

ALBERTO QUADRIO CURZIO
MARCO FORTIS
Editors

Research and Technological Innovation

The Challenge
for a New Europe



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Alberto Quadrio Curzio · Marco Fortis
(Editors)

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The Challenge for a New Europe

With 66 Figures and 19 Tables

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Preface

This volume contains some essays of two international conferences both organized by Fondazione Edison under the aegis and with the scientific collaboration of the Accademia Nazionale dei Lincei.

The first conference is “Districts, Pillars, Network Facilities” held in Rome, in the siege of Lincei at Palazzo Corsini, on 8th and 9th April, 2003. The Organizing Committee of this conference was composed by Giacomo Becattini, Sergio Carrà, Marco Fortis, Giorgio Lunghini, Luigi Pasinetti, Umberto Quadri, Alberto Quadrio Curzio, Alessandro Roncaglia and Edoardo Vesentini.

The second conference is “New Science, New Industry – The Challenges for the New Europe” held in Rome in the siege of Lincei at Palazzo Corsini, on 13th and 14th October, 2004. The Organizing Committee of this conference was composed by Arnaldo Bagnasco, Patrizio Bianchi, Sergio Carrà, Marco Fortis, Augusto Graziani, Alberto Quadrio Curzio, Edoardo Vesentini and Giovanni Zanetti.

Both were international conferences with the participation of a total of 48 speakers coming from 9 different countries.

We publish in this volume only some essays of the two Conferences as the decision to edit a book in English was taken only after the two conferences were over. Therefore not all the speakers were able to contribute with a paper.

Some information are useful to know the two organizing Institutions.

Accademia Nazionale dei Lincei was founded in Rome in 1604 by Federico Cesi and had among its founding members Galileo Galilei who published under the aegis of the Academy his famous *Istoria e dimostrazioni intorno alle macchie solari* (1613). Lincei is one of the oldest and most famous national academies of science in the world and has its siege in Rome at Palazzo Corsini and Villa Farnesina where there are also paintings by Raphael.

Fondazione Edison is much younger having been founded in 1999. It encourages research and dissemination of knowledge about social, economic, cultural and civil issues. It promotes research and innovation related to local production systems and industrial districts. Up to now it has published seven books in an Italian series of the Editor Il Mulino, one book with Accademia Nazionale dei Lincei and two books with Springer.

The editors of this volume, personally and on behalf of Fondazione Edison, wish to extend their heartfelt thanks to all those who have contributed to the success of the conferences and particularly to all of the speakers, whose papers are presented in this volume. Many thanks are due to Valeria Miceli who gave her valuable contribution to the editing of this volume and to Beatrice Biagetti who gave her valuable contribution to the secretarial activities for the organization of the conferences.

Milan, March 2005

Alberto Quadrio Curzio
Marco Fortis

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Introduction - Research, Technology, Innovation: Analysis and Cases

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1. Foreword

We begin this book, which contains some essays of the international conferences described in the preface, with a brief reflection on the two institutions that promoted them: Fondazione Edison, which organized the conferences, and Accademia Nazionale dei Lincei, which gave the scientific sponsorship to them.

Both these institutions are important for their different traditions in the fields of scientific and technological research.

Fondazione Edison is closely associated with the historical roots of Edison, founded in 1884 and of Montecatini, founded in 1888. The two firms later on merged in a new firm named Montedison.

The two companies were able to build on their 'local' civil and economic base and then expand nationally and internationally by constantly focusing on technological innovation. It is a well-known fact that the discovery of polypropylene, for which Giulio Natta received the Nobel Prize in 1963, was made possible by the support of Montecatini in an outstanding example of collaboration between industry and research. Many other remarkable personalities throughout Montecatini's and Edison's histories deserved mention for their ability to combine entrepreneurial spirit and scientific and technological innovation, most notably Guido Donegani, Giacomo Fauser and Giuseppe Colombo¹.

Accademia Nazionale dei Lincei, which honoured the mentioned conferences with its trust and scientific sponsorship, was founded in 1603, making it the oldest Academy in the world. It is worth mentioning that its founding members included

¹ Quadrio Curzio A, Fortis M, Pavese C (2003), *Il Gruppo Edison: 1883-2003. Profili economici e societari*, Vol I-II, Il Mulino, Bologna.

Galileo Galilei, who in 1613 published his *Historia e Dimostrazioni Intorno alle Macchie Solari* as part of the Academy's proceedings. This is not the place for a lengthy and detailed presentation of the extraordinary scientific merits of the Accademia dei Lincei and of its contributions to Italian and international scientific history. Interestingly, Giulio Natta, Nobel Prize, was a member of the Academy in 1947, as were Giuseppe Colombo, member since 1888 and Giacomo Fauser, member since 1948².

It seems to us, then, that the holding of these international conferences and the publication of this book provide an historical perspective linking these two institutions, which share a complementary vision, even though their objectives are different. And this vision is that science and technology must cooperate and this means for us that industry can not prosper without research.

The same vision is also shared in this volume whose purpose is to explain the importance of scientific research and technological innovation to improve or to maintain economic leadership.

The volume is organized into 11 chapters many of which are rich of data, tables and figures. It is divided into two sections: the first one providing a historical and theoretical perspective on scientific-technological innovation and its importance for industrial growth.

The second section presents some national success stories to confirm the theoretical perspective and provide examples of how public policies and private incentives can combine fostering research and innovation and consequently attracting investments and generating growth.

Let us consider briefly some of the main points of the essays and of the book. The selection will be highly personal and therefore we apologise with the authors if they do not agree with our choices, even if we quote them extensively

2. Historical and Theoretical-Applied Perspectives

From the previous foreword, it should be clear that for us history matters very much. This is also the reason why we asked *Joel Mokyr* to provide an historical perspective to the whole conference and he done that in a very satisfactory way around the concept of 'useful knowledge' in its essay "The intellectual origins of modern economic growth: knowledge and technological change in the industrial revolution".

According to Mokyr the Industrial Revolution was the result of two phenomena: on one hand the increase in the relative contribution to economic growth of technological progress compared to other elements; and on the other one the transformation of the institutional basis supporting this progress.

Mokyr asks how it is possible to explain such change and suggests that "the change in the rate and nature of economic growth in the West must be explained

² Among the many publications on Lincei see D Freedberg (2002) *The eye of the Lynx*, The University of Chicago Press, London, Chicago.

through developments in the intellectual realm concerning this ‘useful knowledge’.” This is the center of what we like to call its rational interpretation that can be spelt out as follows: “The short answer as to why the West is so much richer today than it was two centuries ago is that as collectives, these societies ‘know’ more. This does not necessarily mean that each individual on average knows more than his or her great-great grandparent (although that is almost certainly the case given the increased investment in human capital), but that the social knowledge, defined as the union of all pieces of individual knowledge, has expanded. Greater specialization, professionalisation, and expertisation have meant that the total amount of knowledge that society controls is vastly larger than ever before. The effective deployment of that knowledge, scientific or otherwise, in the service of production is the primary – if not the only – cause for the rapid growth of western economies in the past centuries”.

In his paper Mokyr develops what we call a historical-theoretical approach, based largely on the experience of the Western economies in the eighteenth century. This is the centre of what we like to call its historical interpretation that can be spelt out as follows: “The Enlightenment in the West is the only intellectual movement in human history that owed its irreversibility to the ability to transform itself into economic growth. It did so by fuelling the engine of economic growth through the sustained supply of useful knowledge and the ability to apply this knowledge eventually to the nitty gritty of production in the fields and workshops where the GDP is ultimately produced.”

On these two foundations (Rational and Historical) Mokyr develops all his analysis. We consider here only two points. The first one is institutional, the second one relates to access costs.

From the institutional point of view, Mokyr points out that we had long term growth also by “providing the economies with institutional steering wheels that on the whole prevented them from crashing the vehicle of economic growth into the trees of rent-seeking, war, and other forms of destructive behaviour.”

From the access costs point of view, Mokyr argues that the irreversibility of the accumulation of useful knowledge was due to ever-falling access costs. “As long as knowledge was confined to a small number of specialists with high access costs for everyone else, there was a serious risk that it could be lost. Many of the great inventions of China and Classical Antiquity in fact were no longer available to subsequent generations. The decline in access costs meant that knowledge was spread over many more minds and storage devices, so that any reversals in technological progress after the Industrial Revolution were ruled out.”

The volume continues with three essays which we call theoretical and applied as they explain with different, but complementary models, the process of innovation also with specific references to effective cases of today experience. One essay deals with the territorialisation of innovation; the second one with the interplay of agglomeration economies and diseconomies in the growth process of a high-tech cluster; the third one with the dynamic features of many high-technology clusters that increase the division of labour and the fragmentation of production.

Territorialisation of innovation: *Christian Longhi*'s paper "Local systems and networks in the globalization process" puts at its centre the innovation both as an engine for the evolution of productivity, economic growth and regional development and a key to explain the reinforcement of the concentration of activities in Europe.

Longhi explains that "As innovation can be considered as the key of competitiveness and of evolution of disparities, the contemporaneous economy can be best characterized as simultaneously globalised and knowledge-based, and deeply shaped by the spatial distribution of competences. Indeed, innovation is a collective process that implies a set of formal and informal relations. Its socio-economic dimension, the importance of intangible elements, of tacit knowledge – largely person-embodied and context dependent – suggest that territorialisation of activities is a basic element of the understanding of the working of the economies. According to this approach, technology is no longer given, and easily transferable across space, but is the result of a process of creation of new resources within firms, between firms, and between firms and other institutions, and highly specific to local areas. These institutional structures, which define the process of innovation, are indeed deeply embedded in particular territories. Global and local are, apparently paradoxically, the two faces of the same process."

In our opinion this is a remarkable application of the more general Mokyr's statement on the role of knowledge. Among the many interesting aspects of Longhi's reasoning let us point out to the following two.

The first one is the meaning of 'glocal': "The deepening of globalisation, from mere relocations to a complex integration of the multinational firms or networks at the world level has shown the increasing importance of the local, of the 'context' as the key of competitiveness and economic development. Different systems of production highly embedded in their region, as industrial districts, have even reinforced during these phases. Far from leading to a 'new geography', the contemporaneous process of globalisation would in fact sustain a cumulative process of reinforcement of existing disparities, of the centres of economic development and wealth creation, in short some sort of lock-in regarding the territorial characteristics of economic activities. The paper will show on the contrary that this apparent stability of the location of economic activities and of the ongoing trends regarding disparities hides in fact deep changes and reorganisation of the whole economic system. It will focus on local systems, as they are apparently the locus of the previous contradiction: when places and locations seem stable, the contemporaneous process of globalisation has in fact induced a deep 'revolution' in their internal and external relationships".

The second aspect is the transformation of linkages among European regions: "Particularly within the economic integration occurring in Europe, the increasing number of linkages of regions with other locations within or across different geographic boundaries is often underlined. In fact the problem is not the quantitative increases of linkages, but their qualitative transformation. The understanding of these transformations is a key to the understanding of the ongoing economic changes and to the definition of coherent strategies of development or related public policies."

Mario Maggioni's paper aim is “to apply an original theoretical framework, derived from population ecology, to the analysis of the development of high-tech clusters in order to underline the interplay of agglomeration economies and diseconomies in their growth process and to stress the complex and different (i.e. synergic, competitive, etc.) interactions which exist between different high-tech industries, within the same area, and between different areas within the same industry”.

Population ecology is concerned with how populations interact with the environment and how these interactions give rise to the larger patterns of communities and ecosystems. Population ecology deals with the study of how natural elements and other organisms interact in competition and in co-operation.

Maggioni translates this suggestion in the field of industrial economics by studying the development of local systems of productions (and in particular of high-tech clusters) as the outcomes of “two distinct but interrelated processes: an inner dynamics (driven by the number of firms already located in the cluster) and an external dynamics (driven by the spatial and industrial interaction between and within clusters)”. These models describe the growth process of an industrial cluster (i.e. the agglomeration in a given area of a number of firms belonging to a certain industry) as a function of the size of the local population of firms, a ceiling level – which takes into account the limit imposed by the available amount of resources (inputs and local infrastructure); and the size of interacting populations (i.e. the number of firms of other industry located in the same area and of the same industry but located in other areas).

The process of internal development is represented within a stock-flow which, according to Maggioni, is able to “take into account a series of typical processes and stylized facts which characterize the clustering phenomenon ...: often new firms in a cluster are started either by people which were previously employed by other local firms willing to try the entrepreneurial venture (spin-off) or by local resident willing to emulate successful entrepreneurs (imitation); in an uncertain environment – where there are information asymmetries between insiders (resident firms) and outsiders (external and “potential” firms) – the number of located firms signals to the potential entrant the profitability of the location; the location of a new firm into an already established cluster signals his quality to potential customers by showing it's ability to survive to harm's length competition in inputs markets”. Moreover the role of agglomeration economies and diseconomies in shaping the growth path of a cluster refers to the fact that “each new entrant increases the locational benefits to each and every incumbents (agglomeration economies, which develop through the marshallian externalities channels: labour market pooling, specialized intermediate inputs, technological externalities and knowledge spillovers) only up to a point, then it decreases them (agglomeration diseconomies) when congestion and competition prevail”.

The paper shows also some interesting empirical application to the US case, by investigating the development of a number of high-tech industries within several US States. The mix of econometric estimation and phase diagrams allows Maggioni to identify the existence of long-run equilibria of inter-sectorial a/o inter-state interactions and to suggest possible future industrial dynamics.

Peter Swann deals with one of the most interesting dynamic features of many high-technology clusters: the increase in the division of labour, and hence the so-called fragmentation of production. "One striking example of this is in the manufacture of personal computers (PCs), where it has become almost meaningless to ask in what country a PC is manufactured. The various components of a PC are manufactured in many different countries, assembly may be done in more than one country, and the final 'badge' may be added somewhere else again. Particular companies (and indeed particular clusters) may become specialized in just one particular activity within the overall process of PC manufacture. This specialization and fragmentation of production depends on interaction between the different activities, and hence on cost-effective communication and transportation."

The objective of Swann's paper is to describe and analyze a simple model of the comparative efficiency of several different industrial structures. At one end the author examines the co-location of all production phases with final consumption; at the other one the emergence of specialized clusters each focusing on just one stage of production. The model shows "how this comparative efficiency depends on economies of scale and scope, economies of agglomeration and congestion costs, and on costs of communication and transportation." The model also explains "how the degree of codification of the production process influences this comparative efficiency, and hence explains why the ICT revolution may cause a relevant change in the clustering pattern of given industries over the product life cycle."

As Swann aptly underlines "while many have focused on the good side of clustering, there is also inevitably a bad side". The role of transportation and communication infrastructure becomes therefore crucial in determining the level and the evolution of regional disparities: without infrastructures "either the cluster do not form or all activity tends to pile into the most concentrated clusters leading to high congestion in the biggest cities and decline of other regions."

In this sense the policy implications of the paper are very important both at the national and European level, as stressed by the author: "the paper is relevant to the process of clustering in many European countries, but especially relevant to issues arising in the United Kingdom. The British government has adopted clustering as a major instrument of industrial policy, and believes it has a role in helping to revive the economies of poorer regions. Unfortunately however, much of the clustering observed in practice is a further concentration of activity into the overheated South East of England."

The paper concludes by showing that a careful industrial policy must take into serious account the role of transportation infrastructure: a fragmented/specialized cluster structure (which is less congestion-prone) "would be more plausible if the public transportation infrastructures were in better condition and cheaper."

3. European Union, National and R&D Cases

This section of the volume can be divided into two parts. The first one (David, Andreta, Lindberg) deals mainly with the situation in the EU even if it presents (mainly David) a wider paradigm. The second part (Feldman, Eatwell, Braunherjelm, Bianchi-Ramaciotti) deals with national and/or sectorial cases.

Paul David's essay, being paradigmatical and applied, is the best link with the previous section. The starting point is a response to the February 2003 *Communication on the role of the universities in the Europe of knowledge*, issued by the Commission of the European Communities which, after having assessed Europe's critical needs in the epoch of 'knowledge-driven economic growth', identifies the university as the institution suited to meet those needs. The Communication called for debate on the changes in the European universities needed to meet the mentioned needs. "Reduced to its essence, this presented a view of Europe's institutions of higher education as possessing the potential to be more effective than its industry at the business of technological innovation. But, it also faulted the university researchers and administrators for failing to make the realization of that potential a priority. What is being advocated, therefore, is tantamount to a program of institutional reforms intended to mobilize of that capability in order to meet a dual societal problem: financing the rising costs of public education and research, and enlarging the share of EU gross domestic product that is devoted to public and private investment in R&D."

David suggests that "the likely costs, as well as the promised benefits of this proposal deserve more careful consideration than they have been receiving from enthusiasts for the grand goal."

With regard to the costs, "it is apparent that many of the features of universities that have rendered them particularly effective when called upon to perform in their historical societal role as 'nodes' in the international dissemination of knowledge and, since Humboldt, as generators of fundamental advances in scientific understanding, might have to be sacrificed in order to effectively carry through the institutional reforms suggested by the EC's *Communication*. Within the familiar context of academic, 'open science' norms and governance structures, the comparative advantage of university-based researchers' lies in conducting inquiries that may provide the foundations for valuable commercial innovations. But the best way to do this is precisely not the closely managed, tightly-coupled search for discoveries and inventions that fires the imaginations of many political leaders, policy-advisors and financially hard-pressed university administrators who are seeking predictable and readily identifiable near-term payoffs."

With regard to the benefits "it is equally apparent that the EC's *Communication* (and many similar policy pronouncements of national government ministries) has failed to show that there is an adequate evidentiary basis for supposing that the envisaged societal gains will be substantial enough to justify attempting to transform Europe's most prestigious academic institutions into 'knowledge-management enterprises.' It is not plausible to suppose that more than a few

among Europe's research universities would, by exploiting the intellectual property created by the people who study and work there, be enabled to contribute materially to the costs of their own upkeep."

David continues by analyzing in details the pros and cons of taking into account the US university-industry relations. "Ideas for European institutional reform and regeneration along those lines clearly have been inspired by perceptions of vigorous university-industry research partnerships, rising patenting activity and the flourishing of academic entrepreneurship in the U.S. during the two closing decades of the past century". He considers the effects of Bayh-Dole Act (1980) concluding that "the highly decentralized approach of the Bayh-Dole Act, in giving every university and public research institute the responsibility for securing and exploiting its intellectual property portfolio, has imposed significant 'learning costs' on the system as a whole and brought into existence a new professional group – university technology managers – who have personal and collective interests in the perpetuation of these arrangements. Concomitantly, there are few if any large, R&D intensive firms in the U.S. that now express general enthusiasm for the Bayh-Dole regime, and, many of their executives now speak in very critical terms about the performance of most of the universities' technology licensing offices."

David's conclusion is sharp and simple as he stresses that there is not a single best recipe for all situations: "European policy-makers concerned with the scientific and technological foundations for business innovation and economic growth should be considering reforms and revitalizing measures that build upon the region's own rich and diverse institutional foundations, rather than risking doing damage to them by blindly imitating a dubious American experiment."

Ezio Andreta in his paper discusses the Lisbon Strategy and the reasons why certain tools have been set in the EU. He takes into account, at least, two aspects: the first one is that of industrial mutation; the other one is that of R&D and innovation.

Industrial mutation, he says, is a central point also in the Agenda of European Councils and in the worries of European Ministers on three grounds: 1) the loss of foreign markets; 2) the loss of jobs; 3) an excessive automation of the production system. Industrial mutation can be exemplified through the existence of "two perfectly active economic systems that, though with different basic characteristics, do co-exist and our challenge is exactly the change-over from one to the other. It is the change-over from traditional industry to a new industry, i.e. from a resources-based to a knowledge-based economy. The traditional industry is overwhelming in Europe, where 80% of industry is traditional, therefore old, suitable for an old pattern that is now changing."

Regarding R&D and innovation, Andreta's worries are due to the fact that: "Europe invests only 2%, or 170 billion euro/year, vs. 280 of the US, which means an absolute-value gap of 110 billions, or a 33% difference, and the absolute value is important because of the critical mass it moves,... in the US 70% of the investment is private and industrial and 30% public. In Europe 55% is private and 45% public. In Japan 80% is private and very little public. In the research sector Europe