The geography of nanotechnology in Italy assesses Italy's role in the international 'nanotechnology race' and analyse the Italian regions' economic development based on their engagement in nanotechnology activities. Thanks to spatial analysis and a relational approach to economic geography studies, this book sheds light on the nanotechnology activities carried out in Italy, through secondary data (e.g. official statistics and databases) and in-depth reviews of previously published case studies. Special attention is devoted to the impact of nanotechnology in the various Italian regions in light of the long-lasting disparities that characterise the socio-economic development of the country.

"Giuseppe Calignano's book on the geography of nanotechnology in Italy is a timely and important contribution to the innovation studies literature" – Rune Dahl Fitjar

"*The geography of nanotechnology in Italy* represents a real benchmark in the field of geography of innovation in Italy" – Fabio Pollice

Giuseppe Calignano received his PhD degree in Geography at University of Salento. Prior to joining the Department of Geography and Regional Research at University of Vienna – where he teaches courses in the fields of economic geography, regional development and social network analysis – he worked as postdoctoral research fellow in Regional Innovation Studies at UiS Business School (University of Stavanger). In 2014, he was a visiting academic at the London School of Economics and Political Science. His major research interests include economic geography and innovation studies, with a particular focus on regional development, innovation networks, cluster policy and development, and university-industry linkages. His work has been published in renowned academic journals in geography, regional science and innovation studies such as *Regional Studies, The Annals of Regional Science, Erdkunde and The Extractive Industries and Society*.

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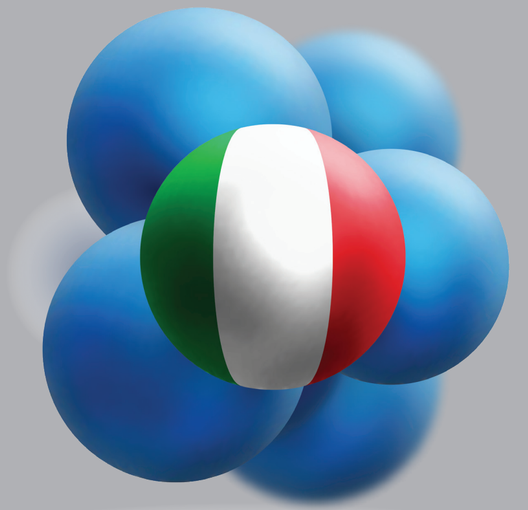
G. Calignano **The geography of nanotechnology in Italy**

GIUSEPPE CALIGNANO

THE GEOGRAPHY OF NANOTECHNOLOGY IN ITALY



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In memory of my father

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ABBREVIATIONS

AIRI – Associazione Italiana per la Ricerca Industriale (Italian Association for Industrial Research)

ARWU – Academic Ranking of World Universities

CNR – Consiglio Nazionale delle Ricerche (National Research Council)

CORDIS – Community Research and Development Information Service

EC – European Commission

EPO – European Patent Office

EU – European Union

EU-25 – European Union of 25 member states

EU-28 – European Union of 28 member states

FP – Framework Programme

FP6 – Sixth Framework Programme

FP7 – Seventh Framework Programme

GDP – Gross Domestic Product

H2020 – Horizon 2020

HEI – Higher Education Institution

ICT – information and Communication Technology

ISO – International Organisation for Standardization

KET – Key Enabling Technology

MIUR – Ministero dell'Istruzione, dell'Università e della Ricerca (Ministry of Education, University and Research)

NMP – Nanosciences, Nanotechnologies, Materials and New Production Technologies

NIS – National Innovation System
NUTS – Nomenclature of Territorial Units for Statistics
OECD – Organisation for Economic Co-operation and Development
QS – QS World University Rankings
R&D – Research and Development
RIS – Regional Innovation System
SME – Small and Medium Enterprise
SNA – Social Network Analysis
SVIMEZ – Associazione per lo Sviluppo dell'Industria nel Mezzogiorno (Association for the Development of Industry in Southern Italy)
USPTO – United States Patent and Trademark Office

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PREFACE

INTRODUCTION

Research at the nanoscale level is a potentially irruptive interdisciplinary field thanks to its application in a multitude of high-technology or science-based industries (biotechnology, cognitive science, information and communication technology (ICT), etc.) as well as traditional industries (textile, ceramics, food, etc.); (see Calignano and Quarta, 2015 and Calignano, 2017). By virtue of its multidisciplinary dimension, the European Union (EU) has included nanotechnology in the Key Enabling Technologies (KETs) potentially helping countries to tackle current and future societal challenges.

Based on this brief premise, this book aims at assessing the role of Italy in the international 'nanotechnology race' and analysing the economic development of the Italian regions based on their engagement in nanotechnology activities.

Thanks to spatial analysis and a relational approach to economic geography studies (e.g. Bathelt and Glückler 2003, 2011) which stress the relational dimension of innovation processes from a spatial perspective, this book aims at shedding light on the nanotechnology activities carried out in Italy through secondary data (e.g. official statistics and databases) and in-depth reviews of previously published case studies. Besides, following Calignano and Quarta (2015), special attention is devoted to the impact of nanotechnology on various Italian regions in light of the long-lasting disparities that characterise the socio-economic development of the country (see, in particular, Chapter V, Section 2.2).

One of the most important features of nanoscale materials is that they can be successfully used in a vast array of fields and sectors, ranging from sporting goods to medicine. As will be explained more in detail later, this peculiarity makes nanotechnology a good means of studying the economic development of a given territory from a geographical perspective. Such a claim is backed by

recent academic studies in the field of economic geography and regional science, according to which nanotechnology is a kind of "lens", or a good proxy, for assessing the national and regional economic development of a country by adopting a spatial perspective (e.g. Roco, 2005; Calignano and Quarta, 2015; Calignano, 2017).

This book is organised as follows. The first chapter introduces the characteristics of nanotechnology, its main applications and the reason why the EU considers nanotechnology to be one of the KETs potentially allowing countries to address great societal challenges (i.e., progressively ageing populations, climate change, optimisation in the use of resources (i.e., energy, water and food), digital technologies, development of efficient and sustainable production systems; Associazione per la Ricerca Industriale – AIRI Nanotec 2011; Di Bello 2013).

The second chapter illustrates some of the main theoretical concepts in the geography of innovation (systemic approaches, relational geography, multiscalar innovation networks, etc.) which makes the study of the diffusion of nanotechnology from a geographical perspective particularly interesting when examining the dynamics related to re-industrialization and regional development of a country.

The third chapter deals with the global dimension of nanotechnology activities and aims at providing insights into the role of Italian organisations in the so-called nanotechnology race at the international level.

The fourth chapter focuses on the distribution of nanotechnology activities in Italy. Having introduced the various indicators adopted for the purpose of mapping such activities in the Italian context, this chapter illustrates how the twenty Italian regions perform in terms of patents, academic publications, nanotechnology companies and engagement of higher education institutions (HEIs) in nanotechnology activities.

The fifth chapter aims at highlighting the key role of nanotechnology in the European Union research and innovation policies. Based on a network and dynamic approach, and primarily with an in-depth review of the research outcomes of empirical analyses already published by the author (i.e. Calignano, 2014; Calignano and Quarta, 2015; Calignano, 2017), this chapter devotes special attention to the collaborative dimension of the EU research and innovation policy as expressed in its main policy initiative, i.e. the EU Framework Programmes (FPs). Besides, special attention is devoted

to the long-lasting disparities between organisations located in the northern, central and southern macro-areas of the country. This relevant and largely debated topic (e.g. Putnam, 1993; Malanima, 2002; A'Hearn and Venables, 2011) is examined in light of the degree of participation of different types of Italian organisations (i.e. private, public and private-public) and their ability to establish connections at various geographical scales in the context of the EU FPs.