

R&D Management under disruption and uncertainty

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Background:

R&D management under disruption is important for both leading firms in developed countries (Christensen, 1997) and latecomer firms in emerging economies (Malerba and Lee, 2021). To embrace the disruption opportunity (Gilbert, 2003), firms must make smart R&D decisions under uncertainty.

Uncertainty, defined as “an individual’s perceived inability to predict something accurately” (Milliken, 1987, p.136), has long been a central topic in R&D management (Moehrle and Walter, 2008; Sicotte and Bourgault, 2008; Stockstrom and Herstatt, 2008; Banerjee and Siebert, 2017). Recent empirical studies have found both positive (e.g. Ross et al., 2018) and negative effects (e.g. Li et al., 2021b) of uncertainty on R&D investment. In addition, uncertainty can also influence various aspects of R&D and innovation, such as R&D collaboration (Banerjee and Siebert, 2017; Fu, et al., 2021), strategic alliances (Kelly et al., 2002; Martínez-Noya and Narula, 2018), product development processes (Verganti, 1997; Kim and Wilemon, 2002), R&D performance evaluation (Bremser and Barsky, 2004), and industry emergence (Moeen et al., 2020). At a more fundamental level, the notion of “uncertainty” *per se* deserves further research, as the term “uncertainty” is often used interchangeably with other constructs such as “risk”¹ and “ambiguity”². For example, some uncertainties are caused by normal fluctuation in market conditions, whereas other uncertainties are triggered by unexpected shocks and disruptive events (Saghaei et al., 2020). Nevertheless, today, we are entering into a time of disruption (Khanagha et al., 2018; Barclay et al., 2021), both non-technological and technological, which increases uncertainty facing different actors (e.g. firm, government, university, research institute) within innovation systems.

¹ Source: “*Risk and uncertainty are closely related and often used interchangeably.*” (Sicotte & Bourgault, 2008, p.468).

² Source: “*...there has often been confusion over the practical meaning of uncertainty and ambiguity.*” (Millar, Groth, Mahon, 2018, p.6).

Since Schumpeter's seminal work on *The Theory of Economic Development* (Schumpeter, 1934), innovation has been recognized as a powerful engine of economic growth. However, R&D and innovation activities not only lead to economic growth but can also lead to societal challenges (e.g. inequality, climate change). Some scholars have started to discuss how innovation research can address these challenges, for example, transformative innovation (Schot and Steinmueller, 2018), mission-oriented innovation (Mazzucato, 2016), inclusive innovation (Chataway et al., 2014; Fu et al., 2022). Despite the recent progress, such discussions, to a large extent, remain at the macro-level, staying in the realm of innovation policies (Weber and Rohracher, 2012; Fagerberg, 2018; Giuliani, 2018). Less attention has been paid to the micro-foundations of such transformative changes (Schot and Steinmueller, 2018; Geels, 2020). Moreover, while technological disruptions may present both opportunities and challenges for the developing countries (Fu, 2020), little is known about how developing country firms and governments are affected by such disruptions and how they shall respond to them. In this special issue, we call for an innovation system approach to tackling challenges faced by R&D managers, industry practitioners, and policymakers in the time of disruption.

The innovation system approach argues that innovation capabilities of nations, regions or sections are an outcome of a sector actors in the national, regional or sectoral innovation system, i.e. the state, universities and research institutes, and industries, and the interactions between them (Freeman, 1987; Lundvall, 1992; Nelson, 1993; Edquist, 1997; Autio, 1998; Howells, 1999; Malerba, 2002; Bergek et al., 2008). More recently, Li et al. (2021a) explicitly incorporated unexpected shock events into the innovation system framework, pointing out that shock events (e.g. Covid-19) are becoming nonnegligible forces that shape the environment in which different actors operate. Different types of disruption might trigger different R&D activities of various players in innovation systems. Here, we highlight several dimensions of disruption for illustrative purposes.

Artificial intelligence, genome editing, and fourth industrial revolution (4IR) technologies (Schwab, 2017; Li et al., 2021a) are bringing more and more technological disruptions (Khanagha et al., 2018; Brougham and Haar, 2020). The Covid-19 pandemic and different variants of the virus (e.g. Delta and Omicron), climate change, and its associated consequences (e.g. floods and extreme weather) are bringing more and more environmental disruptions (Mihalache and Mihalache, 2021; Barclay et al., 2021). The risk of technological competition and decoupling between the world's major economies (e.g. the US and China) are bringing more and more institutional disruptions (Douglas Creed et al., 2014; Shekhar et al., 2020; Rodner et al., 2020). Given the radical changes in terms of technologies, institutions, and environments, market disruptions (Lam et al., 2010; Vith et al., 2019) are also increasing. The advent of an uncertain economy has a fundamental impact on R&D management. In this special issue, we aim to bring together a series of contributions that address various types of disruption, uncertainty, and R&D management at the micro, meso, and macro levels.

Technological disruption: Technological disruption (Khanagha et al., 2018; Brougham and Haar, 2020) comes from radical changes in the technology space, such as the advent of artificial intelligence and robotics (Frey and Osborne, 2017; Brougham and Haar, 2020), the rise of cloud-based digital technologies (Khanagha et al., 2018), and the emergence of digital platforms (Berger et al., 2020). Given the widespread technological disruptions in this period, some scholars (e.g. Schwab, 2017; Li et al., 2021a) claim that we are entering into an era of the fourth industrial revolution (4IR). Whereas the so-called 4IR technologies (e.g. artificial intelligence, cloud computing, advanced robotics, Internet of Things, and autonomous vehicles) bring opportunities for R&D management by providing a powerful analytic tool, it also creates challenges for R&D management by creating managerial and ethical problems (Li et al., 2021a; Martinelli et al., 2021). How do technological disruption and its related uncertainty in innovation systems affect the activities and interactions of different actors? In particular, how will increasing technological uncertainty affect R&D management at the micro, meso, and macro levels? How can firms use different strategies, such as “risk management practices” (Raz et al., 2002), “fuzzy front-end” (Kim and Wilemon, 2002), “balanced scorecard” (Bremser and Barsky, 2004), “prototyping” (Tidd and Bodley, 2002), or “feed-back planning” (Verganti, 1997), to handle technological disruptions and increase the likelihood of project success?

Institutional disruption: Institutional disruption (Douglas Creed et al., 2014; Shekhar et al., 2020; Rodner et al., 2020) represents radical changes in terms of values, beliefs, regulations, policies, and geopolitical status. For example, the increasing technological competition between the world’s largest economies (i.e. the US and China) brings institutional disruption and increases uncertainty faced by firms in the ICT sector (e.g. mobile communications and semiconductors). Meanwhile, governments of different countries can also work together to create new institutions (e.g. the ‘Belt and Road’ initiative) that facilitate innovation collaborations and technology transfer across national boundaries (Chen et al., 2021). Uncertain policies or political environments reduce business confidence, thus decreasing firm investment (Montes and Nogueira, 2021). In particular, changes in regulatory frameworks (i.e. regulatory uncertainty) might render firms’ R&D investment in one sector obsolete while creating opportunities in other sectors. How do institutional disruption and its related uncertainty in innovation systems affect the activities and interactions of different actors? How can firms respond to such shocks and uncertainty either proactively or reactively? What is the role of state policy in generating or reducing such uncertainties? How will the technological competition between the US and China affect international research collaborations (e.g. the development of international technological standards)?

Environmental disruption: Environmental disruption (Mihalache and Mihalache, 2021; Barclay et al., 2021) includes disruption that is induced by exogenous shocks in the natural environment, such as the pandemic (Soluk et al., 2021) and climate change (Goudie, 1993). The Covid-19 pandemic and new variants of the virus have been changing the business environment. Climate change and the deteriorating natural environment add another layer of uncertainty for firms doing business. How do

environmental disruption and its related uncertainty in innovation systems affect the activities and interactions of different actors? In particular, how will environmental disruption and uncertainty influence firms' R&D management? Can firms improve their R&D management to address environmental disruption and protect the environment? How does perceived environmental uncertainty (Jahanshahi and Brem, 2020) affect firms' innovation and imitation strategies?

Market disruption: Market disruption (Lam et al., 2010; Vith et al., 2019) comes from unexpected changes in market conditions and customer demands, which can be triggered by other types of disruption. For example, following the recent development of the Omicron variant of the virus, different countries (e.g. Israel and Japan) announced their restrictions on international travel, bringing market disruption and uncertainty for both established firms in advanced economies and latecomer firms in emerging economies. How do market disruption and its related uncertainty in innovation systems affect the activities and interactions of different actors? For example, how do market disruptions reshape global value chains and how should firms respond to such disruptions? What are the roles of firms and non-firm actors in stabilizing existing markets or creating new markets?

In summary, different types of disruption might break the “structural inertia” and “equilibrium” of an existing innovation system (Narula, 2002, 2003), bringing both challenges and opportunities for different actors' R&D activities. Apparently, different actors within an innovation system might respond to such uncertainties differently. For example, some firms might adopt proactive strategies to shape the innovation system in which they operate (i.e. ‘voice’ strategy), whereas other firms might adopt reactive strategies to either ignore the changes in the focal innovation system (i.e. ‘loyalty’ strategy) or exit the current innovation system (i.e. ‘exit’ strategy) (Hirschman, 1970). Some scholars (e.g., Millar et al., 2018) have started to discuss the challenges and opportunities brought by the disruptions and uncertainty in this era. Although there has been some progress along this line of thinking (Frynas et al., 2018; Kim et al., 2018; Schoemaker et al., 2018), we think the impact of disruptions and uncertainty in this era goes beyond R&D management within companies. It requires systemic thinking at the macro, meso, and micro levels from academic scholars, industry practitioners, and policymakers.

The main goal of the special issue:

The main goal of this special issue is to call for more research on R&D management under disruption and uncertainty. We welcome submissions that address the intersection of disruption, uncertainty, and R&D management. For example, papers can address how different types of disruption/uncertainty affect organizations' R&D management (disruption/uncertainty as “antecedent”) or examine how different R&D management practices can generate or reduce a specific type of disruption/uncertainty

(disruption/uncertainty as “consequence”). We are open to different methodological approaches, such as conceptual, qualitative, and quantitative research.

Potential research questions:

Macro-level

- What role do disruption and uncertainty play in innovation systems?
- When and how do disruption and uncertainty in innovation systems affect activities and interactions of different actors, such as firm R&D, university R&D, and university-industry collaborations?
- How can different countries build open national innovation systems (Fu, 2015) in an era of disruption?
- Will disruption and uncertainty affect international research collaborations (Chen et al., 2019; Fu et al., 2021)? What policies are effective for enhancing international research collaborations under disruption and uncertainty?
- How can we build more inclusive innovation systems to guide the R&D of emerging technologies (e.g. AI)?
- What types of disruption can open “windows of opportunity” (Lee & Malerba, 2017) for developing countries? How can developing countries seize such “windows of opportunity”?

Meso-level

- How do different types of disruption affect technological trajectories in different sectors?
- How do different types of disruption affect international linkages and sectoral dynamics in different sectors?
- When and how do disruption and uncertainty reshape global value chains?
- Why do different sectors differ in the patterns of innovative activities under uncertainty?
- How do different regional innovation systems differ in terms of capabilities to handle disruption and uncertainty?
- What are the impacts of different types of disruption on industrial leadership and latecomers’ catching-up in different sectors?

Micro-level

- How do different types of disruption and related uncertainties affect firms’ R&D decisions and R&D activities?
- How can different actors of innovation systems (e.g. government, firm, university,

research institute) manage their R&D activities under disruption and uncertainty?

- Why do different types of firms and non-firm actors in innovation systems respond to disruption and uncertainty differently (e.g. reactive responses versus proactive responses)?
- How do disruption and uncertainty affect firms' R&D strategy, management practices, investment behaviours, internationalization, or alliances/collaboration strategies (Narula and Martinez-Noya, 2015)?
- When and how do disruption and uncertainty affect open innovation at the firm-level?
- When and how do disruption and uncertainty affect entrepreneurship at the “base of the pyramid” (Fu et al., 2022) and innovation activities in low-income countries (Fu, 2020)?

The above questions are listed only for illustrative purposes. We welcome any submissions that fit into the theme of the special issue.

Schedule:

First date of the open call: March 2022

Online submission window: December 1, 2022 – January 31, 2023

Expected publication date: First half of 2024

Marketing and author engagement:

Pre-submission webinars / panels

We will offer opportunities for authors to engage with the editorial team prior to submitting a manuscript. We will organize online webinars, or panels at the R&D Management annual conference and the GLOBELICS annual conference, to advertise the special issue and encourage submissions.

R&R workshop

We plan to organize an R&R workshop to help authors, who receive the first round Revise and Resubmit, further improve their papers.

Post-publication panel

We will organize a post-publication panel at the AOM annual meeting to promote the selected papers in the special issue. We will also promote the special issue through online platforms such as Twitter, Facebook, and other social media.

Bios of the Guest Editors:***Xiaolan Fu (University of Oxford)***

Xiaolan Fu is the Founding Director of the Technology and Management Centre for Development (TMCD), Professor of Technology and International Development, Fellow of Green Templeton College and a Fellow of the Academy of Social Sciences. She was appointed by the Secretary-General of the United Nations to the Ten-Member High Level Advisory Group of the UN Technology Facilitation Mechanism and to the Governing Council of the UN's Technology Bank for Least Developed Countries. She is also a member of the UN SDSN Leadership Council led by Jeffrey Sachs and a member of the Council for Global Economic Transformation co-chaired by Joseph Stiglitz and Michael Spence. She is the 2019 winner of the CFA Asia-Pacific Research Exchange Award (CFA Institute), the 2018 winner of the Best Journal Paper of the Year Award (European Academy of International Business), the 2017 winner of the Best Paper Award (European Association of Management (EURAM) Innovation Strategic Interest Group), Winner of 2021 Falling Walls Scientific Breakthrough Award, and 2021 R&D Management annual conference Best Paper for collaboration and alliance track.

Her research interests include innovation, technology and industrialisation; trade, foreign direct investment and economic development; emerging Asian economies; innovation and productivity in the UK/US. She has published extensively in leading international journals independently or in collaboration with others. Her recent books include *Innovation under the Radar (2020)*, *China's Path to Innovation*, *China's Role in Global Economic Recovery* and *The Rise of Technological Power in the South*. She is Editor-in-Chief of the *Journal of Chinese Economic and Business Studies*, Associate Editor of *R&D Management*, and serves on the editorial boards of *Industrial and Corporate Change*, *International Journal of Technology Management*, and four other international journals.

Daitian Li (University of Electronic Science and Technology of China)

Daitian Li is Assistant Professor of Management at the University of Electronic Science and Technology of China. He is also a Research Fellow of Sichuan Institute of International Science and Technology Collaboration (Israel), as well as an Adjunct Research Fellow of China Institute for Science & Technology Policy at Tsinghua University. Dr. Li holds a PhD in Business Administration & Management from Bocconi University. His research interests focus on innovation systems, technology and innovation management, and industry evolution. He has won competitive research grants from the National Science Foundation of China, Ministry of Education of China, etc. His research has been published in outlets such as *Journal of International Business Studies*, *Research Policy*, *Harvard Business Review*, *Strategy Science*, *Industrial and Corporate Change*, and *Oxford Handbook of China Innovation*. He is a member of the Editorial Review Board of *Management and Organization Review*, and has served as a Guest Editor of *Industrial and Corporate Change*.

Rajneesh Narula (University of Reading)

Rajneesh Narula is the John H. Dunning Chair of International Business Regulation at the Henley Business School, University of Reading, UK. His research and consulting have focused on the role of multinational firms in development, innovation and industrial policy, R&D alliances and outsourcing. He has published over 100 articles and chapters in books on these themes. He regularly acts as a consultant and advisor to the European Commission, UNIDO, UNCTAD and the OECD, and a variety of other international organisations. He holds honorary appointments at UNU-MERIT, Norwegian School of Business and Oxford University. His publications have appeared in leading journals, including the *Journal of International Business Studies*, *Oxford Development Studies*, *Research Policy*, *Journal of Management Studies* and *Management International Review*.

Max von Zedtwitz (Copenhagen Business School)

Max von Zedtwitz is a professor of global innovation, R&D and product development, especially with respect to emerging markets such as China, at Copenhagen Business School (CBS), with adjunct roles at KTU in Lithuania and at SDU in Denmark. He has also been a professor at Tsinghua University in China (2003), Skoltech in Moscow (2013), and IMD in Switzerland (2000). He has led more than 60 consulting engagements in R&D, technology and innovation strategy, product development operations, global strategy, productivity improvements, product life-cycle management, organizational road-mapping and design, corporate incubation, start-up management, international management, China business and corporate M&A. He has written more than 100 scientific articles and 17 books; he also is on the editorial advisory board of nine journals, including the highly ranked *Global Strategy Journal*, *Technovation*, and *R&D Management*. He has been quoted in periodicals such as the *Economist*, *China Daily* and the *New York Times*.

Beverly Wagner (University of Strathclyde)

Beverly Wagner, Professor of Innovation and supply chain management and Head of the Department of Marketing, Strathclyde Business School. Her research interests are in the field of supply chain and innovation management. This includes buyer/supplier relationships, supplier development, collaboration, value chain analysis, supply chain resilience and supply chain sustainability. Linked to innovation management current research relates to open innovation implementation, the circular economy, frugal innovation and adoption of disruptive technologies.

Beverly has an accomplished record for gaining research, knowledge exchange and consulting projects with organisations such as Barr Construction, Conoco (UK) Limited, BP, Shell Expro (UK), the Turner Group, Scottish Power Energy Networks, Scotland Food and Drink and Offsite Solutions Scotland. She was academic lead and knowledge based supervisor for a recently completed Knowledge Transfer Partnership with Scottish Power Energy Networks. She has published widely in high quality international journals such as *International Journal of Operations Management*, *Journal*

of Business Research, European Journal of Marketing, Technology Forecasting and Social Change and Product Planning and Control. She is Editor-in-Chief of Supply Chain Management: An International Journal.

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