of interest are dynamic processes, including different forms of non-linearities, and are composed of heterogeneous populations of actors, analytical techniques are not very promising. By applying numerical approaches, the possibilities of modelling are dramatically extended. Stan Metcalfe introduces the concept of replicator dynamics, a frequently applied and powerful tool in the analysis of evolutionary processes. Replicator dynamics are used for the study of development processes of populations composed e.g. of firms. These development processes encompass both selection as a representation of competition and growth spurred by innovative success. The chapter by Luigi Orsenigo deals with a particular class of simulation models, namely history-friendly models. Within neo-Schumpeterian economics, history-friendly models are used for the modelling of the development of specific industries, thereby focusing on their particularities. This class of simulation models is significant for its closeness to empirical analysis. The final contribution in this section, by Andreas Pyka and Giorgio Fagiolo, deals with a class of simulation models which only recently have been applied in neo-Schumpeterian economics, but very likely show the strongest potential, namely agent-based models. Modellers generally have to wrestle with an unavoidable trade-off between the demands of a general theoretical approach and the descriptive accuracy required to model a particular phenomenon. Agent-based models have shown themselves to be well adapted to this challenge, basically by shifting outwards this trade-off.

Neo-Schumpeterian meso dynamics: empirics
The first subsection deals with tools and concepts allowing for measuring industry dynamics. The challenge for the empirical strands of Neo-Schumpeterian economics lies in the necessity to investigate and analyse dynamic processes which most often concern intangible knowledge and contain a great deal of qualitative information.

Measuring industry dynamics In their chapter, Uwe Cantner and Jens Krüger introduce empirical tools which allow us to cope with these challenges, in particular dealing with heterogeneity, which is a prerequisite as well as a consequence of every innovation process. Hariolf Grupp deals with science and technology indicators constructed from patent information. In many cases, patents are the only information available, and so a good understanding of the scope of their explanatory power is essential for empirical investigations. Michael Peneder offers an industry classification and taxonomy approach, which may be considered an empirical attempt to

identify technological patterns and regimes. The particular focus of Neo-Schumpeterian economics on innovation and dynamic processes propelled by heterogeneous agents demands the application of tools so far not applied in economics. An attempt to rectify this is made by Koen Frenken in his chapter, where he introduces the important concept of entropy statistics. In the contribution by Thomas Brenner, a particular methodology to identify local industrial clusters is introduced. The idea of clusters as self-organized regional competence agglomerations enjoys enormous popularity both in theory and in politics. To get an empirical grip on innovation clusters is an essential precondition to improving our understanding of the underlying complex processes. The final contribution in this subsection, by Bart Los and Bart Verspagen deals with the important question of measuring technological spillovers. Los and Verspagen give an overview on the different possibilities to tackle this interesting problem empirically and offer a helpful taxonomy of the various spillover measures.

Case and industry studies   Owing to the severe problems and difficulties of the empirical measurement of neo-Schumpeterian dynamics, case and industry studies are frequently used to improve our understanding. Nelson and Winter (1982) coined the notion of 'appreciative theorizing' to describe this important strand of literature within empirical neo-Schumpeterian economics. Chapter 36, by Ken-ichi Imai, deals with the Japanese innovation system and gives a detailed description of the economic as well as institutional developments shaping the multifaceted transformation of Japan's economy. Maureen McKelvey's case study deals with the example par excellence of knowledge-based economies, namely biotech-based industries. In a similar vein, Jackie Krafft's case study covers the telecommunication industry. Both chapters show the huge advantage of case studies, which highlight the particularities of specific industries including a great deal of qualitative information. Paul Windrum's case study deals with innovation in service industries, a part of the economy that is of increasing importance with respect to employment, value creation and much more. However, it is perhaps also the most heterogeneous sector, as it encompasses knowledge-intensive business services as well as fast food restaurants. Paul Windrum's case study is a perfect example of the possibilities of case studies in tackling complex issues. The final case study, by Alfred Kleinknecht and C.W.M. Naastepad, is an example of the investigation of a particular national policy strategy, namely the employment strategy of the Netherlands in the 1990s.

Neo-Schumpeterian macro dynamics: growth and development
A crucial interest of neo-Schumpeterian economics lies in the analysis of the conditions and consequences of economic development. This section

focuses on more quantitative studies of growth and a more qualitative orientation towards economic development.

Growth   F.M. Scherer opens this section with his chapter on Schumpeter and the micro foundations of economic growth. He closely investigates the representation of firms' R&D activities in growth models. In the same tradition, Elias Dinopoulos and Fuat Şener provide an exposition of the scale-effects property in the context of neo-Schumpeterian growth models in their chapter on endogenous growth. In particular, they outline the distinct solutions to the scale-effects problem, discuss implications and offer an assessment of scale-invariant neo-Schumpeterian growth models. Jan Fagerberg then considers the international dimension in offering a Schumpeterian perspective on the technology-driven dynamics of growth and trade, allowing an explanation of dispersed national developments responsible for catching-up and falling-behind processes in economic development. In analysing macroeconomic dynamics, the question of labor replacement versus labor creation has played an important role in economics since David Ricardo's famous chapter on machinery in his 1817 book *Principles of Political Economy and Taxation*. Marco Vivarelli gives an overview of this still open question, and considers as well the various compensation mechanisms found in the literature. In the last chapter of this section, John Foster introduces macro-econometric modelling of neo-Schumpeterian dynamics, and suggests an empirical agenda that has the capacity to highlight the relevance and importance of neo-Schumpeterian economics. In particular, the empirical agenda focuses on the core of neo-Schumpeterian economics, namely on the innovation-related sources of economic growth.

Development   The section on economic development is introduced by Richard Day's contribution, in which he emphasizes the important role of out-of-equilibrium economics for development. Contrary to Schumpeter, who started his analysis of development in a state of equilibrium (circular flow), Day begins in an out-of-equilibrium situation in which the dynamics result from adaptive economizing of the agents. The contribution of Esben Sloth Andersen deals with demand, a topic which only recently has come on the agenda of neo-Schumpeterian economics (e.g. Witt, 2001). Andersen stresses three major points as to why this has to be changed: obviously, demand represents the core force of selection which gives direction to neo-Schumpeterian dynamics; additionally, firms' innovative activities relate, directly or indirectly, to the structure of expected and actual demand; finally, the demand side represents the most obvious way of turning to the much-needed analysis of macro-evolutionary change of the economic

system. The next three contributions deal with long waves, the Kondratieff cycles Schumpeter was so fascinated by in his *Business Cycles* of 1939. Long waves can be considered as an analytical framework for the analysis of long run qualitative change. In this sense, Francisco Louçã focuses attention on the recurrent phenomena of long waves in different cycles. Recurrent phenomena provide justification for cycles, since in the case of only unique features of particular technological breakthroughs, cycles would not be evident. Carlota Perez emphasizes the important co-evolutionary relationship of long term development of the real and the financial sectors of an economy. In the last contribution to the long wave debate, Gerald Silverberg shows how long waves fit into an overarching theory of neo-Schumpeterian economic dynamics, thereby addressing theoretical as well as empirical issues. Paolo Saviotti's chapter on qualitative change has to be considered central neo-Schumpeterian economics. He shows that, without the focus on qualitative phenomena, long run economic development is perfectly misunderstood. In the last chapter of this section, Richard Nelson summarizes neo-Schumpeterian reasoning on growth and development and offers some important issues for the agenda of future neo-Schumpeterian research.

Neo-Schumpeterian economics and the systemic view
As mentioned above, approaches from systems theory are an important intellectual source of neo-Schumpeterian economics. This section is dedicated to the systemic view. Bo Carlsson begins with a survey of the rich literature on innovation systems from a neo-Schumpeterian angle. Then Bengt-Åke Lundvall elaborates on the the lines of development of the most prominent concept stemming from systems theory, namely national innovation systems. In Chapter 55, Hermann Schnabl draws on input–output analysis in order to get a formal grip on these systems. In the following chapter, Phil Cooke and Nicole Schall apply the system concept at the regional level, introducing the important concept of regional innovation systems. Markus Balzat and Horst Hanusch close this section with a chapter summarizing the fundamentals of national innovation systems relevant from a neo-Schumpeterian perspective.

Research and technology policy
Considering neo-Schumpeterian dynamics has important consequences for policy making. Basically, the benchmark in the sense of a welfare optimal solution got lost, while concepts such as enabling infrastructures, platform technologies and R&D networks etc. have aroused attention. This section of the *Companion* deals with neo-Schumpeterian innovation and technology policy. Stan Metcalfe opens with his contribution on innovation policy for knowledge-based economies. The chapter of Horst Siebert then takes the

macro-economic perspective, investigating the conditions furthering and hindering economic growth and focusing on the example of Germany. Georg Erdmann, Jan Nill, Christian Sartorius and Stefan Zundel derive theoretical conditions for effective policy strategies dependent of time. Hardy Hanappi closes the section with a chapter on macroeconomic policy dealing with conceptual and theoretical issues of policy on and for the macro-level in a Neo-Schumpeterian perspective.

The impact of neo-Schumpeterian thinking on different fields
The last part of the *Companion*, Part 7 containing invited contributions, deals with important topics that cannot be allocated to other subjects, but that nonetheless are more or less relevant for the whole body of neo-Schumpeterian economics. Jacques Lesourne opens with a chapter on game theory and the particular role of evolutionary game theory for neo-Schumpeterian economics. In a similar vein, Bart Nooteboom extends the concept of transaction costs in order to make it applicable in the context of learning and innovation processes. Chapters 64 and 65, by JeanLuc Gaffard and Gunnar Eliasson, respectively, investigate the role of neo-Austrian approaches in neo-Schumpeterian economics. Siegfried Berninghaus and Werner Güth introduce the reader to experimental economics, which is of significant importance for neo-Schumpeterian economics, e.g. when it comes to the formulation of alternative behavioral assumptions. Brian Arthur then deals with the important subject of complexity economics. As stated above, complexity economics is an essential intellectual source of inspiration for neo-Schumpeterian economics. The same holds for the following chapter, by Peter Allen, dealing with self-organization, pattern formation, emergent phenomena and phase transitions, which are constitutive features of neo-Schumpeterian economic systems and core concepts in neo-Schumpeterian economics. Besides the time dimension, innovation processes have an important geographical dimension. Claudia Werker considers the neo-Schumpeterian perspective in regional economics and economic geography in the penultimate chapter.

A roadmap to comprehensive neo-Schumpeterian economics
The *Companion* concludes with a final chapter by the editors in which they develop a guideline for a comprehensive neo-Schumpeterian approach which has to encompass not only the real side of the economy, but also financial markets and the role and impact of the state. In this sense, neo-Schumpeterian economics has to consider the co-evolutionary processes between the different economic domains in order to offer a powerful alternative to the economic mainstream for the analysis of economies and their future developmental potentials.

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