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# The Dynamics *of* Knowledge Externalities

Localized Technological Change in Italy



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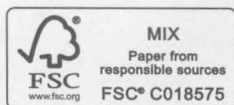
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# The Dynamics of Knowledge Externalities

To Anna, Paolo, Emanuele and Francesco

To Maria Claudia, Bianca, Costanza and Filippo

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# 1. Technological change and Italian growth 1950–1992: an intriguing puzzle

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The economic growth of the Italian economy in the second part of the twentieth century provides large and systematic evidence about fast rates of growth of output and especially total factor productivity, and yet a lack of effort in the formalized generation of technological knowledge, as measured by traditional indicators such as expenses in research and development (R&D) activities or patents.

Since the 1990s, a wealth of case study evidence regarding sectors, firms and regions ‘discovered’ the relevance and complexity of the innovative processes at work during the 50 post-war years. This evidence shows that the Italian economy experienced, up to the early 1990s, fast and intensive growth, mainly driven by the increase of total factor productivity engendered by the widespread introduction of technological and organizational innovations. So far, the Italian case provides puzzling evidence of the growth of an industrial economy characterized by low levels of R&D expenditure and yet high levels of growth of total factor productivity. The solution to the puzzle can be found in the systemic congruence that has emerged in the Italian economy between the organization of the generation of technological knowledge and the traditional characteristics of the economic and industrial structure.

This book aims to draw attention to the relevance and uniqueness of the dynamics of technological change that characterized the industrial system in Italy. Identifying and framing in a structured and coherent interpretative context the significant established and novel elements of empirical evidence, the book shows how, contrary to current opinion, the Italian economic system had a notable capability to innovate, producing relevant technological change both with regard to its rate and direction. By focusing attention on total factor productivity, it is possible to concentrate on the uniqueness

of the technological change that characterized the fast and deep economic development and growth, and the radical structural transformation of the Italian economic system, during the second half of the twentieth century. The innovative ability of Italian firms was based upon the systematic valorization of user-producer interactions between upstream producers of capital goods and downstream producers of consumer goods, within industrial districts, and the systematic development of localized learning rather than on the traditional 'corporate model' based upon mechanisms of formal research funded and performed internally by large firms, as revealed by statistics regarding R&D and measured by indicators such as patents and publications.

From this point of view, the forms, the determinants and the effects of the technological change characterizing Italian economic growth were highly original and call for a specific interpretive model. The central assumption on which this study is based is that technological and organizational change, based upon qualified vertical and horizontal interactions among firms, and characterized by strong directionality towards the introduction of capital-intensive process innovations engendered by the same system of vertical relations, played a central role and it is indispensable to understanding the characteristics, the rhythms, the determinants and the weaknesses of Italian economic growth during the second half of the twentieth century.

This book is the result of an attempt to provide a systematic interpretative framework into which the emerging case study evidence can be framed. The aim is to elaborate an exhaustive and complete picture of Italian economic growth able to account for the characteristics of the process of generation and exploitation of localized technological knowledge and the ensuing introduction of localized technological change, as relevant aspects of Italian economic growth, which have been neglected for a long time and whose relevance has been underestimated. In so doing, this book contrasts the view shared by the main Italian economic history studies in the second half of the twentieth century, that do not give any importance to technological change and, more generally, to the extraordinary growth of output engendered by the substantial increase of total factor productivity up to the early 1990s. In order to provide an interpretative frame able to support the specific characteristics of these dynamics, the first part of the book elaborates the localized

technological change approach, so as to appreciate and stress the role of the external context of the innovation process. It elaborates upon the notion of pecuniary externalities and shows how pecuniary knowledge externalities matter in explaining the dynamic capability of an economic system.

The book relies upon the large volume of literature that considers technological change endogenous to economic activity and actually constitutes its qualifying aspect, but integrates it with an in-depth analysis of the generation and exploitation of technological knowledge. In fact, it is possible to consider technological change as the result of a specific form of economic activity, which consists of the ability to accumulate and generate technological knowledge and expertise, and to draw on this stimulus and potential to introduce specific technological and organizational innovations. In the analysis of the particular process that leads to the introduction of innovation, it is necessary to consider not only the formalized innovative activities, proxied by classical indicators such as patents registered both in Italy and abroad and the expenditures on R&D, but also the more general fabric of technological knowledge, including knowledge interactions and knowledge externalities.

The focus on the localized technological change approach implemented by the notion of pecuniary knowledge externalities enables us to grasp the key role played by the specific character of the organization of the generation of technological knowledge in the Italian economy. In these decades, the organization of the production of knowledge in Italy takes place along two lines. On one hand, the group of large firms that had emerged at the beginning of the century, many under the control of the State, adopts the 'corporate' model. The corporate model was traditionally based upon the pivotal role of the large corporation able to perform intramuros R&D activities. The few Italian corporations in this period are more and more active in funding the generation of new knowledge and play an important role in the performance of these activities.

Next to the imitation and adaptation of the 'corporate' model, however, a second process takes place: one where small firms play an important role. Their efforts in the generation of technological knowledge are seldom identified by statistical measures as they rely on the accumulation and valorization of tacit knowledge, based both on internal learning and mainly upon the collective creation and implementation of external pools of knowledge. The systematic and

systemic usage of external technological knowledge into the generation of new technological knowledge plays a key role in this context. This second part of the Italian economy is able to implement an original 'distributed' model for the organization of the generation, exploitation and dissemination of technological knowledge. Knowledge interactions among small and larger firms within horizontal and vertical network structures, such as industrial districts and technological filieres, provided access to emerging pools of collective knowledge and favoured the introduction of technological and organizational innovations by a broad array of firms. Such innovations, in turn, affected the structure of the system feeding, for quite a long stretch of time that apparently lasted until the early 1990s, a self-sustained and virtuous process of economic growth and structural change.

The empirical analysis shows how total factor productivity experienced a fast increase, not only in the so-called modern (or high-tech) industries but also, and mainly, in the traditional sectors. The rejuvenation of the traditional industries clustered within industrial districts together with the systematic increase in the quality content of their output appears to be one of the key characteristics of the process. In this context, the emergence of key sectors specializing in the supply of specialized machinery and intermediate goods was, at the same time, an input and an output of the process, leading to the creation of technological filieres where systematic user-producer interactions implemented internal learning processes.

As a result, at the aggregate level, the system exhibits a rapid shift away from the corporate model established in the twentieth century in the United States, towards a new distributed model based upon structured interactions among learning agents that share and barter technological know-how horizontally within industrial districts and vertically along filieres. In so doing, an original model of generation of knowledge emerged in Italy along lines that differ both from the established corporate model and the so-called open innovation model that has developed in recent years.

The new open innovation model is characterized by systematic outsourcing of knowledge generation activities and it is increasingly based upon actual knowledge transactions implemented by research contracts assigned by corporations to knowledge-intensive organizations, mainly based in the academic system, and upon the new venture capitalism. Here, the emergence of new surrogate markets for knowledge intensive property rights, resulting from the merging

of financial markets and the markets for knowledge, is crucial. Corporations are experiencing a declining role in the performance of R&D activities while they remain active in funding the generation of new knowledge and its eventual purchase and exploitation, often in the form of mergers and acquisitions of new innovative small firms (Chesbrough, 2003; Chesbrough, Vanhaverbeke and West, 2006; Antonelli and Teubal, 2010).

In the Italian distributed model, the generation of knowledge is the result of enhanced social interactions that rely upon, and at the same time implement, qualified long-term transactions along vertical filieres among upstream suppliers of capital goods and downstream users. Repeated transactions in the markets for intermediary goods provide the opportunity to implement knowledge interactions that are fruitful both for the customers and the vendors of tangible goods. Such qualified user–producer interactions are the result of the implementation of coherent technological filieres that act as effective communication channels for the bilateral exchange of tacit knowledge. Here the emergence of the intermediary markets for machinery and intermediate inputs characterized by low transaction costs and high intensity of knowledge interactions is crucial. Such markets became increasingly articulated and sophisticated by stretching the chains of specialized suppliers by means of processes of vertical disintegration, the birth of new specialized firms and increased division of labour.

Intense market interactions along the chains of specialized suppliers, co-localized within industrial districts, favoured systematic knowledge interactions between users and producers, provided the opportunity to enhance the recombination of dispersed knowledge possessed by different agents and eventually led to the diffused generation of new technological knowledge. Italian small firms, as a result, were able to achieve higher rates of growth, as they were able to make systematic use of external knowledge, that is knowledge generated by other firms, including the corporate part of the economy, the technology generated in other countries and, to a large extent, the pool of collective knowledge implemented within industrial districts and technological filieres, as a key input into the generation of new technological knowledge.

The Italian innovative process was crucially conditioned: by a creative reaction, pulled by the sharp increase in the aggregate demand that Italian firms could take advantage of, via the participation of the Italian economy into the European markets; and by creative

adoption, that is, by the systematic effort to reshape and adapt accessible technologies to their specific needs, providing key feedbacks to the upstream sectors that could, in turn, further improve their product innovations so as to increase their technological congruence with respect to the characteristics of the adopters. The emergence of such an original distributed model of generation, dissemination and exploitation of technological knowledge, with high levels of systemic and organizational congruence with the intrinsic characteristics of the Italian industrial system, played a crucial role in this context.

The emergence of a particular form of organizational and technological congruence is closely tied to the emergence of a specific form of innovative capacity. Thus, the Italian case can be considered an important reference to appreciate the extent to which a country's ability to introduce technological innovations and increase the levels of total factor productivity, that is, to enter and remain on an innovative path, crucially depends on its capacity to adapt the organization of the generation and exploitation of technological knowledge to the specific structural characteristics of its system (Abramovitz, 1956, 1989).



## PART I

The localized generation and exploitation  
of technological knowledge and innovation





## 2. The general framework

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### 2.1 INTRODUCTION

This part of the book elaborates a microeconomic framework at the crossroad of the Schumpeterian and Marshallian traditions of analysis to explain economic growth based upon the role of technological change (Schumpeter, 1911 [1934]). While much of the economics of growth impinges upon an equilibrium approach at the aggregate level, this book uses the Marshallian analysis of partial equilibrium to elaborate a microeconomic Schumpeterian approach that analyses innovation as the consequence and the cause of self-organizing out-of-equilibrium processes. In so doing, it presents a methodological update of the localized technological change approach, stressing the systemic role of pecuniary knowledge externalities. Such externalities become available within qualified systemic conditions such as industrial districts and technological filieres providing abundant and cheap access to external knowledge, an essential input into the recombination and generation of new technological knowledge. This approach is relevant as it provides an interpretation of the Italian puzzle of very low levels of expenditure in R&D and yet high levels of total factor productivity growth.

Our basic argument is that unexpected changes in product and factor markets induced myopic firms, constrained by substantial irreversibility of production factors, to try to innovate. Their localization into (sub-) systems characterized by qualified mechanisms of knowledge governance and hence access to external knowledge at costs that were below equilibrium levels, made their reaction creative as opposed to adaptive. Such localization paved the way to the successful generation of technological knowledge and the eventual introduction of localized technological changes by firms, embedded in the fabric of knowledge networks. Good mechanisms of knowledge governance and effective mechanisms of user-producer interactions along vertical filieres and within industrial districts, made the