

Contents

<i>List of Figures</i>	x
<i>List of Tables</i>	xi
<i>List of Boxes</i>	xii
<i>Contributors</i>	xiii
<i>Preface</i>	xvii
1 Introduction	1
<i>Maureen McKelvey and Magnus Holmén</i>	
1.1 Introduction	1
1.2 Why this book?	3
1.3 Overview of chapters	11
1.3.1 Chapters in Theme 1: experimenting and inertia	12
1.3.2 Chapters in Theme 2: evolution and adaptation of structure	14
1.3.3 Chapters in Theme 3: innovating and technological transformation	16
1.4 Beyond this book	18
THEME 1: EXPERIMENTING AND INERTIA	25
2 The New Craft Skills of Engineering: The Impact of Innovation Technology on Engineering Practice	27
<i>Mark Dodgson, David M. Gann, and Ammon Salter</i>	
2.1 Introduction	27
2.2 Changing nature of engineering practice and knowledge	28
2.3 Case studies	32
2.3.1 Arup	33
2.3.2 Ricardo Engineering	38
2.4 Discussion and conclusions	42

Contents

3 Innovative Opportunities and Dependencies: Illustrations from Mobile Communications	48
<i>Magnus Holmén, Mats Magnusson, and Maureen McKelvey</i>	
3.1 Introduction	48
3.2 Innovative opportunities	49
3.3 Innovative opportunities in 3G and i-mode	53
3.4 Dependencies in innovative opportunities	58
3.4.1 Perceived economic value	59
3.4.2 Perceived ability to mobilize resources	61
3.4.3 Perceived appropriability	63
3.5 Conclusions	66
4 The Great Experiment: Public–Private Partnerships and Innovation in Design, Production, and Operation of Capital Goods in the UK	73
<i>Andrew Davies and Ammon Salter</i>	
4.1 Introduction	73
4.2 Empirical and theoretical background	75
4.3 Innovation in capital goods and repositioning for PPPs	81
4.3.1 The capital goods value stream	83
4.3.2 Repositioning in the value stream	86
4.3.3 Moving from unique to repeatable solutions	88
4.3.4 Challenges of providing PPPs	89
4.3.5 Impact of PPP on government departments and agencies	90
4.4 Discussion and conclusions	91
THEME 2: EVOLUTION AND ADAPTATION OF STRUCTURE	97
5 Complexity, Evolution, and the Structure of Demand	99
<i>John Foster and Jason Potts</i>	
5.1 Introduction	99
5.2 Consumption networks not production functions	101
5.3 The economy is a complex rule-system	103
5.4 The growth of demand and the growth of economies	104
5.5 Correlated preferences	106
5.6 Analysis of economic networks	107
5.7 Orders of complexity	109
5.8 Micro–meso–macro	111
5.9 The complexity of consumption and demand	114
5.10 Evolution and aggregate demand	117

6 Self-Transformation, Self-Organization, and Evolutionary Adaptation in the Economic Process	121
<i>J. Stan Metcalfe and Ronnie Ramlogan</i>	
6.1 Introduction	121
6.2 Some evidence for structural adaptation	128
6.3 Accounting for evolutionary adaptation	135
6.4 The logistic principle	140
6.5 Adaptation, complexity, and the problem of knowledge	144
6.6 The correlation of knowing	148
6.7 Conclusions	152
7 Changing Boundaries of Firms in the Evolution of the Computer Industry: Towards a History-Friendly Model	157
<i>Franco Malerba, Richard Nelson, Luigi Orsenigo, and Sidney Winter</i>	
7.1 Introduction	157
7.2 The conceptual background	158
7.3 A brief discussion of the semiconductor and computer industries	160
7.4 Some theoretical statements on the changing vertical boundaries of firms	163
7.4.1 First prediction–vertical integration	163
7.4.2 Second prediction–vertical integration	164
7.4.3 Third prediction–vertical integration	164
7.4.4 Fourth prediction–disintegration	164
7.4.5 Fifth prediction–disintegration	165
7.4.6 Conclusions from the theoretical statements	166
7.5 The model	167
7.5.1 Computers	167
7.5.2 The market for components	167
7.5.3 Firms’ behaviour and technical progress	168
7.5.4 Demand for computers	170
7.5.5 Vertical integration and specialization	171
7.5.6 The working of the model with two technological discontinuities in components	173
7.6. The simulations	175
7.6.1 The benchmark case: vertical integration	175
7.7. Conclusions	193

Contents

THEME 3: INNOVATING AND TECHNOLOGICAL TRANSFORMATION	199
8 The Effects of Technological Change on the Boundaries of Existing Firms	201
<i>Paul L. Robertson and Gianmario Verona</i>	
8.1 Introduction	201
8.2 Technological stability and the boundaries of the firm	205
8.2.1 Core and distinctive competences	206
8.2.2 Transaction costs	207
8.2.3 Behavioural factors	208
8.2.4 Summary	209
8.3 Technological change and the boundaries of the firm	209
8.3.1 Dynamic capabilities	209
8.3.2 Dynamic transaction cost	212
8.3.3 Modularity and firm boundaries	214
8.4 Conclusions	217
9 Transitions, Transformations, and Reproduction: Dynamics in Socio-Technical Systems	227
<i>Frank W. Geels and René Kemp</i>	
9.1 Introduction	227
9.2 Multilevel perspective and types of change	229
9.2.1 Reproduction	234
9.2.2 Transformation	235
9.2.3 Transition	235
9.3 Case studies	236
9.3.1 The hygienic transition from cesspools to integrated sewer systems in the Netherlands (1870–1930)	236
9.3.2 The transformation of Dutch waste management (1960–2000)	243
9.4 Conclusions and policy implications	249
9.4.1 Steering and management	251
9.4.2 Transition management in the Netherlands	252

10 Analysing Flexibility and Stability in Co-evolutionary Processes	257
<i>Magnus Holmén and Maureen McKelvey</i>	
10.1 Introduction	257
10.2 Transformation as involving novelty, destruction, or renewal?	259
10.2.1 The character of change	260
10.2.2 Doing and interpreting empirical research	262
10.3 Co-evolutionary processes in the innovating economy	266
10.4 Discussion	274
<i>Index</i>	283

1

Introduction

Maureen McKelvey and Magnus Holmén

1.1 Introduction

Flexibility and Stability in the Innovating Economy is a book that addresses the nature of industrial dynamics, structural change, and transformation in our time. The aim is to understand, conceptualize, and explain what changes and what does not in the economy, and how individual actors and ‘systems’ relate to one another through differences in perceptions and actions. Thus, the central focus of this book is on the question of evolutionary processes and complex transformation in the economy, with a particular emphasis on the nature of flexibility and stability.

One common starting point for all chapters in this book is that innovation and entrepreneurship continue to disrupt the economy, thereby sometimes fundamentally changing activities and moving the economy in new directions. At other times, resistance and inertia may be more prevalent. This can lead to ‘tensions’ across the system, where tensions can arise between actors, elements, and processes that tend to exhibit flexibility and those that tend to exhibit stability, in different parts of the economic system. Such tensions spring, for example, from differential rates of change, from the variable abilities of actors to respond to systemic changes, and from the existence of both turbulence and inertia at different levels within the same system.

Conceptualizing actors—whether individuals, firms, or other organizations—as capable of innovating and learning has important implications for understanding economic transformation over time. This can be illustrated through two opposing sets of assumptions. In one set, researchers may simply assume that existing organizational forms survive and that known information provides all the relevant signals about the economic system. In this case actors only have to adjust to these signals, and various actors likely interpret the signals in similar ways. Within the mainstream of economics, the analytical framework rests on given environmental conditions to which firms adapt in optimal ways; changes in external conditions generate reactions by firms,

Introduction

and consequently new positions of firms in the competitive landscape. This is a common way of thinking about industrial dynamics and the economy as a system—and in this case, the actors just need to modify behaviour to adjust to those signals, and thereby the system as a whole makes a transition to a new phase.

This book makes a set of rather different assumptions that imply that economic transformation involves fundamental change and is driven by actors, a view that has implications for how we need to understand and explain networks and systems. We assume that knowledge and information are separate, that the value and validity of much information is uncertain and difficult to interpret, and that information does not evenly distribute among actors but is only localized in certain places, industries, or actors. In this case, no one actor can be assumed to have all the correct and relevant ‘signals’. Moreover, it is impossible for any decision-maker to have full information and to assess all possible outcomes. Change is a historical process, filled with uncertainty. The present and future must therefore be seen as the result of history as a process unfolding, with different possible branching points and trajectories.

The theoretical assumptions made in this book have a number of implications for understanding flexibility and stability in the innovating and transforming economy. Under these conditions, various actors will make ‘mistakes’ and use diverse assessments of the future when trying to interpret and react to signals. As knowledge may be distributed among different actors, they may decide to team up to pool resources, to network, or to make alliances for specific goals. Therefore, what actors perceive and the problems they select, what they do, how they learn, and how well they can use and transform that knowledge to solve later problems or take advantage of later opportunities are crucial. This requires a new way of problematizing such endogenous, innovation-driven processes. It also implies that diverse actors will make choices in the present and future that will also fundamentally change the rate, direction, and outcomes, or future trajectories, of the economic system. Finally, the economic system as a whole will transform internally through aspects such as self-organization so that economic transformation is irreversible.

Thereby the concept of economic transformation is defined here in a specific way, in relation to the ongoing processes of industrial dynamics, structural change, and transformation. *Economic transformation* as a concept used in this book refers to a non-reversible process, encompassing quantitative and qualitative changes in components and connections, driven by opportunities and innovations. Such economic transformation may well be driven by processes of complexity and self-organization as well as processes of actors acting, adapting to contexts. Moreover, the concept of transformation, as used here, may result from very different processes, including ones driven by very large and discontinuous changes as well as ones driven by very small changes,

which follow upon an existing trajectory. We would argue that such qualitative transformation is a normal part of the market economy—not a special event.¹

Hence the authors in this book share a common approach to the economy as an inherently dynamic and complex system, consisting of diverse, changing, and interacting components and activities. We will argue that industrial dynamics primarily consists of endogenous, innovation-driven transformation of the economy, which in turn incorporates aspects of business, technological, public policy, and organizational processes. Framing the book this way stresses the necessity of viewing the economy as a sequence of processes and temporally dependent events occurring in irreversible time. But in doing so, this book also stresses that diverse actors are deciding, doing, and acting in ways that affect the outcome in evolutionary processes and complex transformation of the economy.

Section 1.2 asks the question, ‘Why this book?’ in order to place this book in its intellectual framework and specify our book themes, which are further developed throughout the nine subsequent chapters. Section 1.3 provides an overview of each of these nine chapters. A short paragraph introduces the title, authors, and main ideas of each chapter. These chapters are grouped into the three themes, each of which plays upon and reflects the book title in some way. Section 1.4 engages the reader to consider issues ‘Beyond this book’. The reason for this section is that although *Flexibility and Stability in the Innovating Economy* addresses issues related to industrial dynamics, structural change, and transformation, which are issues of interest to many readers, much more research may be developed around the specific issue of flexibility and stability in the innovating and transforming economy.

1.2 Why this book?

As stated earlier, this book focuses on the question of evolutionary processes and complex transformation in the economy, with a particular emphasis on the nature of flexibility and stability. This book contrasts with, but also contributes to, the vast literature on industrial dynamics, evolutionary economics, systems of innovation, management of innovation and technology, history of science and technology, economic history, and economic transformation. This section explains where our thinking started in this book project, in order to address these issues, as well as how the development of ideas led to three themes and ten chapters by 19 researchers.

The key concepts addressed within this edited volume are ‘flexibility’ and ‘stability’ set in relation to the innovating and transforming economy. From the start of this project, these concepts focused our attention on three issues. First this book project started from the idea of ‘change and not change’ and of differential change in economic transformation. These concepts signify that

Introduction

change de facto occurs at different rates, in different directions, on different levels, and in different dimensions of the economy. Our communities in innovation studies, industrial dynamics, and evolutionary economics tend to stress the 'changing' aspects rather than continuity (Constant 2002). Still, 'change' can only be understood in contrast to something that is not changing. Hence, when we started writing this book one issue that was highlighted is how and why different endogenous dimensions of an economy change and how other dimensions remain stable over some period of time.

Second, we started from the premise that aspects of flexibility and stability would require a conceptualization that could lead to debates about how and why diverse actors drive systems, as well as how and why systems constrain and enable actors, albeit perhaps on different timescales. This implied that the book should bring together scholars working on related topics but still different issues, and in quite different ways. This also implied that relationships between different levels of analysis would be particularly important, such as whether and why different actors such as firms and organizations also constitute a systemic level, such as sectors or nations.

Third, this book project also wanted to raise the question of whether the nature of flexibility and stability is in some ways related to debates about the subjective choice of actors relative to an objective, heterogeneous albeit structured reality. The entrepreneurial firm may, for example, experience change as rapid and destructive because many firms are being started, going bankrupt, diversifying while at the industry level, market concentration remains constant over a long period, such that change appears slow and conservative. Hence to the extent that authors wished to address the issue of subjective versus objective 'reality', we started with the idea that the perspective likely depended on differing interpretations of economic transformation, in terms of aspects such as the rate, direction, level, and dimension of change.

These three issues formed the starting point for why this book project examines flexibility and stability in the innovating and transforming economy, and all three are classical themes within, say, sociology, organizational science, and evolutionary economics. Yet relative to these rich debates, little research has addressed the conceptual and analytical foundation upon which we can analyse flexibility and stability in economic transformation.

Using the concepts of 'flexibility and stability' and of 'actor level and system level', Table 1.1 provides an overview of relevant and sometimes overlapping concepts that are useful to analyse evolutionary processes and complex transformation in the economy. Table 1.1 illustrates many relevant concepts for such research. These notions can be related, where e.g. 'learning' at the flexibility/actor level can be related to 'routine' at the stability/actor level and to 'responsiveness' at the flexibility/system level. Table 1.1 clearly shows that linking flexibility and stability to the level of analysis opens up new vistas of analysis. Depending on the research questions and the theories developed,

Table 1.1. An initial conceptualization of flexibility and stability

	Flexibility	Stability
Actor level (e.g. a firm, university, organization, government).	Learning Adaptability New connection	Routine Resistance Regeneration of competencies and resources Rigidity
System level (e.g. national economy, network, industry, sectoral, and regional innovation systems).	Responsiveness Adaptation Turbulence Phase shift Transition	Rigidity Inertia Instituted practices Trajectory

these types of concepts may be useful to highlight particular puzzles. One set may be useful to identify aspects such as the rate and direction of change at different levels and in different dimensions of the economy. But then the question becomes, how and why are they related? Another set may be useful to explain why it is that what at one level appears to be turbulent and persistent change, appears, at another level, to exhibit consistency over time. Similar concepts may be relevant within several ‘boxes’ or across several theories.

Hence, we mean that the conceptualization of flexibility and stability as a research topic opens up new vistas of research, in order to ask questions such as:

- How much, and why do the actors have ‘flexibility’ in relation to systemic dynamics?
- How might different dimensions and characteristics of the system help drive ‘flexibility’ in responses by actors?
- How might elements which seem to indicate ‘stability’ at one level still require much diversity, learning, and turbulence among the particular set of actors?

Taking up flexibility and stability in the innovating and transforming economy as a research topic has meant that not only do we need to address many new questions but also we may need to reinterpret existing questions through new insights. And each question represents ideas—and opens up room for new ideas—which can be debated and further developed beyond this book.

Indeed, once one begins thinking in these terms, it is clear that existing literature abounds with many different sets of concepts that help us capture and highlight aspects of such processes, but neglect other aspects. This implies that different and sometimes almost contradictory concepts are used in the literature. For example, the idea of routines has been a recurring theme within evolutionary economics—and yet much of this literature and of entrepreneur-

Introduction

ship literature stresses the opposite concept, namely the need for quick adaptability and new connections. Similarly, literature about national institutional frameworks often stresses aspects of inertia and trajectories in explaining the differential performance of national economies—and yet much of this literature is also concerned with points of turbulence and the need to respond to new regimes and trends, such as the globalization of capitalism. So, through this book, we wished to find ways to discuss and debate across narrow academic specializations in order to address the larger issues.

To carry on such a debate, we simply wish to start by reminding ourselves and the reader that even though this book broadly adheres to the modern Schumpeterian, or evolutionary economics tradition, there is a historical legacy for understanding industrial dynamics, structural change, and economic transformation.

Arguably, the conceptualization of flexibility and stability in industrial dynamics and economic transformation needs to be understood in terms of the writings of many classic as well as more modern scholars. Much of the modern understanding of economic transformation draws upon and extends the insights of scholars such as Joseph Schumpeter, Adam Smith, Carl Menger, Karl Marx, Alfred Marshall, Thorstein Veblen, Max Weber, and Allyn Young.² For example, this understanding may draw upon Adam Smith's and Allyn Young's views that the progression of the division of labour and specialization is both dependent upon and shapes the size of the market in a non-tautological way. Or, Karl Marx's view that basic science and technological change are harnessed to the productive core of capitalism; Joseph Schumpeter's view that economic transformation is endogenously driven by innovations and entrepreneurship; Carl Menger's view that the subjective nature of needs and wants and complementarities and causal interdependencies among economic goods and knowledge drive the evolution of sectors; and Thorstein Veblen's view that economic change is non-teleological and that habits of thought are at the heart of any economic activity. Hence, a long historical legacy can be developed for many modern ideas of relevance to flexibility and stability.

While encompassing many scholars, modern industrial dynamics can still be described in part as the legacy of Joseph Schumpeter (Hanusch 1999). Schumpeter's key insight was that change is endogenous to economic systems: it is not imposed from without, but rather is generated within, and it is that insight that is followed here. Schumpeter argued that fundamental change in existing activities as well as the introduction of entirely novel activities would keep providing the 'fuel' to the capitalist engine. Through innovations and creative destruction, the existing and old activities are modified but keep existing—as well as helping to give rise to new ones. This can be claimed to be a forward looking view of the economy where heterogeneous expectations and actions among a range of different organizations and individuals keep shifting and reorienting economic activities.

Nelson (1996: 87) argues that this is 'Schumpeter's most consistent and elaborated argument about innovation and economic transformation, that it fundamentally involves disequilibrium and that standard equilibrium theory in economics cannot cope with it and its economic consequences'. In other words, innovation and entrepreneurship continue to disrupt the economy, thereby fundamentally changing activities and moving the economy into new directions.

This part of the Schumpeterian legacy can be best captured by a quotation. In *Capitalism, Socialism and Democracy*, Schumpeter ([1947](1975): 82–3) states:

Capitalism, then, is by nature a form or method of economic change and not only never is but never can be stationary. And this evolutionary character of the capitalist process is not merely due to the fact that economic life goes on in a social and natural environment which changes and by its change alters the data of economic action; this fact is important and these changes (wars, revolutions and so on) often condition industrial change, but they are not its prime movers. Nor is this evolutionary character due to a quasi-automatic increase in population and capital or to the vagaries of monetary systems of which exactly the same thing holds true. The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates.

In this quote, Schumpeter provides a broad view of the importance of internal processes of change within many aspects of the economy. Although Schumpeter stresses that different types of innovations drive economic change, this book interprets this view to mean that diverse actors are driving such innovation processes.

Schumpeter emphasized two broad types of change—a more radical and a more incremental type. These have been tested in the sense of hypotheses about what degree and type of change tends to matter the most for long-term economic growth. On the one hand, there is likely to be radical, disruptive change that rests on new knowledge bases and the rise of new industries. This dimension of change is stressed by Schumpeter himself in his major work, *Business Cycles*. More recent innovation scholars like Freeman and Perez (1988) stress that major shifts in the 'techno-economic paradigm' spark productivity increases across the economy where new technologies are accompanied by institutional shifts. This line of argumentation can be found within other parts of economics, where for example Kuznets (1954, 1959) stresses that economic growth is driven by the emergence of new industries. On the other hand, the second type of change is incremental in that the economy exhibits continuous small changes in products and processes. These are incremental shifts that, over time, create major changes in outputs, methods, skills, and productivity

Introduction

levels. This dimension of change relates to the argumentation about how division of labour and specialization drives economic growth (Young 1928) and it does so by stressing the long-term impacts of a series of small changes. In terms of flexibility and stability, the debates about radical and incremental innovations can be linked to level of analysis, as well as aspects of rate, direction, and outcomes of innovation processes.

Another important writer for understanding flexibility and stability was Menger ([1871](1976)). A major contribution of Menger was that he stressed the importance of individuals and subjectivity through the focus on (subjective) needs and wants. From this perspective, Menger and his successors went on to outline how knowledge and interdependences among heterogeneous capital goods shape or determine industrial organization.³ Flexibility comes about in that different actors may choose different uses of capital goods, but at the same time, the choice set is constrained because of the nature of the individual capital goods as well as its overarching structure, providing some stability to the economic system. In terms of flexibility and stability, this perspective opens up debates about 'subjective' choice versus 'objective' systemic conditions and how an existing structure may affect problem or opportunity identification and selection.

Thus, in somewhat different ways, this book draws upon a rich historical legacy. The classical economists focused on key issues underlying transformation, such as how increases in productivity come about, the sources of economic returns, the reasons and returns on investment into technology and R&D, the importance of organizational design, and the like. Such issues have remained important in modern scholarship, represented in many articles and books and thereby remain key for analysing evolutionary processes and complex transformation in the economy. And yet there has previously been too little attention on flexibility and stability within such processes. This is problematic in the view of the editors in that we argue that the issue of flexibility and stability are at the core of evolution and transformation, and as such need to be studied more systematically. However, given the relatively little direct attention, it is far beyond the scope of this book to 'solve' this issue.

Therefore, this book and each chapter in this book are set to problematize issues related to flexibility and stability in an ever-evolving economy, rather than to solve a known and well-defined problem. This book provides a collection of new scholarship that can debate these issues.

In the process of writing and debating each chapter and the book as a whole, we have sharpened our core common assumptions as well as points of differences. Our broadly Schumpeterian approach to understanding the economy provided some shared intellectual commons for this endeavour—including an understanding that business, technological, public policy, and organizational changes are somehow linked in driving endogenous innovation-driven

transformation. Beyond that, all nine of the subsequent chapters problematize issues related to *Flexibility and Stability in the Innovating Economy*, not only in terms of their own contribution, but also in relation to whether they mainly focus on ‘flexibility or stability’ or on ‘actor and component level or system level’. Specific concepts may appear at different levels, and authors may define similar concepts in somewhat different ways.

Clearly, each subsequent chapter will therefore make its own unique contribution. The processes underlying flexibility and stability are difficult to catch because they are complex, each contribution can only focus on a narrow aspect, as authors use their chosen set of theories, providing their unique interpretation of a research question. Yet these chapters also relate to each other by taking their own position within debates of relevance to the book as a whole.

The chapters have therefore been grouped into three themes which reflect the book title *Flexibility and Stability in the Innovating Economy*:

Theme 1: Experimenting and inertia

Theme 2: Evolution and adaptation of structure

Theme 3: Innovating and technological transformation

Each of these three themes thus reflects and plays upon the issue of flexibility and stability in the innovating and transforming economy. The three themes are the result of discussions, writings, and debates among the authors, as interpreted by the editors. As such, these three themes are a better, if clearly still imperfect, map to addressing evolutionary processes and complex transformation in the economy, with a particular emphasis on the nature of flexibility and stability.

Theme 1, ‘Experimenting and inertia’, addresses what happens, as new organizational forms and new knowledge are developed in existing and new organizations. In this case, flexibility and stability are interpreted as processes occurring primarily at the actor level, with dependences and interactions to the system level. The three chapters in this theme focus on questions related to how and why actors try out new things, from within existing engineering practices, existing views of business opportunities, and existing assumptions underlying contracting and provision of public goods. On the one hand, firms and other actors are engaged in search activities to do new things—such as develop and benefit from knowledge and innovations. On the other hand, the actors are working, starting from old ways of doing things but face unclear choice sets about the future, for example in terms of economic environment, technological opportunities, and competitive conditions. To survive under such conditions they have to experiment. At the same time, they draw upon past experience and competencies to solve new problems thereby leading to inertia in some dimensions. Theme 1 thus reflects research questions that are directly related to what happens over

Introduction

time in the economy, as actors perceive, think, decide, act, and influence others through business relationships.

Theme 2, 'Evolution and adaptation of structure', has three chapters addressing issues about how to understand the overall evolving economy, where evolution and adaptation of structure are endogenous and can be seen as historical processes. In this case, flexibility and stability are primarily interpreted at the system level while still analysing interactions to the actor level, or to components of the system. These three chapters present a view on the economy where co-evolution, adaptation, and the making of connections between elements matter because they help shape and reorient search, innovation, and production. They all start from an explicitly evolutionary economics perspective, albeit with different interpretations of what these theories mean. Hence, each chapter provides a somewhat uniquely different theoretical perspective on what structure and order mean and especially how and why they might change—or not—over time. Theme 2 is thus closely linked to Theme 1 through their common interest in the observation that the economy can be simultaneously characterized as actors' diversity and systemic order.

Theme 3, 'Innovating and technological transformation', has three chapters explicitly addressing innovating and technological transformation, in particular the degree and type of change occurring over time. Indeed, they have a shared interest in the role of technological change as related to different sets of processes in industrial dynamics, socio-technological systems, and co-evolutionary processes. In doing so, all three chapters consider the relationship and interactions among actor and system levels as processes involving feedback over time. They thereby set technological transformation in relation to inertia and evolution. Theme 3 focuses on a particular kind of change and each chapter presents perspectives on how and why the diversity of actor behaviour are linked to broader systemic characteristics. Table 1.2 places the six concepts of 'experimenting', 'inertia', 'evolution', 'adaptation', 'innovating', and 'technological transformation' in relation to the two dimensions of actor/system level and flexibility/stability. Thus, it uses the same dimensions as Table 1.1, placing only the concepts of Themes 1, 2, and 3.

Table 1.2. Conceptualizing flexibility and stability in the three themes

	Flexibility	Stability
Actor level	T1: Experimenting T2: Evolution T3: Innovating	T1: Inertia
System level	T2: Adaptation	T1: Inertia T2: Evolution T3: Technological Transfosmation

In this way, Table 1.2, albeit still imperfectly, relates concepts to the central ideas and three themes explored within this book.

Indeed, Table 1.2 suggests that the exploration of these themes in this book will answer certain questions but also open up new vistas and thereby new questions. For, by doing this simple exercise, Table 1.2 also outlines how concepts may stretch across either of the two dimensions in that some concepts go across several 'boxes'. The reason is that many concepts bring several dimensions into play. While some concepts may fit neatly within one box, other concepts can be categorized in several boxes because they focus on linkages, tensions, and relationships across dimensions.

In summary, this book problematizes the issues identified earlier through nine chapters grouped in the three themes. In doing so, this book takes one of the challenges within evolutionary economics and innovation literature seriously, namely how and why to combine levels of analysis related to actor and system, or what has been traditionally called individual and structure, in order to explain both unique trajectories of development and general characteristics of the transformation of the economic system. Because of the complexity of the overarching issues, there is no single level of analysis or approach that will provide a correct and exhaustive answer.

1.3 Overview of chapters

This section provides a short summary of each chapter, including author, titles, and abstract, and the chapters are organized within the three themes. Thereby, this section should help direct the reader who is interested in particular issues and authors to the relevant chapters—as well as giving more detailed insights into the book as a whole.

As mentioned earlier, researchers writing subsequent chapters all make their unique contribution by focusing on his/her more specific research question, and they also work within rather specific academic communities. Theories used in this book therefore draw from a range specific disciplines and fields, especially economics of innovation, industrial dynamics, evolutionary economics, business history, organization studies, technology and innovation management, science and technology policy, and entrepreneurship. Thus to address specific questions subsequent chapters in this book will deal with different theories, different levels of the economic system, and different aspects or variables of the economic system to bridge a few of these problems. Nonetheless, the chapters taken together provide a means to explain and stress why analysing *Flexibility and Stability in the Innovating Economy* requires putting together the many diverse pieces of our common conceptual and empirical puzzle into an interesting mosaic.

1.3.1 *Chapters in Theme 1: experimenting and inertia*

Chapters 2, 3, and 4 in Theme 1 discuss flexibility and stability, primarily at the actor level.

Chapter 2, 'The new craft skills of engineering: the impact of innovation technology on engineering practice' by Mark Dodgson, David Gann, and Ammon Salter, explores the impact of the use of innovation technologies such as simulation, modelling, and rapid prototyping on engineering practice for a business context. These innovation technologies help redefine the role of engineers in the innovation process, creating a new division of innovative labour both with organizations and across organizations. In doing so, this chapter explores the boundaries of experimentation and inertia within particular domains of problem-solving to create new opportunities and value.

The difference between engineering knowledge and scientific knowledge retains a central position in the main theories of innovation. And yet there is a growing body of literature focusing on the 'distinctiveness' of engineering problem-solving, and the nature of engineering knowledge is itself coming under increasing examination. Williams (2003) argues that engineering is witnessing two major patterns of change, one involving a deepening of knowledge in specialist domains, and the other a broadening set of interests and pursuits outside normal engineering practice. She calls these two trends the 'expansive disintegration' of engineering.

This chapter focuses on innovation technologies in relation to experimenting and inertia. Using the experiences of two leading engineering organizations, Arup and Ricardo, this chapter explores how the use of the new technologies can help reshape engineering problem-solving and, in turn, engineering knowledge. The chapter suggests that the use of the new technologies is creating opportunities for some engineers to create new value by allowing users and clients to play with different alternatives. However, the creation of this new value will require new forms of engineering problem-solving and knowledge, often far removed from the traditional demarcations of traditional engineering practice.

Chapter 3, 'Innovative opportunities and dependencies: illustrations from mobile communications', by Magnus Holmén, Mats Magnusson, and Maureen McKelvey, addresses the role played by innovative opportunities as one force driving economic transformation through dependencies. As such, this chapter explores the extent of experimentation and inertia when actors identify, act upon, and realize innovative opportunities.

Innovative opportunities refer to a set of different elements within the process whereby actors identify, act upon, and realize new combinations of resources and market needs—to try to benefit from their future economic potential. The proposed concept draws upon earlier proposed opportunity

concepts: technological, entrepreneurial, and productive, but provides a more comprehensive tool for capturing innovation as it includes elements of value perception, resource mobilization, and value appropriation. In this chapter, innovative opportunities are used as a concept for capturing dependencies between key processes in innovation, as well as understanding the systemic effects present in complex innovation activities characterized by uncertainty. The dependencies are illustrated by case studies of the early stages of development of technology and business platforms in the telecom area, more specifically 3G and i-mode. The empirical observations demonstrate dependencies among different actors which result in 'systemic' effects, and these take the form of dependencies across different types of opportunities (technological, entrepreneurial, and productive) as well as dependencies across different elements of these processes (value perception, resource mobilization, and value appropriation). Such interdependencies are argued to be one force helping drive flexibility and stability in economic transformation, as drawn out in the conclusions of this chapter.

In Chapter 4, 'The great experiment: public-private partnerships and innovation in design, production, and operation of capital goods in the UK', by Andrew Davies and Ammon Salter, public-private partnerships (PPPs) are becoming the key mechanism for the design, production, and operation of capital goods in the public sector in the UK and elsewhere. There has been little independent empirical research on the impact of new arrangements on the innovation process in capital goods. Thus, this chapter explores the boundaries of innovating, learning, and experimenting within particular types of organization forms of contracting for capital goods.

This type of contracting is becoming increasingly important to the economy, because long-term service contracts between the public and private sectors or PPPs are increasingly common. They have become a much used 'tool' for governments looking for opportunities to lower risk and shift responsibility for the production and operation of fixed capital goods to the private sector. Moreover, they represent a Schumpeterian transformation in the capital goods sector that reshapes the division of labour between the public and private sector and alters the potential for innovation in the design, production, and operation of capital goods. The chapter focuses on the central motivations behind the movement towards PPPs and explores the impact of these new contractual arrangements on innovation in the capital goods sector. The greatest impact of the new arrangements appears to have been the emergence of a PPP industry and, along with this, a new division of labour among private providers and public procurers of capital goods. In addition to its traditional role as designer and builder of systems, the private sector has taken on greater downstream responsibility for operation and maintenance of systems previously handled in-house by public sector organizations.

1.3.2 Chapters in Theme 2: evolution and adaptation of structure

Chapters 5, 6, and 7 in Theme 2 mainly analyse flexibility at the actor and system levels.

Chapter 5, 'Complexity, evolution, and the structure of demand', by John Foster and Jason Potts, argues that evolutionary economics should be founded upon complex systems theory rather than upon neo-Darwinian analogies concerning natural selection which have been focused especially on supply-side considerations and competition among firms and technologies. Such analogies are useful to understand the resolution of variety, but they do not help us understand how variety is generated and diffused. Hence, the interpretation of evolution and adaptation of structure presented in this chapter stresses complex systems theory.

Generally, an economic system is a complex geometry of connections between rules and elements. Thus, economic evolution involves change in the connective structure of an economic system towards more ordered complexity. Network connections exist between consumers, between producers, and between producers and consumers. When dealt with in an explicit and systematic way, the flexibility and stability of economic systems can be studied in a more coherent way than hitherto.

The authors argue that conceptions such as production and consumption functions should be replaced by network representations in which the preferences or, more correctly, the aspirations of consumers are fundamental and, as such, the primary drivers of economic growth. Technological innovation is viewed as a process that is intermediate between these aspirational networks and the organizational networks in which goods and services are produced. Consumer knowledge becomes at least as important as producer knowledge in determining how economic value is generated and it becomes clear that the stability afforded by connective systems of rules is essential for economic flexibility to exist but that too many rules result in inert and structurally unstable states. In contrast, too few rules result in a more stable state, but at a low level of ordered complexity. The chapter explores economic evolution from this perspective using random and scale-free network representations of complex systems.

Chapter 6, 'Self-transformation, self-organization, and evolutionary adaptation in the economic process', by Stan Metcalfe and Ronnie Ramlogan, focuses on the connection between economic adaptation and economic development and growth. Thus, this chapter also explicitly draws upon evolutionary economic theory and complexity theory to address the specific issue of adaptation.

The authors argue that economic adaptation is inseparable from the growth of knowledge and that market-based dynamics give adaptation a form that is central to change in modern capitalism. Reallocation of resources is the con-

sequence of different beliefs, the imagination that the economic world can be organized differently. This is the primary reason why economies evolve and adapt, in that they are instituted variation, selection, and developmental processes.

Understanding at multiple levels is the necessary condition for an economy to operate, which in turn stimulates the growth of new knowledge and thus the emergence of new understandings. This is a system, therefore, in which neither the component parts, which consist of knowledgeable individuals, nor their patterns of intercommunication, the social relations, are given. The point about the complex knowledge system is that it is evolving in parts and connections, as such it is 'restless' in that it is always becoming something else in an unpredictable way (Metcalf 1998). Within this conceptualization of the innovating and transforming economy as restless capitalism, the effects of adaptation to change may be positive or negative.

Chapter 7 is 'Changing boundaries of firms in the evolution of the computer industry: towards a history-friendly model', by Franco Malerba, Richard Nelson, Luigi Orsenigo, and Sidney Winter. It analyses the changing boundaries of firms in terms of vertical integration and disintegration (specialization) in dynamic and uncertain technological and market environments. Like the previous chapters in this theme, this chapter also explicitly draws upon evolutionary economic theory, but here with a focus on modelling industrial dynamics as co-evolutionary processes.

In particular, this chapter addresses the question of stability and change in firms' decisions to 'make or buy' in contexts characterized by periods of technological revolutions punctuating periods of relative technological stability and smooth technical progress. The analysis is centred upon the coupled dynamics of competencies, market structure and on the co-evolution of the upstream and downstream industries. The chapter is inspired by the case of the computer and semiconductor industries and proposes the building blocks of a model in the 'history-friendly' style, showing how alternative dynamics of demand and technical change might generate profoundly different patterns of evolution in the two industries. After a brief recount of the long-term evolution of the two industries, as it emerges from the historical and economic literature, the model examines why certain computer producers (e.g. IBM) were vertically integrated into semiconductors early on in the evolution of the industry and why later on they disintegrated, becoming specialized system producers acquiring part or all of their needs for semiconductors from the market, i.e. from specialized producers. The main argument proposed in the chapter concerns the role of co-evolution in the upstream and downstream industries in explaining the changing boundaries of firms.

1.3.3 Chapters in Theme 3: innovating and technological transformation

Chapters 8, 9, and 10 in Theme 3 link flexibility at the actor level with stability at the system level.

Chapter 8, 'The effects of technological change on the boundaries of existing firms', by Paul L. Robertson and Gianmario Verona, explores the reciprocal relationship between technological innovation and the boundaries of the firm, and thereby complements Chapter 7 with an interest in industrial dynamics.

Innovation and technological change are part of the core of discussing firm boundaries, not least because the authors argue that innovation is highly unlikely to lead to uniform changes in the relationship between firms. While in some cases, technological change and increasing transaction costs might lead to convergence (vertical integration) among firms in certain industries, other types of technological change and decreasing transaction costs (brought on by a diffusion of knowledge) could lead to divergent patterns (vertical differentiation or disintegration), even in the same industries. Far from being random, however, the nature and degree of these changes may be predicted through an examination of the economic and technological contexts in which particular firms operate.

This chapter explores the paths that firm boundaries might be expected to follow under a variety of circumstances. The basic argument is that, while one might follow Langlois (2003) in believing that there will be a tendency for large, vertically integrated enterprises to become less common in the technological environment that seems to unfold at present, other tendencies will also be afoot, leading to a spectrum of different types of inter- and intrafirm relationships. This includes, in some cases, the creation of new giant enterprises of the sort whose evolution in the early twentieth century was described by Chandler (1962, 1977) as the imposition of a 'visible hand' to reduce uncertainties in market-based relationships.

Chapter 9, 'Transitions, transformations, and reproduction: dynamics in socio-technical systems', by Frank W. Geels and René Kemp, explores innovating and technological transformation in terms of competing socio-technical systems that evolve over long time periods.

This chapter examines changes in functional systems from both a theoretical and empirical perspective. It offers a typology of system changes and two brief case studies based on multilevel analysis. The case studies are the hygienic transition from cesspools to integrated sewer systems (1870–1930) and the transformation in waste management (1960–2000) in the Netherlands. Three types of processes through which systems may change are described: reproduction, transformation, and transition. In the case of reproduction, there is no fundamental change at the meso level (the orientation of dominant actors, regime rules, and key technology or knowledge base), which instead is

the case when stabilizing factors dominate. In the case of transitions and transformations in socio-technical systems there are meso-level changes, created either by problems or new opportunities afforded by changes in technology and changes in the overall landscape. Transitions and transformations can only occur when developments at multiple levels amplify each other. This is worked out in a scheme of dynamic interactions between actors, systems rules, and social networks. The novelty of the scheme is that a regime perspective is combined with an actor perspective.

Thus, the two empirical cases are used to explore the conceptual framework. The empirical cases illustrate that transitions and transformations are non-predictable processes with emergent systemic properties, in which niches, surprises, and crises play an important role. Even the outcomes of goal-oriented transitions can only be understood through events and crossover effects from various processes at different levels. Whereas diversity is desirable from a lock-in point of view, diversity may also create uncertainty and delay transition and transformation processes.

Chapter 10, 'Analysing flexibility and stability in co-evolutionary processes', by Magnus Holmén and Maureen McKelvey, poses the question of how we can analyse conceptually and empirically *whether or not* certain types of change have occurred, as well as by pointing out research areas to further address how, why, and in what dimensions such transformation has occurred.

Our motivation for writing this chapter is simple: to encourage research on the interlocking importance of business, technological, public policy, and organizational change over time. This chapter focuses on considerations related to systematically linking theoretical arguments with empirical material.

This chapter first addresses how the amount or degree of 'change' can be conceptualized, as compared to the amount or degree of 'not change'. The proposal is that we can do so by distinguishing between the relative amounts of 'old' and 'new' that is found—within some defined, specific characteristic of the economic system that is observed empirically. Three concepts are therefore introduced here—namely novelty, destruction, and renewal. The chapter then explains and outlines six points about how flexibility and stability can be understood from a paradigmatic perspective on the innovating and transforming economy. The reason for pursuing this line of (paradigmatic) argumentation is twofold. One is that there are many researchers from different disciplines who are coming into the study of innovation and technological change in relation to industrial dynamics, structural change, and transformation. Thus there is a need to provide a brief introduction that links our concepts into a way of understanding economic transformation. The second is to use these six points, in relation to the discussion of flexibility and stability, in order to sketch out some interesting research questions.

1.4 Beyond this book

This concluding section presents a few reflections to help stimulate readers' further development of the ideas outlined earlier. The comments in this section are meant to stimulate readers to think about 'Beyond this book' while reading subsequent chapters.

To begin with, we would like to stress that each of the individual chapters in this book opens up room for new ideas and ways of approaching this topic. Many different concepts, theoretical explanations, and methods to conduct research can be found there, symbolizing the heterogeneity of ideas still waiting to be explored. The reason this book involves researchers from different fields is not simply because there are many ways of attacking the issues of dynamics. The editors' view is that for a deeper understanding of tensions and dynamics, we need progress in understanding how and why to connect the incentives and behaviour of the individual actors with system characteristics and system dynamics. Such progress will depend on communication among researchers who are specialized in different areas.

Moreover, the three themes—'Experimenting and inertia', 'Evolution and adaptation of structure', and 'Innovating and technological transformation'—suggest areas of research in relation to analysing flexibility and stability. The following discussion of research within each theme is done in a fairly abstract way to point to a few of the issues raised by the preceding chapters in this book.

Theme 1: Given that economic change fundamentally relies upon endogenous processes, diverse actors are developing new market and technological knowledge, identifying and exploiting opportunities, and revising the organization of business relationships. From this perspective, therefore, economic transformation is likely to be driven by the development of new formalized and fundamental knowledge—as well as the development of knowledge based on organizational learning and experience-based judgements. Innovating and learning are key because rather than assuming there is one 'optimal' solution, the shared assumption across the chapters is that the outcome is the result of historical processes. Hence, we should address what happens when actors are experimenting with different organizational forms. Such experimenting may be driven by both firm strategy and adaptation to environmental conditions, and their choices will affect the trajectory of further economic development. Yet the boundaries of innovating, learning, and experimenting may be affected by systemic conditions and not all actors strive for change, some resist change.

Thus, experimenting and inertia may be linked together when understanding what diverse actors are doing during economic transformation. Under certain circumstances, actors will work within the existing organization and knowledge as appropriate and applied to the task at hand. And yet, in

other circumstances, new and different types of business, technological, public policy, and organizational processes will need to be developed in order to solve the business and economic problems at hand. This implies that research should further explore the tensions that will arise between 'old' and 'new' knowledge and organizations as experimentation, strategies, learning, and institutional context influence which specific types of knowledge and organizational forms are tried out in any given case.

Theme 2: This theme addresses how certain economic phenomena and inherent properties of the system may be channelling economic transformation through connections in complex systems, adaptation of structure and co-evolutionary processes. The chapters in this book primarily interpret flexibility and stability at the system level, with interactions to the actor level. They thereby address some core issues where more research could be done. For one thing, the chapters in this theme all start from an explicitly evolutionary economics perspective, albeit with different interpretations of what these theories mean. This implies that more research is necessary to further develop this theoretical paradigm, which is core to the idea of an innovating and transforming economy. In relation to flexibility and stability, particularly important issues are about demand as a fuel for the creation and production of goods and services, as well as the role of adaptation and of networks in driving economic transformation. A particularly fruitful avenue may be to try to seriously link our understanding of consumers and users to an understanding of economic transformation.

Theme 3: This theme raises questions of flexibility and stability in relation to how and why economic change can be channelled into developing along particular trajectories. The chapters here sketch different ways to proceed on such topics as related to different sets of processes in industrial dynamics, socio-technological systems, and co-evolutionary processes. For example, there are questions related to concepts and explanations for how and why certain 'transitions', 'transformations', and 'trajectories' occur as well as how and why stability may occur. It appears that such processes may be explained either in terms of systemic characteristics and emergent properties, or as arising from interactions and interdependencies of individual actors.⁴ The research may particularly wish to explore flexibility and stability, in relation to the dependencies between the decisions and actions of actors and systemic conditions. The idea of long-term trajectories could further be explored in relation to firms but also in relation to the particular role of government and public policies.

In short, each individual chapter and each of the three themes highlights insights related to explaining and exploring flexibility and stability in evolutionary processes and complex transformation of the economy. On the one hand, these processes of industrial dynamics, structural change, and transformation are the result of individuals, firms, and organizations actively

shaping, learning about, predicting under uncertainty, and reacting to their context(s). On the other hand, these broader processes and systems also exhibit their own dynamics, and thereby constrain and enable these actors. This book does not solve this challenge, because instead of trying to provide the 'correct' interpretation, the collection of scholarship, which constitutes this book, answers only some questions and opens up a variety of new debates.

In our opinion, one of the key issues that requires further exploration is how and why aspects of cognition and learning influence broader systemic transformation. Hence, one area for future research would be to explore the interactions between individual agents and systems, especially what triggers individual actors to alter their behaviour, whether through competencies, cognition, or learning. This could be used, for example, to explain differential interest in starting businesses and entrepreneurship in different times and places. Specifically, how do individual actors recognize an innovation, a chance to do something new, an opportunity? According to Loasby (2001) the triggering mechanism for an individual (actor) *identifying* an opportunity or a problem can be understood in what he refers to as Pound's principle.⁵ The principle states that problems (or opportunities) are identified by the *difference* between some existing situation and some desired situation. The argument here is that these differences go back to the distinction between *a perception of* what something could be like or how something could be done and *a perception of* something factual.⁶ Hence, perception and cognition is an important aspect of the ability for firms and agents of public policy to react to environmental changes—but they also act in advance of expected future states. This leads to the development of new sets of questions. For example, under these conditions, what does experimentation and learning actually mean? And how and why are new connections made, or new feedback mechanisms developed to interpret the environment? A related question is: How is cognition economized? The answer to this question helps explain the extent to which knowledge functions as a public good, as well as the division of innovative labour, between different actors and systems (Loasby 1999). Loasby refers to this as 'bounded cognition' and puts it into sharp contrast with Simon's 'bounded rationality', which is a rationalistic information processing view.

Finally, it would be useful to develop the epistemological foundations of the evolving and innovating economy further, because doing so is necessary to address some of the challenges facing researchers and decision-makers. Differences in epistemological foundations matter when deciding how to 'do' social science and also to develop useful knowledge for practitioners. Many of the debates in subsequent chapters address—directly or indirectly—how much (and which parts) of empirical and historical accounts can be used to develop predictive and explanatory models. For example, one aspect of this is how to continue the tradition of confronting conceptual and theoretical approaches

with empirical understanding, known as ‘appreciative theorizing’ (Nelson and Winter 1982). Theoretical constructs do not take precedence over other ways of perceiving and intermediating with the world, but neither are empirical cases and illustrations considered the only way to approach ‘truth’ about the economy. Hence, we must debate how science is ‘done’, especially the epistemological foundations of what we ‘know’ and how we know it in social sciences.

Indeed, all of social science—and most of medicine, engineering, and large parts of natural science—face the same problem. That is, how does one go about sorting out the specific, context-dependent outcomes from more generalizable laws and predictions of behaviour?

Our community is faced with particular challenges in explaining flexibility and stability in economic transformation, given the insight that history matters in such a fundamental sense that no two states of the system are the same, nor may the dynamics be explained through simple mechanisms. On the one hand, this book stresses that very history-specific and unique aspects—such as phenomena, events, people, and organizations—are inherently part of what may, on the other hand, be the result of ‘explanatory variables’ conceptualized in terms of systematic outcomes and trends. This implies that theoretical explanations are not simply ‘proving’ hypotheses to make predictions but they are instead ‘exploring’ how and why serendipity, human choice, and specific conditions combine with more ‘structural’ causal factors.

In summary, we believe that debating issues about *Flexibility and Stability in the Innovating Economy* lifts up many themes that could be of relevance to readers. Given that this issue represents one of the front lines of theory development in the field, there are many points of contention among similarly minded researchers and hence, many debates are ongoing in subsequent chapters. For this reason, this book provides an interdisciplinary analysis, with a collection of scholarship that represents diverse perspectives on the core issues. In doing so, this book is primarily conceptual and theoretical, with relevant empirical material to illustrate the arguments and to make the case. In different ways subsequent chapters argue that understanding these fundamental issues are critical for academic debate, public policy, and firm strategies—as well as for stimulating further research.

Notes

1. See Nelson 1996; Metcalfe 1998.
2. There are many references for each of the classic writers, but some of the important references include Schumpeter 1947; Smith [1776] (1991); Menger [1871] (1976); Marx (1890); Marshall 1890; Weber 1961; Veblen 1898; and Young 1928.
3. Such as Hayek (1937, 1945), Lachmann ([1956] 1978).

Introduction

4. In this case, the notion of 'systemic characteristics' could refer to understanding the linkages between system changes (i.e. changes of the system as a whole) or to the ongoing dynamics (or lack thereof) between actors and components within that system, or to the interaction among the two previous ideas.
5. This was first outlined by Pounds (1969) in an article '... noticed by hardly anyone' (Loasby 1976: 96).
6. This raises the question of the source of differing perceptions, and Loasby (1976) lists four categories from which such differences with the perception of the present situation can be found: *a*) historical, *b*) external to the firm, *c*) planning which should have led to an anticipated or intended outcome, and *d*) imaginative, a notion of what might be.

References

- Chandler, A. D. (1962). *Strategy and Structure: Chapters in the History of Industrial Enterprise*. Cambridge, MA: MIT Press.
- Chandler, A. D., Jr. (1977). *The Visible Hand: The Managerial Revolution in American Business*. Cambridge, MA: The Belknap Press.
- Constant, E. W. II (2002). 'Why Evolution is a Theory About Stability: Constraint, Causation, and Ecology in Technological Change', *Research Policy*, 31(8–9): 1241–56.
- Freeman, C. and Perez, C. (1988). 'Structural Crises of Adjustment, Business Cycles and Investment Behaviour', in Dosi et al. (eds.), *Technical Change and Economic Theory*. London: Pinter. pp. 38–66.
- Hayek, F. A. (1937). Economics and Knowledge. *Economica*, New Series, 4: 33–54.
- Hayek, F. A. (1945). 'The Use of Knowledge in Society', *American Economic Review*, 35(4): 519–30.
- Hanusch, H. (ed.) (1999). *The Legacy of Joseph A. Schumpeter*. Two-volume reference collection. Cheltenham, UK: Edward Elgar.
- Kuznets, S. (1954). *Economic Change*. London: Heinemann.
- Kuznets, S. (1959). *Six Lectures on Economic Growth*. Glencoe, IL: Free Press.
- Lachmann, L. M. [1956] (1978). *Capital and Its Structure*, 2nd edn. Kansas City, KS: Sheed Andrews and McMeel.
- Langlois, R. N. (2003). 'The Vanishing Hand: The Changing Dynamics of Industrial Capitalism', *Industrial and Corporate Change*, 12(2): 351–85.
- Loasby, B. J. (1976). *Choice, Complexity and Ignorance: An Enquiry into Economic Theory and the Practice of Decision Making*. London: Cambridge University Press.
- (1999). *Knowledge, Institutions and Evolution in Economics*. London: Routledge.
- (2001). 'Cognition, Imagination and Institutions in Demand Creation', *Journal of Evolutionary Economics*, 11: 7–21.
- Marshall, A. (1890). *Principles of Economics: An Introductory Text*. London: Macmillan.
- Marx, K. (1890). *Das Kapital*.
- Menger, C. [1871] (1976). *Principles of Economics*. Translated by J. Dingwall and B. F. Hoselitz. New York: New York University Press.
- Metcalfe, J. S. (1998). *Evolutionary Economics and Creative Destruction*. London: Routledge.

- Nelson, R. (1996). *The Sources of Economic Growth*. Cambridge, MA: Harvard University Press.
- Nelson, R. R. and Winter, S. G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: The Belknap Press.
- Pounds, W. F. (1969). 'The Process of Problem Finding', *Industrial Management Review*, 11: 1–19.
- Schumpeter, J. A. (1947). *Capitalism, Socialism and Democracy*, 2nd edn. New York: Harper and Brothers.
- Smith, A. [1776] (1991). *The Wealth of Nations*. Amherst, NY: Prometheus Books. (Original title 'An Inquiry into the Nature and Causes of the Wealth of Nations'.)
- Veblen, T. (1898). 'Why is Economics Not an Evolutionary Science?', *The Quarterly Journal of Economics*, 12.
- Weber, M. (1961). *General Economic History*. New York: First Collier Books.
- Young, A. (1928). 'Increasing Returns and Economic Progress', *The Economic Journal*, 38(152):527–42
- Williams, R. (2003). *Retooling: A Historian Confronts Technological Change*. Cambridge, MA: MIT Press.

