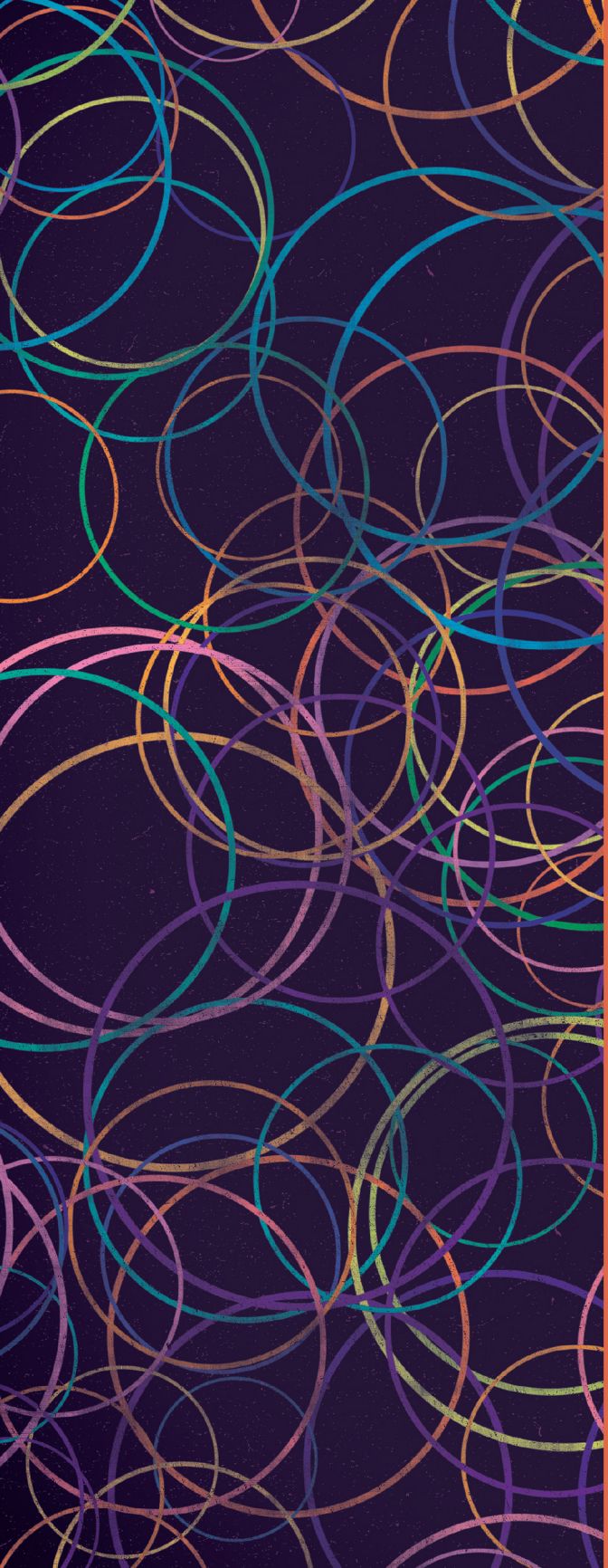

Circular Economy Supply Chains

From Chains to Systems

Edited by

Lydia Bals
Wendy L. Tate
Lisa M. Ellram

Circular Economy Supply Chains

This page intentionally left blank

Circular Economy Supply Chains: From Chains to Systems

EDITED BY

LYDIA BALS

Mainz University of Applied Sciences, Germany

WENDY L. TATE

University of Tennessee, USA

AND

LISA M. ELLRAM

Miami University, USA

United Kingdom – North America – Japan – India – Malaysia – China

Emerald Publishing Limited
Howard House, Wagon Lane, Bingley BD16 1WA, UK

First edition 2022

Copyright © 2022 Emerald Publishing Limited.

Reprints and permissions service
Contact: permissions@emeraldinsight.com

No part of this book may be reproduced, stored in a retrieval system, transmitted in any form or by any means electronic, mechanical, photocopying, recording or otherwise without either the prior written permission of the publisher or a licence permitting restricted copying issued in the UK by The Copyright Licensing Agency and in the USA by The Copyright Clearance Center. Any opinions expressed in the chapters are those of the authors. Whilst Emerald makes every effort to ensure the quality and accuracy of its content, Emerald makes no representation implied or otherwise, as to the chapters' suitability and application and disclaims any warranties, express or implied, to their use.

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN: 978-1-83982-545-3 (Print)
ISBN: 978-1-83982-544-6 (Online)
ISBN: 978-1-83982-546-0 (Epub)

ISOQAR certified Management System, awarded to Emerald for adherence to Environmental standard ISO 14001:2004.

Certificate Number 1985
ISO 14001

INVESTOR IN PEOPLE

Contents

List of Figures and Tables *ix*

About the Editors *xiii*

About the Contributors *xv*

Acknowledgements *xxi*

1: Introduction to Circular Economy Requirements: From Supply Chains to Value Systems

Chapter 1 Introduction to Circular Economy Supply Chains: From Supply Chains to Value Systems
Lydia Bals, Wendy L. Tate and Lisa M. Ellram *3*

Chapter 2 Industrial Symbiosis: Novel Supply Networks for the Circular Economy
Weslynne S. Ashton, Marian R. Chertow and Shahana Althaf *29*

Chapter 3 No Rest for the Complex: Information Flows, Adaptation, and Emergence in Circular Supply Systems
Elizabeth M. Miller *49*

2: The Role of Production (Actor: Producers)

Chapter 4 Shaping the Transition from Linear to Circular Supply Chains
Jennifer Rogan, Frank Fürstenberg and Andreas Wieland *69*

Chapter 5 Circular Business Models: A Network Approach to Promote Circularity and Value Co-Creation from the Producer's Perspective
Katharina Spraul and Stephanie Stumpf *89*

3: The Role and Types of (Reverse) Logistics (Actors: Scavengers and Decomposers)

Chapter 6 The Effects of Recycling Locations on Closed-loop Supply Chain Performance
Petchprakai Sirilertsuwan *111*

Chapter 7 Stakeholder Theory and Supply Chains in the Circular Economy
Muhammad Umair Shah and James H. Bookbinder *129*

4: The Role and Types of Business and Retail Consumers (Actor: Consumers)

Chapter 8 From End-of-the-road to Critical Node: The Role of End-user "Consumers" in Shaping Circular Supply Chain Management
Ben Hazen, Ilenia Confente, Daniel Pellathy and Ivan Russo *151*

Chapter 9 Secondary Markets: Enabling the Circular Economy
Dale Rogers, Haozhe Chen and Zac Rogers *167*

5: The Role of Information and Financial Flows (Main Actor: Decomposers)

Chapter 10 Blockchain Technology and the Circular Economy: An Exploration
Mahtab Kouhizadeh, Qingyun Zhu, Lojain Alkhuzaim and Joseph Sarkis *189*

Chapter 11 Toward Sustainability: A Review of Analytical Models for Circular Supply Chains
M. Ali Ülkü, Dawne M. Skinner and Gonca Yildirim *215*

6: The Role of the Business Context (Policymakers, NGOs, etc.)

Chapter 12 Determinants of Circular Economy and Sustainable Development of European Countries
Tihana Škrinjarić *239*

Chapter 13 Waste Not, Want Not: The Regulatory Barriers of Upcycling Frass
Carla Kornelia Smink and Rikke Dorothea Huulgaard *271*

7: Lessons Learned in the Move to a Circular Economy

Chapter 14 Learning to Implement the Circular Economy in the Agri-food Sector: A Multilevel Perspective
Joe Miemczyk, Valentina Carbone and Mickey Howard *283*

Chapter 15 Blanc de Gris, an Urban Mushroom Farm: Lessons from the Emergence of a Circular Business Model
Laura-Yi Lévesque, Emmanuel Raufflet and Linda Rouleau *303*

Chapter 16 Circular Tourism: A Destination Approach
Mette Alberg Mosgaard, Søren Kerndrup and Martin Lehmann *313*

Chapter 17 Circular Public Procurement: A Case Study of Workwear and Laundry Services
Rikke Dorothea Huulgaard, Heidi Simone Kristensen, Arne Remmen and Carla Kornelia Smink *329*

Chapter 18 Examples of Innovative Circular Economy Business Models (CBMs) from the Clothing and Textile Industry
Savu Rovanto and Anu Bask *343*

Chapter 19 Osklen Case Study: The Hurdles of Sustainable and Circular Fashion in Brazil
Leonardo Marques *357*

Index *367*

This page intentionally left blank

List of Figures and Tables

Figures

Fig. 2.1. Industrial Symbiosis Network at The Plant, Chicago, USA, in 2017. 35
Fig. 2.2. The Percentage of Local Industrial Demand for Materials That Could Be Met Through Industrial Symbiosis in Mysore, India. Each Color Represents a Different By-product. 38
Fig. 4.1. Simplified Butterfly Diagram: The Circular Economy Concept. 71
Fig. 4.2. Simplified Representation of the Adaptive Cycle and Cross-level Linkages in a Panarchy. 72
Fig. 5.1. Circular Business Model Canvas. 92
Fig. 5.2. Overview of the Research Process. 95
Fig. 5.3. Coding Structure. 98
Fig. 5.4. Framework to Design OBMs for a Circular Economy. 102
Fig. 6.1. Comparison between Cost and CO_2e of Different R-R Supply Chains and Important Cost and CO_2e Factors. 117
Fig. 6.2. Result Examples of R-R Supply Chain Costs for Each Sorting Facility Location After Varying Used Garment Prices and Gross Profit Percentages Delivering Similar Result Patterns for 25, 50, 74, 100, and 125 Gross Profit Percentages. 119
Fig. 6.3. Result Examples of R-R Supply Chain CO_2e for Each Sorting Facility Location After Varying Co_2e of Water Freight and Heat Energy Delivering Similar Result Patterns for 0.00001, 0.000017, 0.00002, and 0.000033 Water Freight $kgCO_2e/kg.km$. 120
Fig. 9.1. Secondary Market Channels in the United States (2020). 171
Fig. 9.2. Returns to Secondary Market Flow. 172
Fig. 9.3. Size and Growth of the US Secondary Market ($). 173
Fig. 9.4. Retail Store Openings and Closings in the United States (2015–2020). 174
Fig. 9.5. Stock Price Chart for Traditional and Secondary Market Retail Chains. 176
Fig. 9.6. Changes in Firm Usage of Secondary Markets. 180
Fig. 9.7. Secondary Market Usage and Inventory Management. 180
Fig. 9.8. Patagonia Apparel Repair Center, Reno, Nevada. 182
Fig. 9.9. Number of Nordstrom and Nordstrom Rack Stores. 182

Fig. 10.1. Reverse Logistics Processes. 195
Fig. 11.1. Linear, Sustainable, and Circular Supply Chains. 218
Fig. 11.2. Publication Trends on CE, SSC, and Quant CE-SSC, and Their Distribution Over Research Areas. 219
Fig. 11.3. SUTs and IO Tables for Three Regions, A, B, C. 228
Fig. 11.4. SSCA and CSC Canvas. 231
Fig. 12.1. Clustering of Countries Based on Efficiency Scores and Variables From Table 12.5, Year 2010. 261
Fig. 12.2. Clustering of Countries Based on Efficiency Scores and Variables From Table 12.5, Year 2014. 262
Fig. 12.3. Clustering of Countries Based on Efficiency Scores and Variables From Table 12.5, Year 2017. 263
Fig. 13.1. Conventional Management Practice of Food Losses. 272
Fig. 13.2. Insect Industry's Potential Contribution to the Circular Economy. 276
Fig. 14.1. Circular Economy Capability Maturity Model. 285
Fig. 16.1. Map of Northern Jutland, Denmark. 318
Fig. 16.2. Circular Economy Tourism in a Destination Approach at Slettestrand, Denmark. 324
Fig. 17.1. Linking CE and PP. 332
Fig. 19.1. Osklen's Circular Fashion Supply Network: A Biomimicry Lens. 361
Appendix A19.1. Sustainability and Circular Economy Communication at Osklen's Windows. 363

Tables

Table 1.1. Overview of Edited Book. 6
Table 1.2. Main Findings and Practical Implications. 12
Table 1.3. Future Research Suggestions. 21
Table 3.1. Key Information Flows on Local Supply Networks, Extended Supply Systems, and Biosphere Impacts That Can Contribute to the Emergence of Circular Supply Systems. 59
Table 4.1. Reorganization: How the Apparel Sector Is Creating New Combinations of Resources in the Transition From a Linear to a Circular Economy. 79
Table 5.1. Exemplary Quotes According to Established Themes. 99
Table 6.1. Reverse Logistics Data From Sending Used Garments From Sorting Facilities to Recycling Locations. 115
Table 6.2. Supply Chain Cost and CO_2e With Recycled Fiber for Three Markets Under Two Computational Scopes. 122
Table 7.1. Literature Review (2015–2020). 134
Table 8.1. Overview of Circular SCM Loops – Definitions and Ideas to Integrate Consumers. 156
Table 9.1. Percentage Change of Stock Price 2009–2021. 177

Table 10.1. CE Performance Measurements. 198
Table 10.2. Blockchain for CE Performance Measurement. 200
Table 11.1. CLSC Decision Levels. 223
Table 11.2. Parameters and Decision Variables for MIP Formulation. 230
Table 12.1. Data Description, DEA. 250
Table 12.2. Super Efficiency Scores and Rankings. 254
Table 12.3. Super Efficiency Scores and Rankings, Without Malta and Luxembourg. 256
Table 12.4. Additional Variables for the Panel Regression. 260
Table 12.5. Panel Data Estimation Results. 261
Table 13.1. Classification of Insect Frass and Their Treatment (Based on IPIFF, 2019). 274
Table 14.1. Circular Economy Levels of Maturity in Agri-Food. 297
Table 15.1. Generic Challenges of Circular Entrepreneurs. 310
Table 16.1. The Destination Approach to Circular Tourism. 320
Table 16.2. Tourism Initiatives in Network. 322
Table 17.1. The Content of the Guide on Sustainable Procurement of Workwear and Laundry Services. 335
Table 18.1. Groups and Examples of Illustrative Cases. 345

This page intentionally left blank

About the Editors

Dr **Lydia Bals** is Full Professor of Supply Chain and Operations Management at Mainz University of Applied Sciences Mainz, an external Postdoctoral Research Fellow at EBS Universität and affiliated with Copenhagen Business School. Her primary areas of research include sustainable supply chains, purchasing organization and competences, and offshoring/reshoring.

Wendy L. Tate (PhD, Arizona State University, 2006) is the Taylor Professor of Business and the Ray and Joan Myatt Faculty Research Fellow at the University of Tennessee, Haslam College of Business, Department of Supply Chain Management. She teaches and researches strategic sourcing, sustainability, and supply chain financial impacts.

Lisa M. Ellram, PhD is University Distinguished Professor and the Rees Distinguished Professor of Supply Chain Management at the Farmer School of Business, Miami University, Oxford, OH. Her primary areas of research interest include sustainability, buyer–supplier relationships, services purchasing and supply chain management, offshoring and outsourcing, and supply chain cost management.

This page intentionally left blank

About the Contributors

M. Ali Ülkü, PhD, MSc, is a Full Professor and the Director of the Centre for Research in Sustainable Supply Chain Analytics, in the Rowe School of Business at Dalhousie University, Canada. His research is on sustainable and circular supply chain and logistics management, and analytical decision models.

Lojain Alkhuzaim is a PhD candidate within the Business School at Worcester Polytechnic Institute. Her research focuses on the applications of energy analysis and system dynamics within the context of sustainable supply chain management.

Shahana Althaf is a Postdoctoral Associate at the Yale School of the Environment. She is a Fellow of the World Economic Forum's Global Future Council on Net Zero Transition. Her expertise is in the field of industrial ecology – analyzing different material systems to inform strategies to improve their sustainability.

Weslynne S. Ashton is an Associate Professor at the Illinois Institute of Technology. Her research, teaching, and practice are oriented around transitioning our socio-ecological systems toward sustainability and equity. She studies industrial ecology, circular economy, and the role of innovation and entrepreneurship in addressing social and environmental challenges.

Anu Bask is Adjunct Professor in Sustainable Supply Chain Management at the Turku School of Economics, University of Turku, Finland. She serves as Director of Logistics and Business part of InterTran Research Group and as Director of the Kataja's Finnish Graduate School of Logistics and Supply Chain Management.

James H. Bookbinder is a Professor of Management Sciences, University of Waterloo (Canada). He edited the book, Global Logistics: Transportation in International Supply Chains, Springer (2013). He is a Senior Editor, Journal of Business Logistics; an Associate Editor, Naval Research Logistics; and served as president of Canadian Operational Research Society.

Valentina Carbone is Professor at ESCP business school, in Paris, she established and co-chairs the ESCP Chair on Circular Economy. Her research deals with sustainable supply chain management, sharing economy, and circular economy transition.

She is in charge of a web-show on sustainable supply chain, mostly in French (https://supplychain-village.com/video-on-demand/supply-chain-durable/).

Haozhe Chen is an Associate Professor of Supply Chain Management at Iowa State University. His research focuses on reverse logistics, supply chain integration/collaboration, third-party logistics, and international logistics. He has published over 40 articles in supply chain management and logistics journals, and he has eight years' experience in international trade.

Marian R. Chertow is Professor of Industrial Environmental Management at the Yale School of the Environment and Director of the Center for Industrial Ecology. Her research and teaching focus on industrial ecology, circular economy, and waste management. Professor Chertow is best known for her leadership in industrial symbiosis studying collaborative industrial clusters where one firm's waste becomes another firm's feedstock.

Ilenia Confente is an Associate Professor of Marketing and Supply Chain Management at the University of Verona. Her main research focuses on the following topics: customer value and loyalty, digital marketing and omnichannel strategies, circular economy, and consumer value perceptions. Her research has been published in several academic journals.

Frank Fürstenberg is a Professor of Logistics and Supply Chain Management at NORDAKADEMIE in Hamburg/Elmshorn, Germany. His current research interests cover aspects of sustainable/circular and social supply chains as well as digital transformation in logistics. He is a Co-founder of the Reimagining Supply Chains Initiative.

Ben Hazen enjoys working in and researching areas related to innovation diffusion, technology management, supply chain management, and sustainability. He has managed, taught, and researched closed-loop supply chain processes for more than 20 years and publishes in journals covering related fields.

Mickey Howard is Professor in Sustainable Supply Chain Management at the University of Exeter Business School. His research examines how circular business and closed-loop systems create value for business and society while protecting the environment. He has served as Director of Research and co-founded the Circular Economy Business Forum.

Rikke Dorothea Huulgaard (MSc, PhD) is an Associate Professor in the Department of Planning at Aalborg University, Denmark. Her main research areas are ecodesign, EU environmental product policies, circular economy, and how to integrate circular economy into companies' business models.

Søren Kerndrup is Associate Professor at Aalborg University's Department of Planning. His research focuses on analysis of entrepreneurship, innovation and knowledge in clusters, networks and regions for development of strategies, and activities enabling a shift toward a more economic sustainable development.

Mahtab Kouhizadeh is an Assistant Professor of Supply Chain Management at the University of Rhode Island. She holds a PhD in Operations Management from Worcester Polytechnic Institute. Her research focuses on supply chain management, blockchain technology, and sustainability. She has co-authored several journal publications, book chapters, and conference proceedings.

Heidi Simone Kristensen (PhD) is an Assistant Professor in the Department of Planning at Aalborg University Denmark. Her main research areas focus on the following: circular economy in organizations; green, sustainable, and circular public procurement; environmental management systems; innovation; and ecolabeling and standardization.

Martin Lehmann is Associate Professor of Sustainable Development at Aalborg University. His research focuses on innovation systems and partnerships for sustainable development; he has for more than 20 years worked closely with national and international stakeholders in understanding and developing local and regional partnerships for sustainable development and transformation.

Laura-yi Lévesque is an MSc graduate from HEC Montreal. She studied the emergence of small-scale circular economy network in Montreal's food industry.

Leonardo Marques is an Associate Professor at Audencia Business School (France) and Vice-President of the International Purchasing and Supply Education and Research Association (IPSERA). His research looks at transparency, sustainability, and circularity in supply networks and can be found in outlets such as the Journal of Supply Chain Management.

Joe Miemczyk is a Professor of Supply Chain Management and Sustainability at the London campus of ESCP Business School. His research integrates sustainability in operations, supply chain management, and circular economy. He has widely published and has presented his research to business and academic communities in many countries.

Elizabeth M. Miller is a doctoral candidate at the Aalto University School of Business. She researches system change and the emergence of circular production with the FINIX research consortium on resource-wise textile business. Her work is supported by the Academy of Finland's Strategic Research Council, grant 327296/FINIX consortium.

Mette Alberg Mosgaard is Associate Professor at Aalborg University. For the past 19 years, she has conducted research within sustainability and circular economy, especially on companies' contributions. Her main focus has been on the interplay between environmental management systems and circular economy and measures facilitated through networks and institutions.

Daniel Pellathy is an Assistant Professor of Management at Grand Valley State University. His research has been published in several leading academic journals.

He is also a frequent writer on forward thinking articles published in outlets such as *Supply Chain Management Review* and the *Wall Street Journal*.

Emmanuel Raufflet is Professor at the Management Department of HEC Montreal. He serves as Academic Director of Institut EDDEC (Environment, Sustainable Development, and Circular Economy). He conducts research in circular economy, sustainable development, and business ethics.

Arne Remmen (PhD) is Technology and Society Professor in the Department of Planning at Aalborg University, Denmark. Since 1980, he has researched the relationship between technological and social change focusing on the dynamics of innovation within clean production, eco-design, and sustainable product policies.

Jennifer Rogan is a Research Associate at the Department of Operations Management, Copenhagen Business School. Her current research focuses on circular and nature-positive business models.

Dale Rogers is the ON Semiconductor Professor of Business at Arizona State University (ASU). He is the Director of the Frontier Economies Logistics Lab and the Internet Edge Supply Chain Lab ASU. He is the Director of Global Projects for Instituto de Logística e Supply Chain in Brazil.

Zac Rogers is an Assistant Professor of Supply Chain Management at Colorado State University. His primary research interests include supply chain sustainability, emerging logistics technologies, supply chain cyber security, and various other topics. He is a contributor to the Logistics Managers' Index and earned a PhD from Arizona State University.

Linda Rouleau is Professor at the Management Department of HEC Montreal. Her research work focuses on micro-strategy and strategizing in pluralistic contexts. She is also researching on sensemaking and organizing in extreme contexts. She has published in peer-reviewed journals such as *Academy of Management Review*, *Organization Science*, *Accounting*, etc.

Savu Rovanto is a PhD candidate at Aalto University School of Business at the Faculty of Information and Service Management. Their research focuses on how companies facilitate society-wide transition to circular economy. Savu conducts part of their research in Japan and explores the institutional angle of the CE transition.

Ivan Russo is an Associate Professor of Logistics and Supply Chain Management at the University of Verona. His research focuses on supply chain management, logistics service quality, closed-loop supply chain and circular economy, the marketing/logistics interface, and customer loyalty.

Joseph Sarkis is a Professor of Management within the Business School at Worcester Polytechnic Institute. He earned his PhD from the University of Buffalo.

His research and teaching interests include sustainability, technology, operations, and supply chain management. He has authored over 500 publications.

Muhammad Umair Shah is a Lecturer in the Department of Management Sciences, Faculty of Engineering at University of Waterloo, Canada. He received his MASc and PhD in Management of Technology from the University of Waterloo. His research interests center around stakeholder theory, circular economy, computational social science, and technology ethics.

Petchprakai Sirilertsuwan is a postdoc at LouRIM, UCLouvain. Her research focuses on factors and performance of circular economy strategies, manufacturing location decisions, and multi-tier supply chain network design for business, environmental, and socio-economic sustainability. She is passionate about generating impactful practical research and supporting sustainability transitions at all levels.

Dawne M. Skinner, PEng, MASc, MBA, is a PhD student in Industrial Engineering at Dalhousie University, focusing on modeling and optimizing closed-loop supply chains. She is a former Schmidt MacArthur Fellow and has led several first of their kind national circular economy studies in Canada.

Tihana Škrinjarić, PhD, is employed as an Advisor at the Croatian National Bank, Croatia. Before this, she was an Assistant Professor at the Faculty of Economics and Business, Zagreb, Croatia. Her research areas are applied econometrics, financial economics, performance measurement, and financial stability.

Carla Kornelia Smink (MA, MBA, PhD) is Associate Professor in the Department of Planning at Aalborg University in Denmark. Since 1998, she has studied developments in environmental regulations in industrialized countries. In her current research, she focuses on shifting the regulatory approach towards a circular bioeconomy.

Katharina Spraul is Full Professor of Sustainability Management at Technische Universität Kaiserslautern, Germany. Her research deals with sustainability issues across sectoral boundaries and has been published in scientific outlets such as *Business & Society*, *Circular Economy and Sustainability*, *Journal of Business Ethics*, and *Nonprofit & Voluntary Sector Quarterly*.

Stephanie Stumpf is a Research Assistant at the Chair of Business Administration, in particular Sustainability Management, at Technische Universität Kaiserslautern. She graduated with a Master's degree in Sustainable Business and Economics in 2019. Her Master's thesis was focusing on the promotion of environmental behavior, using insights of behavioral economics.

Andreas Wieland is an Associate Professor of Supply Chain Management at Copenhagen Business School. His current research on supply chain transformation

reinterprets global supply chains as social–ecological systems. He is a Co-founder of the Reimagining Supply Chains Initiative. He is also the Editor of the blog scmresearch.org.

Gonca Yıldırım is an Assistant Professor of Industrial Engineering at Çankaya University (Turkey). She holds a PhD from the University of Florida. Her research interests include optimization applications, inventory planning, and control. She has published in *International Journal of Production Economics* and *Journal of the Operational Research Society*, among others.

Qingyun Zhu is an Assistant Professor of Management Science at the University of Alabama in Huntsville. She earned a PhD in Operations Management from Worcester Polytechnic Institute. Her research focuses on sustainable supply chain management, product deletion/elimination, and blockchain technology applications.

Acknowledgements

This research was partially funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – 417752672. We kindly thank the DFG for its support.