

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*.

ISBN 978-88-6611-839-8



9 788866 118398

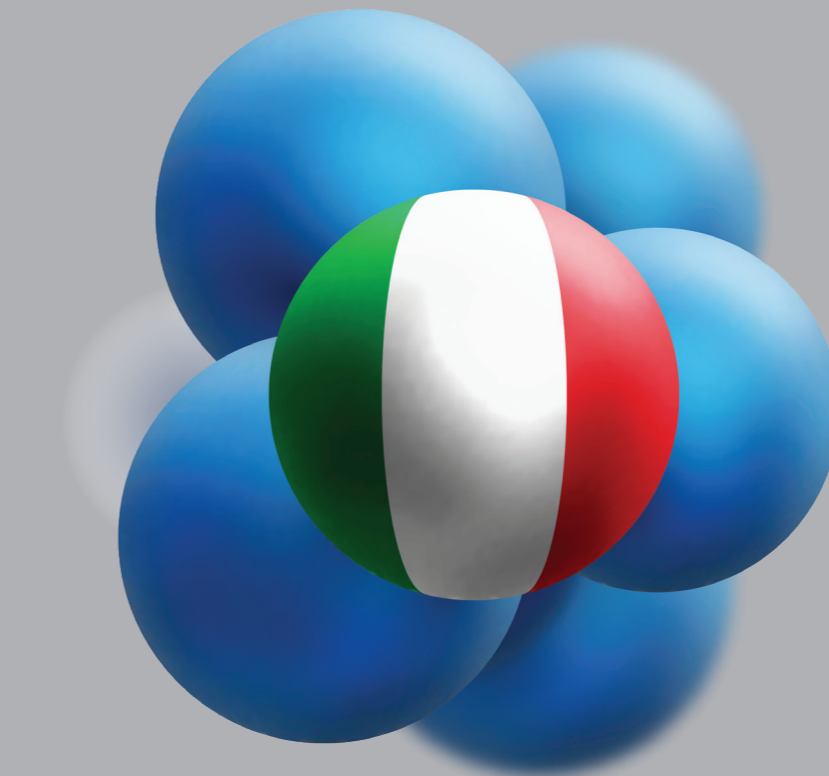
€ 15,00



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

GIUSEPPE CALIGNANO

THE GEOGRAPHY OF NANOTECHNOLOGY IN ITALY



CACUCCI  EDITORE
BARI

GIUSEPPE CALIGNANO

**THE GEOGRAPHY
OF NANOTECHNOLOGY
IN ITALY**

CACUCCI  EDITORE
BARI

PROPRIETÀ LETTERARIA RISERVATA

© 2019 Cacucci Editore – Bari
Via Nicolai, 39 – 70122 Bari – Tel. 080/5214220
<http://www.cacuccieditore.it> e-mail: info@cacucci.it

Ai sensi della legge sui diritti d'Autore e del codice civile è vietata la riproduzione di questo libro o di parte di esso con qualsiasi mezzo, elettronico, meccanico, per mezzo di fotocopie, microfilms, registrazioni o altro, senza il consenso dell'autore e dell'editore.

In memory of my father



CONTENTS

List of figures	9
List of tables	11
Abbreviations	13
Acknowledgements	15
Preface	
Introduction	

CHAPTER I

ADOPTING KETs FOR TACKLING SOCIETAL CHALLENGES: NOTES ON THEIR DIFFUSION IN ITALY

1. Nanotechnology as a KET
 - 1.1. *KETs in Italy*

CHAPTER II

NANOTECHNOLOGY, RE-INDUSTRIALIZATION AND SOCIO- ECONOMIC DEVELOPMENT

1. A systemic approach to innovation: regional innovation systems
2. A relational approach to the study of regional economic development
3. The relationship between modes of innovation, knowledge bases and knowledge sourcing
4. Nanotechnology, regional economic development and multi-scalar innovation networks

CHAPTER III

NANOTECHNOLOGY: THE NATIONAL IMPLICATIONS OF A GLOBAL PHENOMENON

1. The global dimension of nanotechnology activities
2. The role of Italy in the world's nanotechnology race

CHAPTER IV

THE DISTRIBUTION OF NANOTECHNOLOGY ACTIVITIES IN THE ITALIAN CONTEXT

1. Mapping the outputs, impact and diffusion of nanotechnology in Italy
 - 1.1. *Introducing the indicators: patents, publications, companies and HEIs*
2. Nanotechnology patents
3. Nanotechnology publications and citations
4. Nanotechnology companies and engagement of HEIs
 - 4.1. *Nanotechnology companies in Italy*
 - 4.2. *Nanotechnology in the Italian HEIs*

CHAPTER V

NANOTECHNOLOGY IN THE EU RESEARCH AND INNOVATION POLICIES

1. The collaborative dimension of the EU nanotechnology policy
2. Italian organisations in the EU nanotechnology network
 - 2.1. *Presence and participation of the Italian organisations in the EU FPs*
 - 2.2. *The EU nanotechnology network as a lens for examining regional disparities in Italy*

Conclusion

Afterword

Appendix

References

LIST OF FIGURES

Figure 1. Regional distribution of KET patents – Share of patents; EU-28, country level (Year: 2011)

Figure 2. Regional distribution of KETs patents – Number of patents; EU-28, NUTS 2 Level (Year: 2011)

Figure 3. Share of country in nanotechnology patents relative to the share of country in total patents - Countries with more than 500 patents (Years: 2000-2003 and 2010-2013)

Figure 4. Total number of indexed nanotechnology articles by the top ten countries (Years: 2010-2015)

Figure 5. Total number of indexed nanotechnology articles by the top ten countries plus Italy (Years: 2016-2018)

Figure 6. Average number of times the nanotechnology articles have been cited in the Journal Citation Reports (ISI Web of Science) – Top ten countries plus Italy (Years: 2016-2018)

Figure 7. Number of dedicated firms active in nanotechnology, 2008-2015 (OECD countries)

Figure 8. Share of nanotechnology patents and publications - Italian SMEs and large companies (Year 2010)

Figure 9. Private and public nanotechnology organisations located in the Italian regions (Year: 2010)

Figure 10. Private and public organisations in Italy - Macro regional areas: North, Centre and South (Year: 2010)

Figure 11. Shares of funds allocated in FP6-NMP and FP7-NMP (Top 10 countries in the FP7-NMP)

Figure 12. Knowledge ties between Italian regions (FP6-NMP)

Figure 13. Knowledge ties between Italian regions (FP7-NMP)

Figure 14. Proportion of public, private and public-private Italian organisations (national level)

LIST OF TABLES

Table 1. Overall KETs performance ranking

Table 2. Comparison of the main characteristics of the symbolic, synthetic and analytic knowledge base

Table 3. Total number of nanotechnology granted patents in EPO and percentage variation (Years: 2016-2018)

Table 4. Total number of nanotechnology granted patents in USPTO and percentage variation (Years: 2016-2018)

Table 5. Number of nanotechnology articles indexed in ISI Web of Science (Years: 2016-2018)

Table 6. Italian private nanotechnology organisations, R&D personnel employed in nanotechnology activities, publications and patents (Year: 2010)

Table 7. Italian universities with more than 50 articles indexed in the ISI Web of Science database; Macro-regional areas and overall rank (Year: 2018)

Table 8. Average number of times nanotechnology articles have been cited in the Journal Citation Reports (ISI Web of Science), Macro-regional areas and overall rank (Year: 2018)

Table 9. Top World's, Europe's, and Italy's organisations in the field of nanotechnology in the ARWU Ranking; Country and Overall Rank or Tier (Year: 2019)

Table 10. Top World's and Italy's organisations in the field of nanotechnology (materials science) in the QS Ranking - Reputation; Country and Score (Year: 2019)

Table 11. Density, number of ties and average degree (FP6-NMP and FP7-NMP)

Table 12. Italy's role in the EU nanotechnology network (FP6-NMP and FP7-NMP): centrality measures and rank (in parentheses)

Table 13. Countries making up the network core in the FP6-NMP and FP7-NMP. Overall number and presence of organisations and average presence by countries

Table 14. Strength of ties, FP6-NMP and FP7-NMP (countries with more than 1,000 connections)

Table 15. Top 20 organisations (FP6-NMP and FP7-NMP)

Table 16. Measures of dispersion, FP6-NMP and FP7-NMP (countries with more than 1,000 connections)

Table 17. Intra and inter-regional pairs, FP6-NMP and FP7-NMP (Italian regions)

Table 18. Overall participation and participation per 10,000 inhabitants in the FP6-NMP and FP7-NMP (country level)

Table 19. Overall participation and participation per 10,000 inhabitants in the FP6-NMP and FP7-NMP (Italian regions, NUTS 2 level)

Table 20. Correlation table - private, public and public-private organisations (Italian regions, NUTS 2 level)

Table 21. Clusters of Italian regions based on their private, public and overall participation per 10,000 inhabitants (FP6-NMP and FP7-NMP)

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

ACKNOWLEDGEMENTS

I gratefully acknowledge my collaborators, with whom I have published joint papers on the impact of innovation activities in Italy, and in particular, Cosimo Alessandro Quarta for the valuable and insightful discussions on the relationship between nanotechnology and regional development.

I also thank my colleagues at the University of Stavanger and the University of Vienna for assisting my research activities in every way possible.

I am grateful to my wife Giuliana for always believing in me.

And finally I thank my son Antonio for being the engine of my life.



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, multi-scalar 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.