Introduction

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This book focuses on the role of public research institutions in helping to promote the processes of technological and economic catch-up in developing areas, and of local policy in fostering local science–technology linkages with incoming foreign-owned multinationals. The underlying idea is that public research, educational and political institutions, as well as private corporations, are key actors in technological and economic processes since they may reinforce (or reverse) local *virtuous* (*vicious*) cycles by providing capabilities in basic research, the training of highly skilled labour, and networking connections with scientific and professional communities (and therefore access to knowledge and contacts) in other parts of the world. Despite being a peculiar feature of the new innovation model of the knowledge-based economy, the close relationship between knowledge transfer, innovation and economic growth has historically been an important mechanism capable of stimulating economic take-off. Notwithstanding the difficulties of identifying the ingredients of successful recipes, a crucial conceptual cornerstone of the book is the belief that public research institutions help to create the conditions required for local knowledge development and a greater capacity for problem-solving in local enterprises through their interactions with other local actors.

This view is framed within a specific understanding of technological change against which the interplay between science and technology, and between multinationals and local actors, as well as catching-up processes, are investigated. In particular, the contributors to this volume share the belief that knowledge is largely excludable and its use partially rivals, rather than merely being a ‘public good’. These characteristics can be summarized in the *tacit* nature of technological change resulting from the specificity of the learning process. Economic actors (whether firms, users, countries, regions, or public institutions – according to the level and the focus of analysis) are heterogeneous as far as their cognitive capabilities, environmental information and technological opportunities are concerned. In following an individual learning path, economic actors develop over time specific routines and rules of thumb which allow them to tackle daily uncertainty by means of innovative activity. Far from being on the shelf, these

heuristics are highly tacit and embedded in the experience acquired in everyday life. That is, the transfer and adoption of new technologies implies a specific cost which may well equal the cost of first introduction (Antonelli, 1995). Accordingly, the process of heuristics development and, therefore, technological change has a strong path-dependent connotation in the sense that at any point in time the production, implementation, selection and adoption of new technologies by an economic actor greatly depends on the technology he/she has used up to then. Thus, technological change can be said to be *localized* in the sense that the exploration and development of new techniques are likely to occur in the neighbourhood of the techniques already in use.

Along these lines, new knowledge is the result of a specific and *local* learning process where it is hard to disentangle the role played by public research institutions and corporate research laboratories. In this perspective, no clear boundaries can be drawn between science and technology *ex ante*, while the two can be neatly distinguished *ex post* on the grounds of the degree of availability of the outcome of the research process. As pointed out in the pioneering work of Nelson (1959) and Arrow (1962), the 'public good' character of scientific output causes a shortage of scientific research since private actors will invest just as much as they will be able to directly exploit by economic returns. Following the argument of these two authors, no cure for this market failure can be provided by extending intellectual property rights to scientific information since this would raise the cost of other private actors interested in using it above the cost of its reproduction, the result being that too little science would be employed in the economy, with detrimental consequences for economic growth. Conversely, no such problems arise as far as technology output is concerned due to its tacit nature. However, as anticipated above, complementarities do exist between science and technology since the advances of the former may well depend on the advances of the latter. These complementarities are mirrored by the intensification of the linkages between corporate actors and public research institutions in terms of efforts of knowledge production as a result of several parallel phenomena. In the knowledge-based economy, the emergence of streams of scientific knowledge widely applicable to a broad range of production problems and the high rates of knowledge obsolescence has doubtless played a role in this story. Similarly, if the growing complex and interrelated nature of knowledge development has nowadays imposed budget constraints on corporate actors, universities are increasingly forced to look for external funding shifting towards a stronger market orientation. Firmly convinced of the complementarity of science and technology, the contributors to this volume frame their analysis of the role of public research institutions in economic growth and development within an inno-

vation system approach. Far from being theoretically new, the concept of innovation system proposed by Freeman (1987) in the 1980s is well suited, we believe, to investigate the role of universities and public laboratories in contemporary efforts at catch-up given its emphasis on the wide range of institutions whose actions influence, focus, stimulate, or delay, innovation in an economy (at the national or regional level).

Within this systemic approach, multinational corporations (MNCs) do play a role in shaping and directing catching-up processes by interacting with local actors and, therefore, becoming part of the local system of innovation. The underlying notion of the MNC adopted throughout the book is that of an internationally dispersed network whose units source new knowledge complementary to the corporate learning path in different locations. The interplay between the multinational network and the local environment gives rise to patterns of national (regional) specialization as well as to clusters of (domestic and foreign) firms where location-specific knowledge spillovers take place. These spillover mechanisms gain great value when basic knowledge is involved due to its tacit and, then, geographically sticky nature (Cantwell and Santangelo, 1999). Despite the development of information and communication technology (ICT), empirical evidence has been provided on the significance of geographical proximity in the sourcing and transmission of context-dependent and locally embedded knowledge (Santangelo, 2002). These considerations bear great implications for the host locations (countries and regions), which, being ranked by MNCs on the grounds of their knowledge potential, compete in attracting foreign investment. Thus MNCs can play a major role in the processes of catch-up of countries (regions) behind the technological and economic frontier.

Drawing upon a specific understanding of the nature of technological change, the roles of universities and public research laboratories in catching-up processes, and the roles of international business, are developed in three parts, each of which deals with a specific aspect of the issue at hand. These three parts are preceded by the chapter by Cristiano Antonelli (Chapter 1) setting the theoretical framework underlying the whole volume as far as the nature of technological change is concerned. In particular, Antonelli's chapter proposes an analytical model of localized technological change where the dynamics of creative adoption of new technologies gives rise to an S-shaped diffusion path, and emphasizes the implications for the relations between the economics of innovation and the economics of growth. In Part I, the contribution of Richard Nelson (Chapter 2) elaborates on the roles of research in indigenous universities and public laboratories in technological and economic catch-up by drawing on some insightful commentary on historic events. Along these lines, Roberto Mazzoleni's chapter (Chapter 3) takes a close look at academic

systems in Germany, France, the USA and Japan in the nineteenth century as well as the way in which they have been influenced by the emergence of national patterns and cross-border cooperation. This part closes with Mario Calderini and Chiara Franzoni's chapter (Chapter 4), which surveys recent works testing for the hypothesis of rivalry between basic and applied research, discusses their findings and limitations, and comments on the implications for the economics of science and technology, and policy intervention.

Part II focuses on the other main actor of this volume, the MNC. John Cantwell (Chapter 5) provides an overview of the relationship between MNCs and local economic systems, by discussing the origins of clusters, the principal types of spillovers and associated cluster types that have been observed, and the science–technology linkages found in clusters. Christian Bellak (Chapter 6) tests four hypotheses of firm strategies and interaction between firms on the basis of the existing (industry-comparative and firm-competitive) advantage combination on a representative sample of Austrian manufacturing firms during 1990–2000. The Turkish experience is the focus of the chapter by Aykut Lenger and Erol Taymaz (Chapter 7), who investigate the determinants of innovativeness in Turkish manufacturing industries by drawing on the system view of innovation and the micro view of dynamic capability and by paying special attention to foreign firms (i.e. MNCs), their interactions with domestic firms, and their impact on domestic capability building. Davide Castellani and Antonello Zanfei (Chapter 8) empirically investigate the significant heterogeneity in productivity and innovative behaviour of (foreign and domestic-owned) multinationals relative to domestic uninationals firms in Italy and discuss the policy implications of their results.

Part III, devoted to the analysis of catch-up and innovative activity in backward locations, opens with the chapter by Furman and Hayes (Chapter 9), who investigate convergence in national innovative capacities, focusing on the country-level investments, institutional configurations and national policy decisions that shape the success of 'follower' nations in catching up to the world's leading innovator countries in terms of per capita innovative output. Rosalia Epifanio (Chapter 10) examines the role of 'context' variables for innovative activity in a lagging self-contained region such as Sicily on a sample of 72 small manufacturing firms, drawing the conclusion that such variables may constitute 'ties' or may trigger vicious mechanisms, instead of promoting dynamic positive synergies. The chapter by Maria da Conceição Rego (Chapter 11) focuses on a population of former University of Évora (Portugal) students in order to assess their connections with the city of Évora and its surrounding areas after graduation, and analyses their impact on regional economic activity and their con-

tribution to the improvement of the regional labour force. The analysis devotes some space also to the relationships between Évora University and other regional agents, in terms of knowledge and innovation transfer.

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