

Beyond the Pandemic?

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Beyond the Pandemic? Exploring the Impact of COVID-19 on Telecommunications and the Internet

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

First edition 2023

Editorial matter and selection © 2023 Jason Whalley, Volker Stocker and William Lehr.
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British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

ISBN: 978-1-80262-050-4 (Print)

ISBN: 978-1-80262-049-8 (Online)

ISBN: 978-1-80262-051-1 (Epub)



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Certificate Number 1985
ISO 14001



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List of Abbreviations

4G	Fourth generation of mobile communications
5G	Fifth generation of mobile communications
AI	Artificial intelligence
ATUI	African Telecommunications Union
AWS	Amazon Web Services
BEREC	Body of European Regulators for Electronic Communications
BR	ITU-R Bureau
BSI	British Standards Institute
C&W	Cable & Wireless
CAPEX	Capital Expenditure
CCTV	Closed Circuit TV
CDN	Content Delivery Network
DSA	Digital Services Act
EC	European Commission
EdTech	Educational Technology
EECC	European Electronic Communications Code
EU	European Union
FCC	Federal Communications Commission
FTC	Federal Trade Commission
FWA	Fixed Wireless Access
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GP	General Practitioner
HIPAA	Health Insurance Portability and Accountability Act
ICT	Information and Communication Technologies
IMT	International Mobile Telecommunications
IoT	Internet of Things
ITU	International Telecommunications Union
ITU-R	Radio Sector of the International Telecommunications Union
IXP	Internet Exchange Point
LLA	Liberty Latin America
Mbps	Megabits per second
MNO	Mobile Network Operators
NB-IoT	Narrowband Internet of Things
OECD	Organisation for Economic Co-operation and Development
OIO	Open Internet Order

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OTT	Over-the-top
RR	Radio Regulations
RRB	Radio Regulations Board
SARS	Severe Acute Respiratory Syndrome
SDG	Sustainable Development Goal
SMS	Short Messaging Services
TVWS	TV White Spaces
UCC	Uganda Communications Commission
UHF	Ultra High Frequency
VA	Veteran's Affairs
VPN	Virtual Private Network
WFH	Work from Home
WHO	World Health Organisation
WRC-19	World Radiocommunications Conference of 2019
WRC-23	World Radiocommunications Conference of 2023

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Preface

We have all been affected by COVID-19. Since the emergence of the virus in late 2019, it has wrought far-reaching social and economic changes. As the virus spread, both within and between countries, governments imposed restrictions – these were wide-ranging in nature, often unprecedented, and sought to limit what individuals and companies could undertake. Individuals were instructed to work from home (WFH) where possible and education at all levels moved online to reduce the ability of the virus to spread, resulting in empty city centres and bustling suburbs on the one hand and creating challenges for parents to home-school their children on the other.

Companies changed how they operated. Some companies ceased to operate as the spread of the virus negatively impacted global value chains, reducing, and in some cases completely cutting, the flow of manufactured products between countries. While some companies continued to operate, albeit at much lower levels of activity than prior to the start of the pandemic, others saw dramatic increases in demand for their services. Perhaps nothing better epitomises this than the growth in demand for online video conferencing software, with ‘zoom’ being used to describe video conferencing regardless of which software is actually being used.

But not everyone experienced the pandemic in the same way. Those working in knowledge-intensive industries were able to WFH; not only did this mean that they could maintain their employment, but it also removed them from crowded offices and public transport where the virus could be easily transmitted. Of course, WFH was not without a myriad of challenges: homes became offices, bringing family members into close contact for long periods of the day, and they also became schools, forcing parents to juggle their work commitments with those of educating their children.

Working at home was not an option for those employed in other parts of the economy, such as those in the construction or healthcare sectors. In these and other sectors, economic activity ground to a halt, resulting in unemployment and the accompanying financial hardship for individuals, and people were exposed to the possibility of contracting COVID-19 as they went about their work.

Experiences were also different between countries. Some countries tried to minimise the impact of the pandemic, keeping as much of the economy open as possible, while others imposed wide-ranging and sometimes long-lasting restrictions that severely curtailed the liberties of individuals and shut down large parts of the economy. As the pandemic spread around the globe, countries sought to

learn from one another, resulting in a high degree of commonality in the strategies adopted by governments. Having said this, the responses also highlighted the institutional differences that exist between countries, in terms of how restrictions were imposed as well as the financial support provided to both individuals and businesses.

Given the highly disruptive nature of the pandemic, global in scale and protracted in time, many have sought to comment on its impact. Not only has social media been awash with commentary, but countless academics and research organisations have published articles and reports on the impact of COVID-19. A voluminous literature soon emerged, but one that was often characterised by its snapshot nature – many more articles, for example, appeared that described the technological solutions to monitor those with COVID-19 than those that evaluated how such approaches have fared over time. Similarly, the imposition of various lockdown restrictions was associated with numerous commentaries on their immediate impact, with far fewer examining their consequences over the long term or the extent to which the restrictions imposed to tackle successive waves of the pandemic interacted with one another.

This volume emerged out of informal bilateral discussions among the authors of the various chapters that questioned the initial (snapshot) assessments of the impact of COVID-19. These discussions asked, in essence, a simple but intriguing question: what will the impact of COVID-19 be in the longer term? The initial assessments of the impact of COVID-19 were rooted in the uncertainty and dynamism that characterised the emergence of and reaction to the virus. In essence, the emergence of COVID-19 in China and its subsequent global diffusion generated a lot of responses and associated commentary but ascertaining what they meant for the longer term was challenging given how fast events were changing. Now, over two years after the initial emergence of COVID-19 and after successive waves of the virus have occurred, we have the opportunity to look back at events and assess in a more reflective manner the impact of COVID-19.

Given the enormity of the pandemic, it is simply not possible to cover everything within a single volume. Instead, our approach towards the content of the volume has been guided by a desire to shed light on three related questions. Firstly, what happened? Secondly, how did the pandemic affect different parts of the economy, and thirdly, how did COVID-19 shape key (on-going) policy debates? These questions are not addressed to the same degree in each chapter, enabling as a consequence the chapters to offer a focused analysis of a sector or policy issue. Sometimes this analysis is detailed, while on other occasions a ‘big picture’ approach is adopted. Not only does such an approach illustrate the scope of the pandemic and its impacts, but it also enables the nuances and subtleties of its impact to emerge as well. Insights from each of the chapters are brought together in the conclusion where we return to the aforementioned three guiding questions.

This volume lays the foundation for future explorations of the socio-economic impact of COVID-19. As noted above, the volume is not comprehensive in its coverage. One way future research could build on the analysis contained within the volume is to examine what happened in other sectors. Manufacturing and construction are examples of such additional sectors, as are logistics and

hospitality. Another way is to expand the policy debates that are examined, with perhaps the most pressing being how to tackle the multiple digital divides that the pandemic exposed.

We are acutely aware that the bulk of this volume draws on the experience of developed countries. This does not reflect the global nature of the pandemic. It does, however, reflect how the book was conceived and, to a lesser extent, the networks of the three co-editors. Subsequent efforts need to build on the insights from this volume, expanding the analysis of the impact of COVID-19 on developing countries and critically assessing how they fared. Integral to these assessments, which will be described in detail in each country, is also an evaluation of the effectiveness and efficacy of the responses that were implemented to tackle the pandemic. This will entail identifying and then assessing the institutional response that was undertaken, by governments as well as regulatory agencies, as well as cataloguing and critiquing how businesses sought to cope with the impact of the pandemic.

Such an assessment, regardless of the country, is not easy. It will require extensive amounts of data covering the whole period of the pandemic as well as the whole economy. A lot of data did emerge as the pandemic took hold. Google Mobility reports, for example, which was published for many countries and cities around the world, illustrated how the use of public transport or visits to supermarkets or parks were affected by the pandemic and the restrictions imposed to limit its spread. This was complemented by official statistics that illustrated, among other things, the impact of the pandemic on employment, the incomes of individuals and economic activity in different parts of the economy and regions of the country. Companies also published reports detailing the impact of the pandemic on their operations, demonstrating how they had responded as well as how they had sought to support their customers and suppliers. And news organisations also played a role in aggregating and disseminating COVID-19-related data; the *BBC*, like many other news agencies, devoted a considerable proportion of its efforts to the pandemic, while the *Financial Times* placed its coverage in front of its paywall.

There are signs, however, that the initial enthusiasm to collect and share COVID-19-related data is abating. Perhaps due to a combination of factors such as the protracted nature of the pandemic and gradual adjustment to COVID-19 through successive waves of the virus, combined with the costs and the insights that it offers into how a company operates, there appears to be fewer data available. Declining COVID-19-specific data, coupled with the less frequent collection and publication of that data that is still available, will impact the ability to understand the impact of COVID-19 in both the near and longer term.

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August 2022

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Acknowledgements

Volker Stocker gratefully acknowledges funding by the Federal Ministry of Education and Research of Germany (BMBF) under grants no. 16DII124 and 16DII131 (“Weizenbaum-Institut für die vernetzte Gesellschaft - Das Deutsche Internet-Institut”). William Lehr and Jason Whalley acknowledge the financial support they received during their time as Research Fellows at the Weizenbaum Institute for the Networked Society (Berlin, Germany).

The co-editors gratefully acknowledge the excellent editorial assistance by Max Kronfeld, who checked each chapter and saved the authors so much time by ensuring that the references conformed to APA7.

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Chapter 1

Introduction

Jason Whalley, Volker Stocker and William Lehr

Abstract

This chapter is contextual in nature. It provides an overview of the impact of COVID-19, highlighting both the significant number of deaths caused by the pandemic as well as the economic disruption that occurred. Particular attention is paid to the role of digital technologies during the pandemic, which enabled a wide range of activities (e.g. work, education and shopping) to go online. The disruptive impact of COVID-19 is widespread and far-reaching, with the pandemic acting as a ‘change agent’ expanding and encouraging the greater use of digital technologies. The second half of the chapter presents summaries of the other chapters in the book. In doing so, it illustrates the scope and scale of the impact of COVID-19, the multitude of different challenges it has caused, and how these varied across different regions and contexts, as well as the diversity of reactions to the pandemic. Some of these reactions are technical in nature, while others are commercial and political. The summaries also draw attention to ongoing policy debates, the significance of which has been heightened by the pandemic.

Keywords: COVID-19; socio-economic impact; structure of the book; broadband; cybersecurity; future of work; digital infrastructures

1.1. Introduction

The impact of COVID-19 has been significant. Globally, by April 2022, just over six million people have died from the virus (WHO, 2022), with the number dying varying considerably between countries. For example, while just over 134,000 people had died in Germany by the end of April 2022, the comparable figure for the UK was 174,000 (FT Visual & Data Journalism Team, 2022). The corresponding figures for Japan and Australia were, respectively, 29,000 and 7,000 (FT Visual &

Beyond the Pandemic?

Exploring the Impact of COVID-19 on Telecommunications and the Internet, 1–15

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doi:10.1108/978-1-80262-049-820231001

Data Journalism Team, 2022). Of the six million deaths reports, the European Union (EU) collectively accounted for just over one million and the United States for just under one million (FT Visual & Data Journalism Team, 2022). While these deaths, in their absolute numbers and relative differences, reflect many factors, they underline the significant human cost that the pandemic has wrought.

Governments sought to contain the spread of the pandemic by imposing numerous restrictions. While the stringency of these restrictions varied between countries (Hale et al., 2021), which reflected the societal and institutional characteristics of the country, there was a degree of commonality to the responses adopted: governments sought to limit the spread of the disease through limiting social interactions, encouraging individuals not to socialise and for organisations to adopt virtual ways of working wherever possible. In parallel to these restrictions on social interactions, some governments supported the development of vaccines, resulting in the emergence of multiple drugs from different companies – for example, AstraZeneca, BioNTech and Moderna – being used to tackle COVID-19. Once the vaccines were available and had received the relevant regulatory approvals to be used, governments established vaccine roll-out schemes, which were often ambitious in their scope and speed, to vaccinate their populations (Bloomberg, 2022; Evershed et al., 2021; Mathieu et al., 2021; Maxmen & Subbaraman, 2021; NAO, 2022; Sasse & Hodgkin, 2022). Some governments also developed technological solutions to track cases, utilising the widespread availability of smartphones to ascertain who interacted with whom and take appropriate action if someone was diagnosed as being COVID-19 positive (Russo et al., 2021). Not only did these ‘track and trace’ apps vary technologically (O’Neill et al., 2020) but also in their cost – Germany’s app cost €20 million (Connolly, 2020) while the UK’s app was more expensive at £76 million (NAO, 2021). Although these apps raised privacy concerns in various countries and contexts (Norton Rose Fulbright, 2021; Starks, 2020), the adoption and effect of these apps and thus their actual contribution to containing the spread of the virus has been fundamentally questioned (de la Garza, 2020; White & van Basshuysen, 2021).

As more people were infected with COVID-19 and governments imposed restrictions to tackle its impact, the economy was also affected (Yeyati & Fillippini, 2021). Countries saw their GDP fall as economic activity declined, with some of the falls being very sharp. The declines in GDP have also differed between countries (Jackson et al., 2021). Looking at the G7 group of countries, between 1Q20 and 3Q20, the UK experienced a much larger fall in its GDP (as measured by volume) than the other countries (ONS, 2021a). The UK’s GDP fell by 8.6%, with the equivalent figures for other members of the G7 being, for example, around 5% for both Canada and Italy (ONS, 2021a). Looking further afield, the GDP of Poland fell by 2.7% in 2020 while that of Spain declined by 10.8% in the same period (Jackson et al., 2021). As the pandemic has progressed, with waves of new variants and associated restrictions on the one hand and improved medical responses on the other, GDPs have recovered. Having said this, the protracted nature of the pandemic has resulted in the recovery taking longer than was initially anticipated. Moreover, both the impact on and the recovery paths

within different parts and sectors of the economy have varied considerably. An insightful overview of the recovery in different countries, albeit rich ones, is provided by the OECD's COVID-19 Recovery Dashboard (OECD, 2022). The data show and compare the recovery process in different countries along a wide variety of different dimensions related to economic strength and equality (inclusion), as well as resilience and ecological sustainability. These insights illustrate the different dimensions of the impact that COVID-19 had on countries.

To counter the spread of COVID-19, individuals and organisations were encouraged to go online. Individuals began to work from home, though this was not possible for everyone due to differences in the knowledge intensity of their employment (Dingel & Neiman, 2020; Holgersen et al., 2021; Stocker & Whalley, 2021). Moreover, even when it was possible, numerous problems emerged such as how to work in homes not designed to accommodate what became long-term working as well as how to manage the blurred line between work and private life (Al-Habaibeh et al., 2021; Farrell, 2020; Toniolo-Barrios & Pitt, 2021). And as education moved online, another challenge that many parents faced was how to juggle home educating their children with working (BBC, 2021; Canales-Romero & Hatchfeld, 2022).

There were initial concerns that the Internet would not be able to cope with the rapid and unexpected increase in demand as activities moved online. For the most part, it did cope rather well. Operators saw an increase in demand that would typically occur over the course of a year happen in just a few weeks, with usage patterns emerging that led to troughs in usage being filled in to lessen the difference that occur between highs and lows in demand. Furthermore, as working from home blurred the distinction between weekdays and weekends, demand patterns converged accordingly. To cope with the increased demands placed on their telecommunications infrastructures, operators had to invest in their networks. A frequent observation made in this context was that previous investments had provided networks with 'headroom' that helped them cope with the pandemic-related surge in demand. Since this surge created an upward level shift in demand, it, in essence, brought forward infrastructure investments (Feldmann et al., 2020, 2021; Stocker & Whalley, 2021).

While the Internet coped well with the increased demands placed on it, other parts of the technological infrastructure needed to support and enable the move online struggled, at least initially. The widespread move of work, education, etc., online requires connectivity along with cloud and video conferencing infrastructures. Not all providers of relevant online services could seamlessly expand their operations to meet the new demand while maintaining high and stable levels of customer experience. For example, Microsoft Teams famously struggled when Europe was logging in to work remotely in February 2020 when restrictions forced a large number of individuals to work from home. Their service was interrupted for about two hours (Warren, 2020). Similarly, Zoom struggled to cope with the dramatically changing demands for their service due to remote work and online learning early in the pandemic. Large parts of their user base experienced degraded performance or (partial) outages (Narcisi, 2020). Moreover, unprecedented privacy and security challenges emerged.

The challenges different providers of online services faced varied considerably. As the pandemic revealed, cloud-based services scaled and generally fared quite well during the pandemic. While some large content providers that have their own cloud and serving infrastructures faced complications with scaling their capacities – arguably related to supply chain problems that impeded the pace at which they could upgrade and expand their infrastructures – some companies like Dropbox resorted to public cloud solutions to scale their operations to meet new demands (O’Brien, 2020; Svedlik, 2020).

Organisations turned to video conferencing software to support their remote work or education, allowing hitherto largely unknown applications like Teams and Zoom to dramatically expand their number of users. Zoom, for instance, was launched as a product in 2013 and had steadily grown so that by the end of 2019, 10 million people were participating daily in meetings using the software (Zoom, 2020). By April 2020, this figure had grown to 300 million (Zoom, 2020). Although this growth undoubtedly brought about benefits, enabling individuals to communicate and companies to shift their work online, a number of problems emerged. It erroneously claimed its video services were encrypted (Chin, 2020; Kastrenakes, 2020), and were arguably slow to react when features introduced to enhance convenience were abused (Newton, 2020; Peters, 2020). Notwithstanding the problems that Zoom encountered, it has, like Teams, enjoyed spectacular growth during the pandemic: it has seen its revenues grow from \$622 million in the year to January 2020 to \$4,099 million in the year to January 2022 (Zoom, 2022), while Teams surpassed 270 million active monthly users in January 2022 (Foley, 2022).

The relative robustness of telecommunications infrastructure, coupled with the widespread availability of video conferencing software, facilitated the move online of many activities. Unsurprisingly, working from home negatively impacted on the number of people commuting to work. Google Mobility Trends, as visualised by Our World in Data (Ritchie et al., 2020), have captured and vividly demonstrate the fall in the number of workplace visitors that occurred as lockdowns were imposed to limit the spread of COVID-19. Significantly reduced levels of commuting had a knock-in effect on other activities; shifting, among other things, where individuals spent their day and money away from city centres towards the suburbs (Ramani & Bloom, 2021; Romei & Burn-Murdoch, 2020). Such shifts, which were just one among the many impacts that COVID-19 had on urban areas, exacerbated the existing (developmental) challenges within cities (Athey et al., 2021; UN, 2020). Some commentators, however, noted that the pandemic provides an opportunity for changes to be made in urban areas, tackling existing problems as well as those that emerged due to COVID-19 (Athey et al., 2021; Lenhart & Mistry, 2020; Shenker, 2020; Tabary, 2020; Vianello & Krabbe, 2021).

Successive waves of the virus have prolonged the pandemic, with restrictions being gradually lifted over many months – see, for example, the ‘Government Stringency Index’ or ‘Stay-at-home restrictions’ reports generated by Our World in Data (Ritchie et al., 2020). The protracted nature of the pandemic provided individuals with ample opportunity to familiarise themselves with, and adjust

to, new ways of working. While some made significant changes, with the term ‘great resignation’ being coined in the United States to encapsulate the scale of the number of people making changes (Chugh, 2021), many embraced working from home and even moved outside of densely populated areas to more rural areas, a development which has become known as the so-called ‘donut effect’ (Bloom et al., 2022; Ramani & Bloom, 2021). As a consequence, the easing of restrictions has not been accompanied by the mass return of employees to offices but instead by a degree of uncertainty regarding ‘post-pandemic’ ways of working (Alexander et al., 2021) and the desire of many to remain wholly online or engage in hybrid ways of working (Ernst & Young Global, 2021; Lund et al., 2021; ONS, 2021b).

That some have cast doubt on the relationship between the pandemic and individuals resigning (Fuller & Kerr, 2022), noting individuals were making significant lifestyle changes before COVID-19, illustrates the need to both place pandemic-related developments within a wider context as well as question the extent to which changes have been accelerated by COVID-19. For instance, although working from home did occur before the pandemic, COVID-19 resulted in a step change in its adoption and use as governments imposed restrictions to limit the spread of the virus (Strauss, 2021). As these were lifted, the instances of working from home declined but were still at levels far in excess of those from before the pandemic commenced. The pandemic has, therefore, resulted in a step change increase in working from home. The scale of the changes of working from home in the United States and UK were outlined by Nick Bloom when he stated that:

[...] before the pandemic all-paid-days work from home was very rare, about 5 per cent of paid days. During the pandemic, it was roughly 50 per cent. Post-pandemic, it looks as if those employees are going to work, on average, two to three days a week in the office and two to three days a week at home, so you get to about 25 per cent of days. That is a fivefold increase. Pre-pandemic, working from home was doubling roughly every 12 to 13 years, so it is about 30 years of increase in work from home over the space of 18 months. (Strauss, 2021)

In other areas, the pandemic has been disruptive. There has, for instance, been a significant increase in e-commerce. Global e-commerce sales grew to \$26.7 trillion in 2020 (UN, 2021), with the proportion of all retail sales accounted for by e-commerce growing to 19%. The assessments of the impact of COVID-19 on e-commerce often differ in their exact details, with the numbers differing depending on the methodology adopted and the sectors focused on, but they do agree on the observation that the pandemic has increased e-commerce sales, often substantially. For instance, the pandemic contributed to e-commerce sales of \$102 billion in 2020 and \$116 billion in 2021 in the United States (Berthene, 2022), while another assessment suggested that the onset of the pandemic accelerated e-commerce sales by between four and six years (Koetsier, 2020).

This growth, while highlighting the increasing role that e-commerce plays in retail markets, masks the variation that occurs. Lund et al. (2021) note that

e-commerce accounts for 27% of retail sales in China and 24% in the UK, with the figure being considerably lower in the case of Germany (14%), Spain (9%) and France (9%). The growth rate of retail e-commerce sales in 2020 also varied between countries, with the rate doubling in the case of France, trebling in the United States and rising fourfold in the UK (when the average for 2015–2019 is compared to 2020).

A geographically broader assessment of the impact of the pandemic on e-commerce can be found in [UNCTAD \(2020\)](#), which illustrates how it has increased in emerging markets in response to COVID-19. The report also notes how the pandemic has accelerated existing (technological) trends, which apart from the role of online, includes the use of social media but also brought into sharp relief challenges such as the continued use of cash as well as the need to improve the logistical infrastructure underpinning e-commerce. More broadly, while demand for offline retailing has returned as governments relaxed the restrictions they imposed to limit the spread of COVID-19, online retailing has remained strong ([Wheat et al., 2021](#)).

As individuals and companies turned towards e-commerce, online marketplaces witnessed substantial increases in the number of transactions that they supported. For example, in Africa, Jumia witnessed a 50% increase in the number of transactions over the course of the first half of 2020 ([UNCTAD, 2021](#)). The impact of the pandemic was also felt in other areas, with, for example, remote and hybrid approaches to education being quickly developed ([UNESCO, 2020](#)). While blended learning was growing in popularity before the pandemic, COVID-19 rapidly expanded its utilisation and engrained the (new) approaches within the educational sector's ways of working. Similarly, restaurants utilised digital technologies to engage with their consumers when dining-in options were not possible. As restrictions were lifted, these were combined into hybrid approaches that combine elements of dining-in and off-premise consumption (e.g. take away, app-based ordering and delivery) ([Chick et al., 2020, 2021](#)). And companies have developed 'ghost kitchens' to produce food for app-based delivery services ([Kim, 2021](#)).

This volume explores the impact of COVID-19. It seeks to shed light on the degree to which the impact of COVID-19 was disruptive, or whether it wrought changes that amplified and accelerated existing (but perhaps overlooked) trends. In doing so, it seeks to move away from the initial assessments of the impact of COVID-19, which were grounded in the uncertainty associated with the start of the pandemic, towards a more reflective evaluation that places developments within their wider and longitudinal context. The starting point for the analysis contained in this book is determining how the Internet coped with the increased demand that occurred as restrictions were imposed to curb the spread of the virus. Quite simply, without a functioning Internet infrastructure, it would not have been possible to support the move online of a vast array of activities.

But as large parts of the economy moved online and governments sought to cope with the impact of the pandemic, this had a far-reaching impact on those sectors moving online as well as those who used digital services. This book explores

these impacts, albeit focusing on a small number of areas to provide an in-depth analysis of the impact that COVID-19 has had. Collectively, these areas illustrate the multifaceted nature of the transformational impact of the move online, which accelerated existing technological trends on the one hand and created new opportunities on the other. However, the move online of a wide array of activities was not without its problems. Existing challenges, inherent to the widespread use of digital technologies, such as misinformation and digital divides were exacerbated, while new ones emerged reflecting both the scale and speed of the move online as well as the impact of employee availability as people caught the virus.

Moreover, challenges and the ability to effectively respond to the pandemic and resiliently cushion its negative social and economic effects varied considerably across different countries and regions, thus emphasising the impact of the state and affordability of broadband, the presence of cloud and interconnection infrastructures, as well as aspects related to digital skills and literacy. Furthermore, aspects such as employment structures shape the transferability of tasks into the virtual sphere.

1.2. The Structure of the Book

The remainder of this volume is divided into 11 chapters. The first two chapters are united in their exploration of what happened. In Chapter 2 – ‘COVID-19 and the Internet: Lessons Learned’ – Volker Stocker, William Lehr and Georgios Smaragdakis set the stage for subsequent chapters through their comprehensive investigation and evaluation of the evolving impact of the pandemic on Internet usage and traffic. With a focus on the EU and the United States and an exploration of responses to the pandemic by policy-makers and the private sector, the authors derive collective insights and lessons for a future post-COVID-19 world.

The most obvious lesson emerging from the analysis is that the Internet ecosystem and its supporting network infrastructures were able, at least for the most part, to meet the challenge of supporting a massive shift of economic and social activity to online broadband networks and services, at least in most developed countries with advanced telecommunications infrastructures. There were problems, but, in the main, the networks were successful in meeting the demands placed upon them, and, in so doing, helped sustain significant economic activity that otherwise would not have been feasible.

The authors further explain how responses by different actors of the ecosystem helped to cope with the sudden and unexpected shifts and subsequent changes in online activity. COVID-19 re-confirmed and demonstrated to those previously unconvinced the essentiality of access to online services and digital infrastructure for social and economic participation, prompting policy-makers to renew commitments to address digital divides and calling for a holistic consideration of what is needed to address those divides. The chapter lays out how the pandemic has fuelled, accelerated and amplified networking trends, thus acting as a change agent rather than a game changer, making the ecosystem more resilient and robust.

In Chapter 3 – ‘COVID-19 and the Shift to Remote Work’ – J. Scott Marcus highlights the significant impact that COVID-19 had globally on accelerating the shift to remote work; a development that can be considered a potential silver lining to the COVID-19 pandemic tragedy. The shift to remote work had long been anticipated because the increased use of remote work promised many important benefits. Remote work has the potential to increase labour participation and productivity because of the increased flexibility of job design. It can also expand the shift to self-employment, part-time work and increased accessibility to work options for those previously excluded from in-person/full-time work environments. But the shift also has costs in terms of loss of management control and reduced social interaction, and significant up-front adjustment costs in business processes, firms and value-chain organisation.

COVID-19 served as a forcing function, compelling businesses and workers to adopt remote work solutions since status-quo modes of operation were suddenly rendered inoperable. The opportunity and shift to remote solutions varied significantly across countries, workers, tasks, with knowledge-workers being best positioned to switch. Empirical summaries of many key indicators of the underlying enablers and trends evidenced in those indicia before and after COVID-19 and across national markets are provided in the chapter.

Looking ahead, the chapter explains why it is reasonable to expect the systemic shift to more remote work to be permanent although the ‘new normal’ is likely to see a re-balancing as post-COVID-19 restrictions on in-person work are relaxed and as those workers in countries and jobs without telework options see renewed efforts to expand those options (e.g. increased motivation from governments to promote universal broadband). However, inherent differences across jobs and tasks impact on the feasibility of sustainable remote work and there are inherent limits to the benefits of increased remote work.

The impact of COVID-19 is explored in Chapters 4–7 (inclusive). In the first of these – ‘Digital Transformation of Educational Institutions Accelerated by COVID-19: A Dynamic Capabilities Approach’ – André Renz and Romy Hilbig explore the pandemic’s effect in the educational sector. After a brief systematic literature review and discussion, the authors present a theoretical approach based on the dynamic capabilities theory to identify the critical digital capabilities necessary to successfully adapt to the pandemic, especially with respect to the shift to remote/online learning.

While relevant capabilities are subsumed under the categories of digital dynamic sensing, seizing and transforming, the authors identify fast decision-making and flexibility on the side of, employees, students and the teachers’ internal enablers of, and in particular a lack of skills as internal barriers to strategically adapting and transforming the business models of educational institutions. The assessment of the influence of the pandemic on the digital transformation of educational institutions is somewhat sobering but rather unsurprising – even though the pandemic has given rise to a range of innovations, it has not resulted in a transformation of educational institutions.

Smart cities are increasingly common, especially in developed countries. Through the extensive application of ICT, they promise many benefits, ranging