1. Introduction

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This book aims to increase the understanding of the process of knowledge creation and innovation in medium-technology sectors in the EU and to identify the characteristics of knowledge and innovation networks within regional clusters and the barriers to their enlargement at the European level. It investigates strategies that SMEs in medium-technology industries apply to adjust their knowledge creation processes to global structural challenges.

The topic discussed in this book is absolutely crucial for the future of the European economy, as medium-technology industries are not only the dominant sectors for European exports into the global markets, but also still the fastest-growing sectors in international trade. The focus on high-technology sectors and knowledge-intensive business services found in many studies of international organizations, expert groups and scientists misses the point that these new activities are not independent from the traditionally strong manufacturing sectors in Europe, such as medium-technology industries. For example, bio-pharmaceutical inventions will only find their markets when they are linked with more traditional tools from medicine technology (medium-technology engineering plus electronics); modern materials are reducing the weight and increasing the flexibility and functionality of cars; aeroplanes and big machines are developed in cooperation with medium-technology machinery; high-technology electronics and chemical sectors, and new laser technologies have to be linked with optical and machinery industries to develop new products. Thus, integrative technologies are capable of developing connections between medium-technology industries and high-technology segments. Many economic studies forecast relocations of low-technology industries towards the fast-growing emerging markets, like China and India, and extend these forecasts also to the whole medium-technology segment. This general perspective, however, neglects the importance of technological interdependence between the incumbent medium-technology capabilities and new high-technology knowledge streams. Our investigation particularly looks at the implications these linkages have on the medium-technology industry SMEs in Europe.

Due to the underestimation of the role medium-technology sectors will play in the future, the actual scientific insights on how knowledge in these industries is generated, examined and commercialized is limited. Most studies simply transfer the observations from high-technology sectors with their strong role of formal R&D, capital equipment and patents as typical output, to medium-technology sectors, thus neglecting the specificities of these industries. These specificities in innovation processes particularly refer to the concepts of ‘synthetic knowledge’ and integrative technologies, which mean that firms in the medium-technology sectors are able to connect general insights on modern technologies to concrete and very specific engineering problem solutions. Hence, medium-technology industries follow their own rationale in knowledge creation.

Within this book, we first analyse in Chapter 2 the role of medium-technology sectors in the European economy and some major characteristics of these sectors on the basis of the available indicators of export, value-added, employment, human capital and R&D. The aim of this introductory empirical analysis is to demonstrate the importance of medium-tech sectors and to underline the need to design an approach to European innovation policy that considers the specific factors and processes determining knowledge creation and innovation in the medium-technology sectors.

Then, we investigate three main groups of questions addressed to three different target groups. First, in Chapter 3:

- How do medium-technology industry SMEs cope with the structural changes in internationalized markets? Which role do national and international networks play in this adjustment process? Which best practices can be observed at the firm level?

Chapter 3 takes up the strategic management perspective of medium-technology SMEs. Most international management studies on new markets and strategies deal with processes in big multinational firms. In addition, new high-technology start-up firms acting as ‘born global’ are another attractive case study. However, medium-technology SMEs are often seen as outdated due to their lack of management resources and formal R&D as well as their poor international experience and linkages. Within this chapter, we look at strategies that medium-technology SMEs in different European regions can develop to overcome their structural weaknesses and to adjust their knowledge production process.

Traditionally, networks play an important role for medium-technology SMEs, as network linkages help them to share responsibilities within value chains and knowledge on specific machines and products. This traditional function of networks, however, has changed in a remarkable

direction towards knowledge networks and it is one of the major results of our study to show how these new knowledge network structures are used to exploit the traditional strengths of capabilities in medium-technology SMEs in generating tacit knowledge by combining general insights on technological processes with very specific and concrete problem solutions. Hence, innovation performance in medium-technology industries has to be measured in a different way than using the same – more formal and analytical – knowledge indicators such as those in high-technology industries, where patents, licences or R&D contracts play a major role. Instead, a more differentiated view on knowledge creation and commercialization in the European regions is needed to understand the interplay between medium-technology SMEs, large multinational firms, high-technology specialist services and public research units. These network structures need to be very specific, as they combine the traditional networks of medium-technology SMEs, driven by personal and social linkages, with advanced knowledge-intensive organizations, where cognitive proximity and R&D activities play a major role. Thus, the traditional pattern of very innovative high-technology firms and research institutes on one side and on the other, outdated medium-technology SMEs without any competitiveness in future global markets and earmarked to be replaced in the near future, can no longer hold and has to be replaced by a differentiated view on the very specific strengths of European medium-technology companies and the sources of their competitiveness based on capabilities to bridge the gap between different types of knowledge. Case studies from empirical research serve as illustrations to explain the practical experiences with this new pattern of integrative knowledge generation.

Next, in Chapter 4, we ask:

- Which theoretical concepts are able to explain the observed changes in medium-technology industries? Which theoretical recommendations can be made to enhance the internationalization of knowledge flows in medium-technology industries between different European regions?

Chapter 4 investigates the theoretical dimension of the topic. Concepts of innovation theory are mainly focused on high-technology knowledge generation and hardly consider the relational and evolutionary aspects of innovation processes. Knowledge generation in medium-technology industries follows a different rationale, as the network linkages between the firms integrate personal and cognitive issues and the knowledge created is highly specific and tacit. Therefore, this part of the book provides an original theoretical framework, which particularly adds and links three different elements to the existing understanding of innovation.

First, knowledge generation and production is connected with cognitive sciences to understand the linkage between the individual knowledge processing within the individual brain and the exchange of knowledge content within interactions based on joint codes of communication. This perspective has immanent impact on the understanding of innovation processes, as it helps to identify the preconditions for actual and successful cooperation in knowledge creation and the necessary investments that cooperation partners have to take to build up knowledge network structures.

Second, an evolutionary and spatial perspective is introduced by replacing the understanding of innovation as a concrete result of formalized knowledge production processes with an understanding of innovation as an expression of capabilities gained within interactions with other actors and through the informal processing of one's own experiences. This understanding fits much better with the situation of medium-technology SMEs, which usually improve their products and processes continuously by enhancing the capabilities of their employees embedded within internal processes and interactions. Instead of a more linear interpretation of innovation processes, where formal R&D investments and formal collaborations between highly qualified individuals lead to new knowledge, our theoretical concept considers a more systemic approach based on the complex interaction between individuals, the reciprocal sharing of their knowledge and the generation of new ideas in the framework of frequent communication and of application aimed at solving concrete problems.

In particular, this book aims to highlight the regional/spatial character of the cognitive process of interactive learning and of knowledge creation. Innovation processes within firms are related to the external links between the various firms in the local and the international economy and these spatial links are crucial in a long-term perspective. Regional knowledge networks are analysed based on the approach of cognitive economics rather than of economic geography. In fact, this more modern systemic model of the process of innovation, based on concepts derived from cognitive sciences and focused on networks, interactive learning process and the development of creative capabilities, is different from the traditional linear model, which focuses on R&D and technology transfers. The theoretical perspective on cognitive economics and its linkages with regional social and innovation networks offers new insights to existing cluster policy discussions.

Third, an institutional and territorial dimension is integrated by linking the insights of innovation processes in medium-technology SMEs with the emergence, adjustment and extension of network structures. Again,

existing theoretical concepts on innovation are hardly able to explain the complex structure of networks, the specific role of geographical and other forms of proximity and the microeconomic decisions behind participation in networks. By explaining the preconditions for knowledge creation and exploitation in medium-technology SMEs, we are able to identify the driving forces that lead to different and specific network structures in different types of regions and sectors. The book illustrates that governance is a distinct model of regulation of economic relationships different from the traditional orthodox free market model and it is more appropriate for the management of knowledge relations especially in medium-technology sectors. It highlights the role of intermediate institutions in explaining the concentration of these sectors in coordinated market economies rather than in liberal market economies. The concept of 'territorial knowledge management' (TKM), which investigates the preconditions that knowledge networks have to meet for successful knowledge generation processes, highlights criteria to measure the existing capabilities and needs within knowledge networks, and offers recommendations for firms and policy-makers in the improvement and steering of their networks. In particular, it shows the necessary extensions and adjustments in networks, when interregional and international network structures are required. Here, the traditional means of medium-technology SMEs within networks cannot work and instruments of regional policies often fail to build up new structures for these extended networks. Based on our theoretical framework, we are able to explain necessary adjustments and reforms in existing networks.

Finally, in Chapter 5, we ask:

- Which political recommendations can be drawn from the empirical observation and theoretical explanation? What could be a suitable European policy to strengthen integrative knowledge capabilities in medium-technology industries and to enhance the access of SMEs to international knowledge networks in these fields?

In Chapter 5, the focus is directed at political rationales and instruments and aims to reach some conclusions for regional, national and supranational policy-makers in Europe. The empirical case studies examined in the research have been investigated in order to identify recipes for success on a regional level and the implications of these recipes for national and supranational strategies. The best practices in policy clearly show that policy instruments in the medium-technology sectors need to connect strategic, knowledge and institutional aspects within their rationale. In particular, Austrian and French experiences with strategic programmes

like 'competence centres' and 'poles of competitiveness' help to overcome typical scarcities within SMEs and to contribute to building sustainable long-term infrastructures for knowledge networks. Additionally, examples from Germany, France and the United Kingdom stress the importance of institutional support for international linkages, for example by harmonization of qualification standards and joint safety and environmental regulation.

The book focuses on the issue of the European enlargement of regional networks and the various obstacles hindering the SMEs in medium-technology sectors. In particular, innovation policies increasingly require a European dimension. In fact, not only high-technology sectors, but also medium-technology sectors need to be integrated in a European knowledge economy, as they represent a major component of European international competitiveness. Moreover, regional innovation systems specialized in medium-technology sectors require that the effects of market mechanism are integrated by European policy and institutions, in order to ensure a continuous growth and a long-term sustainability, by managing the economic, political, social and environmental imbalances related to economic and technological change.

The first insights of the research were used in discussion with practitioners on the regional, national and European level. Within a Policy Forum on 'Regional Competence Centres and European Knowledge and Innovation Networks' in Rome,¹ concrete experiences were presented and discussed. As a result of this discourse, general statements were developed to explain what the role of policy could be within these new regional knowledge networks and the process towards internationalization of network interactions. This step resulted in some concrete policy recommendations. By adopting a governance approach to cooperation between policy and firms, we explain the specific role each actor has to play to support the emergence of knowledge networks for medium-technology industries and how the funding responsibilities have to be allocated. The analysis focuses on the concept of competence centres as a new tool of innovation policy on a regional and European level. The most important implications of this approach are the inclusion of strategic long-term initiatives transferred to projects, the support by independent knowledge providers, the strategic support by regulation and international fairs and the diversified concept of technology platforms instead of exclusive sectorial instruments. Finally, we discuss the opportunities and preconditions for using this approach for an intensification of knowledge network interactions between the regions in the incumbent and new EU member states.

Having shared our views with many practitioners and experts on the innovative capabilities of medium-technology sectors as a specific source

of strength for European economies, we believe that the reading of this book will be interesting for students and researchers in postgraduate management and innovation studies as well as for managers of SMEs and multinational industrial firms and for experts in innovation policies at the regional and European level.

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NOTE

1. The contributions to this forum can be downloaded at <http://www.ikinet.uniroma2/contributions.htm>.