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Insight Report

The Global Information Technology Report 2016

Innovating in the Digital Economy

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Editors

The Global Information Technology Report 2016 is a special project within the framework of the World Economic Forum's Global Competitiveness and Risks Team and the Industry Partnership Programme for Information and Communication Technologies. It is the result of collaboration between the World Economic Forum and INSEAD.

Visit *The Global Information Technology Report* page at www.weforum.org/gitr.

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Preface

RICHARD SAMANS, Member of the Managing Board, World Economic Forum
MARGARETA DRZENIEK HANOUZ, World Economic Forum

As the 2016 edition of *The Global Information Technology Report* is released, the world is entering the Fourth Industrial Revolution. Processing and storage capacities are rising exponentially, and knowledge is becoming accessible to more people than ever before in human history. The future holds an even higher potential for human development as the full effects of new technologies such as the Internet of Things, artificial intelligence, 3-D Printing, energy storage, and quantum computing unfold.

The exponential speed of developments; disruption across all major industries; and the impact on entire systems of production, management, and governance are what differentiates these developments from previous "industrial revolutions." However, while all these developments will bring many benefits, they also carry risks. If managed well, they have the potential to give rise to innovation that will drive growth and social impact. If not handled appropriately, challenges such as the rising threat of cyberattacks that expand into the physical world, privacy issues, and the polarizing effects of technologies on labor markets could derail these benefits. Countries and businesses that embrace these developments, anticipate challenges, and deal with them in a strategic way are more likely to prosper, while those that do not will more likely fall behind.

Information and communication technologies (ICTs) are the backbone of this revolution. The future of countries, businesses, and individuals will depend more than ever on whether they embrace digital technologies. And many of those who stand to gain the most are not yet connected.

Since 2001, *The Global Information Technology Report* series published by the World Economic Forum in partnership with INSEAD and Cornell University has measured the drivers of the ICT revolution globally, using the Networked Readiness Index (NRI). The Index has evolved over time and currently assesses the state of networked readiness using 53 individual indicators. For each of the 139 economies covered, it allows the identification of areas of priority to more fully leverage ICTs for socioeconomic development.

Four important messages emerge from the *Report* this year. First, innovation is increasingly based on digital technologies and business models, which can drive economic and social gains from ICTs if channelled in a smart way. Second, the way businesses adopt ICTs is key for leveraging them for development, so encouraging businesses to fully embrace the powers of digital technologies should be a priority of governments. Third, both the private sector and governments need to step up efforts to invest in innovative digital solutions to drive social impact. Last but not least, a sustainable digital economy will depend on quickly evolving governance frameworks that allow societies to anticipate and shape the impact of emerging technologies and react quickly to changing circumstances.

Against this background, the *Report* is meant to be a call for action. Policymakers must work with other stakeholders to swiftly adopt holistic long-term strategies for ICT development and lead in adapting governance and leadership behaviors to ensure that ICTs deliver maximum benefits. Under the theme "Innovating in the Digital Economy," *The Global Information Technology Report 2016* highlights striking innovation patterns in the NRI data that can help point the way for policy and investment priorities.

As the digital economy is developing exponentially, its measurement must evolve as well. Chapter 1.1 therefore includes an outlook for potential next steps for the NRI that can serve as a starting point for discussing the evolving concepts and measurements of networked readiness. In the course of the coming year, we plan to identify key questions concerning the drivers and implications of the emerging Fourth Industrial Revolution and develop relevant concepts and measures with experts, policymakers, and businesses to be included in the updated next edition of the NRI.

The *Report* is part of the World Economic Forum's wider efforts to address digital technology questions through its System Initiative on the Digital Economy and Society. The aim of this initiative is to help shape the Internet as a true and open platform and as a driver of economic development and social progress. We hope that through this *Report* and its system initiatives the World Economic Forum can contribute to making the ICT revolution truly global, growth-supportive, and inclusive.

Acknowledgments

ALAN MARCUS
World Economic Forum

Over the past 16 years, the World Economic Forum, INSEAD, and, more recently, Cornell University have partnered on publishing *The Global Information Technology Report* (GITR), which examines the increasing proliferation of technology and its effects on advancing global prosperity. Today we have come to a critical tipping point, where the ICT-fueled digital economy is taking off in an exponential way. We have also come to recognize the beginning of a Fourth Industrial Revolution, which will fundamentally change the way we live, work, and relate to one another. This transformation is not defined by any particular set of technologies, but rather by a transition to new ecosystems built on the infrastructure of the digital revolution. The World Economic Forum is seeking to shape and design these new systems by emphasizing and scaling cross-sector and cross-geographic collaborations. The key findings of this *Report* over the years led to and informed a broad range of discussions around the Forum's *Future of Digital Economy and Society* system, such as digital inclusion and access, cybercrime and cybersecurity, data privacy and usage, digital transformation of business, digital governance, and trade across borders.

Under the theme "Innovating in the Digital Economy," this year's *Report* looks into how digital technologies are changing the nature of innovation in various ways. The *Report* examines the exponential shift brought about by digital technologies, the way we measure the impact of innovation, the continuous pressure for both tech and non-tech sectors to boost innovation through digital means, and the need for agile governance and regulation systems to adapt to the speed and scale of changes while mitigating ethical, legal, and regulatory risks.

Each year, the ICT Industries and the Global Competitiveness and Risks Teams at the World Economic Forum collaborate on the annual production of the GITR; the *Report* has evolved to become one of the most respected publications of its kind. As we shift toward a systems approach to solve the most challenging issues stemming from the Fourth Industrial Revolution, this *Report* will continue its evolution to capture milestones in unleashing the full potential of the digital economy led by ICTs, and to inform decision-making processes for policymakers and organizations across sectors and regions.

We would like to acknowledge the editors of the *Report*, Silja Baller at the World Economic Forum; Professor Soumitra Dutta, Dean of the College of Business at Cornell University; and Bruno Lanvin at INSEAD. The World Economic Forum and INSEAD and, more recently, Cornell University have been publishing the GITR since 2001; through this longstanding partnership, the three institutions have developed and evolved the Networked Readiness Index (NRI) to reflect the growing importance of technology and innovation across the world.

A special thanks also goes out to our *Report* partner, Cisco, for its continuous support and engagement in this year's edition. We also wish to convey our gratitude to Robert Pepper, John Garrity, and Connie LaSalle at Cisco Systems for their unique contributions, built upon the insights generated by the NRI; their enhancement of its thematic elements; and their contributions to the overall distinctiveness of the *Report.*

We would like to extend our sincere thanks to Professor Klaus Schwab, Chairman of the World Economic Forum for his leadership. Appreciation goes to the core project team: Silja Baller, Oliver Cann, Attilio Di Battista, Danil Kerimi, and Roger Yong Zhang. We also wish to acknowledge the leadership of Richard Samans, Member of the Managing Board, as well as Jennifer Blanke, Chief Economist, and the contributions of members of the Global Competitiveness and Risks Team: Ciara Browne, Roberto Crotti, Gaëlle Marti, Margareta Drzeniek Hanouz, Caroline Galvan, Daniel Gomez Gaviria, Thierry Geiger, and Stéphanie Verin. Appreciation also goes to the members of the Information and Communication Technology Industries Team, under the leadership of Cheryl Martin, Head of Centre for Global Industries, and Murat Sönmez, Chief Business Officer: David Connolly, Aurelie Corre, Daniel Dobrygowski, Mara Kelly, Peter Lyons, Isabelle Mauro, Derek O'Halloran, and Adam Sherman.

Last but not least, we would like to express our gratitude to our 160 Partner Institutes around the world and to all the business executives who completed our Executive Opinion Survey.

Foreword

CHUCK ROBBINS
Chief Executive Officer, Cisco Systems

In my 18 years at Cisco, I have seen first-hand how technology can transform industries and lives. As the role of hardware, software, and services becomes even more important for governments, businesses, and individuals, the high-speed broadband Internet Protocol (IP) networks that enable them have become integral to daily life. In fact, by 2020, there will be over 26 billion Internet-connected devices and over 4 billion global Internet users. Broadband Internet has been categorized as one of the world's most important general-purpose technologies, with the capability to dramatically impact social structures and entire economies.

Underpinning this development is data's role as the new currency. Every day, exabytes of new data are created and transported over IP networks. In 2016 the world has entered the "zettabyte era": global IP traffic will reach 1.1 zettabytes, or over 1 trillion gigabytes. By 2020 global IP traffic will reach 2.3 zettabytes. This data growth is fueling economies, sparking innovation, and unleashing waves of creativity. This year's *Global Information Technology Report* highlights the role of technology, and broadband in particular, in driving global innovation.

But no innovation can occur without the network. IP networks have the capacity to connect every person, every country, and every IP-enabled device. Global networks allow data to flow unimpeded, driving growth and enabling collaborative innovation in many areas, from production to processes. Those countries that are adept at fostering digital activity will continue to see new industries emerge, as well as experience the accelerated development of traditional sectors.

The global Internet must therefore be allowed to further develop without obstacles—this is essential in order for everyone to benefit. Increasingly, barriers to digital flows threaten to diminish the Internet's potential to drive positive social and economic impact. The open exchange of information is a hallmark of the growing knowledge economy. All stakeholders—including governments, businesses, the technical community, citizens, and consumers—play a role in building trust and confidence in global networks. Privacy and security should be integrated into technological design from the outset; strategies to protect and maintain the integrity of data must account for an array of diverse and emerging risks; and policy should enable innovation and global data flows while safeguarding against those who seek to cause damage.

Getting the balance right requires active, collaborative participation from everyone. At Cisco, we are committed to helping drive the next wave of global growth, productivity, and innovation.

Executive Summary

SILJA BALLER, World Economic Forum
SOUMITRA DUTTA, Cornell University
BRUNO LANVIN, INSEAD

Part 1 of the 2016 edition of *The Global Information Technology Report* assesses the state of networked readiness of 139 economies using the Networked Readiness Index (NRI) (Chapter 1.1) and, under the theme "Innovating in the Digital Economy," examines the role of information and communication technologies (ICTs) in driving innovation (Chapters 1.1 and 1.2). Part 2 consists of an extensive data compendium with the detailed performance of each economy in the NRI (Section 2.1) and rankings for each of the 53 individual indicators included in the NRI (Section 2.2).

PART 1: INNOVATING IN THE DIGITAL ECONOMY

We are at the dawn of the Fourth Industrial Revolution, which represents a transition to a new set of systems, bringing together digital, biological, and physical technologies in new and powerful combinations. These new systems are being built on the infrastructure of the digital revolution. *The Global Information Technology Report 2016* features the latest iteration of the NRI, which assesses countries' preparedness to reap the benefits of emerging technologies and to capitalize on the opportunities presented by the digital revolution and beyond.

The Networked Readiness Index 2016

Chapter 1.1 presents the results of the NRI 2016, which measures the capacity of countries to leverage ICTs for increased competitiveness and well-being. It also considers innovation trends of recent years through the lens of the NRI.

The networked readiness framework

The networked readiness framework rests on six principles: (1) a high-quality regulatory and business environment is critical in order to fully leverage ICTs and generate impact; (2) ICT readiness—as measured by ICT affordability, skills, and infrastructure—is a pre-condition to generating impact; (3) fully leveraging ICTs requires a society-wide effort: the government, the business sector, and the population at large each have a critical role to play; (4) ICT use should not be an end in itself. The impact that ICTs actually have on the economy and society is what ultimately matters; (5) the set of drivers—the environment, readiness, and usage—interact, co-evolve, and reinforce each other to form a virtuous cycle; and (6) the networked readiness framework should provide clear policy guidance.

The framework translates into the NRI, a composite indicator made up of four main categories (subindexes), 10 subcategories (pillars), and 53 individual indicators distributed across the different pillars:

A. Environment subindex
1. Political and regulatory environment (9 indicators)
2. Business and innovation environment (9 indicators)

B. Readiness subindex
3. Infrastructure (4 indicators)
4. Affordability (3 indicators)
5. Skills (4 indicators)

C. Usage subindex
6. Individual usage (7 indicators)
7. Business usage (6 indicators)
8. Government usage (3 indicators)

D. Impact subindex
9. Economic impacts (4 indicators)
10. Social impacts (4 indicators)

The computation of the overall NRI score is based on successive aggregations of scores: individual indicators are aggregated to obtain pillar scores, which are then combined to obtain subindex scores. Subindex scores are in turn combined to produce a country's overall NRI score. The appendix of Chapter 1.1 presents the detailed methodology and composition of the NRI.

About half of the individual indicators used in the NRI are sourced from international organizations. The main providers are the International Telecommunication Union, UNESCO and other UN agencies, and the World Bank. The other half of the NRI indicators are derived from the World Economic Forum's Executive Opinion Survey (the Survey). The Survey is used to measure concepts that are qualitative in nature or for which internationally comparable statistics are not available for enough countries. The 2015 edition of the Survey was completed by over 14,000 business executives in more than 140 countries.

Key Findings

Under the theme "Innovating in the Digital Economy," *The Global Information Technology Report 2016* highlights the ways in which the digital revolution is changing both the nature of innovation and the rising pressure for firms to innovate continuously. The analysis yields four key findings:

Key Finding 1: The digital revolution changes the nature of innovation. One of the key characteristics of the digital revolution is that it is nurtured by a different type of innovation, increasingly based on digital technologies and on the new business models it allows. In addition to making traditional research tools more powerful, it allows for new and near-costless types of innovation that require little or no R&D effort. Examples include the digitization of existing products and processes, distributed manufacturing, blockchains, and advertising-based "free services" as well as the prospect of more "uberized" activities in multiple sectors, including transport, banking, entertainment, and education.

The NRI data show that the minds of business executives around the world are increasingly focused on innovation, as reflected by the steady upward trend in firms' perceived capacity to innovate. Traditional measures for innovation, such as the number of patents registered, are picking up only part of the story. Instead, new types of innovation, such as business-model innovation, look set to become an important part of the innovation story: executives in almost 100 countries report increases in the perceived impact of ICTs on business-model innovation compared with last year.

Key Finding 2: Firms will face increasing pressure to innovate continuously. Seven countries stand out in terms of economic and digital innovation impact: Finland, Switzerland, Sweden, Israel, Singapore, the Netherlands, and the United States. Considering the different elements of networked readiness for these seven countries, it is noticeable that all seven are characterized by very high levels of business ICT adoption. This technology-enabled innovation in turn unleashes new competitive pressures that call for yet more innovation by tech and non-tech firms alike.

Because digital technologies are driving winner-take-all dynamics for an increasing number of industries, getting there first matters. However, although firms feel that overall capacity to innovate has increased, a stagnating rate of ICT adoption and usage by existing firms across all regions suggests that a large number of firms are not getting into the game fast enough.

Key Finding 3: Businesses and governments are missing out on a rapidly growing digital population. In recent years, digital innovation has been primarily driven by consumer demand. Yet this increasing demand for digital products and services by a global consumer base is largely being met by a relatively small number of companies. Businesses need to act now and adopt digital technologies to capture their part of this growing market. A widening and worrying gap is also emerging between growth in individual ICT usage and public-sector engagement in the digital economy, as government usage is increasingly falling short of expectations. Governments can do more to invest in innovative digital solutions to drive social impact.

Key Finding 4: A new economy is shaping, requiring urgent innovations in governance and regulation. As the new digital economy is taking shape, offering it the right framework conditions will be crucial to ensuring its sustainability. Digital technologies are unleashing new economic and social dynamics that will need to be managed if the digital transformation of industries and societies are to deliver long-term and broad-based gains. A resilient digital economy also calls for new types of leadership, governance, and behaviors. A critical ingredient for the success and sustainability of the emerging system will be agile governance frameworks that allow societies to anticipate and shape the impact of emerging technologies and react quickly to changing circumstances.

Networked Readiness Index 2016: Results overview

Chapter 1.1 then reports the rankings of the overall NRI 2016, its four subindexes, and their respective pillars.

The composition of the group of top 10 performers is unchanged from last year. The group consists of a mix of high-income Southeast Asian (Singapore and Japan) and European countries (Finland, Sweden, Norway, the Netherlands, Switzerland, the United Kingdom, and Luxembourg) as well as the United States. Networked readiness therefore remains highly correlated with per capita income.

Europe remains at the technology frontier with seven out of the top 10 NRI countries being European. Yet the performance range is wide, with Greece dropping four places to 70th position and Bosnia and Herzegovina closing the group at 97. Several Eastern European countries—notably the Slovak Republic, Poland, and the Czech Republic—are making big strides, landing spots in the top 50 of the NRI; better affordability and large improvements in economic and social impacts are contributing to this success in these three countries in a major way. Italy is another notable mover this year, improving 10 places to reach 45th position as economic and social impacts of ICTs are starting to be realized (up 18 in the global impact rankings).

The **Eurasia region** continues its upward trajectory, with the average NRI score for the region increasing significantly since 2012. In particular, it is notable that the improvement is observed across all four elements that make up the Index: Environment, Readiness, Usage, and Impact. The region is led by Kazakhstan, which

continues on its positive trajectory of recent years to land in 39th position this year.

Leading the **Emerging and Developing Asian** economies in 2016 is Malaysia, which continues to perform strongly and moves up one spot to 31st position overall; this performance is supported by a government that is fully committed to the digital agenda. The top five in the region in terms of overall ICT readiness remain China, Malaysia, Mongolia, Sri Lanka, and Thailand, as in 2015. The group of Emerging and Developing Asian countries has been both moving up and converging since 2012. Individual usage in the region is still one of the lowest in the world, but has been growing strongly in recent years.

The performance range of countries in the **Latin America and Caribbean region** remains widely dispersed with almost 100 places between Chile (38th) and Haiti (137th). There was no clear trend from 2015 to 2016 in terms of relative performance, with Chile and Haiti staying put; of the remaining group, half of the countries improve their ranking and the other half drop. Considering the absolute NRI score, however, the region has been moving up and converging since 2012. In order to foster the innovation forces that are key for thriving in the digitized world and the emerging Fourth Industrial Revolution, many governments in the region will urgently need to reinforce efforts to improve the regulatory and innovation environment in their countries.

The UAE (26th) and Qatar (27th) continue to lead the Arab world when it comes to networked readiness. The **MENAP region** (Middle East, North Africa, and Pakistan) is home to two of the biggest movers in this year's rankings: Kuwait (61st, up 11) and Lebanon (88th, also up 11). In both cases, individuals are leading the charge with the business sector catching up and strongly contributing to the successful performance. Although governments are lagging behind in terms of digital adoption (81st in Kuwait, 124th in Lebanon), the business community in both countries is registering an increased weight on ICTs in government vision and efforts to improve the regulatory environment.

This year's NRI also sees several **sub-Saharan African** countries among the top upward movers, including South Africa (65th, up 10), Ethiopia (120th, up 10), and Côte d'Ivoire (106th, up 9). Leadership in terms of digital adoption is coming from different groups of stakeholders. Although efforts are very much government-driven in Ethiopia and Côte d'Ivoire, the business sector is providing the most momentum in South Africa. Going forward, the largest barriers to tackle for Côte d'Ivoire will be infrastructure and affordability; reversing the trend of a deteriorating business and innovation environment for South Africa; and individual usage and skills for Ethiopia.

Chapter 1.1 provides an overview of the performance of the 10 best-performing countries in the NRI 2016, a selection of economies that were among the top movers as well as other selected economies, including members of the G20 outside the top 10.

The Index maps a quickly evolving space and has been adapted since its inception in 2001. Since the digital economy is developing exponentially, its measurement must be adapted to reflect the new realities on the ground. A multi-stakeholder process will be put in place to identify key questions concerning the drivers and implications of the emerging Fourth Industrial Revolution and to develop relevant concepts and measures with a view to incorporating these findings into the next edition of the NRI.

Cross-border data flows, digital innovation, and economic growth

In Chapter 1.2, Robert Pepper, John Garrity, and Connie LaSalle explore the impact of the free flow of data across national borders on innovation and growth. The authors highlight the development of cross-border data traffic over Internet protocol, starting with the first email messages in the early days of the Internet to today, where over 3.2 billion people across the world have access to and use the Internet.

The flow of digital communication between countries, companies, and citizens has been recognized for years as a critical driver of economic growth and productivity. Countries adept at fostering digital activity have witnessed the emergence of new industries as well as the accelerated development of traditional sectors. However, despite the intensive and extensive growth of the global Internet, concerns over growing barriers to digital flows are mounting.

The authors first review the literature on the impact of cross-border data flows on countries, companies, and individuals. The chapter then presents an original analysis of the growth of new services built on the free flow of trade through global digitization, and concludes by discussing policy guidelines that mitigate concerns over national data transmission while simultaneously maximizing the benefits of cross-border data flows.

PART 2: DATA PRESENTATION

Part 2 of the *Report* contains individual scorecards detailing the performance in the Networked Readiness Index of each of the 139 economies (Section 2.1) and tables reporting the global rankings for each of the 53 individual indicators composing the NRI (Section 2.2).

Part 1

Innovating in the Digital Economy

CHAPTER 1.1

The Networked Readiness Index 2016

SILJA BALLER, World Economic Forum
ATTILIO DI BATTISTA, World Economic Forum
SOUMITRA DUTTA, Cornell University
BRUNO LANVIN, INSEAD

We are at the dawn of the Fourth Industrial Revolution. The Fourth Industrial Revolution represents a transition to a new set of systems that bring together digital, biological, and physical technologies in new and powerful combinations (Box 1). Just as the digital revolution was built on the heart of the second industrial revolution—electricity, mass communication systems, and modern manufacturing—the new systems that mark the Fourth Industrial Revolution are being built on the infrastructure of the third, digital revolution—the availability of global, digital communications; low-cost processing and high-density data storage; and an increasingly connected population of active users of digital technologies.

The Global Information Technology Report 2016 features the latest iteration of the Networked Readiness Index (NRI), which represents a key tool in assessing countries' preparedness to reap the benefits of emerging technologies and capitalize on the opportunities presented by the digital transformation and beyond. More particularly, the *Report* assesses the factors, policies, and institutions that enable a country to fully leverage information and communication technologies (ICTs) for increased prosperity and crystallizes them into a global ranking of networked readiness at the country level in the form of the NRI.

Countries are assessed over four categories of indicators: (1) the overall environment for technology use and creation (political, regulatory, business, and innovation); (2) networked readiness in terms of ICT infrastructure, affordability, and skills; (3) technology adoption/usage by the three groups of stakeholders (government, the private sector, and private individuals); and (4) the economic and social impact of the new technologies. Whenever relevant, the Index looks at what the different actors in society, both private and public, can do to contribute to the country's networked readiness.

An important channel by which digital technologies can contribute to increased prosperity is via their impact on innovation. As the digital transformation is gathering speed and looks ready to substantially change the global industrial landscape, staying ahead of the curve is becoming more and more important for business survival. Under the theme "Innovating in the Digital Economy" this chapter shines a spotlight on recent innovation trends. It develops a taxonomy of mechanisms for the innovation impact of digital

Acknowledgments: The authors are grateful to David Aikman, Marisol Argueta, Jennifer Blanke, Oliver Cann, Sangeet Choudary, Nicholas Davis, Miroslav Dusek, Mehran Gul, Sriram Gutta, Anastasia Kalinina, Elsie Kanza, Danil Kerimi, Martina Larkin, Alan Marcus, Patrick McGee, Viraj Mehta, Fulvia Montresor, Vanessa Moungar, Bernhard Petermeier, Mel Rogers, Mark Spelman, Christoph Sprung, Lisa Ventura, Bruce Weinelt, Eric White, Justin Wood, and Alex Wong as well as to the Global Competitiveness and Risks Team—Ciara Browne, Roberto Crotti, Margareta Drzeniek Hanouz, Caroline Galvan, Thierry Geiger, Daniel Gomez Gaviria, Gaëlle Marti, and Stéphanie Verin—for valuable feedback and discussions.

Box 1: The Fourth Industrial Revolution

We are at the beginning of a global transformation that is characterized by the convergence of digital, physical, and biological technologies in ways that are changing both the world around us and our very idea of what it means to be human. The changes are historic in terms of their size, speed, and scope. This transformation—the Fourth Industrial Revolution—is not defined by any particular set of emerging technologies themselves, but rather by the transition to new systems that are being built on the infrastructure of the digital revolution. As these individual technologies become ubiquitous, they will fundamentally alter the way we produce, consume, communicate, move, generate energy, and interact with one another. And given the new powers in genetic engineering and neuro-technologies, they may directly impact who we are and how we think and behave. The fundamental and global nature of this revolution also poses new threats related to the disruptions it may cause—affecting labor markets and the future of work, income inequality, and geopolitical security as well as social value systems and ethical frameworks.

Adapted from Klaus Schwab, *The Fourth Industrial Revolution,* 2016.

technologies and draws on NRI data to characterize current innovation dynamics.

One of the key characteristics of the digital era is that it is nurtured by a new type of innovation. In addition to making traditional research tools more powerful, digital technology allows for near-costless types of digital innovation by recombination that requires little or no research and development (R&D) effort.[1] Examples of this type of innovation include the digitization of existing products and processes; new business models, including platform businesses, distributed manufacturing, blockchains, and advertising-based "free services"; and innovation processes such as crowd-sourcing. A key challenge associated with analyzing this new characteristic of innovation is the insufficiency of traditional measures for innovation outcomes, such as patenting activity. Indeed, the NRI data show diverging trends between patenting activity and firms' perceived capacity to innovate, with the latter rising rapidly across all regions.

A second observation regarding innovation in the digital era is that technology unleashes new competitive pressures—for example, by integrating markets—that call for yet more innovation by tech and non-tech firms alike. In addition, because new technologies are driving winner-take-all dynamics for an increasing number of industries, getting there first matters. Firms thus face growing pressure to innovate continuously and scale fast so as not to be displaced. Out of the 10 pillars that constitute the NRI, a high rate of ICT adoption among firms is the most common characteristic of countries that obtain the greatest economic and innovation impact from ICTs. The NRI data suggest that these conditions are in place for only a handful of countries: a perceived stagnating rate of ICT usage by existing firms across all regions indicates that a large number of firms are not getting in the game fast enough.

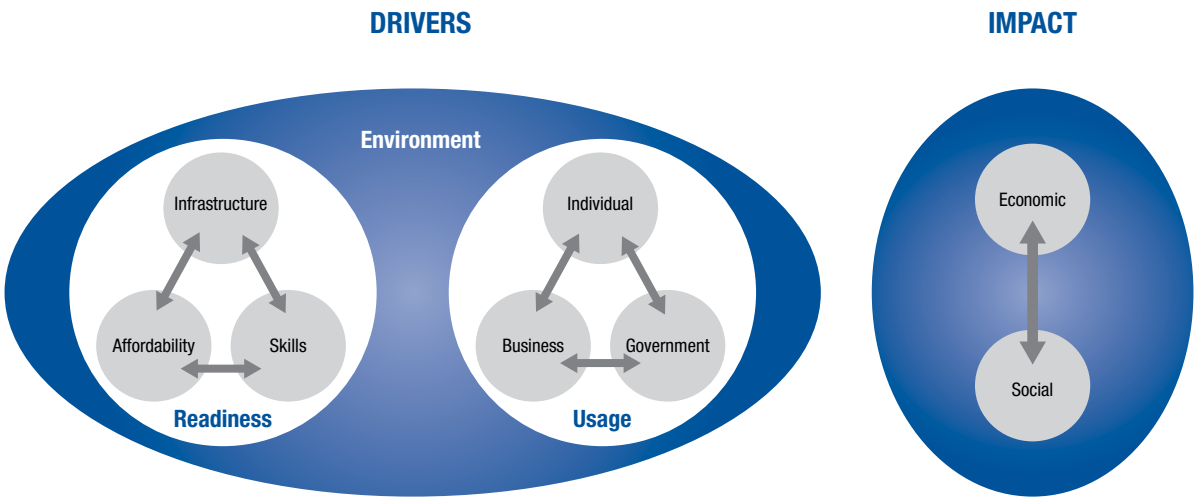
The forces and systems of the emerging Fourth Industrial Revolution will need to be channeled and designed in order to achieve broad-based gains. Finding the right framework conditions in the form of competition and employment policies will be vital. Because the importance of network dynamics has grown significantly with the platform economy, the emergence of lock-in effects needs to be addressed in order to ensure a level playing field. When it comes to the job market, digital technologies are already disrupting existing career paths, ousting entire sets of skills, and creating the need for new ones. At the same time, platform technologies are increasingly used to match workers with jobs, leading to more and more freelance activity. Policy will need to ensure that these developments are not accompanied by a loss of social protection for workers. Education and life-long learning will have key roles to play in the years to come as even more fundamental changes are to be expected in the Fourth Industrial Revolution.

The innovation spotlight concludes by pointing out that the digital economy raises new challenges in multiple arenas, not only in terms of economic imperatives. It also calls for new types of leadership and behaviors, as well as more flexible approaches to governance. New innovation governance approaches, such as the framework for Responsible Research and Innovation (RRI),[2] are highly relevant in this context and are used to anticipate the long-term impacts of emerging technologies.

The second section of this chapter turns to overall global trends in networked readiness as well as regional assessments. The chapter then presents this year's rankings and country-level highlights, including profiles of the top 10 performers and the top countries moving up in the Index.

The Index maps a quickly evolving space and has been adapted since its inception in 2001. Since the digital economy is developing exponentially, its measurement must be modified to reflect the new realities on the ground. This chapter therefore also includes an outlook for potential next steps for the NRI as a starting point for discussing the evolving concepts and measurements of networked readiness. A multi-stakeholder process will be put in place over the course of next year to identify key questions concerning the drivers and implications of the emerging Fourth Industrial Revolution and to develop relevant concepts and measures with a view to incorporating these findings into the next edition of the NRI (see Box 2).

Figure 1: Networked readiness framework



INNOVATION IN THE DIGITAL ECONOMY THROUGH THE LENS OF THE NRI

This section begins with an overview of the networked readiness framework and then considers two key mechanisms by which digital technologies are affecting innovation: the first mechanism is changing the nature of innovation, whereas the second is driving a new urgency to innovate. Next, four key findings that emerge from the analysis of historical and this year's NRI data are presented.

The networked readiness framework

Launched by the World Economic Forum in 2001 and significantly extended in 2012, the NRI can help to assess countries' ability to capitalize on the digital revolution and their preparedness to benefit from the emerging Fourth Industrial Revolution. This chapter uses the NRI to point out some striking patterns in countries' innovation performance. The Index aggregates data from 53 indicators, organized on the basis of the networked readiness framework (Figure 1). Networked readiness rests on whether a country possesses the drivers necessary for digital technologies to unleash their potential, and on whether these technologies are actually impacting the economy and society.

The *drivers* are grouped within three subindexes as follows:

A. Environment subindex

1. Political and regulatory environment (9 indicators)
2. Business and innovation environment (9 indicators)

B. Readiness subindex

3. Infrastructure (4 indicators)
4. Affordability (3 indicators)
5. Skills (4 indicators)

C. Usage subindex

6. Individual usage (7 indicators)
7. Business usage (6 indicators)
8. Government usage (3 indicators)

D. Impact subindex

9. Economic impacts (4 indicators)
10. Social impacts (4 indicators)

About half of the 53 individual indicators used in the NRI are sourced from international organizations. The main providers are the International Telecommunication Union (ITU); the World Bank; the United Nations Educational, Scientific and Cultural Organization (UNESCO); and other UN agencies. Carefully chosen alternative data sources, including national sources, are used to fill data gaps in certain cases. The other half of the NRI indicators are derived from the World Economic Forum's annual Executive Opinion Survey (the Survey). The Survey is used to measure concepts that are qualitative in nature or for which internationally comparable statistics are not available for enough countries.[3]

The 2016 iteration of the Index covers 139 economies, accounting for 98.1 percent of world GDP. Angola, Barbados, Burkina Faso, Libya, Suriname, Timor-Leste, and Yemen—all covered in the 2015 edition—have been excluded, in line with the country coverage of *The Global Competitiveness Report 2015–2016.* Sierra Leone was also excluded, even though Survey data do exist for that country, because too many data points were missing for other indicators. Benin, Bosnia and Herzegovina, Ecuador, and Liberia have been reinstated this year. The appendix provides a detailed description of the networked readiness framework and its rationale, together with a complete methodological note on the computation of the NRI.

Box 2: Possible next steps for the Networked Readiness Index

The NRI, a critical tool for tracking access and impact

Since its inception in 2001, the NRI has proven critical as a tool to identify gaps, to catalyze action, to structure policy dialogue, and to track progress in ICT readiness over time. The indicators that make up the NRI shine a light on two major questions: (1) What level of ICT access and use is reached within a country? (2) What is the impact of digital technologies once there is access?

In order to ensure that the NRI remains relevant in the fast-changing field of ICTs, adjustments to the Index in the next edition are envisaged. To this end, the Forum will convene relevant experts and put in place a rigorous multi-stakeholder consultation to ensure that the Index continues to build on the latest developments in terms of both data and methodology.

Key questions going forward

In a next step, two sets of questions will require attention if the digital revolution is to be shaped in a way that can bring broad-based improvements in living standards, making our societies more prosperous and inclusive.

First, there is a need to measure the impact of technologies beyond productivity and innovation, ensuring that the digital revolution is also socially beneficial and sustainable. In assessing the impact of the unfolding digital revolution, parts of the picture are currently missing. Ideally more mechanisms would be captured by which new technologies enable and empower people and to more systematically keep track of distributional impact. What is measured matters for the way trust in new technologies is built and the way the emerging Fourth Industrial Revolution can be shaped.

Second, new indicators could usefully be introduced to better map various micro-factors of ICT readiness. For example, although the supply side regarding the access question can be measured (see infrastructure and coverage data in the NRI), there are gaps in understanding of the demand side. In particular, a good understanding of the offline population in environments where digital infrastructure is available is absent. Lack of relevant content, missing platforms, and affordability or privacy concerns are potential explanations for why individuals and businesses do not join the online world even though the infrastructure is in place. When it comes to measuring the availability of local content, the World Economic Forum's Global Agenda Council on Media, Entertainment and Information (June 2016) has recently provided suggestions for new indicators in this respect. In a next step, systematic data sources for these indicators will need to be identified. It may be possible to capture some of these demand-side factors using either survey data or possibly commercially collected data. In order get a more accurate picture of the offline population, household surveys will be a critical complement.

Ideally, and conditional on the availability of systematic data, new indicators would also be introduced to anticipate key aspects of the Fourth Industrial Revolution infrastructure and systems.

Country-level measures of ICT readiness will need to be complemented with contextualizing data at the local level. The World Economic Forum is catalyzing data collection at this level in regional partnerships under the umbrella of the Internet for All initiative. Public-private partnerships are vital in this context because data that are critical for public policy are currently collected by private entities.

Unlocking new data sources

Digital technologies have opened the way to new types of data. Given the high frequency, larger coverage, and greater accuracy of such data, it will be important to integrate these into the NRI to the largest extent possible. In order to do so, progress will be essential on several fronts with regard to data access and sharing: much of the new, critical data are being collected by private entities and the location of these data is not necessarily known. Once located, several questions will still need to be solved with regard to data management and sharing. Although data gathering is becoming ever cheaper, data management and storage are not. Considerable legal uncertainties still exist, in particular with regard to privacy considerations and data ownership. Furthermore, the business rationale for data sharing is not necessarily clear in all cases. Finally, big data by itself is missing the local context; thus localized data-gathering efforts continue to remain important. It is worth noting that well-designed surveys are currently still considered best practice for data gathering. Yet as these bottlenecks are being resolved, it will be important to include new data sources that are updated at higher than annual frequency into the NRI data effort.

How digital technology affects the nature and urgency of innovation: Two mechanisms

This section shines a spotlight on the innovation mechanisms brought into play by digital technologies and subsequently shows consistent emerging patterns in the NRI data.

The joint EU/OECD *Oslo Manual* defines innovation as follows: [4]

> An innovation is the implementation of a new or significantly improved product (good or service), a new process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations.

Digital technologies are changing innovation itself in a qualitative way as well as amplifying the urgency to innovate. Identified below are a direct mechanism, which is changing the nature of innovation, and an indirect effect, which drives a new urgency to innovate; the latter applies to tech and non-tech firms alike.

The direct way in which digital technology affects innovation is via an augmentation of existing tools, products, processes, and business models by embedding new technologies. This mechanism applies along the entire value chain from design to marketing. In addition to allowing firms to achieve marginal productivity improvements (e.g., by digitizing existing products

or providing new ways of organizing the production system), digital technologies are importantly changing the nature of innovation itself. The large wave of rapid and accelerating web-driven innovation can be explained by a type of almost costless combinatorial innovation. It relies on the fact that parts that are being combined into new products are bits (protocols and languages) rather than physical parts and components and thus have no time-to-manufacture, no inventory issues, no delivery problems, and can be shipped around the world instantaneously.[5]

In particular, digital technologies are affecting innovation directly in the following ways:

- ***R&D and basic research:*** New technologies augment tools used in research and decrease costs of previously unaffordable research activities. They allow more accurate inference based on larger amounts of data and enable more extensive long-distance research collaboration, including crowd-sourcing.
- ***Product and process innovation:*** Digital technology makes possible new products and services, and re-engineering production systems give cost and quality advantages. Chapter 1.2 in this *Report* provides extensive case study evidence for a wide range of industries to illustrate this point.[6]
- ***Business model innovation:*** Digital technologies are allowing firms to entirely reimagine current business models within the emerging network of people and machines, giving price and quality-of-service advantages over incumbents. Key for businesses are the new opportunities this brings for ways of matching people to needs and of leveraging the network for decentralized information gathering to create systems that are constantly re-optimizing themselves. Thus, in addition to allowing for more efficient *directed/explicit* learning systems in the form of crowd-sourcing models for innovation, the new level of connectivity that characterizes the emerging industrial landscape is also creating increasingly *self*-learning systems. Some of the biggest success stories of the digital era have been companies that have moved into the business of market-making. The gains to be had from this approach to leveraging technology are currently looking bigger than the gains to be had from incremental product and process improvements for existing products.

In an indirect way, digital technology is leading to more innovation by changing the incentives of incumbents to innovate. This is competition-driven innovation, where innovation itself does not necessarily involve new technologies. In particular, this includes technology having the effect of:

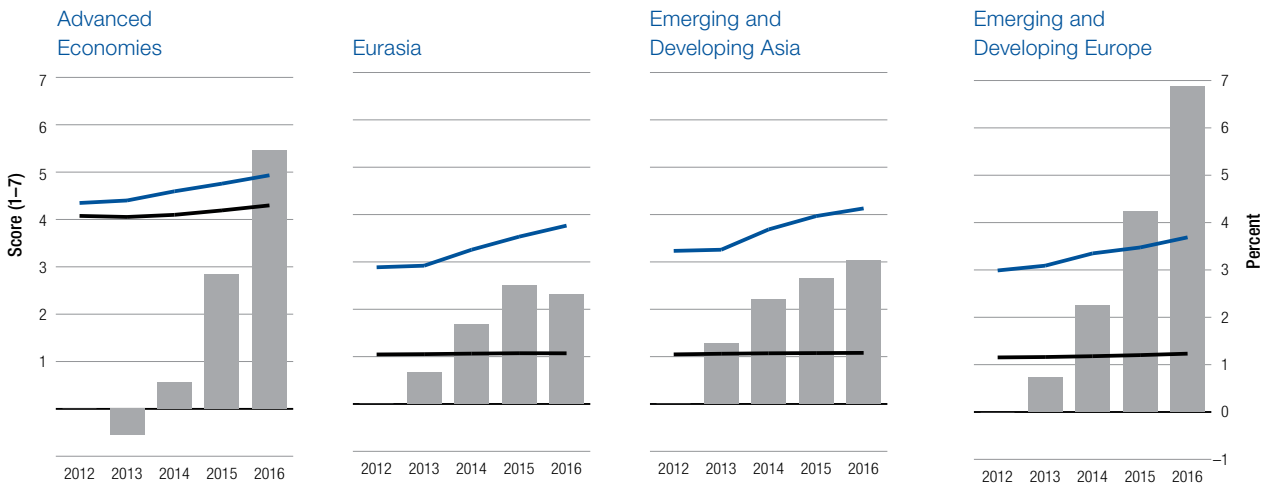
- ***Increasing market size:*** Technology acts to integrate markets by reducing communication costs and increasing matching efficiency, which in turn increases competitive pressures. For example, online platforms through which firms can connect almost without cost to a global consumer base are creating a tougher competitive environment.
- ***Reducing barriers to entry:*** New online services, such as globally accessible cloud computing and online marketing platforms, are saving start-ups and small- and medium-sized enterprises (SMEs) a significant share of the fixed costs of running a business. This facilitates entry and scaling, and thereby contributes to a leveling of the playing field vis-à-vis large incumbents. Mettler and Williams (2011) identify six such types of business platforms: crowd-financing, digital utilities, professional services marketplaces, micro-manufacturing, innovation marketplaces, and e-commerce platforms.[7]
- ***Acquiring and leveraging knowledge of consumer preferences:*** Big data is giving firms the opportunity to target products so they more closely align with consumer preferences based on more accurate information about the latter. This can act like a quality upgrade from the point of view of the consumer, and therefore increases pressure on other firms to innovate themselves.

In addition to increasing competitive pressures from new forms of innovation, the central position of networks in this emerging industrial landscape is dramatically changing the rules of the game for companies across sectors: a key implication for businesses is that the ability to scale fast is starting to become a precondition for innovation success.

Why is innovation alone no longer enough? Across industries, achieving scale quickly (in terms of customer base) is crucial because of the self-reinforcing nature of network effects and the implied winner-take-all outcome for the player that achieves a large enough network the fastest.[8] Scale is also important for self-optimization of systems: the more participants, the faster the system updates priors about the behavior of market participants, allowing for ever closer matches of preferences and creating yet more value. Quick scaling is also allowing companies to set industry standards, which can act as a competitive advantage because the company that scales quickly sets the precedent and thus can define that precedent. Businesses therefore need to substantially accelerate all processes across the firm in order to win the race for the market.

The ability to scale cannot be taken for granted in the digital economy. An ecosystem that systematically allows top innovations to be scaled globally remains a key feature of only a handful of places, including Silicon Valley.[9]

Figure 2: Trends for perceived capacity to innovate and PCT patents per million population, 2012–16



Sources: NRI, 2012–2016 editions. Based on Executive Opinion Survey data and World Intellectual Property Organization (WIPO) PCT data, sourced from the Organisation for Economic Co-operation and Development (OECD) Patent Database.

Technology-enabled innovation is thus creating significant competitive pressures for tech and non-tech firms alike. In competitive economies, the only way to escape is yet more innovation. These mechanisms look set to be reinforced as the Fourth Industrial Revolution is starting to gain a foothold.

Key findings

This section presents the four key findings that emerge from an analysis of the last five years of NRI data.

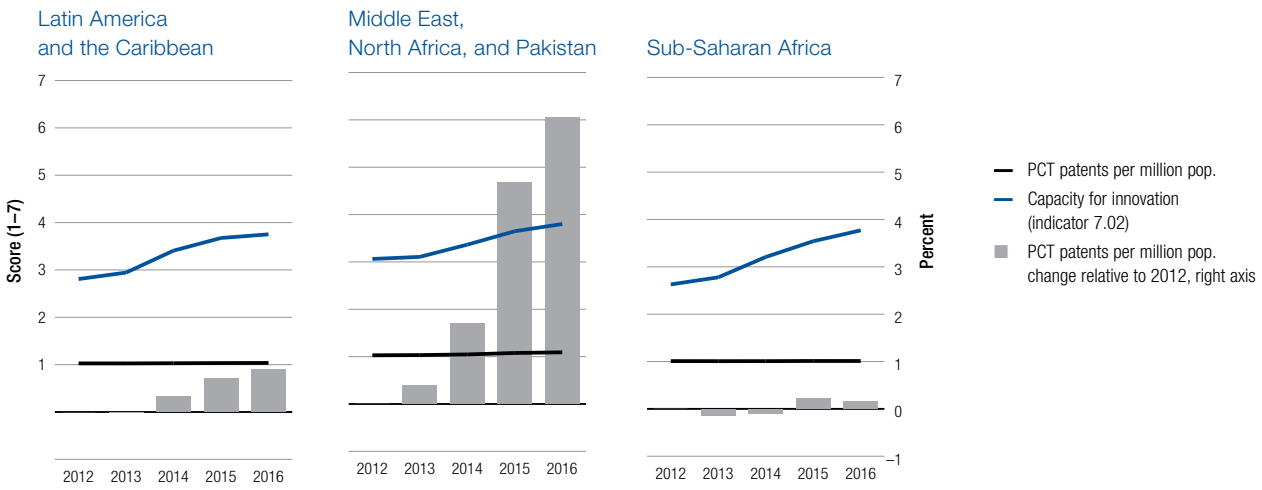
1. The changing nature of innovation: *The minds of business executives around the world are increasingly focused on innovation as reflected by the steady upward trend in firms' perceived capacity to innovate. Traditional measures for innovation, such as the number of patents registered, are telling only part of the story. This is related to the fact that the current transformation is nurtured by a different type of innovation, increasingly based on digital technologies and on the new business models it allows: executives in almost 100 countries report increases in the perceived impact of ICTs on business-model innovation compared with last year.*

The World Economic Forum's Executive Opinion Survey annually asks more than 14,000 business executives in more than 140 economies about their perception of the capacity to innovate by firms in their country. The data of the last five years show some striking global patterns. Business executives across *all* regions of the world state that the capacity to innovate of firms in their countries has increased steadily (Figure 2). With this clear global shift in focus toward innovation by the business sector, three questions arise: Is the increased innovation capacity being realized and reflected in terms of innovation output? If it is, what kinds of innovation are firms engaging in? What is driving this favorable shift in innovation capacity?

Consider the most traditional of innovation output measures: the number of patents normalized by population size. Patenting activity continues on an upward trend in advanced economies and is starting to pick up across most regions of the world. It has been growing in particular in Emerging Europe as well as in the Middle East and North Africa. Figure 2 illustrates these positive trends (with a change in patenting compared to the 2012 base on the right-hand scale). Nevertheless, much of the increased innovation capacity remains unaccounted for once innovation output in the form of patents is taken into account. Several explanations are possible for this observation.

For technologically advanced countries, patent trends are more closely matched to perceived innovation trends, yet in some sectors there is a divergence between the two. Patenting is slowing, particularly in industries with high digital content, at the same time that innovation is accelerating (see Box 3). Several reasons for this slowdown are put forward in Box 3: one driver is the shortening of product cycles, which is especially evident in industries, such as audio-visual technologies and telecommunications, that are most affected by digital disruption. In addition, patent pendency times have been rising. These two developments combined often make it unprofitable for firms to patent their innovations. In addition, the pressure to innovate has increased to such an extent that many firms are focusing their resources entirely on cost-saving/efficiency innovation rather than attempting moonshots, or what Clayton Christensen calls "empowering innovation."[10] Thus, although digital innovation is accelerating, the expectation is that these

Figure 2: Trends for perceived capacity to innovate and PCT patents per million population, 2012–16 *(cont'd.)*



Notes: The number of PCT patents per million population is shown on a normalized scale of 1 to 7. Based on a constant sample of 127 economies. Groupings follow the IMF classification; IMF "CIS" = "Eurasia."

trends will be captured less and less well by traditional innovation measures in the future.

A broader measure of innovation outcomes—the Economic impacts pillar of the NRI, which comprises both patents and survey-based measures of the impact of ICTs on business model and on organizational model innovation—can give some additional insights: the 2016 iteration of the NRI sees a positive change compared to 2015 in the perceived impact of ICTs on business model innovation in almost 100 countries. Importantly, as Figure 3 demonstrates, the increased power of ICTs to enable new business models is being felt across the entire networked readiness spectrum.[11] ICT-driven business model innovation thus is a candidate to be watched as an important source of digital innovation impact.

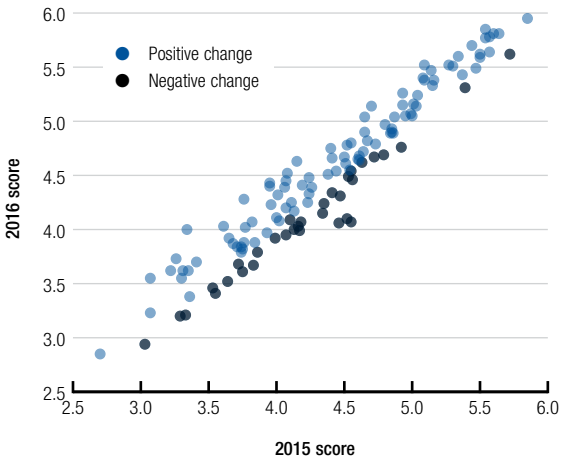
2. The increasing urgency to adopt and innovate continuously: *Although innovation is clearly on executives' minds, seven countries truly stand out in terms of their digital innovation performance. A closer look at their characteristics reveals very high rates of business ICT adoption and a top innovation environment.*

Although perceived capacity to innovate is going up across the world, certain countries are far ahead of the rest in terms of innovation impact as captured by the NRI (Figure 4): when looking at the score distribution for the Economic impacts pillar of the NRI, seven countries stand out in terms of their performance: Finland, Switzerland, Sweden, Israel, Singapore, the Netherlands, and the United States. A closer examination of these top seven innovative countries gives important clues about potential drivers for innovation success in the digital era.

In order to establish how the top seven are different from other countries, Figure 5 shows the distribution of ranks for these countries across all other individual pillars of the NRI. The data reveal some striking patterns: top innovation impact performers are *all* characterized by top ranks in business usage of digital technologies. More particularly, this means these countries perform especially well on the combination of firm technology absorption, innovation capacity, patenting, and business-to-business (B2B) and business-to-consumer (B2C) Internet use as well as ICT staff training. In addition to having very high levels of business ICT use, the top seven all rank highly in terms of their business and innovation environment as well as in individual technology usage.

At the *country* level, high levels of business adoption of digital technologies and a strong business and innovation environment thus stand out as a key

Figure 3: Perceived impact of technology on business model innovation: 2015 vs 2016



Source: NRI, 2015 and 2016 editions.
Note: Numbers are based on a constant sample of a 135 economies.

Box 3: The decline of patents in ICT-driven industries

The World Intellectual Property Organization (WIPO) (2015) shows a global rise of patent applications to a total of 2.7 million, an increase of 4.5 percent over 2014.[1] Yet two patent fields—audio-visual technologies and telecommunications—show a constant decline in their number of patent applications over the last 10 years, of 13 percent and 20 percent, respectively. Moreover, since peaking in 2005, the total number of patent filings of the top 100 global patent applicants has followed a downward trend of more than 20 percent in the last decade. This has resulted in part from a sharp decline in filings by three large companies, which have reduced their patent activities by more than two-thirds. Those three and the remaining companies in the top 100 are predominantly in the computer, semiconductor, telecommunications, and consumer electronic business. Three potential drivers of this trend are shortening product life cycles, longer patent pendency times, and a shift in innovation types:

Product life cycles are getting shorter

Various studies have shown that the duration of product life cycles is steadily decreasing across all industries. Between 1997 and 2012 the average life cycle length across industries fell by 24 percent.[2] The digitalization of almost every business aspect and the resulting efficiency boosts have contributed a big part of this development.

Besides a general shortening of product life cycles, the existence of differences across various industry sectors are especially important with respect to their development cycle times and useful product life spans.[3] For fast, risky industries even small delays in time-to-market can have extensive effects on the expected return. Being late to market yields a significant loss of revenue; this can quickly exceed the costs incurred during the development and manufacturing phase.

Imagine a semiconductor company that produces a chip with two years of product life on the market. Releasing a new chip only one quarter (three months) too late means the company loses more than one-third of the expected return of releasing on time. This could potentially exceed the development costs of the product and be a very sensitive profit killer. Compare this to the world's largest passenger airplane, the Airbus A380, which has a useful product life of around 20 years. Delays in the delivery of commercial airplanes are rather the rule than the exception, and the incurred cost of mistakes are easier to amortize.

Patent pendency time is getting longer

The average patent pendency time has increased in many patent offices around the world to four years and more. This trend, together with the simultaneous shortening of product life cycles across all industries, could have led to a situation where filing patents increasingly become an unpractical and tardy means for technological innovations with short-term applicability. If this was true, we would see the affected industries rather shifting to more time-strategic, broad patenting of features for the sole purpose of delaying the development cycle for competitors.

A shift in the type of innovation toward efficiency

Clayton Christensen (2012) distinguishes three major forms of innovation: "empowering," "sustaining," and "efficiency" innovations. While the first and the second type create and sustain jobs, the third is describing innovations that streamline processes and tend to reduce the number of available jobs.[4]

Fast-paced industries in the sustaining category will feel a continuous pressure to increase productivity, and will incentivize to invest and operate in the efficiency innovation scheme. The 2015 industry employment and output projections to 2024 by the US Bureau of Labor Statistics, for example, find that the US computer and peripheral equipment manufacturing industry is among those with the highest projected changes both in terms of increases in output and declines in employment.[5] This is an indication that the industry is running in full efficiency innovation mode.

How can such an industry then be open to taking more risks by working on completely new approaches and potential moonshots if most resources are spent to increase efficiency to stay in business? One way could be through new partnership models with, and investment in, start-ups. If a business is running like clockwork and trimmed toward optimized outcomes, it might not be the right environment to follow out-of-the-box ideas. A positive development is that an increasing number of agile entrepreneurs with bold ideas are starting to shake up industries that are fully engaged with themselves. In addition, corporate investment arms that strategically back young companies are on the rise. A diversification of corporate culture might be essential for survival in the long run.

Notes

1 WIPO 2015.

2 Roland Berger Strategy Consultants 2012.

3 Prasad 1997.

4 Christensen 2012.

5 United States Department of Labor, Bureau of Labor Statistics 2015.

Contributed by Bernhard Petermeier, Technology Pioneers, World Economic Forum.

characteristic of highly innovative countries. To the extent that digitization allows for faster processes, this finding resonates with both survey-based and anecdotal evidence at the *firm* level, which shows that speed in bringing new inventions to market is the most crucial factor in becoming and staying a top innovative firm in the Digital Age.[12] Because digital technologies are driving winner-take-all dynamics for an increasing number of industries, getting there first matters.

Note that a crucial ingredient for innovation success will continue to be talent competitiveness. Although the NRI contains a broad measure of skills, it currently does not map the availability of the very specialized talent needed to drive digital innovation.[13] Yet this type of talent will be at the core of any success story in the unfolding Fourth Industrial Revolution: it will limit or enhance the ability of individual countries to fuel their development, growth, and employment strategies through digital

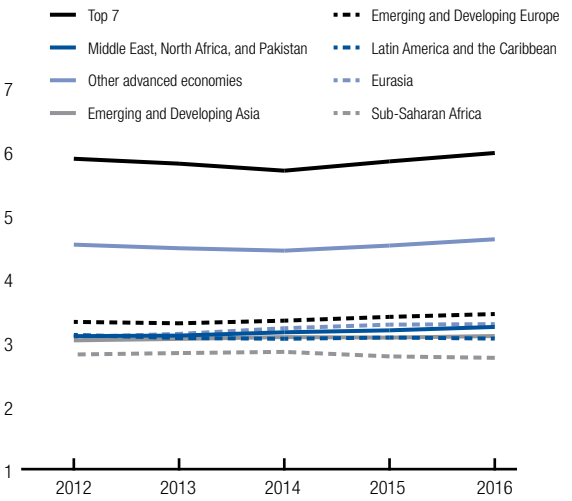
innovation. When it comes to succeeding at innovation, countries critically need to think not only about educating future innovators but also about how to retain talent once educated, as the pull of Silicon Valley remains strong.[14]

3. Missed opportunities: *In recent years, digital innovation has been primarily driven by consumer demand. Yet this increasing demand for digital products and services by a global consumer base is being met by a relatively small number of companies. Businesses need to act now and adopt digital technologies to capture their part of this growing market. A widening and worrying gap is also emerging between growth in individual ICT usage and public-sector engagement in the digital economy, as government usage is increasingly falling short of expectations. Governments can do more to invest in innovative digital solutions to drive social impact.*

The NRI data suggest that business usage and adoption is stagnating or moving only slowly across regions (Figure 6). This suggests that a large number of existing firms are not getting in the game fast enough. The data also imply that it is not a lack of technology take-up by individuals that is holding back business adoption: companies that do adopt digital technologies will find themselves with a fast-growing connected consumer base. As Figure 6 shows, this trend of rising individual adoption is remarkably uniform across all regions of the world. The number of Internet users grew in all but nine countries since the 2015 iteration of the Index. Household ownership of personal computers and the number of households with an Internet connection is also increasing in all but a handful of countries. In particular, the quality of Internet service is improving, with fixed and mobile broadband subscriptions increasing across the board.

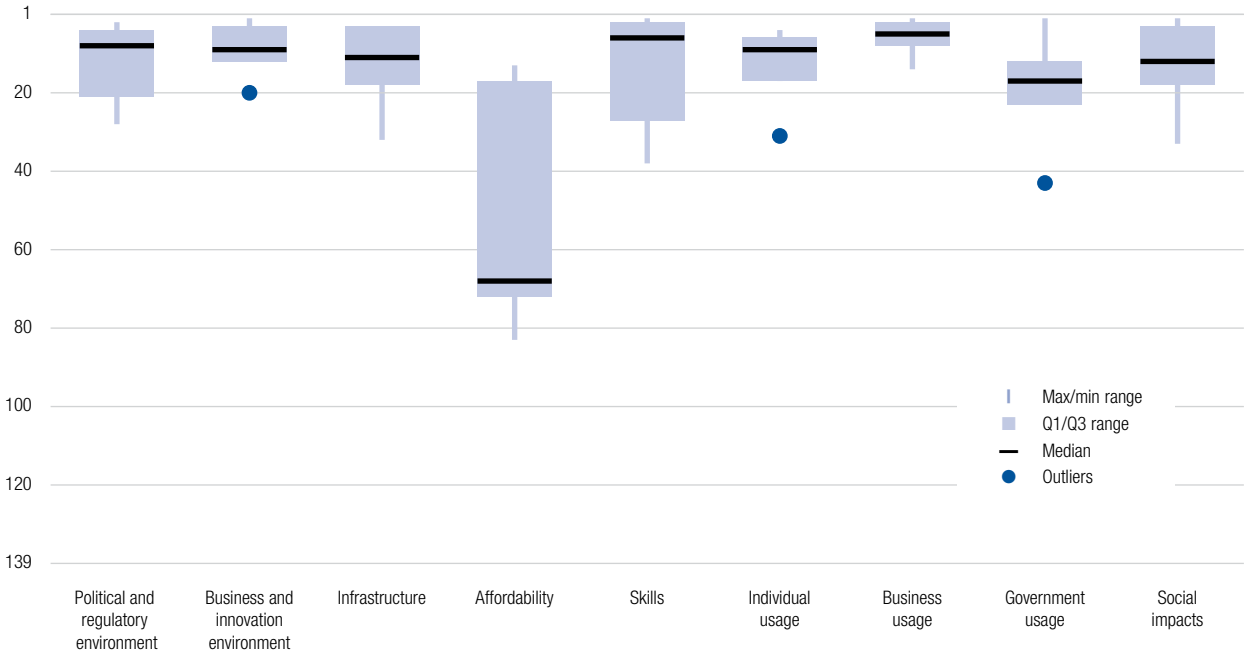
Furthermore, an expectations gap has opened up with respect to public-sector performance in using

Figure 4: Economic impact of ICTs in the Top 7 economies vs other country groups and regions, 2012–16
Score



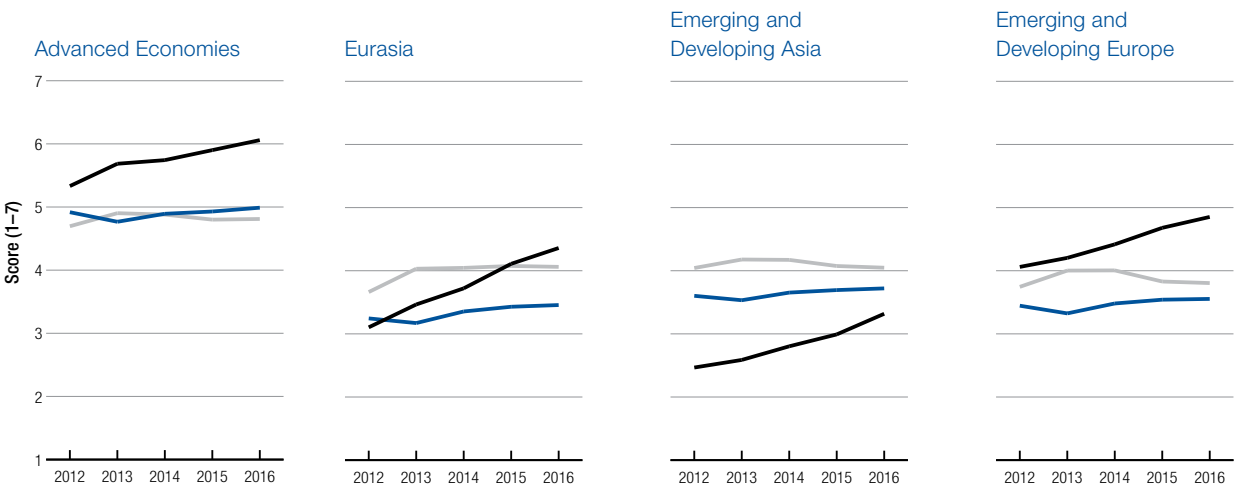
Source: NRI, 2012–2016 editions.
Notes: Top 7 identifies the seven best performers in terms of economic impact: Finland, Switzerland, Sweden, Israel, Singapore, the Netherlands, and the United States. Numbers are based on a constant sample of a 127 economies. Groupings follow the IMF classification; IMF "CIS" = "Eurasia."

Figure 5: Distribution of ranks for Top 7 performers on the economic impacts pillar across the remaining 9 pillars
Rank (1 to 139)



Source: NRI, 2016 edition.
Note: The light blue boxes identify the interquartile range—from the 75th to the 25th percentile—for each distribution.

Figure 6: Time trends for individual, business, and government usage, 2012–16



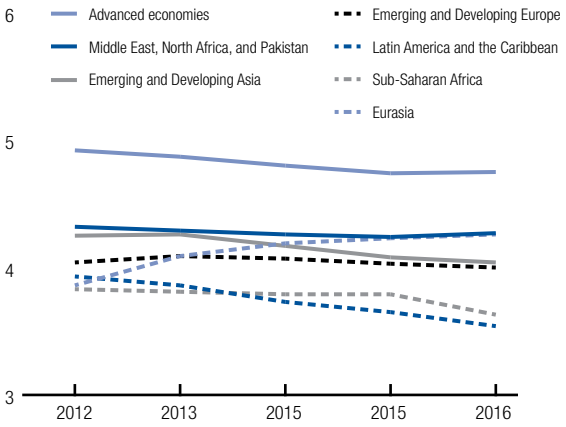
Source: NRI, 2012–2016 editions.

and promoting digital technologies. The upward trend in government usage (NRI pillar 8) observed up to 2013 is slowly being reversed in all regions of the world (Figure 6). Governments are also seen to be falling behind in terms of using digital technologies efficiently for social impact (NRI indicator 10.03, Figure 7). Using ICTs to more efficiently provide services to citizens is an important area where digital technologies can make a difference in generating broad-based gains.

Yet it does not have to be the government alone that is driving social outcomes. Indeed, overall social impact scores (NRI pillar 10) are up in a group of countries, in particular the advanced economies (Figure 8). ICTs can be used in many innovative ways to achieve social impact—for example, in facilitating access to basic services such as healthcare, finance, and insurance (Figure 9). Even in cases where the government remains firmly in charge of the system, access to the system can be facilitated by digital technologies and private initiative. A pioneering example of such a public-private digital collaboration for social impact is a Dutch service provider that has partnered with the government to facilitate access to the justice system (Box 4).

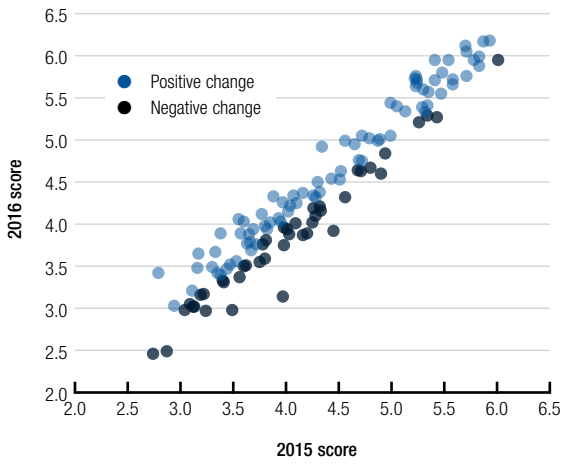
4. Building a resilient digital economy: *As the new digital economy is taking shape, offering it the right framework conditions will be crucial to ensuring its sustainability. Digital technologies are unleashing new economic and social dynamics that will need to be managed if the digital transformation of industries and societies are to deliver long-term and broad-based gains. A resilient digital economy also calls for new types of leadership, governance, and behaviors. A critical ingredient for the success and sustainability of the*

Figure 7: Impacts of ICTs on government efficiency, 2012–16
Score (1–7)



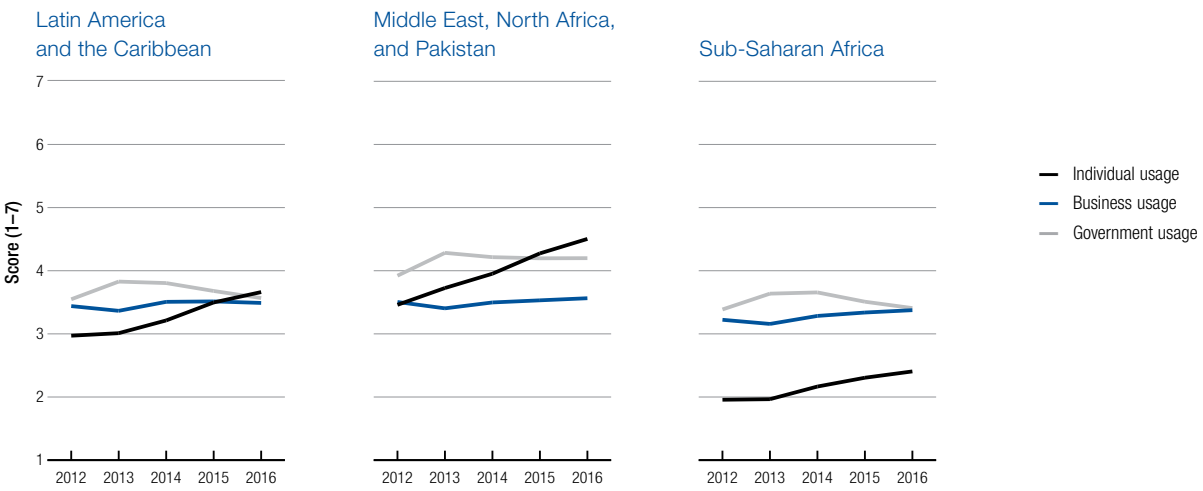
Source: NRI, 2012–2016 editions.
Note: Regional groupings follow the IMF classification; IMF "CIS" = "Eurasia."

Figure 8: Social impacts score (pillar 10): 2015 vs 2016



Source: NRI, 2015–2016 editions.

Figure 6: Time trends for individual, business, and government usage, 2012–16 *(cont'd.)*



Notes: Based on a constant sample of 127 economies. Groupings follow the IMF classification; IMF "CIS" = "Eurasia."

emerging system will be agile governance frameworks that allow societies to anticipate and shape the impact of emerging technologies and react quickly to changing circumstances.

From an economic standpoint, two developments that come in the wake of the unfolding digital revolution carry direct implications for future competitiveness and inclusive growth and will require a careful policy response: the impact of digital technologies and new networks on (1) competition dynamics in product markets and (2) labor market dynamics.

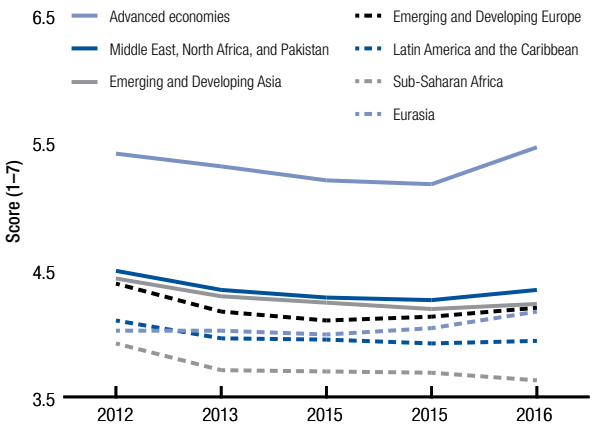
As network dynamics are becoming a key feature of competition in the emerging platform economy, being able to bring products to market fast and scale rapidly is increasingly important for companies. At the same time, the risk of lock-in needs to be managed. Governments can play a supportive role in creating a level playing field by ensuring a business environment that allows firms to quickly react to new developments; this includes speedy procedures for opening a new business and bringing products to market, providing a supportive innovation ecosystem, ensuring that barriers to entry stay low by enforcing a competition regime that counteracts potential network lock-in, and promoting and facilitating ICT adoption by building out infrastructure and having a clear ICT strategy.

Similar to trade liberalization, the spread of digital technologies is creating winners and losers within the labor force. Two key ways in which digital technologies are affecting outcomes can be identified.

First, as digital technologies are increasingly allowing for the automation of routine jobs, they are currently accelerating the polarization of the income distribution because middle-skilled workers are most affected up to this point. In the United States, total employment grew significantly in the lower end of the skill spectrum, where wages were generally stagnating or grew slightly, and at the higher end of the spectrum, where wages grew significantly. Many middle-skilled workers have been seeing their earnings decline or their jobs evaporate.[15]

Economies need to face the double challenge of further upgrading the skills of workers at the upper end of the spectrum while ensuring that the rest, the majority, of the population also receive the necessary training to prosper in the digital world. The World Economic Forum *Future of Jobs* report examines future skills needs via a survey of Chief Human Resource Officers from 366 companies worldwide. The responses indicate that complex problem-solving skills comprise the set of skills that will be considered a core requirement by the largest share of jobs across industries (36 percent). Skills that are not considered crucial today will account for about a third of the most-needed skills by 2020.

Figure 9: Impact of ICTs on access to basic services (indicator 10.01), 2012–16



Source: NRI, 2012–2016 editions.
Note: Groupings follow the IMF classification; IMF "CIS" = "Eurasia."

Box 4: Public-private collaboration in digital social innovation: Rechtwijzer, the Dutch digital platform for dispute resolution

Rechtwijzer 2.0 is a collaborative effort between HiiL Innovating Justice, the Dutch Legal Aid Board, Modria, and the Dutch Ministry of Justice and Security. The online-based dispute resolution (ODR) platform aims to inform people about their legal options as well as to support legal professionals so they can intervene more effectively. The initiative allows citizens to find sustainable solutions to their legal issues, such as divorce, separation, landlord-tenant disputes, and employment disputes. The ODR platform empowers citizens to access justice by providing simple models that have worked for others as well as tailored support by legal professionals. The platform is a major innovation that helps citizens get access to justice and could offer a sustainable solution to many judicial systems.

Rechtwijzer 2.0 is a great example of a wider movement and need: justice innovation. Justice innovation is a form of social innovation that is key to reforming judicial systems. It uses market-based approaches that benefit society. It will help close the gap on the estimated 4 billion people who do not have adequate access to justice. Social innovation is described by the Global Agenda Council on Social Innovation as "the application of innovative, practical, sustainable, market-based approaches to benefit society in general, and low-income or underserved populations in particular."[1] This approach is more collaborative and will empower low-income people to participate in the global economy with dignity.

Note

1 World Economic Forum 2016e.

Contributed by Lisa Ventura, Society and Innovation, World Economic Forum.

Demand for narrow technical skills such as programming or equipment operation and control will be rather stable, while demand will grow for cognitive abilities, content, process, and social skills.[16] Policy must play an important role in terms of supporting the transition of workers into new jobs and ensuring that workers' skills match market demand.

In addition to automation, a second mechanism by which digital technologies are affecting the labor market is through the effects of the platform economy.[17] Digital platforms are used not only to match consumers with goods but also increasingly to match workers with jobs. This is leading to more freelance activity and fewer workers being employed by firms in full-time jobs with correspondingly more uncertainty over income flows and less social protection (e.g., insurance, pension). Despite these developments, continued social protection for workers needs to be ensured.

Anticipatory governance of innovation

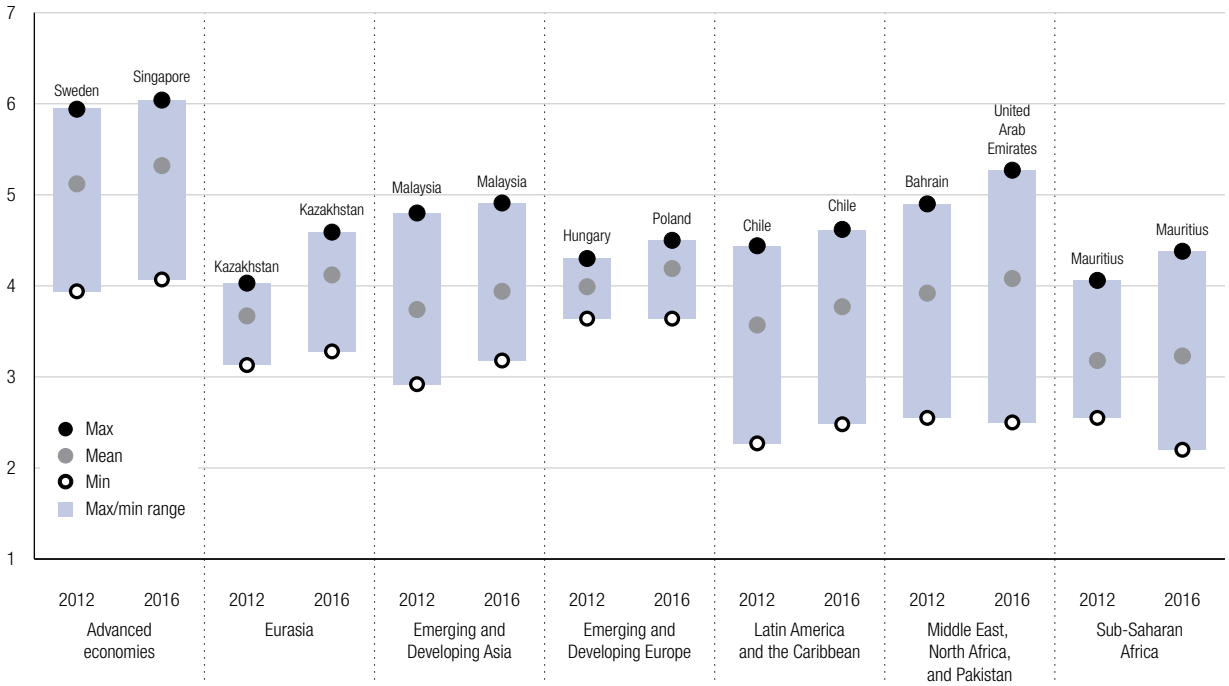
Given the likelihood that extremely powerful and multi-use technologies will be developed, tested, and commercialized in coming years, it will be important to guide innovation and commercialization processes with the wider social, economic, and environmental context in mind. Importantly, new technologies should not be thought of as panaceas or simple tools but rather as entities that exert power over users and that will have different impacts in different social contexts. It is therefore critical to keep in mind the social reality in which emerging technologies will be used and to appreciate the economic and social dynamics they may exacerbate, such as inequality.

Ideally the governance of innovation processes would start before economic policies become a relevant instrument, anticipating some of the important societal challenges as applications are developed. Recognizing these challenges, the European Union has recently adopted guidelines on Responsible Research and Innovation (RRI) that reflect these considerations.[18] RRI is currently applied mainly with regard to emerging technologies—notably nanotechnologies, genomics, synthetic biology, and geo-engineering. It has been defined as "a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products in order to allow a proper embedding of scientific and technological advances in our society."[19]

In terms of evaluating the social desirability of research undertakings, several sets of principles have been suggested: (1) orienting research so as to address major existing or emerging global risks—tightening supplies of energy, water, and food; pandemics; aging societies; global warming; public health and security;[20] (2) constitutional values[21]—for example, in the case of the European Union, "respect for human dignity, liberty, democracy, equality, the rule of law and respect for human rights, including the rights of persons belonging to minorities. […] Moreover […] pluralism, non-discrimination, tolerance, justice, solidarity and equality between women and men";[22] and (3) general principles of human and labor rights as enshrined in the UN Global Compact's 10 principles.[23]

One key challenge to more appropriate forms of innovation governance is the fact that technologies change far faster than regulatory regimes do. As the World Economic Forum's Global Agenda Council on the Future of Software and Society has pointed out,

Figure 10: The Networked Readiness Index by regional group, 2012 vs 2016
Score (1–7)



Source: NRI, 2012–2016 editions.
Note: Numbers are based on a constant sample of 132 economies. Groupings follow the IMF classification; IMF "CIS" = "Eurasia."

technology has so fundamentally changed many behaviors and processes being governed that current regulations are not fully relevant (see *A Call for Agile Governance Principles*). In an attempt to close this "agility gap," the Council took inspiration from agile approaches used in software development to create four "agile governance" principles. The work proposes that policymakers could create governance systems that are more robust, adaptable, and responsive to changing technologies if their decision-making frameworks valued outcomes over rules; if they valued responding to change over following a plan; participation over control; and self-organization over centralization. In addition to suggesting these new heuristics, the Council looks at specific areas where new policy options need to be generated in order to ensure that emerging technologies deliver inclusive benefits to society, including the "gig economy," the use of decentralized payment systems, peer-to-peer transactions, and autonomous devices.

Building on this work, as well as work by the Global Agenda Council on Justice and others, in July 2016 the World Economic Forum launched a new set of Global Future Councils that includes a number of councils specifically focused on the governance of emerging technologies and the potential for new forms of agile governance to guide innovation and the Fourth Industrial Revolution toward positive outcomes for society.

COUNTRY AND REGIONAL TRENDS FROM THE NRI

This section of the chapter turns to the general global and regional trends emerging from this year's results of the NRI (see Tables 1 through 5), as well as to a detailed analysis of the performance of selected economies.

Networked readiness continues to improve almost everywhere in the world, with a clear upward trend in mean country performance across all regions; however, convergence within regions is far from being the norm (Figure 10). Clearly divergent regional performances are observed for the group of countries within Eurasia; Emerging and Developing Europe; the Middle East, North Africa, and Pakistan (MENAP); and sub-Saharan Africa. In the case of MENAP and sub-Saharan Africa, this is driven by the fact that top countries improve their performance at the same time that the performance of the worst-scoring countries is deteriorating. There is a clear upward trend for the entire range of countries for the group of Advanced Economies, Emerging and Developing Asia, Eurasia, and Latin America and the Caribbean. Notably, the group of Emerging and Developing Asian countries is both moving up and converging in terms of overall NRI scores. Average performance on the NRI in 2016 is highest for the group of Advanced Economies, followed by Emerging and Developing Europe, the Eurasian countries and MENAP (the two are approximately even), Emerging and Developing Asia, Latin America and the Caribbean, and Sub-Saharan Africa.

Table 1: The Networked Readiness Index 2016

Rank	Country/Economy	Value	2015 rank (out of 143)	Income level*	Group†
1	Singapore	6.0	1	HI	ADV
2	Finland	6.0	2	HI-OECD	ADV
3	Sweden	5.8	3	HI-OECD	ADV
4	Norway	5.8	5	HI-OECD	ADV
5	United States	5.8	7	HI-OECD	ADV
6	Netherlands	5.8	4	HI-OECD	ADV
7	Switzerland	5.8	6	HI-OECD	ADV
8	United Kingdom	5.7	8	HI-OECD	ADV
9	Luxembourg	5.7	9	HI-OECD	ADV
10	Japan	5.6	10	HI-OECD	ADV
11	Denmark	5.6	15	HI-OECD	ADV
12	Hong Kong SAR	5.6	14	HI	ADV
13	Korea, Rep.	5.6	12	HI-OECD	ADV
14	Canada	5.6	11	HI-OECD	ADV
15	Germany	5.6	13	HI-OECD	ADV
16	Iceland	5.5	19	HI-OECD	ADV
17	New Zealand	5.5	17	HI-OECD	ADV
18	Australia	5.5	16	HI-OECD	ADV
19	Chinese Taipei	5.5	18	HI	ADV
20	Austria	5.4	20	HI-OECD	ADV
21	Israel	5.4	21	HI-OECD	ADV
22	Estonia	5.4	22	HI-OECD	ADV
23	Belgium	5.4	24	HI-OECD	ADV
24	France	5.3	26	HI-OECD	ADV
25	Ireland	5.3	25	HI-OECD	ADV
26	United Arab Emirates	5.3	23	HI	MENAP
27	Qatar	5.2	27	HI	MENAP
28	Bahrain	5.1	30	HI	MENAP
29	Lithuania	4.9	31	HI	ADV
30	Portugal	4.9	28	HI-OECD	ADV
31	Malaysia	4.9	32	UM	EDA
32	Latvia	4.8	33	HI	ADV
33	Saudi Arabia	4.8	35	HI	MENAP
34	Malta	4.8	29	HI	ADV
35	Spain	4.8	34	HI-OECD	ADV
36	Czech Republic	4.7	43	HI-OECD	ADV
37	Slovenia	4.7	37	HI-OECD	ADV
38	Chile	4.6	38	HI-OECD	LATAM
39	Kazakhstan	4.6	40	UM	EURAS
40	Cyprus	4.6	36	HI	ADV
41	Russian Federation	4.5	41	HI	EURAS
42	Poland	4.5	50	HI-OECD	EDE
43	Uruguay	4.5	46	HI	LATAM
44	Costa Rica	4.5	49	UM	LATAM
45	Italy	4.4	55	HI-OECD	ADV
46	Macedonia, FYR	4.4	47	UM	EDE
47	Slovak Republic	4.4	59	HI-OECD	ADV
48	Turkey	4.4	48	UM	EDE
49	Mauritius	4.4	45	UM	SSA
50	Hungary	4.4	53	HI-OECD	EDE
51	Montenegro	4.3	56	UM	EDE
52	Oman	4.3	42	HI	MENAP
53	Azerbaijan	4.3	57	UM	EURAS
54	Croatia	4.3	54	HI	EDE
55	Panama	4.3	51	UM	LATAM
56	Armenia	4.3	58	LM	EURAS
57	Mongolia	4.3	61	UM	EDA
58	Georgia	4.3	60	LM	EURAS
59	China	4.2	62	UM	EDA
60	Jordan	4.2	52	UM	MENAP
61	Kuwait	4.2	72	HI	MENAP
62	Thailand	4.2	67	UM	EDA
63	Sri Lanka	4.2	65	LM	EDA
64	Ukraine	4.2	71	LM	EURAS
65	South Africa	4.2	75	UM	SSA
66	Romania	4.1	63	UM	EDE
67	Trinidad and Tobago	4.1	70	HI	LATAM
68	Colombia	4.1	64	UM	LATAM
69	Bulgaria	4.1	73	UM	EDE
70	Greece	4.1	66	HI-OECD	ADV
71	Moldova	4.0	68	LM	EURAS
72	Brazil	4.0	84	UM	LATAM
73	Indonesia	4.0	79	LM	EDA
74	Seychelles	4.0	74	HI	SSA
75	Serbia	4.0	77	UM	EDE
76	Mexico	4.0	69	UM	LATAM
77	Philippines	4.0	76	LM	EDA
78	Morocco	3.9	78	LM	MENAP
79	Vietnam	3.9	85	LM	EDA
80	Rwanda	3.9	83	LI	SSA
81	Tunisia	3.9	81	UM	MENAP
82	Ecuador	3.9	n/a	UM	LATAM
83	Jamaica	3.9	82	UM	LATAM
84	Albania	3.9	92	UM	EDE
85	Cape Verde	3.8	87	LM	SSA
86	Kenya	3.8	86	LM	SSA
87	Bhutan	3.8	88	LM	EDA
88	Lebanon	3.8	99	UM	MENAP
89	Argentina	3.8	91	HI	LATAM
90	Peru	3.8	90	UM	LATAM
91	India	3.8	89	LM	EDA
92	Iran, Islamic Rep.	3.7	96	UM	MENAP
93	El Salvador	3.7	80	LM	LATAM
94	Honduras	3.7	100	LM	LATAM
95	Kyrgyz Republic	3.7	98	LM	EURAS
96	Egypt	3.7	94	LM	MENAP
97	Bosnia and Herzegovina	3.6	n/a	UM	EDE
98	Dominican Republic	3.6	95	UM	LATAM
99	Namibia	3.6	102	UM	SSA
100	Guyana	3.6	93	LM	LATAM
101	Botswana	3.5	104	UM	SSA
102	Ghana	3.5	101	LM	SSA
103	Guatemala	3.5	107	LM	LATAM
104	Lao PDR	3.4	97	LM	EDA
105	Paraguay	3.4	105	UM	LATAM
106	Côte d'Ivoire	3.4	115	LM	SSA
107	Senegal	3.4	106	LM	SSA
108	Venezuela	3.4	103	HI	LATAM
109	Cambodia	3.4	110	LI	EDA
110	Pakistan	3.4	112	LM	MENAP
111	Bolivia	3.3	111	LM	LATAM
112	Bangladesh	3.3	109	LM	EDA
113	Gambia, The	3.3	108	LI	SSA
114	Tajikistan	3.3	117	LM	EURAS
115	Lesotho	3.3	124	LM	SSA
116	Zambia	3.2	114	LM	SSA
117	Algeria	3.2	120	UM	MENAP
118	Nepal	3.2	118	LI	EDA
119	Nigeria	3.2	119	LM	SSA
120	Ethiopia	3.1	130	LI	SSA
121	Uganda	3.1	116	LI	SSA
122	Zimbabwe	3.0	121	LI	SSA
123	Mozambique	3.0	129	LI	SSA
124	Cameroon	3.0	126	LM	SSA
125	Gabon	2.9	122	UM	SSA
126	Tanzania	2.9	123	LI	SSA
127	Mali	2.9	127	LI	SSA
128	Benin	2.9	n/a	LI	SSA
129	Swaziland	2.9	125	LM	SSA
130	Liberia	2.8	n/a	LI	SSA
131	Nicaragua	2.8	128	LM	LATAM
132	Malawi	2.7	133	LI	SSA
133	Myanmar	2.7	139	LM	EDA
134	Guinea	2.6	142	LI	SSA
135	Madagascar	2.6	135	LI	SSA
136	Mauritania	2.5	138	LM	MENAP
137	Haiti	2.5	137	LI	LATAM
138	Burundi	2.4	141	LI	SSA
139	Chad	2.2	143	LI	SSA

Note: Income level classification follows the World Bank classification by income (situation as of July 2015). Group classification follows the International Monetary Fund's classification (situation as of April 2016). IMF "CIS" = "Eurasia."

* Income groups: HI = high-income economies that are not members of the OECD; HI-OECD = high-income OECD members; UM = upper-middle-income economies; LM = lower-middle-income economies; LI = low-income economies.

† Groups: ADV = Advanced economies; EDA = Emerging and Developing Asia; EDE = Emerging and Developing Europe; EURAS = Eurasia; LATAM = Latin America and the Caribbean; MENAP = Middle East, North Africa, and Pakistan; SSA = Sub-Saharan Africa.

Table 2: Environment subindex and pillars

ENVIRONMENT SUBINDEX			Political and regulatory environment		Business and innovation environment	
Rank	Country/Economy	Value	Rank	Value	Rank	Value
1	Singapore	6.0	2	5.9	1	6.0
2	New Zealand	5.6	3	5.9	6	5.4
3	United Kingdom	5.6	5	5.7	5	5.5
4	Hong Kong SAR	5.6	14	5.4	2	5.8
5	Finland	5.6	4	5.8	9	5.4
6	Norway	5.5	6	5.7	7	5.4
7	Switzerland	5.5	7	5.6	8	5.4
8	Netherlands	5.5	8	5.6	10	5.4
9	Luxembourg	5.5	1	5.9	27	5.0
10	Canada	5.4	15	5.4	4	5.5
11	Ireland	5.4	11	5.5	11	5.4
12	Sweden	5.3	10	5.5	20	5.2
13	United States	5.3	21	5.2	3	5.5
14	Denmark	5.3	17	5.3	16	5.3
15	Qatar	5.3	18	5.3	15	5.3
16	Australia	5.2	13	5.4	23	5.1
17	Japan	5.2	9	5.5	33	4.9
18	Iceland	5.2	22	5.1	17	5.3
19	United Arab Emirates	5.2	25	5.1	13	5.4
20	Germany	5.2	16	5.4	28	5.0
21	Malaysia	5.1	24	5.1	18	5.2
22	Belgium	5.1	20	5.2	22	5.1
23	Estonia	5.0	27	5.0	26	5.1
24	Israel	5.0	28	4.7	12	5.4
25	Austria	5.0	19	5.2	40	4.7
26	France	5.0	23	5.1	35	4.8
27	Rwanda	4.9	12	5.4	63	4.4
28	Saudi Arabia	4.9	29	4.6	25	5.1
29	Chinese Taipei	4.8	40	4.2	14	5.3
30	Portugal	4.7	33	4.4	24	5.1
31	Korea, Rep.	4.7	34	4.3	21	5.1
32	Chile	4.7	38	4.3	19	5.2
33	South Africa	4.7	26	5.0	65	4.3
34	Mauritius	4.7	30	4.6	41	4.7
35	Bahrain	4.6	36	4.3	29	5.0
36	Lithuania	4.6	41	4.2	31	5.0
37	Latvia	4.6	45	4.2	30	5.0
38	Jordan	4.5	39	4.2	38	4.8
39	Malta	4.5	32	4.5	56	4.5
40	Czech Republic	4.5	35	4.3	47	4.6
41	Spain	4.4	47	4.0	37	4.8
42	Macedonia, FYR	4.4	62	3.9	32	5.0
43	Cyprus	4.4	56	3.9	36	4.8
44	Uruguay	4.4	44	4.2	51	4.6
45	Slovenia	4.4	67	3.8	34	4.9
46	Zambia	4.3	61	3.9	39	4.8
47	Kazakhstan	4.3	48	4.0	54	4.5
48	Poland	4.2	57	3.9	53	4.6
49	Turkey	4.2	69	3.8	43	4.7
50	Jamaica	4.2	49	4.0	62	4.4
51	Hungary	4.2	50	4.0	59	4.4
52	Oman	4.2	53	4.0	58	4.4
53	Namibia	4.2	31	4.5	103	3.9
54	Thailand	4.2	80	3.7	48	4.6
55	Panama	4.1	85	3.6	45	4.7
56	Georgia	4.1	73	3.7	55	4.5
57	Croatia	4.1	92	3.5	44	4.7
58	Mongolia	4.1	81	3.6	52	4.6
59	Botswana	4.1	46	4.1	84	4.1
60	Montenegro	4.1	94	3.5	46	4.7
61	Slovak Republic	4.1	74	3.7	60	4.4
62	Indonesia	4.1	65	3.8	64	4.4
63	Bhutan	4.1	37	4.3	102	3.9
64	Cape Verde	4.0	55	4.0	80	4.1
65	Romania	4.0	66	3.8	71	4.2
66	Bulgaria	4.0	101	3.3	42	4.7
67	Russian Federation	4.0	88	3.6	57	4.5
68	Kuwait	4.0	63	3.8	72	4.2
69	Costa Rica	4.0	60	3.9	78	4.1
70	Tajikistan	4.0	42	4.2	105	3.8
71	Ghana	4.0	54	4.0	92	4.0
72	Côte d'Ivoire	4.0	51	4.0	96	3.9
73	Sri Lanka	3.9	64	3.8	81	4.1
74	Azerbaijan	3.9	79	3.7	74	4.2
75	Lesotho	3.9	52	4.0	100	3.9
76	Seychelles	3.9	59	3.9	97	3.9
77	Morocco	3.9	70	3.8	87	4.1
78	Armenia	3.9	116	3.2	50	4.6
79	Mexico	3.9	77	3.7	83	4.1
80	Senegal	3.9	76	3.7	88	4.0
81	Kenya	3.9	75	3.7	93	4.0
82	Iran, Islamic Rep.	3.9	91	3.5	76	4.2
83	China	3.9	58	3.9	104	3.8
84	Guyana	3.9	86	3.6	79	4.1
85	Italy	3.8	96	3.4	68	4.3
86	Vietnam	3.8	82	3.6	91	4.0
87	Dominican Republic	3.8	100	3.4	69	4.3
88	Albania	3.8	109	3.2	61	4.4
89	Philippines	3.8	87	3.6	85	4.1
90	Gambia, The	3.8	43	4.2	123	3.4
91	Lebanon	3.8	126	3.0	49	4.6
92	Greece	3.8	108	3.3	66	4.3
93	Lao PDR	3.8	68	3.8	106	3.8
94	Ukraine	3.8	113	3.2	67	4.3
95	Kyrgyz Republic	3.7	103	3.3	75	4.2
96	Trinidad and Tobago	3.7	104	3.3	77	4.1
97	Peru	3.7	118	3.1	70	4.3
98	Honduras	3.7	95	3.4	95	3.9
99	India	3.7	78	3.7	110	3.7
100	Mali	3.7	71	3.7	116	3.6
101	Uganda	3.7	72	3.7	118	3.6
102	Colombia	3.7	97	3.4	94	4.0
103	Serbia	3.7	110	3.2	82	4.1
104	El Salvador	3.6	106	3.3	90	4.0
105	Ecuador	3.6	111	3.2	86	4.1
106	Ethiopia	3.6	89	3.6	109	3.7
107	Guatemala	3.6	122	3.0	73	4.2
108	Liberia	3.6	84	3.6	117	3.6
109	Tunisia	3.6	90	3.5	112	3.7
110	Nepal	3.5	114	3.2	99	3.9
111	Moldova	3.5	125	3.0	89	4.0
112	Tanzania	3.5	83	3.6	125	3.4
113	Egypt	3.5	102	3.3	113	3.7
114	Cameroon	3.5	105	3.3	114	3.7
115	Pakistan	3.4	128	3.0	98	3.9
116	Nigeria	3.4	117	3.2	111	3.7
117	Malawi	3.4	93	3.5	126	3.4
118	Brazil	3.4	98	3.4	124	3.4
119	Cambodia	3.4	124	3.0	108	3.7
120	Mozambique	3.3	112	3.2	121	3.5
121	Bosnia and Herzegovina	3.3	120	3.1	120	3.6
122	Swaziland	3.3	115	3.2	122	3.4
123	Benin	3.3	99	3.4	130	3.3
124	Argentina	3.3	127	3.0	115	3.6
125	Paraguay	3.3	133	2.7	101	3.9
126	Gabon	3.3	107	3.3	131	3.3
127	Madagascar	3.2	129	2.8	119	3.6
128	Zimbabwe	3.1	121	3.0	132	3.2
129	Bolivia	3.1	119	3.1	134	3.2
130	Bangladesh	3.1	137	2.5	107	3.7
131	Algeria	3.1	123	3.0	133	3.2
132	Nicaragua	3.0	130	2.7	128	3.3
133	Myanmar	3.0	134	2.7	127	3.3
134	Burundi	2.9	136	2.5	129	3.3
135	Mauritania	2.8	135	2.6	135	3.0
136	Haiti	2.8	131	2.7	138	2.8
137	Guinea	2.7	138	2.5	137	2.9
138	Chad	2.7	132	2.7	139	2.6
139	Venezuela	2.6	139	2.2	136	3.0

Table 3: Readiness subindex and pillars

READINESS SUBINDEX			Infrastructure		Affordability		Skills	
Rank	Country/Economy	Value	Rank	Value	Rank	Value	Rank	Value
1	Finland	6.6	3	7.0	13	6.4	2	6.5
2	Chinese Taipei	6.4	1	7.0	12	6.5	23	5.8
3	Iceland	6.4	7	7.0	19	6.3	15	6.0
4	Norway	6.4	1	7.0	28	6.1	12	6.0
5	United States	6.4	5	7.0	17	6.4	27	5.8
6	Austria	6.3	13	6.6	5	6.7	28	5.7
7	Sweden	6.3	3	7.0	25	6.2	25	5.8
8	Canada	6.2	7	7.0	61	5.6	11	6.1
9	Switzerland	6.2	11	6.8	70	5.4	3	6.4
10	Australia	6.2	7	7.0	57	5.6	13	6.0
11	Hong Kong SAR	6.2	25	6.0	16	6.4	10	6.1
12	Denmark	6.1	17	6.4	31	6.1	17	5.9
13	Germany	6.1	12	6.6	55	5.6	8	6.1
14	Korea, Rep.	6.1	5	7.0	48	5.8	35	5.6
15	Japan	6.1	14	6.6	49	5.8	14	6.0
16	Singapore	6.1	15	6.6	72	5.3	1	6.5
17	Belgium	6.1	19	6.4	62	5.5	4	6.4
18	Estonia	6.0	16	6.5	59	5.6	19	5.9
19	Luxembourg	5.9	26	6.0	36	6.0	20	5.9
20	United Kingdom	5.9	20	6.3	53	5.7	24	5.8
21	Cyprus	5.9	33	5.5	22	6.3	16	6.0
22	Czech Republic	5.9	23	6.3	46	5.8	39	5.5
23	Netherlands	5.9	18	6.4	83	5.0	6	6.2
24	New Zealand	5.9	10	6.8	97	4.6	7	6.2
25	Slovenia	5.8	24	6.1	60	5.6	21	5.8
26	Bahrain	5.8	31	5.8	40	5.9	31	5.7
27	France	5.8	22	6.3	76	5.2	18	5.9
28	Poland	5.8	35	5.3	11	6.6	40	5.5
29	Ireland	5.7	27	6.0	77	5.2	9	6.1
30	Ukraine	5.7	51	4.7	6	6.6	33	5.6
31	Latvia	5.6	43	5.0	23	6.3	36	5.6
32	Russian Federation	5.5	52	4.7	10	6.6	48	5.4
33	Portugal	5.5	40	5.1	41	5.9	34	5.6
34	Spain	5.5	34	5.4	42	5.9	57	5.3
35	Trinidad and Tobago	5.5	37	5.2	44	5.9	43	5.5
36	Malta	5.5	21	6.3	88	4.8	44	5.5
37	Israel	5.5	32	5.5	68	5.5	38	5.5
38	Costa Rica	5.5	60	4.5	21	6.3	30	5.7
39	Kazakhstan	5.5	64	4.4	7	6.6	45	5.4
40	Turkey	5.5	59	4.5	2	6.9	69	5.0
41	Italy	5.5	39	5.1	52	5.7	37	5.6
42	Lithuania	5.4	57	4.5	34	6.0	26	5.8
43	Armenia	5.4	61	4.4	18	6.3	51	5.4
44	Mongolia	5.3	79	4.0	4	6.7	62	5.2
45	Montenegro	5.3	41	5.0	67	5.5	50	5.4
46	Georgia	5.3	65	4.4	15	6.4	64	5.1
47	Croatia	5.3	47	4.8	66	5.5	42	5.5
48	Serbia	5.2	45	4.9	56	5.6	61	5.2
49	Macedonia, FYR	5.2	56	4.6	39	5.9	66	5.1
50	Bosnia and Herzegovina	5.2	50	4.7	32	6.1	84	4.7
51	Kuwait	5.2	30	5.8	89	4.8	77	4.9
52	Moldova	5.1	69	4.2	29	6.1	70	5.0
53	Romania	5.1	55	4.6	73	5.2	41	5.5
54	Qatar	5.1	29	5.8	120	3.1	5	6.4
55	Brazil	5.1	58	4.5	26	6.2	91	4.5
56	United Arab Emirates	5.0	28	5.9	116	3.4	22	5.8
57	Mauritius	5.0	68	4.3	65	5.5	53	5.3
58	Hungary	5.0	48	4.8	80	5.0	56	5.3
59	Slovak Republic	5.0	70	4.2	51	5.8	72	5.0
60	Saudi Arabia	5.0	36	5.2	101	4.3	49	5.4
61	Panama	5.0	63	4.4	33	6.1	93	4.5
62	Thailand	4.9	67	4.3	64	5.5	73	5.0
63	Sri Lanka	4.9	103	3.0	35	6.0	32	5.7
64	Tunisia	4.9	82	3.7	24	6.3	85	4.7
65	Chile	4.9	54	4.6	84	4.9	67	5.1
66	Colombia	4.9	76	4.1	58	5.6	79	4.9
67	Azerbaijan	4.8	74	4.1	71	5.3	68	5.1
68	Albania	4.8	75	4.1	92	4.7	29	5.7
69	South Africa	4.8	44	4.9	74	5.2	95	4.4
70	Oman	4.8	46	4.9	96	4.6	76	5.0
71	Ecuador	4.8	78	4.0	78	5.1	63	5.2
72	Bulgaria	4.8	38	5.2	111	3.8	52	5.4
73	Malaysia	4.8	71	4.2	91	4.7	46	5.4
74	Seychelles	4.8	49	4.7	98	4.5	74	5.0
75	China	4.7	90	3.3	63	5.5	47	5.4
76	Uruguay	4.7	53	4.7	87	4.8	83	4.8
77	Greece	4.7	42	5.0	110	3.9	58	5.3
78	Argentina	4.7	66	4.3	n/a	n/a	71	5.0
79	Kyrgyz Republic	4.7	97	3.1	27	6.1	81	4.8
80	Bhutan	4.7	73	4.1	45	5.9	103	4.1
81	Indonesia	4.6	105	2.9	38	5.9	65	5.1
82	Vietnam	4.6	121	2.4	3	6.8	82	4.8
83	Iran, Islamic Rep.	4.6	101	3.0	37	6.0	80	4.8
84	Mexico	4.6	84	3.7	54	5.7	92	4.5
85	Venezuela	4.6	89	3.3	50	5.8	88	4.6
86	Paraguay	4.5	62	4.4	79	5.1	105	3.9
87	Lebanon	4.5	77	4.0	109	4.0	55	5.3
88	India	4.4	114	2.6	8	6.6	101	4.1
89	Peru	4.4	72	4.1	95	4.6	94	4.5
90	Jamaica	4.4	93	3.2	69	5.4	86	4.6
91	El Salvador	4.4	83	3.7	75	5.2	98	4.2
92	Philippines	4.4	87	3.6	107	4.1	54	5.3
93	Jordan	4.3	92	3.2	94	4.6	59	5.3
94	Morocco	4.3	102	3.0	20	6.3	110	3.7
95	Algeria	4.3	80	3.9	99	4.4	89	4.6
96	Cape Verde	4.3	100	3.1	86	4.8	75	5.0
97	Egypt	4.2	94	3.1	47	5.8	111	3.7
98	Bangladesh	4.1	107	2.8	14	6.4	122	3.1
99	Honduras	4.1	96	3.1	85	4.9	97	4.2
100	Cambodia	4.1	98	3.1	43	5.9	120	3.3
101	Guyana	4.0	104	2.9	104	4.2	78	4.9
102	Bolivia	4.0	91	3.2	103	4.3	90	4.6
103	Dominican Republic	4.0	85	3.7	106	4.2	104	4.0
104	Pakistan	4.0	126	2.1	1	6.9	127	2.8
105	Kenya	3.9	99	3.1	102	4.3	96	4.2
106	Nepal	3.9	130	1.9	30	6.1	115	3.6
107	Lao PDR	3.9	108	2.7	82	5.0	106	3.9
108	Lesotho	3.7	120	2.4	81	5.0	108	3.8
109	Guatemala	3.7	86	3.6	108	4.0	118	3.4
110	Namibia	3.6	81	3.9	119	3.2	109	3.8
111	Botswana	3.5	95	3.1	125	2.9	87	4.6
112	Guinea	3.5	132	1.8	9	6.6	137	2.1
113	Ghana	3.5	125	2.2	105	4.2	102	4.1
114	Zimbabwe	3.4	123	2.3	112	3.8	100	4.1
115	Rwanda	3.3	106	2.8	114	3.6	117	3.5
116	Ethiopia	3.1	122	2.3	93	4.6	131	2.5
117	Nigeria	3.1	113	2.6	100	4.3	134	2.4
118	Myanmar	3.1	115	2.6	122	3.0	113	3.6
119	Gabon	3.0	128	2.0	113	3.6	116	3.5
120	Nicaragua	3.0	88	3.5	136	1.9	112	3.6
121	Tajikistan	3.0	133	1.6	134	2.2	60	5.2
122	Gambia, The	3.0	109	2.7	123	3.0	121	3.2
123	Swaziland	3.0	119	2.5	133	2.2	99	4.2
124	Uganda	3.0	112	2.7	117	3.3	126	2.9
125	Mozambique	2.9	131	1.9	90	4.8	136	2.1
126	Côte d'Ivoire	2.9	110	2.7	127	2.9	123	3.1
127	Zambia	2.7	129	2.0	129	2.5	114	3.6
128	Benin	2.6	116	2.6	126	2.9	133	2.4
129	Senegal	2.6	118	2.5	130	2.5	128	2.8
130	Tanzania	2.6	117	2.6	131	2.3	125	2.9
131	Cameroon	2.6	138	1.1	128	2.8	107	3.8
132	Haiti	2.5	137	1.1	115	3.5	124	3.0
133	Burundi	2.5	134	1.3	124	2.9	119	3.3
134	Malawi	2.4	111	2.7	135	2.0	130	2.7
135	Liberia	2.2	135	1.2	121	3.1	132	2.4
136	Mauritania	2.1	136	1.2	118	3.3	138	1.9
137	Madagascar	2.0	124	2.2	138	1.0	129	2.8
138	Chad	1.9	127	2.0	137	1.9	139	1.9
139	Mali	1.9	139	1.1	132	2.3	135	2.4

Table 4: Usage subindex and pillars

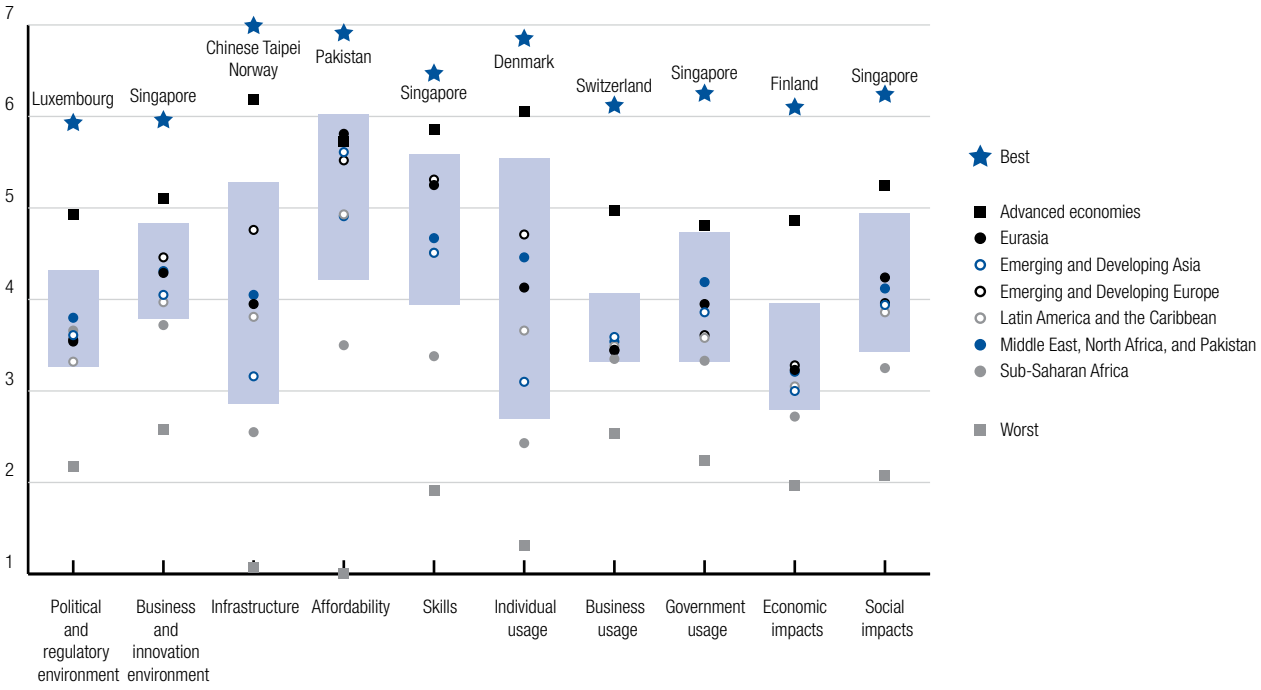
USAGE SUBINDEX			Individual usage		Business usage		Government usage	
Rank	Country/Economy	Value	Rank	Value	Rank	Value	Rank	Value
1	Singapore	6.0	12	6.4	14	5.4	1	6.3
2	Japan	5.9	11	6.4	3	5.9	7	5.4
3	Netherlands	5.9	8	6.6	7	5.8	14	5.4
4	Sweden	5.9	4	6.7	2	6.0	23	5.0
5	Luxembourg	5.9	2	6.8	15	5.4	9	5.4
6	Korea, Rep.	5.8	10	6.5	13	5.4	4	5.6
7	Finland	5.8	6	6.6	5	5.8	21	5.0
8	United States	5.8	17	6.2	4	5.9	12	5.4
9	Norway	5.8	3	6.7	11	5.5	18	5.2
10	Denmark	5.8	1	6.9	9	5.7	38	4.7
11	United Kingdom	5.7	5	6.6	16	5.2	10	5.4
12	Switzerland	5.7	9	6.6	1	6.1	43	4.5
13	United Arab Emirates	5.6	19	6.2	27	4.6	2	6.2
14	Germany	5.6	18	6.2	6	5.8	30	4.8
15	Israel	5.5	31	5.6	8	5.8	17	5.3
16	Chinese Taipei	5.5	24	6.0	12	5.5	24	5.0
17	New Zealand	5.5	20	6.1	20	5.0	13	5.4
18	Iceland	5.5	7	6.6	18	5.1	36	4.7
19	Qatar	5.4	23	6.0	25	4.8	5	5.5
20	France	5.4	25	6.0	19	5.0	15	5.3
21	Austria	5.4	27	5.9	10	5.6	28	4.8
22	Australia	5.4	13	6.3	24	4.8	22	5.0
23	Estonia	5.4	15	6.3	28	4.4	8	5.4
24	Bahrain	5.3	14	6.3	37	4.0	3	5.7
25	Hong Kong SAR	5.3	16	6.3	21	4.9	37	4.7
26	Canada	5.2	30	5.7	22	4.9	19	5.1
27	Belgium	5.2	22	6.0	17	5.2	42	4.6
28	Ireland	5.2	28	5.9	23	4.9	25	4.9
29	Saudi Arabia	5.1	21	6.0	42	3.9	11	5.4
30	Malaysia	5.1	47	5.1	26	4.7	6	5.5
31	Lithuania	4.9	35	5.5	29	4.3	33	4.7
32	Spain	4.8	33	5.6	43	3.9	32	4.7
33	Malta	4.7	26	5.9	40	4.0	49	4.3
34	Portugal	4.7	45	5.1	33	4.2	29	4.8
35	Latvia	4.6	36	5.5	35	4.1	50	4.3
36	Oman	4.5	39	5.3	94	3.4	34	4.7
37	Czech Republic	4.5	29	5.8	31	4.3	101	3.4
38	Uruguay	4.5	44	5.2	90	3.4	27	4.8
39	Chile	4.5	52	4.9	47	3.9	39	4.6
40	Russian Federation	4.5	40	5.3	67	3.6	44	4.4
41	Azerbaijan	4.4	56	4.8	58	3.7	35	4.7
42	Slovenia	4.4	38	5.4	30	4.3	86	3.6
43	Italy	4.4	37	5.5	52	3.8	62	4.0
44	Kazakhstan	4.4	58	4.8	69	3.6	26	4.8
45	Slovak Republic	4.4	34	5.6	48	3.9	73	3.7
46	Costa Rica	4.3	55	4.8	38	4.0	56	4.1
47	Kuwait	4.3	32	5.6	72	3.6	81	3.7
48	Hungary	4.2	41	5.3	73	3.6	70	3.8
49	Poland	4.2	42	5.3	64	3.6	82	3.6
50	Macedonia, FYR	4.2	49	5.0	92	3.4	58	4.1
51	China	4.1	75	3.9	44	3.9	40	4.6
52	Cyprus	4.1	51	4.9	54	3.8	75	3.7
53	Jordan	4.1	70	4.1	41	3.9	47	4.4
54	Colombia	4.1	71	4.1	82	3.5	31	4.8
55	Mauritius	4.1	66	4.3	55	3.8	48	4.3
56	Montenegro	4.1	61	4.6	99	3.4	53	4.2
57	Brazil	4.0	57	4.8	59	3.7	84	3.6
58	Croatia	4.0	43	5.2	98	3.4	90	3.5
59	Turkey	4.0	65	4.3	56	3.8	57	4.1
60	Morocco	4.0	67	4.2	105	3.3	41	4.6
61	Panama	4.0	72	4.0	39	4.0	60	4.1
62	Greece	4.0	50	4.9	87	3.5	91	3.5
63	Thailand	4.0	64	4.3	51	3.9	69	3.8
64	Bulgaria	4.0	48	5.0	77	3.5	102	3.3
65	Armenia	4.0	69	4.1	101	3.4	46	4.4
66	Philippines	3.9	79	3.8	36	4.0	63	4.0
67	Sri Lanka	3.9	102	2.8	49	3.9	20	5.0
68	Romania	3.9	60	4.7	68	3.6	96	3.5
69	Trinidad and Tobago	3.9	59	4.7	79	3.5	94	3.5
70	Seychelles	3.9	62	4.3	70	3.6	79	3.7

USAGE SUBINDEX			Individual usage		Business usage		Government usage	
Rank	Country/Economy	Value	Rank	Value	Rank	Value	Rank	Value
71	Mongolia	3.9	82	3.7	61	3.7	51	4.2
72	Georgia	3.8	68	4.1	108	3.2	54	4.1
73	Argentina	3.8	53	4.9	103	3.4	111	3.3
74	Mexico	3.8	84	3.6	66	3.6	52	4.2
75	South Africa	3.8	77	3.9	32	4.2	105	3.3
76	Moldova	3.8	63	4.3	112	3.2	66	3.9
77	Lebanon	3.8	46	5.1	97	3.4	124	2.9
78	Indonesia	3.8	92	3.3	34	4.1	65	3.9
79	Serbia	3.7	54	4.9	125	3.1	106	3.3
80	Tunisia	3.7	78	3.9	107	3.3	55	4.1
81	Vietnam	3.7	85	3.6	81	3.5	61	4.0
82	Ecuador	3.7	87	3.5	83	3.5	64	3.9
83	Rwanda	3.6	127	1.9	60	3.7	16	5.3
84	Kenya	3.6	107	2.6	50	3.9	45	4.4
85	Jamaica	3.6	86	3.5	62	3.7	87	3.6
86	Albania	3.6	83	3.6	93	3.4	76	3.7
87	Cape Verde	3.6	81	3.7	95	3.4	88	3.6
88	Ukraine	3.6	76	3.9	63	3.6	114	3.1
89	Egypt	3.5	80	3.8	129	3.0	67	3.8
90	El Salvador	3.5	91	3.3	78	3.5	85	3.6
91	Ghana	3.5	89	3.5	80	3.5	98	3.4
92	Peru	3.5	93	3.2	91	3.4	74	3.7
93	Honduras	3.4	104	2.8	46	3.9	78	3.7
94	Namibia	3.4	98	3.0	57	3.7	92	3.5
95	Senegal	3.4	106	2.6	53	3.8	68	3.8
96	Botswana	3.4	94	3.2	96	3.4	89	3.6
97	Dominican Republic	3.4	95	3.2	88	3.5	95	3.5
98	Venezuela	3.3	74	3.9	131	3.0	118	3.0
99	Iran, Islamic Rep.	3.3	90	3.3	126	3.1	93	3.5
100	Côte d'Ivoire	3.3	109	2.6	65	3.6	80	3.7
101	Bhutan	3.3	99	2.9	111	3.2	83	3.6
102	Gambia, The	3.3	108	2.6	85	3.5	77	3.7
103	India	3.3	120	2.1	75	3.6	59	4.1
104	Kyrgyz Republic	3.2	88	3.5	109	3.2	117	3.0
105	Guyana	3.2	105	2.7	76	3.5	99	3.4
106	Guatemala	3.2	100	2.8	45	3.9	122	2.9
107	Bosnia and Herzegovina	3.2	73	4.0	123	3.1	133	2.6
108	Bolivia	3.1	97	3.0	132	3.0	108	3.3
109	Nigeria	3.1	112	2.5	86	3.5	112	3.3
110	Cambodia	3.1	101	2.8	104	3.3	116	3.0
111	Bangladesh	3.0	121	2.1	119	3.1	72	3.8
112	Paraguay	3.0	96	3.1	121	3.1	128	2.7
113	Zambia	3.0	126	2.0	71	3.6	104	3.3
114	Cameroon	2.9	125	2.0	74	3.6	107	3.3
115	Mali	2.9	113	2.5	124	3.1	113	3.2
116	Tajikistan	2.9	116	2.3	102	3.4	115	3.1
117	Lao PDR	2.9	124	2.0	89	3.4	110	3.3
118	Pakistan	2.9	123	2.1	110	3.2	103	3.3
119	Gabon	2.9	110	2.5	115	3.2	119	2.9
120	Uganda	2.9	129	1.9	106	3.3	97	3.4
121	Zimbabwe	2.8	114	2.5	117	3.1	120	2.9
122	Benin	2.8	119	2.2	84	3.5	127	2.8
123	Ethiopia	2.8	136	1.6	127	3.0	71	3.8
124	Mozambique	2.8	128	1.9	114	3.2	109	3.3
125	Algeria	2.8	103	2.8	133	2.9	130	2.7
126	Tanzania	2.7	134	1.7	122	3.1	100	3.4
127	Swaziland	2.7	115	2.4	116	3.2	131	2.7
128	Lesotho	2.7	122	2.1	120	3.1	121	2.9
129	Nepal	2.6	117	2.2	128	3.0	129	2.7
130	Liberia	2.6	130	1.8	113	3.2	123	2.9
131	Nicaragua	2.6	111	2.5	130	3.0	138	2.3
132	Madagascar	2.6	135	1.6	100	3.4	125	2.8
133	Mauritania	2.5	118	2.2	135	2.8	134	2.5
134	Malawi	2.5	137	1.5	118	3.1	126	2.8
135	Guinea	2.3	133	1.8	136	2.8	135	2.5
136	Haiti	2.3	132	1.8	134	2.8	139	2.2
137	Myanmar	2.3	131	1.8	138	2.6	137	2.3
138	Chad	2.2	139	1.3	137	2.6	132	2.6
139	Burundi	2.1	138	1.3	139	2.5	136	2.4

Table 5: Impact subindex and pillars

IMPACT SUBINDEX			Economic impacts		Social impacts	
Rank	Country/Economy	Value	Rank	Value	Rank	Value
1	Singapore	6.1	5	5.9	1	6.2
2	Netherlands	6.0	6	5.8	3	6.1
3	Sweden	5.8	3	6.1	12	5.6
4	Finland	5.8	1	6.1	18	5.5
5	United States	5.8	7	5.8	7	5.7
6	Israel	5.7	4	5.9	15	5.5
7	United Kingdom	5.6	11	5.3	5	5.9
8	Switzerland	5.6	2	6.1	33	5.0
9	Norway	5.6	8	5.4	8	5.7
10	Korea, Rep.	5.6	14	5.1	4	6.0
11	Canada	5.4	12	5.2	11	5.6
12	Luxembourg	5.4	9	5.4	23	5.3
13	Hong Kong SAR	5.3	13	5.2	14	5.5
14	Japan	5.3	15	5.1	16	5.5
15	Germany	5.3	10	5.4	30	5.2
16	Estonia	5.2	24	4.6	6	5.9
17	Denmark	5.2	16	5.1	26	5.3
18	United Arab Emirates	5.2	26	4.3	2	6.1
19	France	5.2	20	4.9	17	5.5
20	Chinese Taipei	5.2	18	5.0	20	5.4
21	Australia	5.2	23	4.7	9	5.7
22	Iceland	5.1	22	4.8	21	5.4
23	Belgium	5.0	19	4.9	31	5.1
24	Austria	5.0	21	4.9	29	5.2
25	New Zealand	5.0	25	4.6	19	5.4
26	Ireland	5.0	17	5.0	34	5.0
27	Qatar	4.9	28	4.2	10	5.6
28	Lithuania	4.8	27	4.3	25	5.3
29	Portugal	4.7	31	4.1	24	5.3
30	Malaysia	4.6	30	4.1	28	5.2
31	Latvia	4.5	34	4.0	32	5.1
32	Bahrain	4.5	48	3.5	13	5.5
33	Malta	4.5	33	4.0	37	4.9
34	Spain	4.4	35	4.0	39	4.8
35	Chile	4.4	47	3.5	27	5.2
36	Uruguay	4.4	62	3.4	22	5.4
37	Slovenia	4.3	29	4.1	50	4.5
38	Saudi Arabia	4.3	40	3.7	36	4.9
39	China	4.2	37	3.8	41	4.7
40	Kazakhstan	4.2	51	3.5	35	4.9
41	Russian Federation	4.1	38	3.7	45	4.6
42	Costa Rica	4.1	49	3.5	40	4.8
43	Czech Republic	4.1	32	4.1	67	4.2
44	Slovak Republic	4.1	41	3.6	47	4.6
45	Panama	4.0	45	3.6	51	4.5
46	Azerbaijan	4.0	50	3.5	48	4.5
47	Hungary	4.0	36	3.8	64	4.2
48	Italy	4.0	39	3.7	62	4.2
49	Sri Lanka	4.0	70	3.2	42	4.7
50	Kenya	3.9	54	3.4	52	4.5
51	Jordan	3.9	61	3.4	53	4.4
52	Colombia	3.9	84	3.1	43	4.7
53	Macedonia, FYR	3.9	55	3.4	55	4.3
54	Armenia	3.9	56	3.4	56	4.3
55	Rwanda	3.9	99	2.9	38	4.8
56	Cyprus	3.9	43	3.6	70	4.1
57	Montenegro	3.8	52	3.5	63	4.2
58	Turkey	3.8	67	3.2	54	4.4
59	Poland	3.8	44	3.6	74	4.0
60	Mongolia	3.8	82	3.1	49	4.5
61	Greece	3.8	65	3.3	58	4.3
62	Philippines	3.8	60	3.4	66	4.2
63	Georgia	3.8	91	2.9	44	4.6
64	Croatia	3.8	42	3.6	82	3.9
65	Thailand	3.7	74	3.2	57	4.3
66	Oman	3.7	95	2.9	46	4.6
67	Mauritius	3.7	69	3.2	61	4.2
68	Bulgaria	3.7	46	3.5	83	3.9
69	Ukraine	3.7	59	3.4	75	4.0
70	Mexico	3.7	64	3.3	71	4.1
71	Moldova	3.7	81	3.1	60	4.2
72	Senegal	3.6	63	3.3	81	3.9
73	India	3.6	80	3.1	69	4.1
74	Honduras	3.6	53	3.5	87	3.8
75	Ecuador	3.6	86	3.0	68	4.1
76	Vietnam	3.6	92	2.9	65	4.2
77	Romania	3.6	72	3.2	79	3.9
78	Indonesia	3.5	85	3.1	73	4.0
79	Brazil	3.5	75	3.1	77	3.9
80	Morocco	3.5	110	2.8	59	4.3
81	Peru	3.5	88	3.0	72	4.1
82	Seychelles	3.5	73	3.2	86	3.8
83	Côte d'Ivoire	3.4	66	3.3	92	3.6
84	Tunisia	3.4	93	2.9	78	3.9
85	Egypt	3.4	58	3.4	103	3.5
86	Dominican Republic	3.4	68	3.2	94	3.6
87	Cape Verde	3.4	77	3.1	89	3.7
88	Trinidad and Tobago	3.4	78	3.1	90	3.7
89	Serbia	3.4	79	3.1	93	3.6
90	Kuwait	3.4	102	2.9	84	3.9
91	El Salvador	3.4	106	2.8	80	3.9
92	Argentina	3.4	87	3.0	88	3.7
93	South Africa	3.4	57	3.4	112	3.3
94	Jamaica	3.3	76	3.1	97	3.5
95	Guyana	3.3	94	2.9	91	3.7
96	Guatemala	3.3	71	3.2	107	3.4
97	Albania	3.3	121	2.6	76	4.0
98	Bhutan	3.2	119	2.6	85	3.8
99	Tajikistan	3.2	101	2.9	96	3.5
100	Gambia, The	3.2	103	2.9	95	3.5
101	Namibia	3.2	98	2.9	100	3.5
102	Iran, Islamic Rep.	3.2	100	2.9	101	3.5
103	Lebanon	3.2	83	3.1	114	3.3
104	Lao PDR	3.1	97	2.9	110	3.4
105	Pakistan	3.1	105	2.8	106	3.4
106	Bolivia	3.1	113	2.7	98	3.5
107	Bangladesh	3.1	104	2.8	108	3.4
108	Botswana	3.1	107	2.8	105	3.4
109	Mali	3.1	96	2.9	113	3.3
110	Kyrgyz Republic	3.1	114	2.7	104	3.4
111	Ghana	3.1	117	2.7	99	3.5
112	Venezuela	3.0	118	2.6	102	3.5
113	Zambia	3.0	115	2.7	111	3.3
114	Nigeria	3.0	90	2.9	123	3.0
115	Cameroon	3.0	89	2.9	124	3.0
116	Mozambique	2.9	112	2.7	117	3.1
117	Cambodia	2.9	111	2.7	122	3.0
118	Paraguay	2.9	109	2.8	125	3.0
119	Ethiopia	2.9	131	2.4	109	3.4
120	Uganda	2.9	120	2.6	118	3.1
121	Bosnia and Herzegovina	2.8	123	2.6	119	3.1
122	Tanzania	2.8	132	2.4	115	3.3
123	Benin	2.8	108	2.8	128	2.8
124	Zimbabwe	2.8	133	2.3	116	3.2
125	Lesotho	2.7	130	2.4	121	3.1
126	Liberia	2.7	125	2.5	127	2.9
127	Madagascar	2.7	126	2.5	126	2.9
128	Nepal	2.7	136	2.3	120	3.1
129	Algeria	2.6	124	2.6	132	2.7
130	Gabon	2.6	127	2.5	129	2.7
131	Malawi	2.6	128	2.5	130	2.7
132	Nicaragua	2.6	122	2.6	133	2.6
133	Mauritania	2.5	116	2.7	134	2.4
134	Swaziland	2.5	134	2.3	131	2.7
135	Myanmar	2.4	129	2.4	135	2.4
136	Haiti	2.3	135	2.3	136	2.4
137	Burundi	2.1	137	2.1	138	2.2
138	Guinea	2.1	139	2.0	137	2.2
139	Chad	2.1	138	2.0	139	2.1

Figure 11: Best and worst performers and regional performance by NRI pillar
Score (1–7)



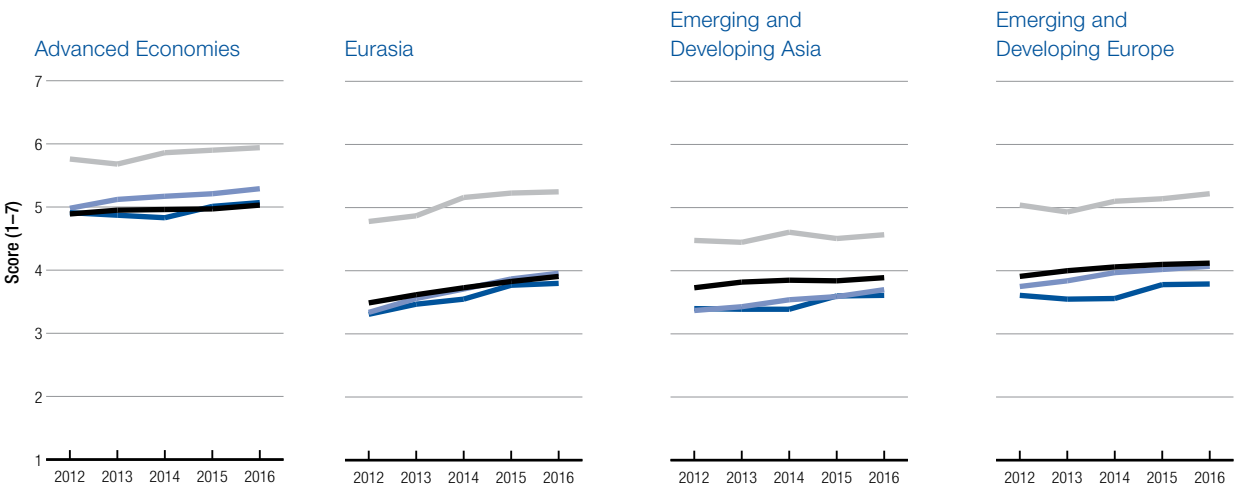
Notes: The light blue boxes identify the interquartile range—from the 75th to the 25th percentile—for each distribution. Regional groupings follow the IMF classification; IMF "CIS" = "Eurasia."

The overall improvement in the NRI score masks a diversity of trends across subindexes (Figure 12 on page 22). Most importantly, there is a clear positive trend both in terms of Usage and Impact across regions. The regulatory and innovation environment is perceived to be improving as well, but although this improvement has been large in Eurasia, it is almost negligible in Latin America and the Caribbean, where regulatory reforms seem to have come to a standstill in many countries. Performance in terms of Readiness is mostly stagnant, with large intertemporal fluctuations driven by changes in affordability and sluggish improvements in skills and infrastructure, where investments have not been enough to keep up with the pace of increase in Usage. Affordability remains a barrier to ICT adoption and use in sub-Saharan Africa, and indeed this barrier seems to be growing.

The distribution of scores across the 10 pillars shows interesting patterns (Figure 11) and provides further support for the findings outlined above. Infrastructure and individual usage are the two areas with the largest dispersion of performance across countries, with advanced economies leading the way and sub-Saharan Africa still behind other regions—although certain countries in the region are pushing ahead (see the Country/Economy Profiles). Countries' scores in business usage and economic impact is most skewed toward the lower end of the distribution, with the average performance of advanced economies placed well ahead that of the rest of the world and that of the best performers (Switzerland and Finland, respectively) having the largest gap from the upper end of the interquartile range. This confirms that businesses in only a few economies are leveraging ICTs at their full potential and reaping the resulting strong economic impact. As in previous years, affordability is the only area where advanced economies as a whole are not the best-performing group (note that while "affordability" indicators capture prices without quality adjustments, it is ultimately the price that poses the entry barrier for the poorest and not the quality-adjusted price). The advanced economies are preceded in this regard by the group of Eurasian countries, and Pakistan is the market with the lowest price points. Sub-Saharan Africa is at this moment still the lowest-scoring region, with the notable exception of the perceived political and regulatory environment, where the region follows advanced economies and MENAP countries and precedes Emerging and Developing Asia, Emerging and Developing Europe, Eurasia, and Latin America and the Caribbean. In terms of best performers, Luxembourg replaces New Zealand this year as having the best political and regulatory environment, and Finland has been toppled by Singapore as the country with the best skillset.

Overall, and as was explored in detail in the 2015 edition of this *Report,* the digital divide is still wide, yet progress is being made. In particular, several initiatives have been formed to tackle this gap, including the World Economic Forum's Internet for All initiative, which aims to help connect the 4 billion people who are not yet online (see Box 5).

Figure 12: Trends at the subindex level, 2012–16
Score (1–7)



Source: NRI, 2012–2016 editions.

Top 10 NRI performers

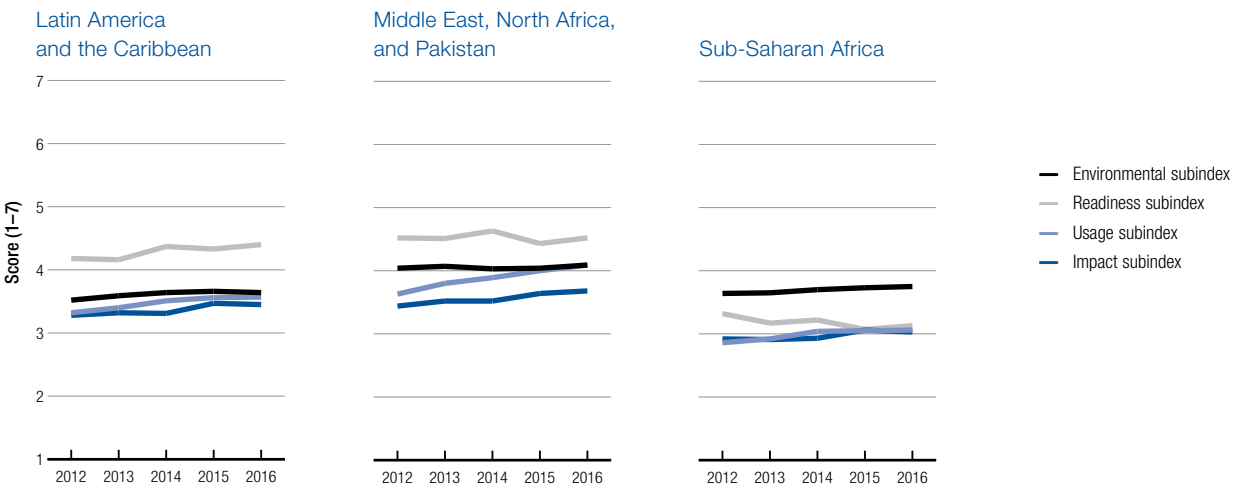
The composition of the group of top 10 performers is unchanged from last year. The group consists of a mix of high-income Southeast Asian (Singapore and Japan) and European countries (Finland, Sweden, Norway, the Netherlands, Switzerland, the United Kingdom, and Luxembourg) as well as the United States. Networked readiness therefore remains highly correlated with per capita income.

1. Singapore tops the Index this year, defending its number 1 position. Its outstanding performance is underlined by the fact that it ranks 1st in the world in three of the four subindexes (Environment, Usage, and Impact), driven by top spots on several pillars: political and regulatory environment (2nd), business and innovation environment (1st), skills (1st), government usage (1st), and social impact (1st). Overall, this ranking is to a large extent the result of strong government commitment to the digital agenda, including its Smart Nation program. The drop in the Readiness subindex to 16th place is largely explained by a drop in the affordability of broadband, although the price points of broadband packages may hide quality differences (i.e., a price increase may come with a quality increase). Singapore currently has an offline population of 18 percent, potentially explained by its demographics, and the country is still out of the top 10 for individual usage (12th) and business adoption (14th). Nevertheless, gains from ICT adoption are widely shared in Singapore, as the country tops the Social impacts pillar, making excellent use of digital technologies to provide access to basic and government services and ensuring that schools are connected.

2. Finland stays in 2nd place with an unchanged overall score, but sees some slight rank drops for the Environment, Usage, and Impact subindexes. The country tops the rankings in the Readiness subindex. This is the result of high scores in particular in the infrastructure (3rd) and skills pillars (2nd); in addition, affordability is very good (13th), although Finland is one of several countries that sees broadband prices increase significantly this year (51st, down from 39th in 2015). There is currently room for improvement in particular in the business and innovation environment, where Finland ranks 9th. With 14 days to start a business, the country comes in only at a low 81st place in this particular indicator; as pressure for firms to bring products to market quickly is increasing, these types of framework conditions matter more than ever. That said, Finland has extremely good access to the latest technologies (1st) as well as venture capital (6th), and its businesses are highly connected (5th on business usage). These factors are all important in helping Finland achieve its top global rank in economic impacts. The government is currently perceived as playing a less proactive role in promoting ICTs than in the past (21st place, down from 10th in 2013): indicators are dropping for government procurement of advanced technologies, importance of ICTs to government vision, government success in ICT promotion, and ICT use to boost government efficiency.

3. Sweden keeps its 3rd position in the NRI as scores in all four subindexes remain almost unchanged. Overall, it ranks best in Usage (4th), which derives from very high scores in individual (4th) and business usage (2nd), and notably does very well in Impact (3rd). Businesses are taking advantage of the fact that their consumer base is highly connected, which is reflected in one of the highest rates of B2C interaction globally (4th). Government, on the other hand, is not yet connecting with citizens online to the same extent as business, with a 45th rank for the government E-Participation

Figure 12: Trends at the subindex level, 2012–16 *(cont'd.)*
Score (1–7)



Notes: Based on a constant sample of 127 economies. Groupings follow the IMF classification; IMF "CIS" = "Eurasia."

Index. In general, the Swedish government is perceived as less proactive than other advanced economies in their use of digital technologies (23rd for government usage); in particular, business executives feel that it has somewhat been losing sight of the digital agenda (20th for government ICT vision, down from 11th in 2014). Yet the government has been taking steps to improve the overall framework conditions for business: there is visible progress in several areas of the political and regulatory environment and the business and innovation environment pillars. In particular, Sweden slashes the number of days it takes to start a business from 16 to 7, moving it up 45 places in the ranking in this indicator to 42nd place. Driven to an important extent by the business sector, digital technologies are making themselves felt in terms of economic impact (3rd) and an improvement by four places in social impact to 12th.

4. Norway moves up one rank to 4th place, with small but positive score changes in all four subindexes. The country seems to have reached a plateau, with little

Box 5: The World Economic Forum's Internet for All initiative

Internet for All is one of the core projects of the Forum's Digital Economy and Society System Initiative. As a critical enabler of the Fourth Industrial Revolution, Internet for All focuses on connecting the over 4 billion people not yet connected to the Internet. The project's core objective is to develop scalable, replicable, public-private collaboration models to accelerate Internet access and adoption at the national, regional, and global levels.

In 2015, Internet for All convened stakeholders from various backgrounds to collect successful practice examples for global Internet access and adoption, and to develop a framework in which to accelerate achieving "Internet for all." The framework emphasizes the need for an ecosystem approach to simultaneously address the challenges related to infrastructure, affordability, skills and awareness, and content. The report also includes a checklist, based on the framework, to help policymakers and others assess where their countries currently stand and the kinds of programs to consider. The white paper "Internet for All: A Framework for Accelerating Internet Access and Adoption" can be accessed at http://www3.weforum.org/docs/WEF_Internet_for_All_Framework_Accelerating_Internet_Access_Adoption_report_2016.pdf.

In 2016, Internet for All has two main objectives:

1. To develop new scalable and replicable on-the-ground models of public-private collaboration, in partnership with governments, to accelerate the achievement of the broader social and economic priorities of the country/region in the context of accelerating Internet for all. Programs will be launched initially in up to three countries/regions. The first such program, for Northern Corridor countries in East Africa (Kenya, Rwanda, South Sudan, and Uganda), was launched in May 2016, and additional country program partnership opportunities in Asia and Latin America will also be explored.
2. To develop a physical and digital platform that results in increased coordination and collaboration among the multiple private, bilateral/multilateral, and non-profit organizations involved in catalyzing Internet access and adoption at the global, regional, and country levels.

movement in its total NRI score in recent years. Its digital economy is built on the very solid basis of top regulatory and innovation environments (6th and 7th, respectively) as well as the world's best ICT infrastructure. Although fixed broadband prices are relatively high (71st) there has not been a further increase this year, and with 96.3 percent of the population online (2nd for individuals using the Internet), the high prices do not seem to act as an access barrier. Similar to the situation in Sweden, Norwegian firms are capitalizing on the high ICT literacy among the general population and workforce by using digital technologies heavily in their interactions with consumers as well as among each other (8th and 7th, respectively). There has also been a visible positive move in government usage (importance in vision, success in ICT promotion, and government efficiency), moving the country up six places to the 18th rank in the government usage pillar. Unsurprisingly, these strong digital foundations are reflected in two 8th ranks for the two Impact pillars.

5. The **United States** moves up two ranks overall, continuing a positive trend from 2013 (from 9th place in 2013 to 7th in both 2014 and 2015 to 5th place this year). This is based on improvements in all four subindexes.[24] The United States stands out in terms of its extremely favorable business and innovation environment (3rd), which has given rise to one of the most agile and digitized business sectors globally. The public sector is also using digital technologies effectively to deliver services to citizens (4th the on Government Online Service index) and to facilitate participation (9th on the E-Participation Index). All stakeholders can take advantage of very low broadband prices (ranked 17th), with the cheapest package at US$16 per month, compared to a global average of US$52 and an average of US$26 in high-income countries;[25] however, although international Internet bandwidth per user has been growing steadily in recent years, the race has accelerated such that the United States is slipping from 34rd in 2013 to 42nd this year. The overall impact of digital technologies in the United States is strong (it ranks 7th for both economic and social impacts) and growing, in particular in the social dimension: this year, the United States moves up 15 places to rank 15th in the perceived impact of ICTs on access to basic services.

6. The **Netherlands** drops by two spots in the overall rankings, but remains one of the countries that makes the best use of digital technologies to achieve both economic and, in particular, social impacts (it ranks 6th and 3rd, respectively, in the two pillars and 2nd in the Impact subindex). This is despite high mobile tariffs (105th) and high and rising broadband prices (85th, down from 68th). Other drops at the indicator level can largely be attributed to the fact that, although conditions are stable or even improving slightly in absolute terms, other countries are moving ahead faster. This is true in particular for the business and innovation environment as well as ICT infrastructure. The Dutch population is one of the most technology savvy and connected in the world (8th for individual usage), an asset that both the government and the business sector are making good use of (3rd for B2C Internet use, 8th for the Government Online Service index, and 1st for the E-Participation index). Businesses are extensively deploying digital technologies to reshape their business and organizational models (4th in both indicators) and basic service providers, whether they are public or private, are working hand-in-hand with the population to facilitate access via their platforms (2nd).

7. Switzerland slips by one spot overall to 7th, placing in the top 10 for the Environment, Readiness, and Impact and 12th for Usage subindexes. The country moves up by two places in the innovation environment assessment, largely driven by a jump in perceived availability of venture capital as well as continued high levels of government procurement of advanced technologies; this is against an overall global trend of falling government demand for the latest technologies. However, in general the government has so far been a less avid adopter and promoter of digitization, as reflected in a 43rd place for government usage. Although it is strong in the high-tech procurement market, it seems to be using digital technologies relatively less to interact with citizens. On the other hand, the country remarkably places 1st for business usage, driven by high business technology absorption and innovation capacity and high levels of digital B2B interaction (interestingly, more than with consumers). This in turn has been generating strong economic impact (2nd rank), as reflected also in a steady upward trend in the share of knowledge-intensive jobs (3rd).

8. The **United Kingdom** remains in 8th position, improving slightly in absolute scores on all four subindexes. Improvements at the indicator level are particularly concentrated in the business and innovation environment: perceived venture capital availability, the quality of management schools, and government procurement of advanced technologies have all increased compared to last year, while the number of days and procedures to start a business was reduced. Although infrastructure and individual usage are moving in the right direction, they are not moving fast enough to result in gains in the rankings. Business adoption is high and UK businesses are top in the world in making use of the Internet to interact with their consumers as well as with their production network (1st in B2C, 2nd in B2B). They are also pushing the boundaries in terms of using ICTs to reshape their business and organizational models (ranking 2nd and 1st, respectively). The government is also moving closer to the global frontier in terms of technology use, jumping six places into the top 10 of the government usage pillar.

9. Luxembourg's NRI rank stays the same as last year at 9th place, with its overall score continuing its steady upward trend. Improvements at the pillar level

come in three areas: political and regulatory environment and individual usage, moving Luxembourg to 1st and 2nd place in these categories, respectively, and in the area where the country is most behind, affordability: here in particular, a large drop in mobile cellular tariffs moves the country up 14 places in the affordability pillar. Although performance in terms of innovation environment is mixed, good availability of venture capital (8th) and a strong government commitment to procuring advanced technologies (5th) bode well for the commercialization of new ideas. In general government is perceived to play an important role in supporting Luxembourg's digital economy, with business executives attesting to a high importance of ICTs in the government's vision (5th) and its success in ICT promotion (6th). Furthermore, strong framework conditions have been put in place, reflected in the top rank regarding the level of sophistication for ICT related laws (e.g., for e-commerce, digital signatures, and consumer protection). The country also boasts a top infrastructure with top ranks for international bandwidth (1st) and the number of secure servers per capita (3rd).

10. Japan remains in 10th place overall, as in 2015, and is able to climb two places to 2nd in the Usage subindex; with business and government usage already among the highest globally (3rd and 7th, respectively), the country moves up two places in individual usage to 11th place. The business and innovation environment is improving visibly with progress in the perceived availability of venture capital, the quality of management schools, and government procurement of advanced technologies; this is the continuation of a strong positive trend, moving the country from 40th place in 2014 to 33rd in 2016 in this particular pillar. Japan also keeps building out its infrastructure, in particular international Internet bandwidth and the number of secure servers. In terms of impact, the country is slightly losing ground, mainly because its peers are moving ahead faster.

Top movers

Italy is among the group of top movers this year, climbing up by 10 places to an overall NRI rank of 45. The most significant driver is a large improvement in terms of both economic and social impacts, putting Italy 18 places ahead in the Impact rankings to 48th. Over the past years, the Italian government has launched a number of policies aiming at improving the provision of online services to its citizens and creating a better environment for start-ups and innovative companies. However, key constraints remain, including the lack of venture capital and the overall political and business environment. Here the country seems to be moving in the right direction, gaining in almost every aspect of the regulatory environment pillar, but it remains far below the global average. Italy is currently doing best in individual usage (37th), followed by business (52nd) and government use (62nd). Yet only a small portion of Italians are connected to fixed broadband: the number has been historically low but the gap with other advanced economies has only increased in recent years, when subscriptions per 100 people increased by less than 10 percent from 21.9 (28th highest, in 2010) to 23.5 (36th, in 2014). With the private sector currently reorganizing itself and the launch of the 2015 national Digital Agenda, which will unfold in the coming years, the country has an opportunity to close this gap. Going forward, it will be important to capitalize on this positive momentum.

The **Slovak Republic** is one of the two biggest movers in this year's NRI, climbing 12 ranks to 47th place, mainly on the back of reinforced effort from the public sector: although the country ranks fairly low in the regulatory environment (its lowest ranks overall are in this category), it is starting to catch up this year in terms of the effectiveness of law-making bodies, laws relating to ICTs, and judicial independence. Furthermore, the government is perceived to have been more active in procuring advanced technologies as well as putting digital technologies to use to increase government efficiency. This is reflected in large moves compared to last year for these indicators, of 29 and 31 places, respectively (to 89th and 80th). In addition, the business and innovation environment is perceived to be improving markedly in terms of venture capital and tech availability, as well as procedures to start a business. Together with fairly high individual usage (34th), a good level of buy-in from the business sector (48th), and quickly dropping fixed broadband prices, the efforts to embrace the digital economy are starting to pay off: the Slovak Republic is able to improve its ranking in the Impact subindex by 14 places to 44th. This is thanks to better access to basic services as well as firms taking advantage of digital technologies to innovate in terms of organizational and business models.

Kuwait is another top mover in the NRI this year, moving up 11 spots to 61st place. This gain is supported by substantial improvements in particular in Readiness, Usage, and Impact. These improvements are very much driven by individuals and businesses. Kuwait is doing very well overall in terms of individual adoption—ranking overall 32nd and very high in individual indicators: mobile coverage (1st), mobile phone subscriptions (2nd), households with personal computers (14th), and mobile broadband subscriptions (2nd)—and is close to attaining a rank in the top half for business adoption. In particular, the country substantially improves its international Internet bandwidth per user, jumping more than 50 places to rank 51st, according to ITU data. All of this is starting to show in terms of economic impacts: Kuwait reports a large perceived improvement in ICT impact on business model innovation this year (although starting from a low base). Although social impact is perceived to have improved less than economic impact, it is worth noting that the social impact of ICTs in Kuwait is perceived to be substantially higher than economic impact (84th for social, 102nd for

economic). This is a good basis on which to build for further improvements, and the government continues on its course to improve the regulatory environment, as it has done over the past year.

Despite an overall mixed performance, **South Africa** makes large strides in the overall NRI rankings to 65th, almost entirely driven by improvements in infrastructure and affordability. South Africa's digital transformation is mostly business driven, as the country notably performs best in business usage (32nd), followed by individual usage (77th), followed by government usage (105th). Although the country is perceived by South African business executives to be performing relatively well in terms of its regulatory and political environment, its innovation and business environment is rated significantly worse and, in addition, shows strong signs of deterioration—especially regarding technology and venture capital availability, government procurement of the latest technologies, and days as well as procedures to start a business. It would be a pity if these developments were to offset investments in infrastructure that have significantly increased international Internet bandwidth and put the country among the top 20 globally on this particular indicator. Furthermore, mobile tariffs have more than halved and broadband tariffs dropped slightly, reducing barriers to adoption also in terms of affordability. In order for impact to start materializing, significantly more buy-in from government will be needed across all areas of vision, promotion, and efficient use.

Lebanon is the second biggest mover this year, gaining 11 ranks to land in 88th place in the overall NRI. Importantly, the country is registering substantial positive moves in all four subindexes. In terms of adoption, Lebanon is doing best in individual usage (46th), followed by business usage (97th) and government usage (124th). Most indicators of personal usage have been improving over the past year, with the business sector catching up in its use and adoption of digital technologies; with overall perceived progress in business adoption being slow around the world, this is a positive exception to the trend. Starting from a low level, government indicators are also moving in the right direction: in particular, the regulatory environment is improving in terms of judicial independence, the efficiency of the legal system, and the effectiveness of law-making bodies. Substantial improvements are registered for the impact of ICTs on business models, organizational models, basic services, and government efficiency. Building also on a solid basis in terms of education, skills, and knowledge-intensive jobs, Lebanon has many of the factors in place to continue on this positive trajectory.

Côte d'Ivoire stands out as improving in almost every dimension of networked readiness. All but eight indicators go up this year, leaving the country nine places improved in 106th position. The business community reports large gains in the regulatory and business environment. In particular, strong government efforts to lower entry barriers by slashing the number of days (from 32 to 7 days since 2013) and procedures to start a business (4 steps, down from 10) are noteworthy. Business executives also feel that the government has a strong ICT vision and correspondingly considerable success in ICT promotion (80th place for government usage, up from 114th). In addition, they attest to considerable ICT-driven improvements in government efficiency. As business and individual usage are also growing strongly, the existing infrastructure is starting to be stretched—this is one of the few areas where Côte d'Ivoire is falling behind. Going forward, progress in upgrading infrastructure and tackling affordability seem top priorities for sustaining momentum.

Ethiopia moves up 10 spots to 120th place in the NRI, led by the government sector (71st for government usage). Yet the business sector is starting to catch up, moving up 8 spots to 127th, as executives feel innovation capacity in the country is increasing and businesses are starting to explore the use of the Internet to interact with consumers (123rd this year, up from 138th). It will be important that this momentum is not broken by a deteriorating business environment; in particular, setting up a new business seems to be getting tougher, with the required number of days and procedures increasing. The private sector is also still constrained by a very small base of online consumers: only 31 percent of the population had a mobile phone subscription in 2014. Yet, because prices are falling significantly, ICTs will become accessible to a larger part of the population (93rd rank on affordability, up from 113th). In addition, the country has been edging forward on the skills dimension, although a large gap remains to be closed. Importantly, the NRI figures suggest that there have been significant improvements in giving schoolchildren access to the Internet (ranking 96th, up from 115th), an effort that will most certainly pay off in the coming years.

Other selected economies

The **Republic of Korea** further improves its score but less than its peers, and thus slips one notch to 13th. The country's political and regulatory environment, historically one of its relative weaknesses, has improved significantly, especially when it comes to the judicial system. Infrastructure has also improved further, allowing Korea to climb to 5th position globally on the back of increased international bandwidth capacity (approximately 50 percent higher) and a further increase in the number of secure servers installed in the country. Digital technologies are fully leveraged in Korea to provide online services to the population (4th) and allowing the participation of citizens in public life and decision-making (1st). With 98.5 percent of households having access to the Internet, Korea has one of the most tech-savvy populations in the world. However, a stronger entrepreneurial spirit will be necessary to bring

innovation out of the large *chaebols* and into the rest of the economy. Although it has increased in recent years, venture capital availability is still low, with most funds being channeled to existing companies rather than start-ups in the seed and early-growth stages.

Canada improves its absolute performance but less than its peers, thus sliding down three positions to 14th. The country can rely on one of the best business and innovation environments in the world (4th), where starting a business is easy and quick (ranking 3rd on both time and procedures to start a business). The potential of a highly skilled workforce (11th) remains partially untapped, as individual usage remains relatively low (30th): for example, there are only 54.3 mobile broadband subscriptions per 100 people in Canada (52nd), compared to 102.7 in the United States. Although the government has been quite successful in using digital technologies to provide online services (10th) and allow citizens' e-participation (14th), it has not shown a strong vision for ICTs (49th) nor has it been particularly successful in promoting them (38th). This might change in the future because the government is stepping up efforts to promote innovation policies, which will need to include a strong ICT component. Once an innovation leader in the mobile industry, Canada still relies heavily on mining and medium-technology sectors. Improving businesses' adoption of ICTs (22nd) can be a powerful driver of innovation for the country.

Germany drops two spots this year to 15th place, despite a slight improvement in its absolute score. Although businesses operate in a very good regulatory environment (16th), more can be done to support new firms—for example, by reducing further the number of days and procedures required to start a business. Germany's infrastructure and skills base is one of the best in the world, while fixed broadband prices are high and rising. Individual adoption and usage is increasing further, although it is not moving fast enough to move Germany up in the rankings on this dimension. Germany is one of the highest-scoring countries for business usage (6th), yet the government is not yet using digital technologies to their full potential (30th); that said, executives feel that the government is starting to develop a stronger digital vision. A big positive jump is registered this year for the impact of ICTs on access to basic services.

With a stable overall score, **Australia** slips two spots to 18th position. Improvements in terms of Environment (16th, up one) are outweighed by a deterioration of the country's level of Readiness, especially when it comes to affordability (57th), where fixed broadband subscriptions remain particularly expensive (US$46.7 PPP per month, ranked 100th worldwide). Individual usage has also increased in the country, with mobile broadband subscriptions largely widespread (10th highest penetration in the world) and more common than fixed ones (25th). The Australian government and public sector are among the leaders in the world in providing online services (8th) and allowing citizens' e-participation (7th), but there is room for improvement in the level of businesses' adoption of ICTs (28th), as the country still relies heavily on mining industries. The country's National Innovation and Science Agenda, launched in December 2015, if fully implemented, might help to orient Australia's economy more toward innovation, bridging some of the gaps, especially in venture capital availability (40th worldwide) and the creation of new business models via ICTs (41st).

With an improvement of performance across the board, **France** climbs up two positions to 24th place. Government and businesses are pushing the frontier of networked readiness in the country. France is the global leader in delivering public online services to its citizens and one of the best in terms of allowing their e-participation to the government's decision process (4th). Over the past year, the government has also increased efforts in promoting ICTs and providing a long-term vision for the sector, including a Digital Republic Bill aiming to guide the way in which the ICT revolution will shape French society in the future. French businesses have also stepped up their efforts to leverage ICTs, especially in terms of adopting new organizational models (26th, up 22 positions) and improving B2B transactions (33rd, up 11). The country can rely on a skilled workforce (18th) and on good infrastructure (22nd), allowing, among other things, one of the highest penetrations in the world of fixed broadband (4th). Issues remain especially in the business environment, which has one of the highest taxation rates in the world—62.7 percent—although on a slowly declining trend.

The **United Arab Emirates** continues to lead the Arab world in terms of networked readiness in 26th position. The government is leading the way to greater digital connectivity (2nd in terms of government usage), providing a consistent vision for the sector and achieving success at promoting it (1st on both indicators). Individual usage has also further improved (19th, up one spot) especially in terms of mobile broadband subscriptions and households with Internet access, although other important ICT services are not yet widely available: in 2014, fixed broadband subscriptions were still 11.6 per 100 people. Businesses' adoption of and the economic impacts of ICTs have been improving in recent years, but a gap still exists with most advanced economies in this area. Patent activity, both general and ICT-related, remains relatively low.

Malaysia's overall position in the NRI has remained largely stable in recent years, with the country climbing one spot to 31st position in 2016. This strong performance continues to be supported by a government that is fully committed to the digital agenda and that is seen to be ahead of its peers in terms of adopting the latest technologies. With approximately two-thirds of the population online, individual usage is growing further (47th, up 10 spots); in particular, the uptake of mobile broadband has taken

off and reached almost 60 percent. An agile business sector (26th for business usage) is using ICTs to its advantage, interacting with consumers online and re-optimizing business models and organizational structures, thereby contributing to the overall strong performance. An increase in international Internet bandwidth (currently ranked 81st) combined with a drop in broadband prices (110th) would give a further boost to Malaysia's digital economy.

Saudi Arabia climbs up two positions to 33rd this year. The government is leading the way to increased networked readiness, promoting ICTs in the country; however, individual usage (21st) and business adoption (42nd) are still lagging behind. Affordability of ICTs (101st) and the general level of skills in the workforce (49th) remain an issue, with only 64 percent of the population using the Internet on a regular basis. Allowing further means of e-participation (51st) might contribute to spurring individual ICT adoption. The business and innovation environment is hampered by one of the most complex and lengthy processes in the world to start a business (125th and 97th, respectively), which reduces access to the market of potential new and innovative competitors. Saudi Arabia remains an oil-based economy, with low patenting activity in both general technology and ICTs. A transition to a more innovation-driven economic model will require improvements in the country's ICT readiness, with a broad-based participation of the population and of the business community in the digital revolution.

The **Russian Federation** remains in 41st place this year, as in 2015. The country places in the top third of the rankings for Readiness, Usage, and Impact, yet continues to be held back by a weak and deteriorating regulatory environment. As mobile and fixed Internet tariffs are very low and dropping further (10th place overall on affordability), individual usage continues to rise in almost every dimension, leaving Russia in 40th place in this category. However, the data suggest that infrastructure build-out is not keeping up with demand as Russia sees its availability of Internet bandwidth per user falling. Although Russia is close to the median in terms of business use overall, online sales to consumers (as opposed to other firms) are particularly strong (35th place). The positive impact of ICTs is felt both in the economic and the social dimensions, as reflected in rankings in the top third for both impact pillars.

Turkey's overall ranking and score remains unchanged from last year at 48th place, yet this fact masks strong conflicting movements at the pillar level. With some of the cheaper mobile and fixed Internet tariffs around and improving digital skills in the population, individual usage is broadening further. Yet these positive movements are offset by a deteriorating regulatory and business environment as well as the declining importance of ICTs in the government's vision and promotion. Overall, the negative effects seem to outweigh the positive ones, with economic impacts and particularly social outcomes suffering. Turkey, however, remains in the top third of the rankings in terms of its business and innovation environment, a good basis from which to push further ahead.

China moves up by three places to 59th based on improvements in Usage and Impact. Adoption by individuals has increased, particularly in terms of mobile broadband subscriptions, which nearly doubled in one year from 21.4 to 41.8 per 100 population. Chinese businesses will need to step up their efforts to embrace digital technologies and spur innovative processes for the country to become an innovation-driven, high-income economy. Although patenting activity has increased significantly in recent years, it is still relatively low compared with that of advanced economies, and the full economic and social impacts of ICTs are still in the process of materializing. The business environment remains one of the key bottlenecks (104th): according to World Bank data, China maintains high taxation on businesses (67.8 percent) and has lengthy and complex processes to set up a new business (121st and 120th, respectively), discouraging new and more competitive firms from entering the market. Recognizing the challenge, the government is currently implementing a reform program to streamline business procedures across the country. The full results of these reforms will be reflected in future assessments.

Colombia maintains the same score as last year, but slips four ranks to 68th because other countries improved their performances. ICT adoption among the population kept increasing at a fast rate: there were 45.1 mobile broadband subscriptions per 100 people in 2014, up from 25.0 in 2013 and 3.7 in 2011. This increase in individual usage has not been matched by a similar trend among businesses or within the government. The extent of usage of ICTs for B2B and B2C operations as well as for the creation of new business models has been stagnating in past years. The overall political and business environment in the country remains its main weakness, with low effectiveness of law-making bodies (121st) and an inefficient judicial system (1,288 days are required to enforce a contract, ranking 133rd in the world in this indicator). Taxation also remains disproportionately high, at a rate of 69.7 percent (6th highest among the countries in the sample).

Brazil comes in at 72nd place this year, partially reversing the strong downward trend of recent years.[26] ICT adoption and usage by both individuals and the business community is good and supported by very good affordability—in particular, cheap fixed broadband Internet connections (14th). Brazil makes large strides in terms of improving individual usage this year, climbing five places to 57th—this is a considerable achievement, given that other countries are also moving quickly on individual adoption. Yet networked readiness in the country continues to be held back by a weak regulatory

environment. The business and innovation environment is also ranked as one of the weakest in the world (124th), with both venture capital availability and government technology procurement falling further. Government support of the ICT agenda is perceived to be weak and the business community sees the government as failing to deliver in terms of incorporating digital technologies in their overall strategy (121st) as well as in the direct promotion of ICT (122nd).

Indonesia moves up six spots to 73rd place this year, driven in part by improvements in affordability and an accompanying strong rise in individual usage (92nd, up five spots). In order to capitalize on this positive trend, infrastructure will need to keep up; as the number of users is increasing, the existing infrastructure is starting to be stretched, which has the country dropping seven spots to rank 105th in this particular pillar. Business and government usage are already high at 34th and 65th rank, with a flat trend line for business and one that has been slightly on the decline for government. Although momentum across pillars is somewhat heterogeneous, a recently reformed regulatory (65th) and business environment (64th) provide a good basis for building out the digital economy, as long as recent backward slides for some important indicators are reversed (legislative, legal system, availability of latest technologies, and number of procedures to start a business).

Mexico places 76th in the NRI overall this year.[27] Individual usage (84th) is rising further; in particular, mobile broadband subscriptions are becoming increasingly popular and individual usage is thus catching up with business usage (66th) and government usage (52nd). Although government use of ICTs was already considered relatively strong in the 2015 NRI, Mexico moves up 13 places in government ICT vision this year, to 71st; importantly, the government makes good use of ICTs to interact with the population, ranking 35th on the government services index. At the same time, the regulatory environment is perceived to have deteriorated along several lines, such as the efficiency of the legal system in settling disputes (104th) and challenging regulations (102nd). Economic impact is on an upward trajectory and Mexico is edging back on the social impacts ranking, having been overtaken by a significant number of countries between 2014 and 2015.

Rwanda climbs three spots this year to 80th position, driven by a government that is very focused on the digital agenda. The government is also making strong efforts to provide a stable regulatory framework, resulting in an improvement of five ranks in the Environment subindex. The private sector is making large strides in terms of adopting digital technologies, moving up 10 places to 60th rank for business usage. Individual adoption is still lagging (127th) as mobile fees and broadband prices remain high; efforts to provide Internet access in schools is an important step in the direction of boosting social gains, providing the next generation with important digital skills. In general, the social impact of digital technologies is being felt, in particular with regard to giving access to basic services.

Argentina continues on its upward trajectory, ranking 89th this year. Weak (though improving) regulatory and innovation environments seem to be the two biggest bottlenecks preventing larger gains from digital technologies. With mobile phone use one of the highest in the world (13th) and an overall solid adoption rate among individuals, businesses are making use of digital technologies to transact with consumers (76th), yet B2B ICT use remains low (120th). There is also much room for greater public-sector adoption of digital technologies: although the Argentinian government seems to be making good use of ICTs to provide services to the population (55th), the business community in 2015 perceived the government as lacking in vision and effort when it comes to ICT promotion. Yet the recent change in government looks ready to bring renewed momentum to the digital agenda. Consistent with previous years, Argentina does not have data in the affordability pillar because of the lack of reliable PPP estimates.

Despite of improvements in its political and regulatory environment (78th, up four) and in its business and innovation environment (110th, up five), **India** slips down two positions to an overall rank of 91. Although India's absolute score has changed only marginally in recent years, the drop can be attributed in part to the fact that other countries are moving ahead at higher speeds. In addition, lack of infrastructure (114th) and low levels of skills among the population (101st) remain the key bottlenecks to widespread ICT adoption, especially in terms of individual usage (120th). A third of the Indian population is still illiterate (95th) and a similar share of youth is not enrolled in secondary education (103rd). Only 15 out of 100 households have access to the Internet and mobile broadband remains a privilege of the few, with only 5.5 subscriptions for every 100 people. This is in spite of the fact that affordability has long been one of the strengths of the Indian ICT ecosystem, with the country ranking 8th this year in this area. A deep divide persists between well-connected metropolitan hubs and remote rural areas, where even the most basic infrastructure is insufficient. In 2015 the government launched the Digital India program, which aims to close this gap by fostering investment in digital infrastructure, improving digital literacy, and increasingly providing online services to citizens. India's performance in terms of providing online services and allowing e-participation has so far been in line with that of peer countries, but far from the global best (57th and 40th, respectively).

Although **Nigeria** did not move overall in the NRI rankings, staying in 119th position, this fact masks significant heterogeneity in terms of moves in individual dimensions of networked readiness—in particular, a six-spot move up in Readiness (to 117th) and a ten-spot

move down in Impacts (to 114th). The improvement in Readiness is to a large extent thanks to Nigeria reaching full mobile coverage this year; broadband prices have also fallen slightly, although they remain high. The political and regulatory environment are perceived to be improving on several fronts, while at the same time the business and innovation environment are perceived as deteriorating. Government usage and engagement is perceived to have dropped significantly over the course of the last year, yet this may change under the new government that came to power in 2015. Overall, conditions for ICT impacts seem to have deteriorated: both economic and social impacts record a decline. A policy priority with far-reaching benefits in other areas should be to address the country's skills gap (134th).

CONCLUSIONS

The picture that emerges from this year's analysis gives reason for optimism but not for complacency. Although there are still large heterogeneities across countries in terms of networked readiness, the overall trend is positive across all regions of the world.

In particular, individual adoption is growing steadily across the globe as efforts continue to close the digital divide. Business executives are optimistic about their countries' growing innovation capacities, yet the digital innovation impact is so far coming through much more strongly in some countries than in others—the gap between seven digital front runners and the followers is wide. The analysis identifies a high level of business adoption and usage of digital technologies as one of the key characteristics of countries in which ICTs are having a robust economic and digital innovation impact. In most countries, businesses are perceived to be moving at only a moderate pace in truly embracing all dimensions of digitization—in their relations upstream with suppliers and downstream with consumers. This process will need renewed momentum if firms are hoping to thrive in the Fourth Industrial Revolution.

Although government use and promotion of ICTs has recently started to fall short of expectations across regions, a number of countries are making large strides in the Index thanks to a strong government ICT vision and engagement in the digital economy. Overall, governments can do more to drive the social impact of digital technologies—for example, by using them to make basic government services more accessible. As technologies are rapidly evolving and can be expected to have a profound impact on our economies and societies, new governance structures will also urgently need to be put in place in order to channel technological forces in ways that bring broad-based gains to societies.

NOTES

1 Varian 2010.

2 Owen et al. 2012.

3 For instance, the prevalence of Internet in schools would ideally be measured by computing the percentage of a country's schools that have Internet access. Similarly, the intensity of competition would ideally be measured by computing a business concentration index (Herfindahl–Hirschman Index). In both cases, however, such statistics are not available for enough countries.

4 Eurostat and OECD 2005, p. 46; cited in Dutta et al. 2015.

5 Varian 2010.

6 For additional detailed case study evidence, see http://reports.weforum.org/digital-transformation-of-industries/go-to-the-case-studies/.

7 Mettler and Williams 2011, pp. 26–27.

8 Positive network effects arise from the fact that a larger number of participants will lead to better and more frequent matches, which in turn means higher value creation, making it more attractive still for new participants to join.

9 Fox 2014.

10 Christensen 2012.

11 The change in the mean of the score distribution from 2015 to 2016 is positive and significantly different from zero at the 10 percent level.

12 BCG 2015. In addition, the following factors are often cited as critical for innovation in the Digital Age: capitalizing on the Internet of Things, high-quality broadband, increasing automation and autonomy of production, a tech savvy and experimenting/risk-loving customer base, availability of venture capital, and a government that puts in place rules that inspire trust in the system (World Economic Forum/Accenture, 2016).

13 See INSEAD's Global Talent Competitiveness Index, which in its 2017 edition will focus on technology and talent: http://global-indices.insead.edu/gtci/.

14 Fox 2014.

15 Autor 2010.

16 World Economic Forum 2016b.

17 Sundararajan 2016.

18 For example, these principles are embedded in the Europe 2020 strategy to create smart growth and the Horizon 2020 program that defines tackling societal challenges as one of the main priorities; see also, for example, Owen et al. 2012.

19 von Schomberg 2011.

20 Lund Declaration 2009.

21 European Commission 2012.

22 See the European Union's Founding Principles of the Union, available at http://europa.eu/scadplus/constitution/objectives_en.htm.

23 United Nations 2000.

24 Note that the improvement in readiness is largely the result of a large drop in fixed broadband tariffs; this drop occurred between 2014 and 2015, yet was not reflected in the data collected for the 2015 edition of the NRI. The price correction was made by the ITU after the publication of the NRI in 2015.

25 ITU 2015.

26 Although there has been an upward movement in the NRI rankings for Brazil this year, this is to some extent the result of a reinstatement of indicator 2.07 (tertiary education enrollment rate), which was not available last year.

27 Note that Mexico is seeing a deterioration in its assessment of Readiness this year because of the way in which the pricing of broadband access is captured. The ITU reports the price of the cheapest package provided by the market leader. The reported price increase came at the same time as an increase in broadband speed included in the package, so it can to some extent be attributed to an increase in quality; nevertheless, accessibility is reduced, which is what the rank move reflects.

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Appendix: The Networked Readiness Index framework: A methodological note

The *Global Information Technology Report* series and the Networked Readiness Index (NRI) were launched by the World Economic Forum in 2001. This represented one of the first attempts to make conceptual sense of the complex information and communication technologies (ICT) reality, identifying the common factors that enable countries to use technology effectively. The networked readiness framework that underpins the NRI was intended to provide guidance for policymakers and civil society on the factors that they need to take into account to fully leverage ICTs in their growth strategies.

The economic literature has largely established the fundamental role of innovation in boosting long-term productivity and growth. Although networked readiness represents only one ingredient in the innovation process, it has become an increasingly important one. Several studies have established the link between ICTs and productivity gains, especially in advanced economies.[1] This will be particularly important in the next decades as the Fourth Industrial Revolution transforms the way economies work and the way societies organize themselves.

The impact of ICTs on our lives goes well beyond their effects on productivity and growth; they also act as a vector of social development and transformation. ICTs can improve access to basic services, enhance connectivity, and create new employment opportunities. Ultimately, ICTs hold significant potential to improve the quality of people's lives and to enhance the way they live, communicate, interact, and engage among themselves and with their governments.

In recent years, the emphasis has moved from the issue of ensuring access to the question of how to make the best use of ICTs in order to improve business innovation, governance, citizens' political participation, and social cohesion. In light of this shift in emphasis, and after two years of research and consultations with experts, the Impact subindex was added to the NRI framework in 2012.[2] Yet there is still room to improve the way we measure the actual impact of ICTs because the availability of data remains limited to only some of the relevant areas of impact. In addition, the complex relationships between ICTs and socioeconomic performance are not fully understood and their causality not fully established. However, our hope is to highlight the opportunities offered by ICTs and provide an indication of the ways they are transforming economies and societies around the world.

The networked readiness framework, briefly outlined in the chapter, rests on six principles:

- A high-quality regulatory and business environment is critical in order to fully leverage ICTs and generate impact.
- Similarly, ICT readiness—as measured by ICT affordability, skills, and infrastructure—is a pre-condition to generating impact.
- Fully leveraging ICTs requires a society-wide effort. All stakeholders—the government, the business sector, and the population at large—have a role to play.
- ICT use should not be an end in itself. The impact that ICTs actually have on the economy and society is what ultimately matters.
- The set of drivers—the environment, readiness, and use—interact, co-evolve, and reinforce each other to create greater impact. In turn, greater impact creates more incentives for countries to further improve their framework conditions, their readiness for ICTs, and their use of ICTs, thus creating a virtuous cycle. Conversely, weaknesses in any particular dimension are likely to hinder progress in others.
- Finally, the networked readiness framework should provide clear policy guidance.

STRUCTURE OF THE NETWORKED READINESS INDEX

The networked readiness framework translates into the NRI, a composite index made up of four main categories (*subindexes*), 10 subcategories (*pillars*), and 53 individual indicators distributed across the different pillars. The full list of indicators, grouped by pillars and subindexes, is provided below.

In this list, the number preceding the period indicates the pillar to which the variable belongs (e.g.,

indicator 2.05 belongs to the 2nd pillar; indicator 8.03 belongs to the 8th pillar). The numbering of the indicators matches the numbering of the data tables at the end of the *Report.*

The computation of the NRI is based on successive aggregations of scores, from the indicator level (i.e., the most disaggregated level) to the overall NRI score (i.e., the highest level). Scores for indicators derived from the World Economic Forum's Executive Opinion Survey (the Survey) are always measured on a 1-to-7 scale and therefore do not require transformation prior to aggregation. These are identified in the list of indicators by an asterisk (*). All the other indicators come from external sources, as described in the Technical Notes and Sources section at the end of the *Report.* In order to align them with the Survey's results, we apply a min-max transformation, transforming them into a 1-to-7 scale.[3]

Unless noted otherwise, we use an arithmetic mean to aggregate individual indicators within each pillar and also for higher aggregation levels (i.e., pillars and subindexes).[4]

Throughout the *Report,* scores in the various dimensions of the NRI pillars are reported with a precision of one decimal point. However, exact figures are always used at every step of the computation of the NRI.

A description of each subindex and pillar are provided below, along with the rationale for their inclusion.[10]

Environment subindex

The success of a country in leveraging ICTs depends in part on the quality of the overall operating environment. The *Environment* subindex therefore assesses the extent to which a country's market conditions and regulatory framework support entrepreneurship, innovation, and ICT development.

The *Political and regulatory environment* pillar (nine indicators) assesses the extent to which a country's political and regulatory environments facilitate ICT penetration and the development of business activities. It does so by measuring the extent of intellectual property rights protection, the prevalence of software piracy, the efficiency and independence of the judiciary, the efficiency of the law-making process, and the overall quality of regulations pertaining to ICTs.

The *Business and innovation environment* pillar (nine indicators) gauges the extent to which the business environment supports entrepreneurship by taking into account measures of red tape, the ease of starting a business, and taxation. It also measures the conditions that allow innovation to flourish by including indicators on the overall availability of technology, the intensity of competition, the demand conditions for innovative products (as proxied by the development of government procurement of advanced technology products), and the availability of venture capital for funding innovation-related projects.

Readiness subindex

The *Readiness* subindex measures the extent to which a country has in place the infrastructure and other factors to support the uptake of ICTs.

The *Infrastructure* pillar (four indicators) captures the state of a country's ICT infrastructure as well as infrastructure that matters for ICT development: mobile network coverage, international Internet bandwidth, secure Internet servers, and electricity production. The *Affordability* pillar (three indicators) assesses the affordability of ICTs in a country through measures of mobile telephony usage costs and broadband Internet subscription costs, as well as an indicator that assesses the state of liberalization in 17 categories of ICT services, because more intense competition tends to reduce retail prices in the long run.

The *Skills* pillar (four indicators) measures the capacity of the population to make effective use of ICTs by taking into account the enrollment rate in secondary education, the overall quality of the education system, and of mathematics and science education in particular, and the adult literacy rate.

Usage subindex

The *Usage* subindex assesses the level of ICT adoption by a society's main stakeholders: government, businesses, and individuals.

The *Individual usage* pillar (seven indicators) measures the level of diffusion of selected ICTs among a country's population, using mobile telephony penetration, Internet usage, personal computer ownership, and the use of social networks.

The *Business usage* pillar (six indicators) captures the extent to which businesses in a country use the Internet for business-to-business (B2B) and business-to-consumer (B2C) operations, as well as their efforts to integrate ICTs in their operations. It also measures the capacity of firms to come up with new technologies by taking into account the number of patent applications under the Patent Cooperation Treaty (PCT). Finally, it measures the extent of staff training as a proxy for the capacity of management and staff to innovate.

The *Government usage* pillar (three indicators) assesses the leadership and success of the government in developing and implementing strategies for ICT development, as well as in using ICTs, as measured by the availability and quality of government online services.

Impact subindex

The *Impact* subindex gauges the broad economic and social impacts accruing from ICTs.

The *Economic impacts* pillar (four indicators) measures the effect of ICTs on competitiveness through technological and non-technological innovations in a country—as measured by the number of patent applications as well as by the

NETWORKED READINESS INDEX 2016

Networked Readiness Index = 1/4 Environment subindex
+ 1/4 Readiness subindex
+ 1/4 Usage subindex
+ 1/4 Impact subindex

ENVIRONMENT SUBINDEX

Environment subindex = 1/2 Political and regulatory environment
+ 1/2 Business and innovation environment

1st pillar: Political and regulatory environment

1.01 Effectiveness of law-making bodies*
1.02 Laws relating to ICTs*
1.03 Judicial independence*
1.04 Efficiency of legal system in settling disputes*[5]
1.05 Efficiency of legal system in challenging regulations*[5]
1.06 Intellectual property protection*
1.07 Software piracy rate, % software installed
1.08 Number of procedures to enforce a contract[6]
1.09 Number of days to enforce a contract[6]

2nd pillar: Business and innovation environment

2.01 Availability of latest technologies*
2.02 Venture capital availability*
2.03 Total tax rate, % profits
2.04 Number of days to start a business[7]
2.05 Number of procedures to start a business[7]
2.06 Intensity of local competition*
2.07 Tertiary education gross enrollment rate, %
2.08 Quality of management schools*
2.09 Government procurement of advanced technology products*

READINESS SUBINDEX

Readiness subindex = 1/3 Infrastructure
+ 1/3 Affordability
+ 1/3 Skills

3rd pillar: Infrastructure

3.01 Electricity production, kWh/capita
3.02 Mobile network coverage, % population
3.03 International Internet bandwidth, kb/s per user
3.04 Secure Internet servers per million population

4th pillar: Affordability[8]

4.01 Prepaid mobile cellular tariffs, PPP $/min.
4.02 Fixed broadband Internet tariffs, PPP $/month
4.03 Internet and telephony sectors competition index, 0–2 (best)

5th pillar: Skills

5.01 Quality of educational system*
5.02 Quality of math and science education*
5.03 Secondary education gross enrollment rate, %
5.04 Adult literacy rate, %

USAGE SUBINDEX

Usage subindex = 1/3 Individual usage
+ 1/3 Business usage
+ 1/3 Government usage

6th pillar: Individual usage

6.01 Mobile phone subscriptions per 100 population
6.02 Percentage of individuals using the Internet
6.03 Percentage of households with computer
6.04 Households with Internet access, %
6.05 Fixed broadband Internet subscriptions per 100 population
6.06 Mobile broadband Internet subscriptions per 100 population
6.07 Use of virtual social networks*

7th pillar: Business usage

7.01 Firm-level technology absorption*
7.02 Capacity for innovation*
7.03 PCT patent applications per million population
7.04 Business-to-business Internet use*[9]
7.05 Business-to-consumer Internet use*[9]
7.06 Extent of staff training*

8th pillar: Government usage

8.01 Importance of ICTs to government vision of the future*
8.02 Government Online Service Index, 0–1 (best)
8.03 Government success in ICT promotion*

IMPACT SUBINDEX

Impact subindex = 1/2 Economic impacts
+ 1/2 Social impacts

9th pillar: Economic impacts

9.01 Impact of ICTs on new services and products*
9.02 PCT ICT patent applications per million population
9.03 Impact of ICTs on new organizational models*
9.04 Employment in knowledge-intensive activities, % workforce

10th pillar: Social impacts

10.01 Impact of ICTs on access to basic services*
10.02 Internet access in schools*
10.03 ICT use and government efficiency*
10.04 E-Participation Index, 0–1 (best)

role of ICTs in the development of new products, processes, and organizational models. It also measures the overall shift of an economy toward more knowledge-intensive activities.

The *Social impacts* pillar (four indicators) aims to assess a country's societal progress brought about or enhanced by the use of ICTs. Such progress includes—but is not limited to—access to education and healthcare, energy savings, and more-active civil participation. Currently, because of data limitations, this pillar focuses on assessing the extent to which ICTs allow access to basic services (education, financial services, and healthcare); the use of the Internet at school, as a proxy for the potential benefits that are associated with the use of ICTs in education; the impact of ICTs on government efficiency; and the quality and usefulness of information and services provided by a country for the purpose of engaging its citizens in public policymaking through the use of e-government programs.

Measuring the impacts of ICTs remains a complex task, and the development of rigorous, international comparable statistics is still in its infancy. As a result, many of the areas where ICTs have a significant impact—especially those where the impact does not translate directly into commercial activities, as is the case in environment, healthcare, and education—are not captured in the NRI. Therefore the Impact subindex should be regarded as work in progress.

METHODOLOGY AND DATA

The structure of the NRI is unchanged from the previous edition.

About half of the 53 individual indicators used in the NRI are sourced from international organizations. The main providers are the International Telecommunication Union (ITU); the World Bank; the United Nations Educational, Scientific and Cultural Organization (UNESCO); and other UN agencies. Carefully chosen alternative data sources, including national sources, are used to fill data gaps in certain cases. The other half of the NRI indicators are derived from the World Economic Forum's annual Survey. The Survey is used to measure concepts that are qualitative in nature or for which internationally comparable statistics are not available for enough countries.[11]

The Survey is administered annually to over 14,000 business executives in all the economies included in the NRI (see Browne et al. 2015 for more details). The Survey represents a unique source of insight into many critical aspects related to a country's enabling environment, such as the extent of red tape and the degree of intellectual property protection; aspects related to the preparedness of its population, such as the quality of the education system; to ICT usage, such as its capacity to innovate and the importance of its government's vision for ICTs; and to ICT impacts, such as the contribution of ICTs to the development of new products and services and to improving access to basic services.

Some of the indicators composing the Index are subject to significant changes in value from one year to the next. In particular, the two price measures (indicators 4.01 and 4.02) used to calculate the affordability pillar score can reflect changes in both the benchmarks used by the ITU and in the Purchasing Power Parity (PPP) estimates sourced from the World Bank. Although there have been no changes to the PPP methodology this year (the conversion factor used is still based on the International Comparison Program 2011),[12] figures for the costs in local currencies of four different services provided by the ITU have changed significantly for some countries.

For two indicators, the number of missing data points remains very high. Indicators 1.07 *Software piracy rate* and 9.04 *Share of workforce employed in knowledge-intensive jobs* are missing data for 35 and 29 economies, respectively, and were not included the calculation for those economies. For each of the other 53 indicators of the NRI, the number of missing data points does not exceed four. In addition, in the absence of data on the adult literacy rate (indicator 5.04) for as many as 22 Organisation for Economic Co-operation and Development (OECD) member countries and Hong Kong SAR, a value of 99 percent was assumed for the purpose of calculating the Skills pillar score.

COUNTRY COVERAGE

The inclusion of an economy depends on the availability and quality of indicators. To be included in the NRI, the number of missing (or outdated) data points for an economy cannot reach five, or 10 percent of all indicators. Because almost half of the indicators entering the NRI are derived from the Executive Opinion Survey, which is the basis for the Global Competitiveness Report (GCR), the coverage of a country in the GCR is a necessary—but not a sufficient—condition for a country's inclusion in the NRI.

NOTES

1 Draca et al. 2006; Cardona et al. 2013.

2 Dutta et al. 2012.

3 Formally, we have:

$$6 \times \left(\frac{\text{country score} - \text{sample minimum}}{\text{sample maximum} - \text{sample minimum}} \right) + 1$$

The *sample minimum* and *sample maximum* are, respectively, the lowest and highest country scores in the sample of economies covered by the GCI. In some instances, adjustments were made to account for extreme outliers. For those indicators for which a higher value indicates a worse outcome (i.e., indicators 1.07, 1.08, 1.09, 2.03, 2.04, 2.05, 4.01, and 4.02), the transformation formula takes the following form, thus ensuring that 1 and 7 still corresponds to the worst and best possible outcomes, respectively:

$$-6 \times \left(\frac{\text{country score} - \text{sample minimum}}{\text{sample maximum} - \text{sample minimum}}\right) + 7$$

4 Formally, for a category *i* composed of *K* indicators, we have:

$$\text{category}_i = \frac{\sum_{k=1}^{K} \text{indicator}_k}{K}$$

When two individual indicators are averaged (e.g., indicators 1.04 and 1.05 in the 1st pillar), each receives half the weight of a normal indicator.

5 For indicators 1.04 and 1.05, the average of the two scores is used in the computation of the NRI.

6 For indicators 1.08 and 1.09, the average of the two normalized scores is used in the computation of the NRI.

7 For indicators 2.04 and 2.05, the average of the two normalized scores is used in the computation of the NRI.

8 The affordability pillar is computed as follows: the average of the normalized scores of indicators 4.01 Prepaid mobile cellular tariffs and 4.02 Fixed broadband Internet tariffs is multiplied by a competition factor, the value of which is derived from indicator 4.03 Internet and telephony sectors competition index. It corresponds to the score achieved by an economy on this indicator normalized on a scale from 0.75 (worst) to 1.00 (best), using the min-max transformation described above. A normalized score of 0.75 is assigned to an economy with a competition index score of 0, which means that a monopolistic situation prevails in the 17 categories of ICT services considered. A normalized score of 1.00 is assigned to an economy where all 17 categories are fully liberalized. Where data are missing for indicator 4.03 (i.e., Mongolia and Venezuela), the score on the affordability pillar, which is simply the average of the normalized scores of indicators 4.01 and 4.02, is used. The competition index score for Chinese Taipei was derived from national sources.

9 For indicators 7.04 and 7.05, the average of the two scores is used in the computation of the NRI.

10 See Dutta et al. 2012 for a more detailed description of each component.

11 For instance, the prevalence of Internet in schools would ideally be measured by computing the percentage of a country's schools that have Internet access. Similarly, the intensity of competition would ideally be measured by computing a business concentration index (Herfindahl–Hirschman Index). In both cases, however, such statistics are not available for enough countries.

12 See http://icp.worldbank.org/ for more information about PPP and the 2011 revision.

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CHAPTER 1.2

Cross-Border Data Flows, Digital Innovation, and Economic Growth

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Forty years ago, the queen of England became one of the first individuals, and the first head of state, to transmit real-time electronic data over national borders.[1] In 1976, just three years after the United States connected ARPANET to London's University College and the Royal Radar Establishment in Norway, Her Majesty Queen Elizabeth II sent an email under the username "HME2."[2] Today over 3.2 billion people across the world have access to and use the Internet, and the flow of digital communication between countries, companies, and citizens, as a component of the "knowledge economy," has been recognized for years as a critical driver of economic growth and productivity.[3] Countries adept at fostering digital activity have witnessed the emergence of new industries as well as the accelerated development of traditional sectors.[4] However, despite the intensive and extensive growth of the global Internet, concerns over growing barriers to digital flows are mounting.

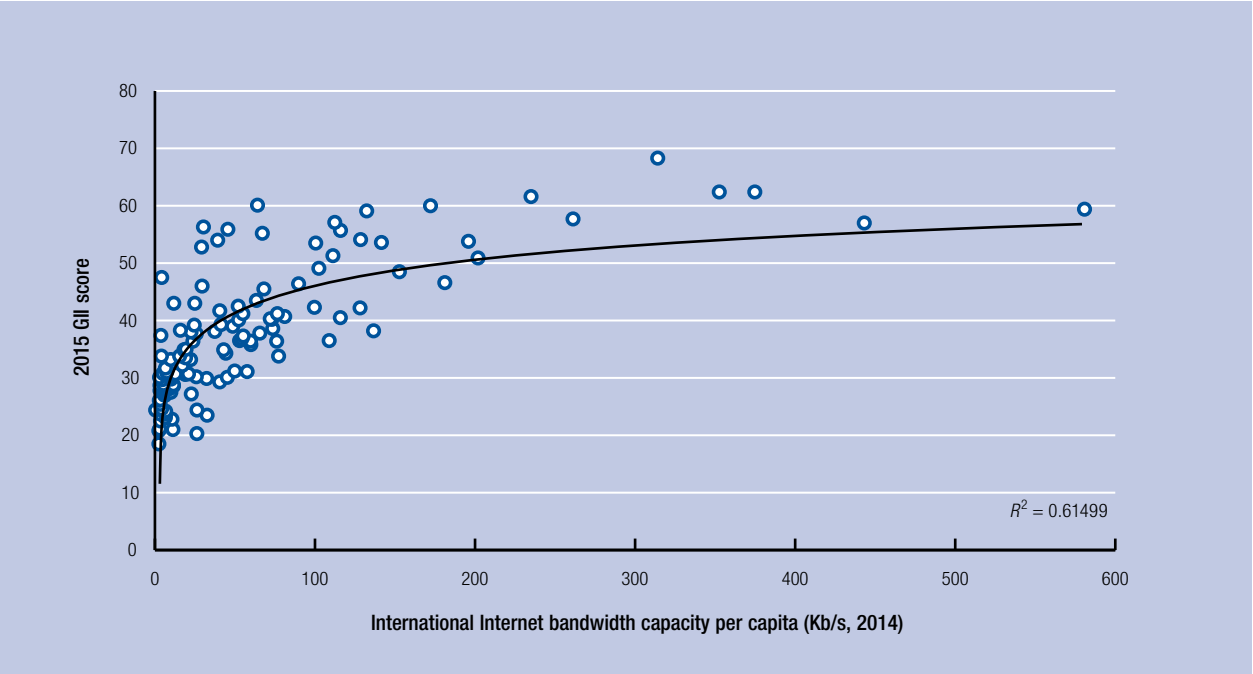
This chapter explores the impact of the free flow of data across national borders on innovation and growth. First reviewed is the literature on the impact of cross-border data flows on countries, companies, and individuals. The chapter then presents an original analysis of the growth of new services built on the free flow of trade through global digitization, and concludes by discussing policy guidelines that mitigate national concerns over data transmission while simultaneously maximizing the benefits of cross-border data flows.

THE GROWTH OF GLOBAL DIGITAL INDUSTRIES AND THEIR NATIONAL ECONOMIC IMPACTS

The development of the commercial Internet has occurred concurrently with a massive expansion of the global economy, which has experienced 6.6-fold growth in nominal terms—from US$11.1 trillion to US$73.5 trillion since 1980.[5] Internet protocol (IP) traffic continues to advance rapidly, with 2019 traffic projected to be 64 times its 2005 volume.[6] Global Internet bandwidth accounts for much of this growth, more than quadrupling between 2010 (<50 terabytes per second) and 2014 (>200 terabytes per second).[7] More importantly, total cross-border Internet traffic increased 18-fold from 2005 to 2012.[8]

This cumulative growth impacts all facets of national economies, not just their budding technology sectors—in fact, an estimated 75 percent of the Internet's benefit is captured by companies in traditional industries.[9] A wide range of positive economic impacts stems from the flow of digital data across borders. For example, 61 percent (US$383.7 billion) of total US service exports were digitally delivered in 2012, and 53 percent of total US imports were digitally delivered.[10] In absolute terms, the amount of digitally delivered exports and imports is even larger in the European Union, which digitally delivered US$465 billion in exports in 2012 and spent US$297 billion on imports. Digital trade is credited with

Figure 1: Cross-border data traffic and national innovation, by country



Sources: Cornell University, INSEAD, and WIPO 2015; ITU 2015b.
Note: The Global Innovation Index (GII) scores range from 0 to 100 (best). Kb/s = kilobits per second.

an estimated increase in US gross domestic product (GDP) of 3.4 percent to 4.8 percent in 2011 and with the creation of up to 2.4 million jobs, according to the United States International Trade Commission (US ITC).[11] The United Nations Conference on Trade and Development (UNCTAD) also estimates that about 50 percent of all traded services is enabled by innovation stemming from the technology sector, which includes the facilitation of cross-border data flows.[12] According to a newly released report by McKinsey & Company, data flows account for US$2.8 trillion of global GDP in 2014 and "cross-border data flows now generate more economic value than traditional flows of traded goods."[13]

Beyond this economic impact, the free flow of data is, itself, a significant driver of innovation. It allows the sharing of ideas and information and the dissemination of knowledge as well as collaboration and cross-pollination among individuals and companies. Internet-enabled innovation requires an environment that encourages individuals to experiment with new uses of the Internet. In places with severe restrictions that inhibit digital collaboration, people are less likely to experiment and, as a result, innovation is less likely to emerge. Countries with an open Internet tend to be more innovative, as demonstrated in Figure 1, which illustrates the relationship between a country's ability to share information and its capacity for innovation. The figure demonstrates that countries with a higher capacity to share data internationally (as reflected by a high international Internet bandwidth capacity per capita) tend to have a greater degree of national innovation as well, quantified in the figure by each country's score on the 2015 Global Innovation Index, a leading measure of innovation capacity at the country level, which is calculated according to 79 different indicators.[14]

Additionally, a high degree of correlation is observed between various measures of potential data flow at the country level and outcome measures. One measure of potential data flow is Freedom House's 2015 Freedom on the Net indicator, which measures 65 countries

Table 1: Correlation coefficients

Country correlation coefficients		Measures of potential data flows	
		International Internet bandwidth	Freedom on the Net (inverse scale; high to low)
Outcome measures	Global Innovation Index score	0.72	–0.49
	2015 NRI Economic impacts pillar	0.71	–0.49

Sources: Cornell University, INSEAD, and WIPO 2015; Freedom House 2015; ITU 2015b; World Economic Forum 2015.
Note: The Freedom on the Net scores range from 0 to 100, where 0 = most free and 100 = least free. Thus a lower score (greater freedom) for a given country is correlated with higher innovation and better economic outcomes.899

on the basis of obstacles to Internet access, limits on content, and violations of user rights. When correlated with the Economic impacts pillar of the 2015 Networked Readiness Index's Impact subindex (Table 1), which serves as an outcome measure, a clear relationship is demonstrated.

THE IMPACT OF CROSS-BORDER DATA FLOWS: FIRMS AND THE ENGINE OF ECONOMIC ACTIVITY

Cross-border data flows acutely impact the ability of firms to conduct business internationally.

In a recent report, Business Roundtable identifies at least six different areas of activity whereby firms may transmit data across national borders to support business operations. These include interconnected machinery, big data analytics, back-office consolidation, supply-chain automation, digital collaboration, and cloud scalability.[15] See Box 1.

Cross-border flows (data and voice, in particular) reduce costs related to both trade and transactions. This includes customer engagement (finding and fulfilling orders) as well as other operational costs associated with doing business. One recent report by the US ITC estimates that the Internet reduces trade costs by 26 percent on average.[16] Additionally, small- and medium-sized enterprises that utilize the Internet to trade on global platforms have a survival rate of 54 percent, which is 30 percent higher than that of offline businesses. Furthermore, those small- and medium-sized firms that are online are almost as likely to export as large businesses.[17]

At the firm level, a multitude of specific examples illustrate how the ability to transmit data internationally improves firm operations and performance. For example, Unilever, the consumer goods company with over 174,000 employees and operations across 190 countries, has developed a global enterprise data warehouse wherein it collects information from all of its operations to deliver full visibility into the entire system. The primary objective of this effort was to compile a comprehensive consumer database, enabling analysis at the most granular level possible. Additionally, aggregating information on the firm's operations helps identify areas where lowering costs and improving business performance can drive more affordable products for consumers.[18]

Similarly, Rio Tinto, the mining company with operations in over 40 countries across six continents, collects real-time data from its trucks and drills, which are then transmitted to its Processing Excellence Center (PEC) in Brisbane, Australia. Active monitoring and real-time adjustment of Rio Tinto's operations have already driven significant savings from operational efficiencies, with more savings certain to follow on the heels of new and emerging process innovation.[19]

At Cisco, the ability to transfer data across borders optimizes the company's operations. For example, the Research Triangle Park facility in Raleigh, North Carolina (Cisco's largest technical assistance center, which has more than 4,500 employees) provides around-the-clock tech support to customers 24 hours a day, 7 days a week, anywhere in the world. When customers and Cisco employees confront challenging hardware or software problems, technical experts are able to log in remotely, run diagnostic tools, and exchange data to and from one another seamlessly. This type of business activity fundamentally relies upon the free flow of data.[20] As the appendix to this chapter further illustrates, firms around the world innovate and optimize business outcomes by transferring data across borders. Moreover, when trade flows between businesses are curtailed, innovation may decelerate through the interruption of technology transfer or through the reduction of competition-driven development, which is why the uninhibited exchange of data is increasingly critical to productivity and growth.

Box 1: Firms' uses of cross-border data flows

In a 2015 report, Business Roundtable—an industry group representing companies with $7.2 trillion in annual revenues and 16 million employees—identified the following six mechanisms by which cross-border data flows drive business benefits to firms.

Interconnected machinery. Companies improve processes and optimize efficiency by interconnecting elements of the production chain, such as real-time monitoring of capital equipment to reduce downtime or to be able to prepare for immediate service replacements.

Big data analytics. Companies collect data gathered from various, or all, aspects of their operations across regions and apply advanced statistical analysis to be able to make better decisions, both for the business and for customer satisfaction.

Back-office consolidation. Companies centralize standard business operations to take advantage of economies of scale (e.g., human resources, accounting, payroll, support call centers, marketing, etc.) by improving buying power and eliminating overlap.

Supply-chain automation. Companies track inventory levels, process reordering automatically, and match supply and demand.

Digital collaboration. Companies increase communication and collaboration between teams.

Cloud scalability. Companies lower capital expenditure and cost structure of information technology (IT) hardware, infrastructure, software, and applications, all provided as a service, and they reduce capital investment in idle capacity, thus lowering the total cost of ownership and increasing business agility and resilience to failures.

Source: Business Roundtable 2015.

Figure 2: Freedom on the Net as a driver of innovation, by country

Sources: Authors' calculation; Barbier et al. 2016; Freedom House 2015; IMF 2015.
Note: Freedom on the Net scores range from 0 to 100, where 0 = most free, 100 = least free.

THE IMPACT OF CROSS-BORDER DATA FLOWS: INDIVIDUALS AND ENTREPRENEURS

At the individual level, the ability to access cloud-based information provides significant benefit. Individuals are increasingly storing more of their personal information online. Cisco's Global Cloud Index estimates that, by 2019, 2 billion Internet users (or 55 percent of all consumer Internet users) will use personal cloud storage, up from 1.1 billion users in 2014. Globally, consumer cloud storage traffic per user will be 1.6 gigabytes per month by 2019, compared to 992 megabytes per month in 2014.[21] Cloud-based services may be hosted in the domestic market or in other countries.

New entrepreneurs also benefit from access to infrastructure, platforms, and software from cloud-based services, which may reside in other countries. These include applications, data, middleware, operating systems, virtualization, servers, storage, and networking capabilities or equipment. Because of the ability to access these services on a pay-as-you-go model rather than committing to a large initial capital investment, the financial barriers to new business entry have fallen significantly. By one estimate, the cost for an entrepreneur to establish a business with a working prototype has fallen from around US$2 million in the 1990s down to less than US$50,000 and approximately six weeks of work.[22] Furthermore, depending on the business model, in some cases startup costs—when supported by the affordability of cloud-based infrastructure—can be as low as US$3,000.[23]

THE FREE FLOW OF DATA AND THE DIGITAL ECONOMY VALUE AT STAKE

Cisco's data analysis demonstrates that the free flow of data enables people and things to connect, which can improve processes and add tremendous value to any given economy. The potential bottom-line *value at stake* (defined as the combination of increased revenues and lower costs that is created or will migrate among companies and industries as a result of increasing the adoption of Internet technologies) is estimated to be US$29.7 trillion over the 2015–24 period.[24] This includes up to US$23.8 trillion in the private sector, where up to one-third of corporate profits may be at stake and where telecommunications service providers have an opportunity to capture US$1.8 trillion in new economic value. Up to US$5.9 trillion may be generated in the public sector as well. These improvements to the overall digital economy represent a potential annual GDP upside of 0.43 percent and potential employment creation of 2.7 million jobs worldwide.

Figure 2 highlights the relationship between the value at stake that can be generated by the digital economy and the Freedom on the Net score. The figure suggests that countries with higher Freedom on the Net scores are better poised to benefit from potential value at stake from digitization.

In other words, those countries and companies that have not positioned themselves in an environment that fosters open Internet practices may find innovation and economic growth hampered. Risks related to

Table 2: Examples of cross-border data flow restrictions

Restriction type	Restriction description
Local data storage	Restricts data flows by requiring specified data—often but not always personal information—to be stored on local servers. May also require specific applications or services to operate in-country, processing data locally to avoid offshore transfer.
Data protection	Restricts data flows through the application of data privacy laws with adequacy and/or consent requirements that cannot reasonably be met without local data storage.
Geolocation data privacy	Restricts data flows by preventing the collection, disclosure, transfer, or storage of geolocation data without an individual's consent.
Traffic routing	Affects data flows by requiring communications providers to route Internet traffic in a specific way.

Source: Business Roundtable 2015.

cybersecurity also slow innovation, as demonstrated by new Cisco survey research, wherein senior executives have determined that cybersecurity concerns have forced their companies to drop some mission-critical projects. Specifically, 39 percent of the 1,014 executives surveyed state that their organization has "halted a mission-critical initiative due to cybersecurity concerns." In Cisco's survey, 71 percent of all respondents somewhat or strongly agree that cybersecurity threats—both potential and actual—hinder innovation. Furthermore, 60 percent somewhat or strongly agree that cybersecurity risk dampens smart and connected product development, a critical element on the path to digitization.[25]

RESTRICTIONS ON CROSS-BORDER DATA FLOWS

The Internet was architected with protocols to identify the fastest possible route to transmit packets of data between any two points. However, increasing concerns of national governments around privacy, security, and local competition have resulted in some policy and regulatory impediments. Difficulties arise when overly restrictive regulations on cross-border data flows create trade barriers and impact business models. Overly burdensome regulations can slow or prevent business transactions, which increases costs and obstructs the delivery of products to the market. Examples of these restrictions, as noted by Business Roundtable, are included in Table 2.

The number and impact of restrictions that are implemented around the world appear to be increasing. The US ITC identifies localization requirements as a barrier for 82 percent of large firms and 52 percent of small- and medium-sized enterprises in the digital communications sector. Localization mandates are the most frequently identified digital trade barrier.[26]

These restrictions impose significant business costs. The burden of compliance related to both cost and logistics can slow or stop business activity and limit innovation. For example, one analysis estimates that disruptions to cross-border data flows and services trade could result in a negative impact on the European Union of up to 1.3 percent of GDP as well as a potential drop in EU manufacturing exports to the United States of up to 11 percent.[27] In seven different countries and regions of the world studied in one analysis, data localization requirements would also result in lower GDP.[28] Conversely, efforts to decrease barriers to cross-border data traffic have been shown to drive growth and, based on 2014 estimates, the removal of obstacles to the flow of data could increase GDP by 0.1 percent to 0.3 percent in the United States.[29]

THE PATH FORWARD: BALANCING GROWTH, DATA FLOWS, AND NATIONAL CONCERNS

As demonstrated above, the benefits of cross-border data flows are significant. Additional empirical work needs to be done, however.[30] And there are still cases where national concerns over privacy, security, and local economic activity may prompt regulations to curb some flows. In those instances, we propose the following guidelines (see Box 2 for examples):

- Minimize fragmentation by ensuring that any policy actions are least-trade-restrictive to achieve legitimate public policy objectives.
- Carefully craft regulations that are as narrow in scope as possible, with clearly articulated goals.
- Coordinate globally to minimize conflicts in regulations between different jurisdictions.
- Evaluate the full costs of any proposed regulation and ensure that costs of compliance do not outweigh the quantifiable benefits.
- Adhere to trade obligations.

In sum, any limitations on cross-border data flows should address specific concrete—not merely

Box 2: Country examples: Singapore and the Netherlands

Steps taken in several economies embody the spirit of the proposed guidelines, illustrating the feasibility of their implementation across national boundaries. For example, the government of Singapore has promoted data centers in an effort to attract their establishment by private or third party entities within its borders.[1] Additionally, Singapore's Personal Data Protection Commission (PDPC) has actively engaged industry in the development of good practices in data management, including those that regard the transfer of data.[2] Furthermore, guidelines for industry compliance with the Personal Data Protection Act (2014) developed by the PDPC have been narrow in scope and organized by sector, and developed in consultation with industry.

While Singapore has enhanced its presence as a global leader in digital transfer by emerging as a major hub for finance and services, the Netherlands has done so by serving as a major port for traded goods as well as a hub for European data traffic. Despite taking different routes to become more connected, both economies have recognized the importance of digital flows, including those both internally and externally facing. Supporting this notion, in the March 2016 report on digital globalization, the McKinsey Global Institute (MGI) finds that global flows of goods, foreign direct investment, people, and data contribute structurally to economic growth by increasing productivity.[3] Assessing MGI's two most highly ranked economies in country connectedness, Singapore (1st) and the Netherlands (2nd) both also rank in the top 10 for data flow, underscoring the crucial significance of open borders for data transfer and, subsequently, global competitiveness and innovation.

Notes

1 See the Singapore, Ministry of Communications and Information website at http://www.mci.gov.sg/web/content/infocomm-media-masterplan/preliminary-ideas/establish-agile-pervasive-and-trusted-icm-infrastructure/digital-harbour.

2 See PDPC Singapore 2016.

3 Manyika et al. 2016.

theoretical—problems, be least intrusive, be minimally restrictive, and, if possible, be time-bound. In cases where market-driven forces justify fragmentation because of business-enhancing reasons, such as when intellectual property may be affected, segmentation should be driven by the market rather than by government requirements.

These actions would minimize any collateral damage done to the economy imposing restrictions, and they would ensure that the Internet continues to serve as a driver of innovation, economic growth, and social development.

NOTES

1 Wired.com 2012.

2 History.com Staff 2010.

3 Katz 2012; ITU 2015a.

4 Pélissié du Rausas 2011.

5 IMF 2015.

6 Cisco VNI 2015.

7 TeleGeography, available at https://www.telegeography.com/research-services/global-bandwidth-research-service/.

8 Manyika et al. 2014.

9 Pélissié du Rausas 2011.

10 Meltzer 2014. Note that a major challenge for understanding just how potent this impact is, however, is the lack of data available.

11 US ITC 2014.

12 Lee-Makiyama 2015; UNCTAD 2009.

13 Manyika et al. 2016, p. 2.

14 Cornell University, INSEAD, and WIPO 2015.

15 Business Roundtable 2015.

16 US ITC 2014, p. 65.

17 Austin and Olarreaga 2012.

18 Castro and McQuinn 2015.

19 Castro and McQuinn 2015.

20 Moore 2015.

21 Cisco 2015.

22 Center for an Urban Future 2012; Mulas, Minges, and Applebaum 2015.

23 Mulas, Minges, and Applebaum 2015; Mytton 2010.

24 Barbier et al. 2016.

25 Barbier et al. 2016.

26 US ITC 2014.

27 Bauer et al. 2013, p. 3; Castro and McQuinn 2015.

28 Bauer et al. 2014.

29 Castro and McQuinn 2015; US ITC 2014.

30 For example, quantifying firm-level impact of new or existing processes enabled by cross-border data flows.

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Appendix:
Examples of firm-level cross-border data flows

Alliance Medical

Alliance Medical has been a pioneer in the trend of remote interpretation and diagnosis of medical images—such as x-rays, ultrasounds, and magnetic resonance imaging (MRI) images. This service reduces wait times and improves the expediency of diagnoses. In addition to the efficiency cost savings, offloading these tasks also allows doctors to spend more time with patients.

Caterpillar

Caterpillar is a global leader in the manufacture of heavy machinery and engines for use in industries from construction and mining to heavy-duty transportation. Real-time sensors in their products monitor performance data and transmit via cellular and satellite connectivity, allowing users to remotely analyze and monitor assets. This allows customers to identify underutilized machines, thus maximizing efficiency, and to make better equipment placement decisions, thus creating substantial cost savings for customers. Cross-border data flow restrictions, such as constraints on the movement of Global Positioning System (GPS) data, may limit Caterpillar's ability to offer such advanced services in certain markets.

Boeing

Boeing has developed a real-time information tool, the Airplane Health Management (AHM), that gathers and transmits data in real time to maintenance crews on the ground. The data are sent across borders (while aircraft are in the air) and helps to reduce delays, midflight turn-backs, and cancellations. A single Boeing 737 engine produces up to 20 terabytes of data every hour in flight. Data are analyzed in real time, even mid-flight, to find and diagnose problems. Any issues are relayed to waiting airline maintenance personnel at the aircraft's next airport destination. The crews can then meet the aircraft with the appropriate airplane parts to make necessary repairs. This sort of intelligence aids operators in spotting trends, eliminating inefficiencies, saving money, and reducing wait times.

General Electric (GE)

GE has embedded advanced sensors in a wide array of machinery to improve the performance of industrial equipment and machines purchased by its customers. The sensors remotely capture performance data from around the globe; these data are used to improve product reliability, safety, and efficiency. For example, in aviation, GE monitors sensor data from aircraft engines around the globe, thus optimizing engines, to help airlines anticipate maintenance issues and address them before aircraft need to be grounded, saving time and money for airlines and travelers. This sensor system saves airlines more than US$2 billion per year worldwide because the sensor technology reduces delays and cancellations caused by aircraft maintenance needs—a capability predicated on the ability to aggregate and analyze sensor data supplied from locations to generate savings for individuals, governments, and businesses across the globe.

MasterCard

As a global payments industry leader, MasterCard connects consumers, financial institutions, merchants, governments, and businesses through electronic payments. The company processes payment transactions initiated in more than 40 million locations in more than 210 countries and territories. Global payment services are inherently dependent on cross-border data flows because each payment transaction requires transfers of payment transaction data between the merchant, the merchant's bank, MasterCard, and the consumer's bank. MasterCard enables merchants to engage in international trade and sell goods and services to foreign travelers. Even when the merchant, the consumer, and their banks are all based in the same country, MasterCard may leverage its global operations hub to add value to the transaction and facilitate safe, efficient, and cost-effective transactions. However, some countries impose restrictions that require local processing of all electronic payment transactions. In doing so, restrictions can force the building or replication of costly infrastructure domestically; this cost may then be passed onto consumers.

Royal Dutch Shell

Royal Dutch Shell has over 150,000 employees across 90 countries and is headquartered in the Netherlands. As one of the world's largest oil and gas companies, it also has a global computing footprint with three main global data centers. Shell uses these computing resources to manage and analyze the data generated by sensors in its wells, particularly from sensitive, low-power sensors that generate high-resolution seismic data. Transmitting data to the global data centers, these sensors are able to detect resources in wells thought to have run dry.

Tesco

Tesco is a global retailer with stores in 12 countries in Asia, Europe, and North America. The consumer goods giant processes real-time data from its electronic shelves to make national pricing changes instantly as well as to predict when products on its shelves need to be reordered, thus preventing understocking and lost revenue. These benefits are passed on to customers in the form of better service, fresher ingredients, lower prices, boosted convenience, and fully stocked shelves. Tesco also combines weather forecasts for each location, updated several times a day, to adjust deliveries and refrigeration needs to prevent food spoilage.

Volvo

Volvo is a Swedish vehicle manufacturer employing over 115,000 people, with operations in over 190 countries. The company embeds real-time vehicle location data and diagnostic information and transmission capabilities into its vehicles and allows for their systems to alert drivers to needed repairs or software upgrades, as well as locating lost or stolen vehicles during emergencies. The company enables customers to gather data on all of their trucks for real-time monitoring, optimizing vehicle and fleet fuel efficiency.

Walmart

Walmart is the world's largest retailer, with over 11,000 stores in 27 countries employing over 2.2 million people worldwide; it maintains e-commerce websites in 10 countries. The company tracks its performance and global operations by collecting data on all aspects of its business, centralizing data, and deploying shared services (such as human resources support with cloud-based platforms). Virtualizing support operations and back-office consolidation helps to reduce the duplication of hardware and software and to increase operating efficiency through economies of scale. Data flow restrictions can prevent such efficiency-enhancing innovations and in the long run discourage larger job-creating investments in other areas of the business.

Sources: Business Roundtable 2015; Castro and McQuinn 2015.