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Economics from an Evolutionary Perspective*

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AN OVERVIEW OF MODERN EVOLUTIONARY ECONOMICS

CHAPTER 1: ECONOMICS FROM AN EVOLUTIONARY PERSPECTIVE

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1. What is This Book About ?

This book is about modern evolutionary economics. It is designed for economists and other social scientists who want to become more familiar with this body of research and writing, and provides an overview of the field, its theoretical orientation, and the empirical findings it has achieved [1]. It brings together several different strands of work in evolutionary economics that have been developing relatively independently and displays the broad perspective on how modern economies work and evolve that together they bring into view [2]. And as evolutionary economics is a work in progress, it considers where the field seems to be going.

The term “evolutionary economics” has been used to denote a wide range of economic research and writing. [3] This book focuses on work aimed to illuminate empirical economic phenomena oriented theoretically by the

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1 A strong background in economics is not required. However, a basic familiarity with the field would be very helpful to the reader, if not indispensable. A large share of the topics treated and concepts employed by evolutionary economists are traditional in economics, and readers will be assumed to have at least a rough understanding of these. And the significant differences between evolutionary and neoclassical economics will stand out more clearly for readers with a familiarity with the latter.

2 We note that much of the work in evolutionary economics has been done by economists who have their home outside of standard economics departments, particularly in business schools and in programs focused on science and technology policy. Much of it has been published in journals outside of the economics mainline, we note in particular the Journal of Evolutionary Economics, Industrial and Corporate Change, and Research Policy.

3 Here are a limited set of references to a vast literature: Veblen, T., 1898, “Why is Economics Not an Evolutionary Science”, Nelson R. and Winter S., 1982, An Evolutionary Theory of Economic Change, Hodgson, G., 1993, Economics and Evolution: Bringing Life Back Into Economics, Metcalfe, J.S., 1998, Evolutionary Economics and Creative Destruction, Dopfer, K., (ed.) 2005, The Evolutionary Foundations of Economics, Winter, S., 2014, “The Future of Evolutionary Economics: Can We Break Out of the Beachhead?”, Dosi, G., 2014, Economic Organization, Industrial Dynamics, and Development: Selected Essays, Malerba F, Nelson R., Orsenigo L., and Winter S., 2016, Innovation and the Evolution of Industries: History Friendly Models

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proposition that the phenomena being studied have evolved, in a sense that will be laid out in what follows. While formal evolutionary modeling has played a significant role in developing and sharpening that perspective, the focus here is not on formal models but rather on the broad perspective on economic activity that they have helped to shape[4]. And, to keep reasonable constraint on the subject matter we will explore, while evolutionary economists clearly have a kinship with the broader body of evolutionary social science research and writing, we do not consider that extensive literature in any detail [5].

This book is tightly focused this way because we, the authors, believe that the value of a broad theoretical perspective, such as that of evolutionary economics, should be judged in terms of the strength and quality of the understanding of empirical phenomena and the illumination of policy questions provided by research oriented by that perspective. We believe that the research done over the last thirty years oriented by evolutionary economic theory has amply demonstrated the value of that theory, and we want to increase the number of scholars who appreciate that.

This introductory chapter lays out the broad orientation taken by evolutionary economists and the questions they regard as central. The following chapters will describe in more depth the evolutionary perspective on fields of empirical study where evolutionary economists have been particularly active, and show the kind of a picture of how economies work and change they provide when they are put together. The concluding chapter considers the evolution of evolutionary economics.

2. Capitalism as a Dynamic Evolving System

At the root of the difference between evolutionary economics and economics of the sort presented in today's standard textbooks is the conviction of evolutionary economists that continuing change, largely driven by innovation, is a central characteristic of modern capitalist economies, and

4 The formal modeling of evolutionary economists is scattered and varied in style ; for a sampling see Nelson and Winter, 1982, Dosi, 2014, Metcalfe 1998, Malerba Nelson Orsenigo and Winter, 2016. . For a survey of evolutionary game theory see J. Weibull, 1995

5 For a broad recent review, see Alex Mesoudi's Cultural Evolution, 2011

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that this fact ought to be built into the core of basic economic theory. Economies are always changing, new elements are always being introduced and old ones disappearing. Of course economic activities and economic sectors differ in the pace and character of change. In many parts of the economy innovation is rapid and continuing, and the context for economic action taking is almost always shifting and providing new opportunities and challenges. And while in some activities and sectors the rate of innovation is more limited, attempts at doing something new are going on almost everywhere in the economy, and so too change that can make obsolete old ways of doing things. Neoclassical theory, which is a significant influence on how most professionally trained economists think [6], represses this.

With our central interest in innovation and the economic conditions continuing innovation generates, evolutionary economists are Schumpeterian, and as Schumpeter does we highlight the amazing, if uneven, economic progress that capitalism has engendered. Economies at the economic frontier today support a standard of living that would have been almost unthinkable two centuries ago, when capitalist economies were just emerging. For evolutionary economists perhaps the most challenging and important economic questions that need to be addressed are: How did the economic progress we have achieved come about? What can be done to enable those societies that to date have not shared in economic progress to do better? And what kind of progress can we expect in the future, and how can we influence the paths taken? [7]

In having these questions at the center of their attention, modern evolutionary economists are returning to the perspective on the workings of market economies laid out long ago by Adam Smith [8], and later Karl Marx, and more recently of course by Joseph Schumpeter. Long run economic development certainly is treated in today's standard economic textbooks, and technological innovation is recognized as the key driving source.

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6 We recognize that many empirically oriented economists do their research and write it up under very little explicit influence of neoclassical theory. But we would argue that even in these cases the implicit influence can be significant. More on this shortly

7 Evolutionary economists also are much concerned with the "creative destruction" associated with innovation driven economic development, and the fact that often the benefits or economic growth are not widely shared.

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However, this subject matter is presented as a special topic, rather than at the heart of economic description and analysis.

Evolutionary economists would argue that analysis of what goes on in the economy at any time cannot be separated from, but must involve in an integral way, explicit recognition of the dynamic processes involved in ongoing innovation driven economic change. The core assumptions of neoclassical theory make it very difficult to do this[9].

There is, first of all, the need to recognize the importance and nature of innovation. Innovation is an activity involving a vision of something that has not existed before and beliefs about its potential value. Inventors and innovators may draw as best they can from what is known empirically about what is and is not likely to succeed. But the imagination and sophistication guiding the effort, and luck, are at least as important in determining what paths are explored and the innovations that actually emerge. These aspects of what innovators see and believe, and don't see, do not fit in very well with a theoretical presumption that economic actors somehow know the best course of action for them.

And in a world of innovation driven change, not just the innovators, but also many economic actors who would prefer to keep on doing what they have been doing often can't because the context they are in has changed, and therefore must take the actions they employ on the basis of limited relevant experience. Again, a theory that presumes that actors have a strong understanding of the context they are in and of appropriate actions to take would seem not to recognize important aspects of what is going on in many contexts..

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8 Recall that Smith begins his great book by describing innovation and productivity growth in pin making. His central interest clearly is in economic development.

9 As we noted, many empirically oriented economists get around this problem basically by ignoring the cannons of neoclassical theory in their empirical work and writing. Thus discussion of what is involved in industrial competition may well stress Schumpeter. But when the analysis is linked to formal theorizing, the emphasis is on how competition affects industry output and prices in equilibrium.

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Similarly, evolutionary economists see an inclination to presume that economic activity tends to be in or close to an equilibrium configuration as a hindrance for analyzing contexts in which innovation is going on, with a variety of new ways of doing things actively competing with each other and with prevailing practice. Some will be winners, and some losers, but the race must be understood as on-going rather than already finished.

On the other hand, the nature of the economic dynamics we have been describing is readily interpretable as an evolutionary process. This certainly is not a new idea. Over a century ago Thorstein Veblen asked “Why is Economics Not an Evolutionary Science?” [10]. While Alfred Marshall[11] generally is associated with the rise of neoclassical economics, in a famous statement he proposed that “The Mecca of the economist lies in economic biology …” And Schumpeter (1950) argued that “..in dealing with capitalism we are dealing with an evolutionary process”. Thus many economists long have believed that the process through which economic change occurs has important aspects similar to those involved in biological evolution; this is why we and our forebears have used the term “evolutionary” to denote our theoretical orientation.

Later in this chapter we will discuss the aspects of economic evolution, and the similarities and differences from evolution in biology, in more detail. However here we want to highlight the following essential features.

First, when we call the process of economic change evolutionary we do not mean to deny, or play down, the purpose, thought, and often the considerable sophistication that lies behind much of economic action taking. Rather, we use the term to highlight the incomplete character of human understanding even in contexts that are illuminated by a strong science, and the consequent uncertainties that surround important parts of economic activity, and which are always present when new things are being created and tried out. The outcomes of trying new things almost always differ, in some cases radically, from what the inventor or innovator had in mind. How things actually work only can be learned in actual practice, and even then reliable learning about the efficacy of new ways of doing things can be slow.

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10 Veblen, 1898

11 The quote is from the eighth edition of Marshall’s Principles, published in 1920

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This characterization clearly fits efforts at significant innovation. But it also fits efforts by economic actors to respond to changes in the economic environment in which they operate, even if the appropriate new behaviors do not require any sophisticated action once they are found. Thus the responses of retail stores to changes in population density or location almost always involve considerable trial and error learning, and failures.

As a consequence, in any field of economic activity where innovation is underway, and we argued earlier that in modern economies no field is completely static, there is bound to be a variety of different ways of doing things employed by different actors. At the same time some of these practices, generally but not always ones that are relatively superior in some sense, are expanding in their relative importance, and others, generally relatively ineffective ones, are declining. And as this goes on new modes of operation may enter the picture. This is very much the way traits evolve in biology.

In many cases an important aspect of the selection processes going on in economic evolution is expansion of actors doing relatively well and the decline and possible disappearance of those doing poorly. [12] However, while there are exceptions, most empirical studies of change in an arena of economic activity find that the principal mechanism through which a new and better practice takes over a large share of the action is adoption by increasing numbers of economic actors. As highlighted above, a principal difference between economic evolution and biological evolution is that economic actors generally are able to choose what they are doing and how they are doing it, and have the capability to learn not only from their own experience but from available information about alternatives. But this is a long way from proposing that economic actors “optimize”.

This perspective on the process of economic change molds not only how evolutionary economists see economic dynamics, but also how they understand what is going on in the economy at any time: the prevailing allocation of resources across activities firms and industries, the technologies and business practices in use, the present quantities of production and consumption of different goods and services, their prices and the prices of the different factors of production, the current structure of industry, etc. We evolutionary economists see these features of economic activity not as an

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12 This statement is relevant to practices employed by firms in competition with each other. It has much less relevance to household practices.

equilibrium configuration with all participants doing the best they can, but as more or less transient phenomena being generated by a path dependent evolutionary process .

Thus the considerable variation at any time in the productivity and profitability of firms within the same industry that is widely observed in market economies is something that evolutionary economists expect, while neoclassical economists have a difficult time explaining it. More generally, evolutionary economists would predict that at any time a number of firms (and households) are making decisions, doing things, that are poorly conceived and for that or other reasons will not turn out well for them. At the same time learning from experience and, for firms, competitive selection will have led to much of prevailing economic behavior being reasonably competent, given the range of practices that are available at that time, and in some cases remarkably effective.

Evolutionary economists of course are interested in what is relatively constant in an economy, as well as the processes of change. However, given their presumption of continuing change, we look for constancies in variables and relationships that tend to hold up in a dynamic economy, and which reflect the nature of the processes driving change. Thus evolutionary economists see the forces of dynamic competition in an economy as generally preventing average rates of profit in an industry from having a strong persistent drift in one direction or another. And while they would expect the prices of different goods and services to be continuingly changing, in many contexts they would expect the ratios of prices to costs to remain relatively constant over relatively long periods of time. On the other hand, evolutionary economists also see drastic breaks from paths that had been relatively stable as an important feature of the creative destruction involved in economic progress.

In short, evolutionary economics puts forth a very different view of what is going on in an economy than that laid out in today's more standard economics. That view highlights continuing change, much of that connected with processes that in the long run generate economic progress, and at the same time requires many economic actors to cope with new conditions. It sees the configuration of economic activity at any time as the current result of an evolutionary process whose workings over time have generated a variety of different behaviors which vary in effectiveness, which have been winnowed but not completely (among other reasons because of the continuing innovation going on). Evolutionary economists believe that this

orientation provides a much better basis for understanding how modern capitalist economies work.

3. Narrowing the Distance Between Economic Theorizing and What Economists Actually Believe.

There is good reason to believe that a significant number of empirically oriented economists, who may present a neoclassical theory of economic activity when they are teaching theory or writing a theoretical article, in fact harbor an implicit evolutionary perspective regarding much of what is going on in the economic world. This is reflected in their writings and other presentations for general audiences regarding such matters as the nature and economic significance of competition in high tech industries, their identification of creative innovation as the key driving source of economic growth, arguments about the need for capital markets to finance the birth and growth of new entrepreneurial firms, and about the importance of flexible labor markets for coping with an economic context where the location and nature of jobs and the needed skills are constantly changing. And the top economic journals often are open to empirical research reports framed implicitly by a dynamic evolutionary point of view.

Evolutionary economists obviously see these developments in a very positive light. However, rather than regarding them as indicating that there is little need to push further, we believe they increase the importance of getting an explicit evolutionary perspective on economic activity better known and entertained more widely.

It is important to recognize that theorizing in economics is of several different kinds and involves different levels of abstraction and generality. Some of it is very general and abstract, providing a broad conception of what shapes what goes on in market economies and how they work. When economists employ the term “neoclassical theory” they tend to mean such a broad perspective on economics, and when we use the term “evolutionary economics” here we are denoting a similarly general and abstract theory of economic activity. At the present time neoclassical theory holds a near monopoly on conceptualizations at a general level of what economic activity and structure are about that professional economists know and teach. Evolutionary economists aim to break that monopoly.

Of course much of economic theorizing is focused not on an abstract view of economic activity in general but on particular sets of phenomena or economic questions. It is concerned with such matters as how labor markets work, how particular prices are determined, the determinants of the overall rate of inflation, the patterns of international trade, etc. A good portion of theorizing at this level is quite formal, often laid out mathematically. Economists often refer to formal theories at this more limited level of generalization as “models”. While formal models have their own particular orientations, those that today are widely known by economists tend to have a general perspective that, not surprisingly, is broadly consistent with the broader conceptions of neoclassical theory. On the other hand, while their work may not be familiar to most economists, evolutionary economists also have been active in formal modeling.

However, what we want to highlight here is that much of the effort by economists to understand what is going on in the economy is abstract to a much more limited degree than the general theoretical orientations and the formal models we have referred to above. Rather, it is quite close to the empirical subject matter it is concerned with, and is the result of economists knowledgeable about that subject matter trying to identify the gist of the forces at work. It is to a considerable extent inductive in nature, and is less logically fleshed out than general theories and formal models. Nelson and Winter (1982) have called this kind of theorizing “appreciative” as contrasted with “formal” theorizing.

Virtually all appreciative theory is expressed verbally, and takes advantage of the richness of natural language, and its ability to describe qualitative as well as quantitative detail. But the cost of this is that it is much more difficult to check on the logical coherency of a complex verbally expressed theory than one that is sharper and articulated more formally, and the ability to explore and deduce implications is much more limited. On the other hand, the ability of formal theory to incorporate details that the analyst believes are important, particularly if these can not be characterized quantitively, is much more constrained.

Nelson and Winter (1982) argue that, if they are oriented the same way, appreciative and formal theorizing should be understood as complements. We propose that most of what economists know about how the economy actually works is contained in our appreciative theories. In contrast, formal theory ought to understood as presenting allegories about what would happen under certain idealized conditions that are a significant

distance from the actual context and course of economic action, but whose analysis can provide insights into the behavior of a more complex reality. In particular, if the broad theoretical orientations are mutually consistent, the stronger logical structure of formal theorizing can help to sharpen the focus and provide a way of thinking about the coherence and scope of the analytic arguments of appreciative theory.

Appreciative theorizing by evolutionary economists has been shaped and supported by formal evolutionary modeling in several of the areas of research we will consider in the following chapters of this book. Economists who are not knowledgeable about evolutionary economics tend not to be aware of these models, and the relationships they highlight and illuminate.

But even more important, we would argue, is the broad orientation to economic activity that is associated with an evolutionary perspective. We suggested above that, today, a good portion of the appreciative theorizing regarding what is going on in economics is being done by economists who have doubts about whether neoclassical theory provides much useful illumination of the empirical phenomena they are trying to understand and explain. But there is too much going on in any arena of economic activity for an empirical observer to see it all, even if the researcher has an open mind. Inevitably what is seen and not seen is going to be influenced to some extent at least by the general conceptions of what economic activity is all about, and the forces molding it, that one has in one's head.

Thus absent an explicit conception of the economy as an evolving system, economists doing empirical research and developing an appreciative theory about what is going – even who are drawn to an implicit evolutionary point of view - are unlikely to highlight the generally significant differences in the behavior and performance of competing economic actors, or recognize adequately the trial and error learning and selection going on, and at the same time the variety of innovations that are being tried out, most of which will not amount to anything but some of which could profoundly shape the path of future change. It takes the perspective provided by explicit evolutionary economic theory to bring phenomena like these into clear view.

This is why we think it so important that the broad evolutionary perspective that we lay out in this book be more widely known. Our argument Is this orientation to how an economy works can bring theory and empirical understanding more in line with each other.[13]

13 And more in line with economic analysis of an earlier time.

4. The Behavior and Capabilities of Economic Actors

These issues come out strongly when one considers how evolutionary economics understands the behavior and capabilities of economic actors. Since the days of Adam Smith a hallmark of economic theorizing has been the presumption that for the most part economic actors do *what* they do with purposes in mind and, in situations that are familiar to them, at least a rough understanding of the consequences of following various courses of action. It can be argued that, if treated with care, and recognizing human fallibility, the theory that economic actors usually behave rationally, in the sense above, has shown considerable explanatory and predictive power. Most evolutionary economists buy this argument.

However, modern neoclassical theory has abstracted the presumption that economic actors mostly act with purposes in mind and some knowledge about how to achieve them into the theoretical assumption that their behavior is optimal, in the sense that what they do is the best possible action for them to take, given their objectives and the constraints they face [14]. For the reasons laid out above, this abstraction of goal oriented behavior does not provide an adequate general basis for understanding the diverse actions being taken in an economy marked by continuing innovation and flux.

We note that the concerns of evolutionary economists about the theory of behavior that over the last half century has come to dominate main line economics clearly overlap those that motivate modern behavioral economics [15]. However, the arenas of economic activity, and the particular aspects of behavior, on which these two bodies of economic analysis focus are different. Behavioral economics has focused almost exclusively on human behavior that is logically inconsistent, or more generally does not seem to further any considered objective the actor might have [16]. The context within which such ineffective or even harmful action is being taken is not highlighted as being new to the actor, but rather can be interpreted as

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14 Of course this proposition often is put forth in terms of expectations.

15 For a fine broad reviews of behavioral economics see Diamond and Vartainen, 2007, and Akerlof and Shiller, 2015

16 For a recent discussion of these matters see Akerlof and Shiller, 2015

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not radically different from situations the actor faces relatively regularly. We evolutionary economists are not surprised by instances of the kind of behavior that behavioral economists highlight, even in contexts that are familiar to the actor. But our broad theoretical presumption is that in contexts that remain relatively constant and thus are familiar to the economic actors, while one certainly would expect to find instances of incompetent or even bizarre behavior, by and large learned actions result in satisfactory, if not optimal outcomes. [17]

We evolutionary economists make a distinction between action-taking in familiar contexts, and action-taking in contexts that are new to the actor and past experience is of little value. To date at least this is not a distinction that has drawn attention from the behavioral economics camp.

Given these interests, many evolutionary economists have been drawn to the conception developed by Herbert Simon and his colleagues of "bounded rationality", which provides a basis for a general theory that recognizes both the factors behind the broad effectiveness of much of economic behavior in many contexts, and also the many exceptions to that tendency, and in particular supports a distinction between contexts that are familiar to the economic actor and those that are not. [18]. The basic premise of the bounded rationality conception of behavior is that the contexts within which individuals and organizations make choices very often are much too complicated for them to understand all the factors bearing on how best to achieve their objectives. On the other hand, they may be able to observe and understand important aspects of the context they are in, and may have the reasoning power to draw out some implications of what they know or think they know. In particular, in contexts that are reasonably stable they may be able to learn from experience and reflection what, given their purposes and wants, seems to work and what seems not to work. [19]

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17 We stress here that "satisfactory" does not connote "close to optimal". What the actors are achieving must of course meet survival needs, and what they will settle for. But this may be far from the best they could do if they knew better.

18 Simon would be considered by some contemporary behavioral economists as within their camp. However, his point of view is not central to most of the statements of what behavioral economics is about.

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In such contexts, and where the actions that need to be taken are recurring, evolutionary economists tend to join Simon and colleagues in proposing that learned “routines” tend to come into existence which, after they are established, are employed without much explicit thinking about the matter on occasions when action of a particular type is called for. This proposition holds for both individual and organizational actors. [20] If the context for action taking remains relatively constant, evolutionary economists would propose that forces of learning and selection are likely to result in the employment of routines that yield satisfactory or at least viable consequences, if not optimal ones. An important part of evolutionary economics is study of how these learning and selection processes operate, and the nature of the routines they generate.

Effective routines need to be responsive to variations in the context for action that occur relatively commonly. Thus in a relatively stable environment one would expect consumers to learn to respond to increases and decreases in prices that fall within the range of normal variation by doing some switching among substitutes, and see suppliers responding to increases or decreases in demand by offering more or less. To learn to respond adaptively and relatively routinely in this way does not require the ability to optimize, and adaptive behavior can be far from optimal. But it is the kind of behavior that boundedly rational economic actors can be expected to have learned to adopt in relatively constant environments. .

However any particular routine, way of doing things more generally, even one that has considerable built in adaptability, and has served adequately for a long time, inevitably will be made obsolete or irrelevant by changes that have occurred. And for a variety of reasons economic actors may choose to, or be forced to, operate in contexts that are new to them and do things that they never have done before and where past experience provides little guidance to appropriate action. Search and problem solving activity aimed to identify or create a satisfactory course of action when

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19 The key references here are: Simon, 1955, March and Simon1958, and Cyert, R., and March, J., 1963l

20 In Nelson and Winter (1982) we reserved the term routine to refer to organizational actions, and much of the subsequent literature follows that tradition. However, in this book the term routine will be used to refer to the standardized behavior of individuals as well as organizations.

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suitable routines do not exist, or need to be modified, is another important component of the behavioral theory in evolutionary economics.[21]

Of course in the eyes of evolutionary economists, the kind of behavior associated with innovation is the principal driver of economic progress, and a central subject for research. There is no clear conceptual line where search and problem solving behavior begins to involve efforts at innovation. However, innovation clearly involves the imagining of courses of action that lie beyond the actor's experience and understanding of what others are doing. Efforts at innovation require search and problem solving that must be effectively creative to work out well, and success also often requires a certain amount of good luck.[22] This certainly characterizes R and D done by firms and other organizations. It also characterizes the efforts of firm management to map out new courses of action.

The central importance evolutionary economists place on search, problem solving, and innovation, in the processes that generate what economic actors do leads them to put particular emphasis on how the ways of doing things that are available to an economic actor come to be evident or are discovered or imagined or constructed. This is a very different orientation than that of conventional decision theory in which the "choice set" generally is taken as a given, and the focus is on the objectives of the economic actors and how these influence choice among a given set of alternatives, rather than on why the alternatives that are considered are what they are. This of course leads evolutionary economists to a central interest in how available options are perceived and the processes through which new ways of doing things get conceived and developed.

These observations pertain to both individual economic actors and to formal organizations. Evolutionary economists recognize that much of economic activity goes on in formal organizations, and that in many contexts organizations are the key economic actors. In modern economies it is firms (and other organizations like hospitals, and schools) that produce or provide

21 It might be noted that this distinction in Simon's behavioral theory between two different modes of arriving at an action – following a routine without much conscious thought, and more conscious thought and problem solving – is closely analogous to the two "systems of behavior" recently put forth by Daniel Kahneman.

22 We note that the treatment of bounded rationality by Simon and his colleagues deals with innovation hardly at all.

most of the goods and services created in economic activity. In many arenas of economic activity most of the innovating is done by firms. A significant fraction of the research and writing by evolutionary economists has been concerned with firm behavior, capabilities, and innovativeness.

How does the traditional presumption of economists - that what economic actors do in any context is molded by the objectives they have there and their beliefs about what actions are likely to be effective in pursuing these, and that the analyst can predict or explain changes in behavior that occur when the context changes on the basis of these presumptions - hold up under the relatively complex theory of behavior we have been describing? We would argue that it holds up pretty well as a rough first approximation, but that there are exceptions, and in any case to get beyond a rough first cut prediction or explanation of what economic actors are doing requires an understanding of the details, like the kinds of routines that are operative, and the way efforts at problem solving and innovation proceed.

When drawn into discussion of what really is going on in the economy, and the factors behind the behaviors of the economic actors involved, we believe that many economists who teach neoclassical economic theory would be in broad agreement with the above. And we would argue that the orientation of evolutionary economic theory provides a much more promising basis for getting at relatively detailed understanding of what economic actors are doing than the assumption that they “optimize”.

5. The Nature and Role of Markets and Competition

Today’s evolutionary economics stands squarely in the main line tradition of economic analysis in seeing market organization of economic activity, with for-profit business as the principal suppliers of goods and services, and competition as the major regulatory mechanism, as the key institutions of capitalist economic systems. However, the view of how markets and market competition work is more Schumpeterian than today’s standard theory. And the case put forth by evolutionary economics for the kinds of benefits society can gain from market organization of economic activity is different than the neoclassical case.[23]

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23 Our orientation of course is Schumpeterian. For a modern statement see Metcalfe 2014

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In modern capitalist economies a staggering range of goods and services are potentially available to customers. These goods and services are largely provided by business firms, who in turn require a wide range of different kinds of inputs. Taken together the range of variables involved and the number of connections among them is enormous. “Solving” the system analytically for an allocation of resources and a production of goods and services that serves the vast variety of human needs reasonably well is a problem that defied Soviet style central planning. Even with the most elaborate economic models run on the most powerful modern computers, solving the allocation problem analytically still cannot be done today in a way that calculates the relevant details.

Yet market organization somehow is able to deal with this problem in a way that often is messy but which by and large “works”. Evolutionary economists would take issue with the theory that the workings of markets generates an optimal, or even an efficient, or even an equilibrium, configuration of economic activity. The workings of markets, even widely supplemented as they are with a variety of government programs and regulatory regimes, clearly leave a number of needs, highly valued by many people, met to a meager degree, and allows and even encourages activities that many regard as positively harmful to society. But while evolutionary economists tend to be less positive about the way markets allocate resources than our more orthodox colleagues, we agree that what markets have achieved is quite remarkable. And they do so not in the simple static context assumed in neoclassical general equilibrium theory, but in one where technologies, available resources, and wants, are changing in unpredictable ways.

Evolutionary economists, as our more orthodox colleagues, see prices as key variables that influence the behaviors of both demanders of a good or service and suppliers, and as usually adjusting to diminish conditions of excess demand or supply particularly when these become large. We tend to see significant changes in quantities or prices or both as usually reflecting shifts in demand or supply. That is, many evolutionary economists are quite Marshallian [24] We are quite comfortable with a good portion of the causal arguments presented in today’s standard price theory texts, if not with the theoretical assumptions used to rationalize those arguments. Thus while we assume that the behavior of economic actors is adaptive in the sense we discussed earlier, we do not assume that what they do is “optimal” for them.

24 For an extended discussion see Nelson, 2013

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And while we, like our neoclassical colleagues, see prices as playing a key role in balancing supply and demand, and as enabling adjustment to changes, we do not assume that markets always are at or near to an "equilibrium" in the standard sense of those terms.

Moreover, evolutionary economists would highlight that markets and competition do a lot more than simply influencing prices and the allocation of resources among different lines of economic activity, given current know-how, which is the focus of neoclassical theory. At the same time markets provide an opportunity and an inducement for economic actors to try out new products and processes, and explore modes of doing and using things more generally that they have not engaged in before. And competition among firms in a market does a lot more than simply providing pressure to keep costs low and for prices not to diverge too much from costs. Competition raises the pressure for firms to innovate and to respond to a competitor's innovation, and increases the rewards from doing so successfully.

More generally, markets in capitalist economies are perhaps the most important among the varied institutions that shape the processes of economic evolution. The advantages of market organization of economic activity are not only that this is a reasonably effective (if not an optimal) way of meeting present perceived wants, given present capabilities and knowledge. Evolutionary economists see it as even more important in the long run that market organization of economic activity and competition provide a spur and a context for the generation of new and potentially better ways of doing things and for sorting out the wheat from the chaff. The allocation of resources and the prices they generate at any time should be understood in this light. [25]

For market organization of economic activity to serve as an engine of progress obviously requires that innovators anticipate that they will be able to reap returns from their innovations when these in fact improve economic performance, and as our innovation systems work this generally involves their ability to garner at least temporary monopoly control over the use of their innovation. But on the other hand, if progress is to be broad and sustained, that monopoly must be limited and competition must not be

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25 The perspective articulated here regarding what is driving positive change in market oriented economies is very close to that developed in Rosenberg and Birdzell, 1986

eroded widely and durably. We have been highlighting the variation in patterns of behavior, including the technologies and other routines used, that one observes among firms in the same line of business, along with significant differences in productivity and profitability. This variation clearly is at least partially associated with the innovation going on by firms in an industry, which not only has advantaged some firms relative to other, but often has led them along different paths. But at the same in most arenas of economic activity one can observe a basic broad similarity in what firms are doing. In many industries most firms employ the same basic technologies, if with different details and with different effectiveness. The broad design of the products or services they provide is similar. So too a wide variety of management practices.

The basic reason is that, given the way that most markets work, while a successful innovator is able to hold control over its new ways of doing things and reap the returns from the advantage they give it over its competitors for a certain period of time, almost always aspects of new productive ways of doing things sooner or later become widely known, and the ability of the innovator to hold off its competitors from using that know-how generally is limited. As a result, the whole industry moves ahead over time. Market competition turns out to be an effective vehicle for collective evolutionary learning.[26]

This is a very different view of what markets do and how they work than articulated in today's standard economic texts. And yet, here too it would appear that many contemporary economists have a view of the advantages of market organization of economic activity, and competition, that is very much in line with the perspective presented above. It is the theory they espouse when presenting formal economics that ignores this. As we have argued, a major advantage of evolutionary economic theory is that it puts forth an abstract view of economic activity, and the role of markets and competition, that squares with what much of the profession actually believes.

We have highlighted that there is no argument here that market mechanisms allocate resources and efforts optimally. Winston Churchill's famous characterization of the virtues of democracy – democracy is the worst form of government except for all the others that have been tried – perhaps is equally apt for market organization of economic activity. But

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26 Lundvall 1992 has stressed collective cumulative learning

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then, modern economies do not operate with market mechanisms and institutions alone. To this we now turn.

6. The Institutional Richness of Modern Capitalism

Economists use the term “institutions” in a variety of different ways. Probably the most widely employed conception of institutions today is as “the rules of the game” (North, 1990) , or the somewhat broader concept of “governing regimes” associated with the structures, constraints, requirements, incentives, and norms operating in particular contexts, and molding the way things are done. As we noted above, economists traditionally have argued that the employment of privately owned for-profit firms and of markets to structure and govern much of economic activity are the hallmark institutions of capitalism. The economic behavior that one observes in capitalist economies certainly is strongly and widely molded by these institutions. For-profit firms operating on markets is the standard way of organizing and managing the production of goods and services in a wide variety of economic sectors. In most of these sectors and others markets provide the vehicle through which those who want something are able to obtain it, and those that have something they want to sell can find customers. Evolutionary economists are in full accord on the powerful role of firms and markets in enabling and molding coordinated behavior in modern capitalist economies. [27]

However, many evolutionary economists have a different view than is standard among economists these days on the other significant institutions of modern economies. The current standard position sees these either as supporting or subsidiary institutions needed to make firms and markets work well, or as responses to “market failures”. Contemporary evolutionary economists, very much in the spirit of an older tradition of institutional economics, tend to be more inclined to consider the nature and operation of non-market institutions in their own right.[28]

We have noted the considerable research done by evolutionary economists on technological innovation in different economic sectors. In virtually all of the areas studied firms and markets have played key roles in the innovation process. But in many areas universities have played key roles.

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27 Thus in many cases the “routines” employed by economic actors in certain contexts are “institutionalized”

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In a number government procurement or other modes of public finance has been important, and government agencies have actively and effectively steered efforts to advance the field.

While unfortunately their empirical study has been limited, it is clear that scientific, technical, and professional societies, play a significant role in the operation of modern capitalist economies, particularly in enabling that new advances in a field become available, if sometimes with a lag, to all those working in the field who have the relevant background understandings. It is these kinds of institutions that support the communal evolutionary advance of know-how.[29]

For evolutionary economists the proposition that these non-market institutions should be understood as there simply to support market processes and fill in for market failures just does not ring right. Thus the early work on computers was largely initiated and funded by government agencies, and for-profit firms and market arrangements (contracts) were used by the government as part of the apparatus it put in place to develop an effective computer. Similarly, in the efforts to find a prevention or a cure for AIDS government agencies and non-profit foundations have been very much in the lead. [30]

More generally, there is a lot more to the institutional structure of modern economies than for-profit firms and markets. Firms and markets do play a role in almost all arenas of economic activity, but in most they share the stage with other institutions. In many sectors firms and markets clearly are the dominant institutions, although almost all such industries are regulated to some degree, and in many publicly provided goods or services are essential to their operation. Think of airlines and airports and traffic control systems. In many sectors non-market institutions play the central

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28 For excellent general discussions of the new and the old institutional economics see Rutherford 1996 and Hodgson 2016. In his work Greif, 2006, while oriented to the questions of today's institutional economics, develops the rich description and analysis associated with the older tradition.

29 Murmann, 2003, provides a fascinating discussion of how this system worked in the evolution of the German dyestuffs industry.

30 Mazzucato, 2013, also has stressed the range of technological fields where government programs have been in the lead

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guiding roles with market mechanisms subsidiary. National security, education, criminal justice and policing are good examples. Some sectors, like medical care, are extremely "mixed", and one cannot understand the activity going on in them, or the ways in which their structure, ways of doing things, and performance have evolved, if one pays attention only to firms and markets.

Also, evolutionary economists are coming to recognize that the evolution of the institutions constraining and molding economic activity is a central aspect of the process of long run economic change. The nature of firms evolves. New kinds of industries and new kinds of markets come into existence. Changing government programs and policies, and changing laws, both are responses to and forces pushing changes in economic activity. While most of the research by evolutionary economists, and scholars more broadly, on innovation has been oriented to technological innovations, increasingly organizational and institutional innovation is on the agenda.

As these recognitions sink in, many evolutionary economists have come to treat modern economies as intrinsically mixed, with political, social, and cultural aspects intertwined with market ones, and to see the theory of the economy as basically a clean simple market system, which has played such a role in influencing the thinking of the profession since Walras, not just as highly abstract and simplified (which is appropriate in a theory at this level of conceptualization) but badly distorting. As we have noted, the "innovation systems" concept has taken strong root among evolutionary economists [31]. There is increasing recognition that the economic growth process involves the evolution of governmental policies and programs, and institutions more generally, as well as technologies and industries. In a number of ways these developments can be seen as a returning to a pre-Walrasian view of political economy, which is well suited to analysis from an evolutionary perspective. .

However, it is fair to say that this recognition of the institutional complexity of modern capitalist economies is not yet as ingrained in evolutionary economics as the other perspectives discussed earlier. The broader building of institutional richness into the basic analytic conceptions of evolutionary economists is a work in progress.

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31 The key references here are Lundvall, 1992, and Nelson, 1993

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7. Evolutionary Economics and Evolutionary Biology.

The term “evolutionary economics” obviously carries the connotation that this orientation to economic analysis has something in common with the perspective of Darwinian evolutionary biology. In this section we flesh out our earlier brief discussion of the similarities and differences.

One basic similarity is that both theories play down the role of deliberate long run planning in determining the prevailing state of affairs.. Darwin’s theory provides an explanation for the remarkably good design that existing animals and plants possess for living in their environments, that does not involve the mind and hand of God. Evolutionary economics provides an explanation for the often striking effectiveness of the ways economic actors presently go about doing things that does not assume an ability to reason, foresee, and control the path of future events that vastly exceeds what we know about human capabilities.

And in both evolutionary biology and evolutionary economics the state of affairs at any time needs to be understood as a frame in a motion picture. While not always directly relevant to understanding of what is going on at present, understanding of why the current phenomena are as they are hinges on analysis of how they came to be.

Further, at a broad level the dynamic mechanisms argued by the two theories to have brought us to where we are, and which will take us to where we will go from here, have similar elements. The dynamic processes in both theories feed off of variety. Both involve selection mechanisms that winnow that variety, increasing the relative importance of some variants and decreasing that of others. In both systems continuing change requires the continuing introduction of new variety, mutations in the case of biology and innovations in economics.

But as we have stressed, there also are important differences. The most fundamental one is the central role played by human purpose, understanding or belief, and deliberate decision making in the economic (cultural) evolutionary processes going on.

It is likely that one reason why many economists have tended to shy away from considering evolutionary economics as a serious approach to analysis of economic behavior and phenomena is their conviction that human beings are not like fruit flies. Evolutionary economists do emphasize the bounded nature of human rationality, that often what economic actors do

is a matter of routine, and that their conscious deliberations inevitably are limited in scope and depth. But evolutionary economics does not treat human actors, individuals or organizations, as like fruit flies, locked into particular patterns of behavior by their genes. They can and do change what they are doing, and try out new practices, based on their notions about what they need to do to prosper or at least survive.

One important consequence is that the distribution of practices going on in an economy tends to change much more rapidly than the population of economic actors changes. We do not want to play down the role of "creative destruction" in the processes whereby a superior new way of doing something replaces an established less effective way; in many cases the process involves the disappearance of many of the older firms. But on the other hand, in many cases the shift over of an industry from one technology to another superior one is accomplished largely by extant firms adopting the new, with the death of established firms and the birth of new ones playing only a modest role. This is very different than in biological evolution where a change in the distribution of phenotypes and genotypes is strongly linked together. And it means that the distribution of practices and understandings being employed in an economy can change very fast.

Also, humans can hold possibilities in their heads, often with the aid of supporting mechanisms like books and the web, and analyze them "off line" before deciding whether or not to employ them in actual practice. Thus many designs are considered by engineers before they decide what they actually want to try out in practice. A wide range of business plans may be conceived, discussed, and analyzed, before a firm decides whether or not to go into a new market. As a consequence, the range of alternatives in play at any time may greatly exceed the number in actual use. And conscious decision making, oriented to meeting objectives more fully, and guided by beliefs about what will do that, plays a central role in economic evolution.

But as we have stressed actions taken on the basis of conscious choice often yield consequences very different from what was intended, and in any case virtually always can be improved by subsequent action undertaken on the basis of learning by doing and using. Actual experience in practice, and what economic actors make of that experience, remain essential aspects of the cumulative change process even in areas where there is strong scientific knowledge. This fact makes it specially important that there generally are a number of economic actors doing and experiencing the consequences of doing different things. Where one observes powerful sophisticated ways of

doing things, these virtually always are the result of a cumulative learning process, where generally a number of different actors have been involved. These factors and others have led us to call the dynamic processes involved evolutionary.

A related difference is that the advance of know-how in economic evolution is, to a considerable extent, a collective phenomenon. The successful innovations of one or a few economic actors relatively quickly become part of the knowledge that the collectivity of economic actors can access.

Today's standard economics takes the remarkable productivity of modern economies for granted. In most of economics this is taken as a given, with the analysis focused on other aspects of what is going on. But what is going on in contemporary economies at any time cannot be understood without recognizing the amazing range of capabilities that today's economic actors have and can work with.

Both evolutionary economic and evolutionary biology highlight that one needs to understand what exists at the present as being the result of the workings of long run path dependent dynamic processes. The present is part of history. It cannot be understood otherwise.

Thus as should be obvious evolutionary economics is very much connected with scholarship on economic history. And a large portion of the writings of economic historians take an evolutionary perspective, explicitly or implicitly.[32]

It is interesting to note that theories that human culture and institutions evolve, in the sense of evolution in evolutionary economics, long preceded Darwin. Hume, and Mandeville, were cultural evolutionary theorists, and so of course was Smith. And, as we have highlighted, in the years since Darwin a number of economists – Veblen, Marshall, and Schumpeter prominent among them - have proposed that economics as a field of analysis is much closer to biology than to physics. In a very real sense today's evolutionary economists are arguing a point of view that has been around for a long time.

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32 Mokyr, 2009, 2016.is prominent among economic historians taking an explicit evolutionary point of view. The dynamics described by North, 1990, and Rosenberg (for example 1994, and with Birdzell, 1988) also clearly are evolutionary.

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8. A Roadmap

The following five chapters describe what has been learned from research over the last three decades on the principal subjects on which work oriented by evolutionary economics has been concentrated. These areas are: technological advance, firm capabilities and behavior, Schumpeterian competition and industrial dynamics, long run economic development in economies at or close to the frontier, and catching up by economies that are lagging. Research in these different areas often has proceeded with only limited communication across them. The authors of this volume believe that, in fact, the different pieces largely complement each other, and together provide a broad and coherent picture of the economic workings and dynamics of modern market economies.

Given their central interest in illuminating the sources of the remarkable increases in living standards that much of the world has achieved over the past two centuries it is not surprising that one of the principal clusters of research by evolutionary economists has been on technological advance. Chapter 2 will describe the orientation of this research and what has been learned.

Economists have been interested in technological advance at least since the days of Adam Smith ; recall his famous analysis of the sources of productivity growth in pin making. But empirical research on technological advance received a major stimulus from the development during the 1950s and 1960s of neoclassical analyses of long run economic growth that gave much of the credit to technological advance. Somewhat ironically, the new empirical knowledge about how technological advance actually occurred led a number of the economists doing that research to propose that those processes were inconsistent with neoclassical theory and, rather, called for an evolutionary perspective. However, because an evolutionary theory of technological advance runs counter to the general body of theory held by most of the economics profession, it is not surprising that much of the research described in chapter 2 has been done not in economics departments but by economists and other scholars at schools or departments concerned with science and technology policy or innovation management..

Earlier we highlighted how evolutionary economists have come to recognize the importance both of the significant differences at any time

among firms operating in a field in the details of their technological knowledge and operations, and at the same time the substantial body of relevant knowledge that is held by virtually all actors operating in a field. While successful innovators may try hard to keep what they have achieved proprietary, sooner or later the gist of new technology almost inevitably becomes part of the public domain. The term “technological paradigm” has been used to characterize this body of broadly shared knowledge. Chapter 2 considers both the mechanisms that often make new technology private for awhile, and those that sooner or later open up access to know-how, and the important consequences of this kind of an evolutionary process.

In most technologies firms play a central role in technological innovation. And there has been considerable interaction between scholars in business schools studying the dynamic capabilities of firms and scholars studying technological advance more generally. However, usually firms (and private inventors and entrepreneurs) are not the only actors involved. In a number of fields university researchers play an important role. Today most fields of technology are supported by university based research in particular fields of science and engineering. In a number there is significant government funding and in some government agencies play a significant role in orienting inventive effort. Considerable research has been directed towards trying to illuminate the division of labor that exists in different fields, and how the “innovation system” fits together. Chapter 2 will discuss research on industry differences as well as features that seem common to technological progress in general.

Chapter 3 surveys the considerable research that has been done on firm capabilities and behavior, viewed from an evolutionary perspective. A good understanding of business firms obviously is an essential part of any broad understanding of how capitalist economies work, since firms are the principal suppliers of goods and services in most (not all) economic sectors, and firms have played central roles in the advance of technologies, and the advance of economic capabilities more broadly. At the same time, understanding the determinants of firm capabilities and behavior is of central interest to management, and to the teaching mission of business schools. And much of the research described in Chapter 3 has been done by scholars at business schools.

Like the evolutionary perspective on technological advance, the emergence of an explicitly evolutionary theory of firm behavior was induced by the perception of some economists that neoclassical theory bearing on

the subject had serious problems. For these economists the proposition that the behavior of firms should be understood as the successful result of their efforts to find and implement actions that would maximize their profits seemed to assume cognitive and calculational capabilities that firms did not have, and also to be refuted by the detailed empirical studies that had been done of how firms actually went about making decisions. And the argument that competition assured that only firms that did in fact implement profit maximizing policies would survive seemed quite inconsistent with the variety of firm behaviors that empirical studies had shown to exist. Evolutionary analysis of firm behavior aimed to provide an alternative perspective.

The theory of the firm that has emerged is based on the proposition that much of firm behavior is built into the routines that a firm has developed over the years. Some routines involve the technologies used by a firm and the division of labor and modes of coordination that are operative in production. Others involve the standard ways a firm goes about such matters as ordering new inventory, mounting a new marketing campaign, or setting the prices it charges for its products. The role of management is seen as monitoring what is going on in the firm, and holding it to a standard, and assessing when firm routines need to be changed and if so in what direction. A considerable body of research has been concerned with the “dynamic” capabilities of firms, which includes prominently capabilities for effective innovation. Firm innovation itself involves considerable use of established routine, along with conscious analysis and deliberation, and explicit managerial decision making. Chapter 3 will discuss these matters in detail, and also present other findings of evolutionary research on firm capabilities and behavior.

The body of research surveyed in chapter 4, concerned with Schumpeterian competition and industrial dynamics, overlaps somewhat the more general literature on technological advance as an evolutionary process surveyed in chapter 2, and also is linked with some of the work surveyed in chapter 3 on firm capabilities and behavior. In recent years data sets have become available that enable one to see the diversity of firms underneath the industry averages, and identify the characteristics of firms that are growing and declining. We thus have a much better picture now than we used to of the dynamics of firms and industry structures in industries where technological advance is rapid.

The chapter also surveys the now substantial body of research concerned with what happens in an industry as the new technology that

launches it emerges, develops, and matures. While all industries are different, many of them conform to a particular pattern in which industry structure concentrates as an underlying technology matures. In recent years there also has been substantial research on how industry specific institutions emerge as the industry develops.

This analysis of dynamics at a sectoral level nicely sets up the review, in chapter 5, of research on long run economic development viewed in the framework of evolutionary economics. Research on this topic has followed several broadly different paths, each of which will be discussed separately, and then integrated.

Research on one of these paths has focused on the driving force of innovation, and the creative destruction that innovation sets in train. In contrast with the neoclassical growth models that for the past half century have dominated most of main line economic analysis of economic growth, evolutionary analysis recognizes the diversity of firm practice that co-exists in the economy at any time, and sees the economic development process as involving, on the one hand, an increase in the use of more productive practices and the decline and ultimate disappearance of less productive ones, and on the other hand continuing innovation that renews variety. Recent models of this genre have recognized the many sectors that comprise an economy at any time, with the growth process involving centrally the birth of new sectors and the decline and disappearance of older ones. Chapter 5 will pay particular attention to this body of writing and the view of long run economic development that it highlights.

Another strand of research on economic development by evolutionary economists has been concerned with the roles played by institutions in fostering the development of new technologies and industries, and in turn with how changing economic structures call for institutional innovation and reform.

Most of the research and analysis we describe in chapter 5 has been addressed, explicitly or implicitly, to economic development in countries at or near the technological and economic frontiers. In recent years a significant body of evolutionary writing has emerged concerned with countries significantly behind the economic frontiers and striving to catch up. We discuss the evolution of evolutionary analysis of the economic catch-up process in chapter 6.

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Earlier analyses of the challenges countries behind the economic frontier faced in trying to catch up with the leaders presumed, explicitly or implicitly, that while intellectual property rights might be an obstacle to adopting some of the technologies used in higher income countries, the basic challenge for countries aiming to catch up was to increase significantly their investments in human and physical capital, and adopt economic policies that reward effective economic operation in a market context. This still is pretty much the view of much of the analysis of catching up presented by economists of relatively orthodox orientation. In contrast, studies by evolutionary economists have highlighted the considerable learning by doing and using, and capability building, that is involved in successful efforts of catch up. Much of this needed capability building is in firms. But the emergence and development of capable firms is greatly facilitated by, and may be impossible without, the emergence of a strong group of engineers and applied scientists who are capable of understanding the technologies being adopted, and the development of the kind of institutions needed to support efficient operation of the industries and technologies being taken aboard.

A few countries that used to be significantly behind the economic and technological frontiers in recent years have achieved the capabilities to compete internationally in industries where technology is very sophisticated and, further, is continuing to change rapidly. A portion of the research reported in chapter 6 is concerned with how countries like Korea and Taiwan were able to do this.

We believe the bodies of research, reviewed in chapters 2-6, all guided by the perspective of evolutionary economics, when fitted together, provide a coherent and illuminating characterization of how modern market economies work, and the nature of the economic dynamics going on. As stated earlier, our principal orientation in these chapters is to empirical phenomena, and the light on them that an evolutionary perspective gives. But there also has been considerable amount of research by evolutionary economists of a more abstract nature. While not the focus of this book, some of this more abstract and formal theorizing by evolutionary economists is described in appendices to several of these chapters.

While chapters 2 through 6 cover most of the empirically oriented research done to date by evolutionary economists, the domain is broadening. We, the authors of this volume, believe that much of the traditional subject matter of economics can be understood better if viewed from an

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evolutionary perspective than from a neoclassical one. In chapter 7 we reflect on the future evolution of evolutionary economics.

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