In times of sweeping demographic changes, policy makers and business executives in mature economies perceive workforce aging as one potential threat to the capacity for innovation and technological progress. However, evidence for age-dependency in innovative performance is still scarce. Pressing questions in this context are for example:

- Does workforce age affect the innovative capacity of firms and regions, and if so, how and through which transmission channels do these effects occur?
- What are the sources of possible age-dependency in innovative performance, in particular with respect to innovation-relevant human capital?
- What are the policy implications of the interplay between workforce age and the capacity to produce technological advances in times of future workforce aging?

Starting from a comprehensive survey and critical discussion of existing studies about the interplay between workforce age and innovation, this book suggests a new conceptual framework to study the age-dependency of innovation. Based on this, three empirical studies investigate how the age composition of a workforce affects inventive performance in European regions, to what extent certain staffing patterns experienced by German firms boost innovative performance and how a region’s entrepreneurial capacity relates to the age composition of its working-age population.

Key words: aging workforce, innovation, entrepreneurship, human capital, demographic change

Dr. Katharina Frosch (MBR) is an economist and social scientist based in Berlin, Germany. Since 2005, she has been engaged as an academic researcher and lecturer on innovation and entrepreneurship, demographic change and applied empirical issues in personnel economics.
Beiträge zur Personal- und Organisationsökonomik

Band 24

Herausgegeben von
Uschi Backes-Gellner, Matthias Kräkel und Kerstin Pull
Katharina Frosch

The Innovative Capacity of an Aging Workforce

Rainer Hampp Verlag München und Mering 2011
To Elisabeth and Karl,
and all others, who brighten my life
Contents

1 Introduction ............................................................................................................................ 2
  1.1 Motivation ......................................................................................................................... 2
  1.2 Workforce age and workforce aging ................................................................................. 5
    1.2.1 Population aging ..................................................................................................... 5
    1.2.2 Workforce age composition and workforce aging ................................................... 6
    1.2.3 Workforce aging driven by labor market determinants .......................................... 8
  1.3 Innovation ........................................................................................................................ 13
  1.4 Outline ............................................................................................................................. 15

2 Survey of the literature .......................................................................................................... 18
  2.1 Introduction ..................................................................................................................... 18
  2.2 Worker’s ages and innovation: Individual level ................................................................ 18
    2.2.1 Summary of findings .............................................................................................. 18
    2.2.2 Discussion of findings: Caveats and ways out ...................................................... 20
  2.3 Age-performance profiles at the aggregate level ............................................................. 22
    2.3.1 Methodological basis and selected findings ......................................................... 23
    2.3.2 Estimation issues ................................................................................................... 24
  2.4 Workforce age and innovation in firms and regions ....................................................... 28
    2.4.1 Firm-level evidence on the age dependency of innovation ................................... 28
    2.4.2 Age diversity and innovative capacity at the firm level ........................................ 30
    2.4.3 Aging and technological change in countries and regions ................................... 32
  2.5 Summary and Discussion ................................................................................................ 35

3 Perspectives on workforce age and innovation ............................................................... 42
  3.1 Scope and research objectives ......................................................................................... 42
  3.2 Age effects on innovation – some starting points .......................................................... 43
    3.2.1 Obsolescence of human capital over workers’ careers ........................................ 43
    3.2.2 Updating and accumulation of human capital over the career ............................ 45
    3.2.3 Cohort effects in the endowment with human capital ........................................... 46
    3.2.4 Summary ................................................................................................................ 47
  3.3 Framework: Transmission channels ................................................................................ 47
    3.3.1 Firm’s research and development activities .......................................................... 48
    3.3.2 Age-specific employment as a knowledge filter ................................................... 49
    3.3.3 Endogenous entrepreneurship as a way out? ......................................................... 50
6.1 Introduction ................................................................................................................... 110
6.2 Age effects on regional start-up activity ................................................................. 112
   6.2.1 From the individual to the regional level ....................................................... 112
6.2.2 Policy-relevant causes of age effects in regional firm formation ................... 113
6.2.3 Research propositions ....................................................................................... 116
6.3 Empirical implementation ....................................................................................... 117
   6.3.1 Estimation strategy ....................................................................................... 117
6.3.2 Data .................................................................................................................. 118
6.3.3 Variables .......................................................................................................... 119
6.3.4 Estimation issues ............................................................................................. 122
6.4 Results .................................................................................................................... 123
6.4.1 Descriptive evidence on age and regional firm formation ................................ 123
6.4.2 Age effects on regional firm formation ............................................................ 127
6.4.3 Exploring the sources of age effects on regional firm formation .................... 130
6.4.4 Simulation ........................................................................................................ 136
6.5 Conclusions ........................................................................................................... 138
7 Summary and conclusions ....................................................................................... 142
7.1 Summary ................................................................................................................ 142
7.2 Integration and discussion of findings ................................................................. 143
7.3 Implications and future directions ....................................................................... 145
References ................................................................................................................. 147
Appendix A .................................................................................................................. 164
Appendix B .................................................................................................................. 169
Appendix C .................................................................................................................. 171
Appendix D .................................................................................................................. 174
List of Tables

Table 1: Demographic structure and changes in the working-age population ................. 7
Table 2: Changes in age group 50-64: Decomposition (in mill. people) ......................... 12
Table 3: How existing studies cope with methodological challenges (part I) ................. 37
Table 4: Descriptive statistics for main indicators ....................................................... 71
Table 5: Age and knowledge effects on regional patenting activity ............................. 73
Table 6: Equality of parameters in the quality-knowledge aggregate ......................... 76
Table 7: Innovative performance, dominance and growth ............................................. 96
Table 8: Workforce structure and flows by dominance and growth regime ................... 98
Table 9: Strategic staffing patterns by dominance and growth regime ......................... 100
Table 10: Innovative performance and different staffing patterns ............................... 102
Table 11: Selected descriptive statistics, regional level ............................................... 125
Table 12: Age effects on regional firm formation ....................................................... 128
Table 13: Human capital, opportunity costs and new firm formation ......................... 131
Table 14: Age-specific migratory flows and new firm formation ............................... 134
Table 15: Firm formation under average aging 2010-2030 ........................................ 137
Table A.1: Assumptions on employment rates by scenario ........................................ 167
Table A.2: Workforce aging under scenarios I to IV .................................................. 168
Table B.1: Regions and periods covered in the analysis .............................................. 169
Table B.2: Age-of-knowledge effects in patenting activity ........................................ 170
Table C.1: Selected firm and workforce characteristics ............................................... 171
Table C.2: Minimum, maximum and percentiles for innovative performance .............. 172
Table C.3: Results of wage regression to determine dominance regime ...................... 172
Table C.4: Potential confounding factors with respect to staffing patterns .................. 173
Table C.5: Strategic staffing patterns in full sample .................................................... 173
Table D.1: Potential sources of age effects in regional firm formation ......................... 177
Table D.2: Indicators and their definition .................................................................... 178
Table D.3: Descriptive statistics for indicators used in regression analysis .................. 179
List of Figures

Figure 1: Workforce size, workforce aging and future trends ............................................... 10
Figure 2: Quality knowledge aggregate ................................................................................. 61
Figure 3: Patenting activity and age of S&T workforce by country .................................... 70
Figure 4: Spatial pattern of age and firm formation in West Germany ............................... 124
Figure 5: Driving factors of regional firm formation and age in 2004 ............................... 126

Figure D.1: Business registrations in West Germany 2002-2006 ................................. 176
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPO</td>
<td>European Patenting Office</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EU-15</td>
<td>The 15 member states of the European Union before 1 May 2004</td>
</tr>
<tr>
<td>FE</td>
<td>Fixed effects</td>
</tr>
<tr>
<td>GMM</td>
<td>General method of moments</td>
</tr>
<tr>
<td>GVA</td>
<td>Gross value added</td>
</tr>
<tr>
<td>HR</td>
<td>Human Resource</td>
</tr>
<tr>
<td>IAB</td>
<td>Institut für Arbeitsmarkt- und Berufsforschung (Research Institute of the German Federal Employment Agency)</td>
</tr>
<tr>
<td>IABS</td>
<td>Employment Sample provided by IAB</td>
</tr>
<tr>
<td>ILO</td>
<td>International Labour Organisation</td>
</tr>
<tr>
<td>IPC</td>
<td>International Patenting Classification</td>
</tr>
<tr>
<td>IV</td>
<td>Instrumental variable (IV estimation = Instrumental variable estimation)</td>
</tr>
<tr>
<td>LFS</td>
<td>(European) Labor Force Survey</td>
</tr>
<tr>
<td>LIAB</td>
<td>Linked employer-employee panel dataset for Germany provided by IAB</td>
</tr>
<tr>
<td>NUTS</td>
<td>Geocode standard (nomenclature d’unités territoriales statistiques)</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Cooperation and Development</td>
</tr>
<tr>
<td>OLS</td>
<td>Ordinary Least Squares regression</td>
</tr>
<tr>
<td>RIS</td>
<td>Regional Information System of the German Federal Statistics Office</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and development</td>
</tr>
<tr>
<td>SOEP</td>
<td>Socio-Economic Panel</td>
</tr>
<tr>
<td>S&amp;T</td>
<td>Science and technology</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
<tr>
<td>US</td>
<td>United States of America</td>
</tr>
</tbody>
</table>
First and foremost, I am deeply indebted to my academic teacher and supervisor of this dissertation, Prof. Dr. Thomas Zwick. I wish to thank him for his tireless efforts, his constructive guidance and for nonetheless leaving me with considerable freedom for own scientific exploration. My gratitude also goes out to Prof. Dietmar Harhoff, PhD, who acted as second supervisor and contributed his expertise on innovation economics and entrepreneurship research to this dissertation; and to Prof. Dr. Arnold Picot, who advised me as a mentor in the graduate program of the Munich School of Management. Without their support and advice, their belief and trust in my ideas, their encouragement and patience, I would not have been able to write this dissertation. It was a great honor and pleasure to work with them.

The interdisciplinary, empirical approach that I took in this dissertation was fostered by the methodological and demographic knowledge and expertise made available by the International Max Planck Research School on Demography, as well as by the MaxNetAging Program, which also financially supported the dissertation. Excellent support in data issues was provided by the staff of the Research Data Center of the Federal Employment Office (IAB) in Nürnberg.

I also owe a debt of gratitude to Alexia Prskawetz who, more than once, provided essential support for the completion of this dissertation, and to Christian Göbel, Pascal Hetze, Michael Kuhn, Carsten Ochsen and Thusnelda Tivig for their willingness to engage in lengthy discussions on economic, econometric and data issues. Finally, I wish to extend very special thanks to Willem Broekema, Jana Bruder, Gregor Büning, Marleen Dettmann, Justin Buckley, Angelika Lenschen, Susanne Lexa, Elke Loichinger, Anna Munteanu, Elena Muth, Katharina Kusenberg, Björn Sahlberg and Robert Wagner: you were constant sources of friendship and support, fruitful cooperation and inexhaustible joy – and safely accompanied me along the bumpy road towards the completion of this work.
Chapter 1

Introduction
The aging of the American population has had wide-ranging impacts on the economy—not all of them obvious. As the baby-boom generation retires, slower workforce growth is constraining the economy’s potential growth rate. Demographic shifts may also impact the pace of wage growth, inflation, layoffs and new business formation. Instead of signaling weakness or stagnation, these developments may simply reflect the reality of America’s changing population. As large numbers of baby-boomers retire, the effects may spread beyond workforce and GDP growth rates. This mass exodus of employees may also be Projected Workforce Aging in Selected European Countries (Percent, share of workers aged 55-64 years to the labor force). Austria Belgium Czech Republic Denmark Estonia Finland France Germany Greece Hungary Ireland Italy Latvia Lithuania Luxembourg Netherlands Norway Poland Portugal Slovakia Slovenia Spain Sweden United Kingdom.

First, there is a significant negative impact of an increase in the share of the workers aged 55–64 on the real growth of output per worker. This is shown in the first column of Table 1. Second, the main channel through which an aging workforce reduces the growth rate of output per worker is lower TFP growth. Columns 2-5 decompose the impact into factors of production and TFP.

Aging workforce challenges & solutions The impact of the aging workforce FAQ. Aging workforce statistics. First off, a couple of aging workforce statistics to give you an idea about the extent of the problem. In the US alone, 10 000 baby boomers turn 65 every day. According to an article by Arlene S. Hirsch, M.A., LCPC, for SHRM, this is something that started in 2011 and will continue until 2030. Since the average retirement age of a baby boomer lies somewhere between 61 and 65, it’s not hard to see that this so-called silver tsunami is going to create some serious challenges for HR; the Slide Number 38.