Introduction

Innovation Studies

In this Introduction, I discuss the possible contribution of Economic Sociology to Innovation Studies and provide some conceptual coordinates for reading the later chapters, starting from the definition of 'economic innovation' and different types of innovation. At an international level, Innovation Studies is an emerging field of research, one that tends to cross over the boundaries of traditional academic disciplines. A number of sociological studies, as well as sociological research, have provided a significant contribution to the development of this new scientific field.

I.1 A field of interdisciplinary research

This book offers an overview of the theories and research (both sociological and otherwise) regarding economic innovation. In economics, there is a large and well-established literature about this particular topic. Over the past few decades, the *economics of innovation* has given rise to a lively flow of studies, including textbooks, university courses and a great deal of empirical research. This has not, however, been the case with economic sociology. Few books exist that are devoted explicitly to innovation and there is also lack of reviews on the subject in the literature. For example, an entry for 'economic innovation' is entirely absent from the first edition of the *Handbook of Economic Sociology* (Smelser and Swedberg 1994), which takes stock of the discipline's issues and the state of the art. Only in the second edition does a chapter appear dedicated to the relationship between technology and the economy: its authorship, however, was assigned to three economists (Dosi, Orsenigo and Sylos Labini 2005). Even the *International Encyclopedia of Economic Sociology* (Beckert and Zafirovski 2006) lacks a specific entry.[1] Paraphrasing Robert Solow's well-known paradox concerning the new economy, it could be argued that innovation can be seen everywhere today except in books about economic sociology.[2]

This lack is not due to the absence of sociological reflection on the subject. On the contrary: starting with the classics, there is a long tradition of studies that address the issue of economic innovation by linking it to the dynamics of capitalist systems. In comparison, in economics the topic of innovation has been

more controversial and, notwithstanding the hints in the work of Adam Smith, only more recently has it become a subject of research. The beginning of the twentieth century saw the pioneering contribution of heterodox economist Joseph Schumpeter – not, coincidentally, very open-minded towards other social sciences – where the question of innovation was treated systematically and correlated with economic development. Such original considerations were, however, only rediscovered in the late fifties and early sixties, when the first contributions by economists regarding the themes of innovation and scientific and technological research were brought together in a collective volume edited by Richard Nelson: *The Rate and Direction of Inventive Activity* (NBER 1962).

Later, in 1974, Christopher Freeman published a book that summarised the main results achieved in the previous decade, and which would go on to become a classic: *The Economics of Industrial Innovation*. Finally, Innovation Studies gained momentum in the eighties with the publication of *An Evolutionary Theory of Economic Change* (1982) by Richard Nelson and Sidney Winter. The book, which puts technological innovation at the centre of the debate about economic change, marks the foundation of an *evolutionary approach* to economics that provides an alternative to neoclassical theories of growth. The contribution of economists to Innovation Studies then progressively becomes prevalent. These economic approaches, however, are 'heterodox' in nature and tend to be located on the outer edges of the mainstream current. Nelson and Winter's book, despite being one of the most cited works on innovation, remains at the margins of 'orthodox' economic science.[3]

This is not accidental. Innovation is a subject that is difficult to understand using the conventional analytical categories of neoclassical economics. The latter is a discipline focused on choice maximisation by individual actors who have well-defined preferences and utility functions, and who compete with one another for the acquisition of scarce resources. Innovative behaviour, however, is marked by insights and choices made in conditions of deep uncertainty, which contrast with the probabilistic and maximising calculations of rational actors. It is also driven by motivations that are not exclusively economic-utilitarian and that follow a logic of interaction in which trust and cooperation often mingle with the customary market transactions. For these reasons the issue of innovation represents a borderline area open to contributions from a number of different disciplines.

At an international level, in fact, Innovation Studies (IS) is taking shape as an emerging field of research – one that tends to cross over the boundaries of traditional academic disciplines (Fagerberg 2013). It is a scientific field that:

- is defined by a shared cognitive focus, centred on the theme of economic innovation;
- hosts a large community of scholars from a wide range of different countries;
- possesses shared intellectual references, as well as specific research centres and meeting places.

A recent study shows a steady increase in articles devoted to innovation, starting from the sixties, with a particularly strong acceleration taking place in the last two decades (Fagerberg and Verspagen 2009, 220, fig. I.1; Fagerberg and Sapprasert 2010, fig. I.1). Researchers who deal with innovation and identify themselves with this field of study are estimated to number, on a global scale, around 4,000 (ibid., 229, note 33), and there are 136 research centres dedicated to the subject. Most of these scholars belong to economic disciplines (58 per cent), followed by engineering (9 per cent), geography (8 per cent), management (6 per cent) and sociology (5 per cent). The remaining 14 per cent come from other areas, ranging from political science to psychology to history, etc.

The field is composed of a multiplicity of small groups that interact closely with one another, but are linked to a wider scientific community. It is a community with a common literature of reference, a number of leading scholars,[4] scientific journals[5] and professional associations,[6] as well as meeting places and conferences (ibid., 228). The vast majority of scholars involved are European (71 per cent), and they, together with those from the United States (17 per cent), clearly dominate the field.[7] Europe, in fact, has a strong tradition in Innovation Studies. A major contribution was made in the mid-sixties with the foundation of the Science Policy Research Unit (SPRU) at the University of Sussex (initially directed by Christopher Freeman), which organised Masters and PhD courses of an interdisciplinary nature (involving economists, sociologists, psychologists, engineers, etc.) and conducted pioneering research on the role of innovation in economic and social changes (e.g. the Sappho project concerning factors of success and failure in innovation). This research centre was also responsible for the founding of the field's most prestigious journal, *Policy Research*, established in 1972 and directed in the beginning by Freeman himself (Fagerberg 2005).

Comparatively speaking, Innovation Studies in the United States has remained more heavily restricted to disciplinary contexts and this partially helps to explain the low proportion of scholars who 'identify' themselves with a scientific field which, as has been said, is highly interdisciplinary in character (Fagerberg and Verspagen 2009, 223).

I.2 The contribution of sociology

IS thus represents a new scientific field – one that is establishing itself at an international level and which focuses on a particular research topic (innovation) shared by researchers from a variety of disciplines. Judging by their numbers, the role played by sociologists seems rather limited. In fact, this is only partially true. A study by Ben Martin (2012) well illustrates the seminal contribution provided by sociology.[8] Martin analyses the scientific papers that have had the greatest impact (the most quoted articles) in what he calls – in a broad sense – Science Policy and Innovation Studies (SPIS).

In the group of so-called *precursors* of SPIS (works published before the end of the fifties), together with Schumpeter's works, there is also a study on social

change carried out in the twenties by William Ogburn (1922) – a sociologist whose observations focused on technological transformation. There are, moreover, many sociological contributions among the *pioneering* works – those published from the late fifties on. First, the research conducted in 1954 by James Coleman, Elihu Katz and Herbert Menzel on the process of diffusion of new drugs in the medical field (1957, 1966). The study concerns the adoption of a new broad-spectrum antibiotic – tetracycline – by doctors in four small Illinois towns, and it highlights the importance of networks of interpersonal communication and the role of opinion leaders in the transmission of innovation. The authors show how the diffusion of innovation takes place according to processes of 'social contagion' arising from informal discussions within the medical profession; and how the dynamics of contagion (the timing of the adoption rate) depend to a large extent on the formal properties of the network of relationships. The work of Coleman, Katz and Menzel, although relevant to studies on the diffusion of innovation, has remained mostly confined to the field of sociology.

A rather different case is that of another pioneering contribution of a sociological nature, *Diffusion of Innovations*, the influential book by Everett Rogers which is still the benchmark work for 'diffusionist studies' and the first edition of which dates back to 1962. This work systematically reconstructs innovation adoption processes, demonstrating how these have well-defined actors and roles and follow a recurring pattern of diffusion: the logistic curve of adoption rates (S-curve). Rogers' book has gone through five different editions up to the present time – the last being in 2003, the year before his death – and is by far the most cited publication in the field of SPIS (Martin 2012).[9]

Other pioneering contributions hail from the world of industrial and organisational sociology, with two works in particular at the forefront. The first, by Joan Woodward (1965), highlights the close relationship between the type of technologies employed, the organisation of work and the economic performance of companies. The second contrasts two organisational models that will have a major influence on subsequent research. In a study of electronics companies, Burns and Stalker[10] (1961) developed two ideal-typical models: a 'mechanistic' organisation of work (of a hierarchical and centralised kind), and an 'organic' one (which is a more decentralised, horizontal and complex model). According to the two researchers, the second model allows for greater fluidity and flexibility in communication, both within and outside the organisation, and in doing so fosters creativity and innovation by ensuring more successful adaptation to technological and market changes.

Even in the period of *maturity* of the SPIS – works published after the eighties – there is no lack of sociological contributions. Ronald Burt's reappraisal (1987) of the study by Coleman, Katz and Menzel on medical breakthroughs – which criticises the idea of social contagion – is much cited. Burt's article, however – like the original work by Coleman and his colleagues – remains confined to the field of sociological literature. Mark Granovetter's essay 'Economic Action and Social Structure: The Problem of Embeddedness' (1985) has, on the other hand, enjoyed far wider circulation. This deals with the importance of

social networks for the circulation of information, and has come to be considered as a kind of manifesto for the 'new economic sociology', an approach that gives preferential attention to social networks. While not explicitly addressing the topic of innovation, this work is among the most cited in IS, and the same goes for the book on 'structural holes' – also dedicated to social networks and the circulation of information – written by Ronald Burt a few years later (1992b). This attention devoted by IS to sociology that deals with social networks – even when it is not explicitly addressing the theme of innovation – should not surprise us.

Starting from the mid-nineties, in fact, IS showed growing interest in inter-organisational relations due to the exponential growth of collaborative relationships between companies (Meeus and Faber 2006). In particular, research and development (R&D) partnerships around world rose from a few dozen in the sixties and seventies, to several hundred in the eighties – reaching a peak of more than 700 examples of cooperation in the mid-nineties. From the early eighties, moreover, these partnerships were concentrated in the high technology sectors (pharmaceuticals, IT and telecommunications, aerospace, etc.).

The second reason why the new economic sociology receives attention is linked to the development of the literature concerning high technology innovation systems, which gives a prominent place to networks of collaboration. Not coincidentally, the research conducted by Walter Powell, Kenneth Koput and Laurel Smith-Doerr (1996) on biotechnology has had a wide resonance. The study shows that in an industry characterised by rapid scientific and technological change, one in which the knowledge base and required skills are complex and dispersed amongst a variety of subjects, *networks of learning* become the 'locus of innovation' *par excellence*. Innovative processes, in other words, pass beyond the boundaries of individual companies and put down roots in inter-organisational networks.

Other relevant sociological contributions to IS came from several studies with an organisational approach (Kimberly and Evanisko 1981; Ettlie *et al.* 1984; Dewar and Dutton 1986) and from neo-institutionalism – in particular from the work of DiMaggio and Powell (1991) on the mechanisms of institutional isomorphism that condition the processes of diffusion and adoption of organisational innovation.

A great deal of attention was also paid to Piore and Sabel's celebrated work (1984) on the issue of flexible specialisation, which shows the changes in the models of competition and organisation of companies in the new post-Fordist scenarios, with the shift from the production of mass standardised goods to diversified quality goods.

Finally, to conclude this brief look at the contributions of economic sociology to IS, two highly cited works come from adjacent areas. The first, which has its origins in the field of Science and Technology Studies (STS), is the book by Wiebe Bijker, Thomas Hughes and Trevor Pinch (1987) devoted to the social construction of technological systems. The second work is concerned with modes of knowledge production and is the result of an interdisciplinary collaboration that also saw the involvement of sociologists. The book, by Michael

Gibbons and others, and emblematically titled *The New Production of Knowledge* (1994), analyses the transition from Mode 1 to Mode 2 knowledge production. In the first mode, production is mainly academic and disciplinary, with marked scientific autonomy in relation to the demands and needs of society. In the second mode, disciplinary boundaries are looser and 'ivory towers' more accessible: research becomes more interdisciplinary and involves a variety of centres and institutions; borders between industry and society are blurred; and the scientific community becomes more responsive to social needs.

As can be seen both sociology in general, and economic sociology in particular, have made a significant contribution to IS. It should also be added, however, that their contribution has so far been sporadic and unsystematic, mostly confined to narrow disciplinary fields (e.g. organisational studies).

There is no justification for this state of affairs. Many scholars of innovation employ concepts and address issues (institutions, trust, collaboration networks, etc.) to which sociology can make a significant contribution at both macro and meso levels (national, regional and sectorial systems of innovation), and at micro level (learning networks and innovative partnerships). In recent years, moreover, the subject of innovation has also become increasingly present within economic sociology's two major approaches: the *comparative political economy* and the *new economic sociology*. Economic sociology has gained in vigour thanks to these two strands, though they themselves have remained separate (Regini 2007; Trigilia 2007a, 2009; Barbera and Negri 2008). IS provides an opportunity for dialogue between them in order to develop an analytical approach of an integrated kind. We will return to this point at the end of Chapter 1. First, however, we need to provide some conceptual coordinates to delineate the topic at hand.

I.3 A first definition

What is meant by 'innovation'? Derived originally from Latin, the verb *innovate* and noun *innovation*, as they are currently used, indicate *the transformation of an existing state of things, in order to introduce something new.*[11] The reference, therefore, is both to the action of change and to its result, implying a contextualisation and a diachronic comparison. Innovation needs to be collocated within the context in which it occurs, and its results can be understood only by making a comparison between *before* and *after*: the state of things prior to and successive to its introduction. These simple considerations give us a process-oriented and relational idea of the concept.

I.3.1 Innovation is processual

Innovation is a complex activity that comprises a series of interconnected phenomena. It involves a number of activities and transitions that scholars have often combined into phases. Everett Rogers (2003, 137ff.), for example, indicates six such phases:

1 the identification of a need or a problem that requires a solution;
2 the decision to carry out research (basic and/or applied) to find this solution;[12]
3 the development of innovation to give it a form and content that meet the needs of those who will use it;
4 the marketing, which is the production and distribution of the product/service that contains the innovation;
5 its adoption and diffusion;
6 the consequences of innovation, which relate to the changes associated with its adoption.

The steps mentioned by Rogers are designed for different kinds of innovation. In recent years, a procedural approach and a division into stages have also been developed for company innovations.

- *The input stage*. Starting off the whole process, a decision is taken to initiate research and innovation by investing human and financial resources in it.
- *The throughput stage*. The central section features the path that the company must take in order to transform input into output through company innovation.
- *The output stage*. At the end of the process, there are the results achieved: the fruits of innovation in terms of new products or services offered on the market. The European survey regarding company innovation (CIS) follows this pattern, with data collection for each of these three steps (Kemp *et al.* 2003).

To avoid misunderstanding, however, some clarification is required. The division of the innovation process into different stages has a purely analytical value: it is useful to define the ideal-typical categories and reference points for the analysis of specific cases. It does not imply that innovation should be thought of in strictly sequential terms, as an orderly and linear succession of stages, each one rigidly distinct from the other; nor that innovative activity necessarily includes the explicit employment of scientific research, from which innovation derives. While the innovative process is always concerned with the creation, diffusion and use of new knowledge, it is not always the case that this new knowledge derives from scientific research: it often comes from the experiences of suppliers, producers and the users of certain goods and services.

For a long period of time, studies on economic innovation were dominated by the so-called *linear model of innovation*, which defines a rigid sequence of stages. It starts with basic research, moves on to applied research, passes into the development stage of innovation, and concludes with production and diffusion.[13]

It is a sequence involving one single direction: upstream (basic research) to downstream (market). As an approach, this was severely criticised by Kline and Rosenberg (1986), who opposed the so-called *chain model*, highlighting how innovation is an uncertain, complex and untidy process, which in most cases

does not start out with research activity. It is a process with a great deal of cross-feedback between the stages, so that much important input to the research comes from the developmental and market phases.

Innovation has a recursive, circular connotation, so it would be an error to limit the 'creative' dimension only to the first phase indicated above – the input stage. For example, with reference to companies, the transformation phase of input into output is not simply a moment where the invention packaged by the R&D department is implemented. This particular phase often produces the stimuli and ideas that then become the subject of systematic company research. Moreover, in the implementation phase, the inventions that come out of the laboratories are profoundly modified, with an ongoing interactive process taking place between research staff and production staff. The same applies to the downstream phase, which involves the economic valorisation of innovations. Market feedback, together with the needs of, and suggestions from, the company's most important customers, provide essential contributions for the generation and development of new products. The innovation process, therefore, cannot be represented as a *direct current*, as a continuous and fixed flow of electrons going in a single direction, but should be thought of rather as an *alternating current*, in which the flux of electrons varies over time, sometimes going forward and at other times going backward.

I.3.2 Innovation is relational

First of all, innovation is relative: it has to be considered in relation to a period and a context. It can be understood and defined only through a comparison between the state of things as they exist within an economic sector, a company, a geographical area, in terms of time T1, and the new state of things realised, in terms of time T2. In addition, innovation relies on the contribution – in an implicit or explicit form – of other actors, both in the generative phase (exchange of ideas, interpretations, etc.) and in the implementation phase. In order to have an impact on the context, it must also be accepted and diffused, and this occurs through the mediation of interpersonal relationships, as sociological studies on diffusion show (Rogers 2003).

I.3.3 Innovation is different from change

Change is a broader and more generic term, and refers to transformations that are not necessarily of an innovative kind. Innovation does bring change with it, but always in order to introduce something new; it involves 'the doing of new things or the doing of things that are already being done in a new way (innovation)' (Schumpeter 1947, 151).

I.3.4 Innovation should be distinguished from invention

Invention means to conceive a new product or process; innovation implies putting these new ideas into practice for the first time (Fagerberg 2005, 34). It

was Schumpeter once again who suggested this distinction, drawing a line between the inventor and the innovator-entrepreneur: 'the inventor produces ideas, the entrepreneur gets things done' (Schumpeter 1947, 152; 1912 Eng. trans. 2012, 65). While the first activity remains confined within the context of knowledge advancement, the second assumes meaningful economic importance. As the Austrian economist observed, ' "getting new things done" is not only a distinct process but it is a process which produces consequences that are an essential part of capitalist reality' (Schumpeter 1947, 152). That said, the line between invention and innovation is not always easy to draw, since in some production sectors inventive and innovative activity tend to overlap (biotechnology, software, etc.). Moreover, as Schumpeter himself pointed out, inventors often tend to exploit their inventions entrepreneurially. This book will, therefore, also deal with inventors (industrial and academic), and inventions for the economy, and in this I take my lead from the suggestion of one of the major economic historians of technology who observes that 'invention and innovation are complements in the long run, technologically creative societies must be both inventive and innovative' (Mokyr 1990, 10). Since inventors and inventions have been neglected by economic sociology, a certain amount of attention will be dedicated to them in this work, considering them as examples of *generative mechanisms of innovation*: in other words, as one possible mode of initiating economic innovation (Hedström and Swedberg 1998; Barbera 2004).

I.3.5 Innovation does not always bring positive results

The term 'innovation' is freighted with a certain evocative power; a kind of bias that leads us to suppose that the changes brought about will always have a positive value. Innovation thus ends up becoming a synonym for 'progress'. This is the wrong way to look at things, since it generates the fusion of two analytical levels which instead must be kept quite distinct: that of the intentions of the innovators and their expectations for improvement, and that of the evaluation of the results produced. The introduction of something new is not necessarily positive; it does not always, at least, lead to the desired results. Innovation can, in fact, fail and/or generate unexpected consequences which are not necessarily beneficial to innovators and/or to the community of reference. The many harmful innovations that have been introduced in recent years in the financial world are a good illustration of this. Here, therefore, the term will be used with a neutral sense. This is for three reasons. The first is that this allows us to problematise – or place within an analytical context – the economic and social impact of innovation. The second is that this use is consistent with the indications provided by the *Oslo Manual*,[14] which gives standardised guidelines for data collection and the study of innovation at company level (OECD/Eurostat 2005). The third is that the activity of innovation is problematic precisely because it is a risky and uncertain one. It is subject to failures that can be technological (relating to the attempted technical solutions), social (relating to the resistance of the actors involved who are threatened by the new solution) or economic (relating to the

market). The introduction of marginal change creates situations of risk (where the probability of success can be calculated based on past experience), while the introduction of fundamental innovation creates situations of radical uncertainty (where the calculation of probabilities is not possible because there is no previous experience to refer to).[15]

I.4 Economic innovation

This book is not concerned with the subject of innovation in general but with economic innovation. In the social sciences there are two different ways of perceiving the economy. The first, defined by Karl Polanyi as *formal*, applies the term to the nexus which unites the means to the ends of an economic action. It refers to a hypothetical situation of choice in which the actor follows rational criteria in assessing the benefits that derive from the allocation of the actor's (scarce) resources to alternative ends. The rationale, then, concerns not the means or the ends, but the relationship between them. The problem with this approach is that of falling into a sort of 'economistic fallacy' (Polanyi 1977). There is, in other words, a process of universalisation of the (utilitarian) motivations and logics of action (based on the assumption of scarcity of resources and the maximising rationality of behaviour) that are unique to a specific historical epoch: that of liberal capitalism, in which trade takes place within a system of markets that regulate prices. It is a definition of economics that is too narrow to investigate – in a historical-comparative perspective – the relationship between economy and society. For this reason, sociology uses a broader and more substantial concept of the term 'economy', which starts with the assumption that man depends on nature and on other people for his survival and the satisfaction of his needs. According to Polanyi (1968), the origin of the substantial concept lies within the concrete economic systems. These can be defined as an instituted process of interaction between man and his natural and social environment, which gives rise to a continuous flow of material means for the satisfaction of human needs.

What is, then, economic innovation? Based on the above, we can provide a first general definition. *Economic innovation* is a process of change that introduces new economic and regulatory elements: in the needs that are met, in the goods and services that are produced, and in the modes of production, distribution and use of these goods and services. The unit of reference varies depending on the analytical level selected: it might be a company, or the consumers, but it could also be the local, regional or national economies, etc.

Picking up on the suggestion of Schumpeter,[16] different authors have defined innovation as a problem-solving process of a combinatorial type: that is, oriented towards the search for new combinations with known elements as a starting point. Often these definitions refer to technological innovation (Fleming 2001; Fleming and Sorenson 2001). The search for new technical solutions, however, is only one aspect of the phenomenon we are dealing with – which is broader and more complex. Economic innovation is not limited to technological change.

Following Keith Pavitt's observation, we can think of it as a process that involves 'matching technological opportunities with market needs and organizational practices' (2005, 88). The role of the innovator (whether an individual or an organisational unit) is to activate and coordinate all the factors that are necessary to achieve this goal (Fagerberg 2005, 34).

With reference to economic sociology, however, these definitions require two specifications:

1 the needs and the actors that it considers are not only those of the market;
2 its purpose is to show that, in each of the phases of the innovation process, there are also social and institutional factors at work in addition to economic ones.

I.4.1 Types of innovation

But let's now try to give some more specific and operational definitions, ones useful for orientation in the study of these phenomena. Our starting point is innovation at company level. The reference point, in this case, is the *Oslo Manual*, which deals with the collection of data in the surveys conducted throughout the various countries of the European Union: 'an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations' (OECD/Eurostat 2005, 46).[17] There are therefore four types of innovation.

1 *Product innovation* involves the production of goods or services that are entirely new, or modified in respect to the previous version.
2 *Process innovation* includes changes in the method of production or delivery of goods and services.
3 *Organisational innovation* refers to new forms of organisation of business operations.
4 *Marketing innovation* may relate to the design and/or packaging of the product, its mode of promotion and placement on the market, as well as methods for determining the selling prices of goods and services.

Every change in these activities must include a certain degree of newness. The degree, however, can vary a great deal. The literature mainly defines two types of innovation:

1 *Incremental innovation*, introducing minor changes – that is, limited modifications in the production or use of a particular good/service.
2 *Radical innovation*, which brings about a far more significant level of newness, reconfiguring the state of knowledge and expertise hitherto used in a given area, and which can, sometimes, create new markets.[18]

Examples of the first type of innovation are the constant changes introduced in the cars, TVs and computers that we use. These modifications are made by manufacturers to improve functionality and/or aesthetics, in order to attract new consumers and beat the competition. Examples of the second type, on the other hand, are the introduction to market of the *first* cars, television sets and computers designed for personal use. Incremental innovation, however, should not be underestimated, given that, in terms of quantity, it represents the largest part of economic innovation, and, in terms of quality, many incremental innovations of a cumulative kind can end up determining changes of great importance.

There is also a third type of innovation which concerns the relationship between products and components. Products are, in fact, composed of various elements assembled together, and innovation can sometimes relate to these individual components without this having an effect on their various relationships. When innovation involves the manner in which the components are integrated together, however, this produces *architectural innovation*, which brings about an overall reconfiguration of the product. An example given by the two scholars who first drew attention to this phenomenon is that of Xerox (Henderson and Clark 1990). At the end of the forties, the American company launched the first photocopying machine on to the market and quickly became the leader in this sector. In the mid-seventies, however, Xerox found itself in difficulty because of competition from a number of companies able to produce smaller and more reliable copiers. Despite the fact that there were no major technological innovations in these new machines, it took several years for Xerox to meet the challenge effectively, since this process involved changes in the architecture of its products.

Alongside individual innovations, broader technological changes must also be considered. *Shifts in technological systems* tend to be very wide-ranging changes that involve a number of economic sectors and bring about the introduction of a constellation of interrelated innovations – some radical, some incremental and some organisational. An example of this is the introduction of new techniques for the production of synthetic materials that, in the first half of the twentieth century, was accompanied by innovations in the petrochemical and machinery fields. *Shifts in techno-economic paradigms (technological revolutions)* involve even more extensive changes that can alter economic development as a whole. The most appropriate example in this case is the technological revolution that took place towards the end of the eighteenth century with the introduction of the steam engine (Freeman 1994, 734).

In this book we will deal with economic innovation in a sociological perspective.[19] The aim is twofold:

1 to stir the interest of students and scholars in the field of economic sociology, demonstrating that the subject of innovation provides room for reflections of a sociological nature;
2 to support the idea that the study of innovation requires an integrated approach, involving an interdisciplinary dialogue and explanations conducted

at a number of levels, both geographical and analytical. In order to understand the processes of innovation, it is necessary to look at the *actors* of innovation, at the *relations* that exist between them, and at the sectoral and territorial *contexts* in which they operate.

I will begin, in Chapter 1, by presenting various sociological contributions to the study of innovation, to be used as *focusing devices*[20] to frame and analyse the different dimensions of innovation. In Chapters 2 and 3 I will focus on a particular type of *innovation actor*: the inventor. Chapter 4 will look at a special configuration of *innovative relationships*: the small-world networks. Finally, the last three chapters will deal with three important *contexts of innovation*: the national, regional and local systems.

Box introduction Self-study prompts

1 What is Innovation Studies?
2 What is sociology's contribution to this particular field of study?
3 What is meant by 'innovation'?
4 Which are the basic traits of this concept?
5 How can 'economic innovation' be defined?
6 What are the main types of innovation?

Notes

1 There are, on the other hand, entries for both 'technological change' and 'organisational innovation'.
2 The original phrase, known as the Solow paradox, runs as follows: 'You can see the computer age everywhere but in the productivity statistics' (1987, 36). There are, fortunately, some notable exceptions, and a few recent sociological studies seem to bear witness to the emergence of new attention for these issues. To cite some of the most relevant studies we can mention Hage and Meeus (2006), Stark (2009) and Block and Keller (2011).
3 At the end of May 2015, the research engine Google Scholar reported almost 29,000 references to this book – an extraordinarily high number for the social sciences. For the most part, however, the references come from articles published in journals of organisational and management sciences and Innovation Studies (Fagerberg and Verspagen 2009, 229).
4 Such figures include Joseph Schumpeter, Richard Nelson, Christopher Freeman, Bengt-Åke Lundvall, Nathan Rosenberg, Keith Pavitt, Giovanni Dosi and others.
5 The most prestigious are *Research Policy*, *Industrial and Corporate Change* and the *Journal of Evolutionary Economics*.
6 For example, the International Schumpeter Society (ISS), the Danish Research Unit for Industrial Dynamics (DRUID) and several others.
7 In a subsequent study, conducted on the core literature on innovation (the most cited publications in leading handbooks), the United States emerges as having a greater role in both the production and use of this literature (*knowledge users*). Among the 20 most important contributions to IS, 11 are authored by North American scholars, eight by Europeans and one by a Japanese. Among knowledge users, however, 46 per cent

are European, 42 per cent American, and the remaining 12 per cent belong to other nationalities (Fagerberg and Sapprasert 2010).

8 Ben Martin teaches Science and Technology Policy Studies at the SPRU – one of the most important centres in the world for Innovation Studies – of which he was director from 1997–2004.

9 Even in Sapprasert and Fagerberg's research (2010) on core IS literature – which uses a different method of identification from that of Martin – Rogers' book receives the highest number of overall citations. It also appears in eighth place in the shortlist of the 20 contributions that have had the greatest impact (the ranking is obtained on the basis of the J-Index value: a normalised citation index that takes into account the various years of publication of the works).

10 Only the first of the two authors is a sociologist.

11 A fairly common definition, found in the best English, French and Italian dictionaries.

12 *Basic research* can be defined as a type of exploratory research, oriented primarily towards the advancement of scientific knowledge and the theoretical understanding of the phenomena studied. *Applied research*, instead, is a kind of research aimed at the practical application of knowledge to solve specific problems. Despite the apparent clarity of this distinction, it is not always obvious into which category a particular type of research falls, or what the relationship is between them. A hierarchical relationship is often assumed: basic research → applied research. In reality, things tend to be more complex, especially if a broad interpretation of applied research is employed which includes all the activities aimed at solving technical problems. *Technique* is a form of operational knowledge regarding 'knowing how' and it can be defined as the set of rules that are applied to the performance of a task, a job, a manufacturing process and the use of related tools and machinery. *Technology* is the body of knowledge related to technical matters. The boundaries that separate applied research and technological knowledge are blurred and the influential relationships between the latter and scientific knowledge are far from unidirectional. Historically, the search for a practical solution for production problems preceded (and drove) scientific understanding of such problems. Moreover, it is not uncommon that applied research and technical innovation are in fact the elements that enable progress in scientific research. On this point, see the remarks made by Nathan Rosenberg (1982).

13 For a detailed historical reconstruction of the acceptance of this particular model, see Godin (2005). Its origins are also linked to the first sociological reflections of Ogburn and Gilfillan, who, in the twenties, integrated the theme of invention with that of innovation (Godin 2008). We will discuss the contribution of these sociologists in Chapter 3.

14 The *Manual* is the result of the joint work of the Organization for Economic Cooperation and Development (OECD) and the European Union (EU).

15 The distinction between risk and uncertainty was introduced by economist Frank Knight (1921). Nelson and Katzenstein, writing about the recent financial crisis, referred to a 'world of risk' and a 'world of uncertainty' (Katzenstein and Nelson 2011; Nelson and Katzenstein 2014). The term radical uncertainty 'refers to the kind of uncertainty that cannot be transformed into calculable risk on a probabilistic basis, and cannot be subjected to evaluation of a statistical and mathematical kind' (Mutti 2009, 262).

16 Schumpeter (1912) talks about 'new combinations' of the means of production.

17 The last version of the *Oslo Manual* provides a very broad definition of 'innovation', which also covers areas neglected in the past. Previous versions (the first and second editions date back to 1992 and 1997 respectively) focused primarily on technological innovations relating to products and processes that interested companies active in the manufacturing sector. The new edition, however, also considers non-technological innovation – such as organisational innovations, and those relating to the marketing of products. In addition, greater importance is given to innovations in sectors less driven

by R&D, such as services, or low-tech manufacturing activities. Finally, the systemic and relational character of innovation is acknowledged, with more attention paid to the analysis of relationships with the other firms and institutions that interact in the innovation process (OECD/Eurostat 2005, 12).

18 A related concept is that of 'disruptive innovation', which focuses on the impact of innovation on markets (Christensen 1997). Disruptive innovation tends to reshape economic activities in a radical way, creating new markets.

19 Little, on the other hand, will be said about organisational, and science and technology studies, which have, over the years, developed a copious and interesting literature. This is, however, much more generally well-known, and its treatment would take up space not available in this book.

20 An expression used by Bengt-Åke Lundvall (one of the leading scholars in IS) with reference to 'national innovation systems', which will be discussed in Chapter 5.