DIGITAL PLANET 2017

HOW COMPETITIVENESS AND TRUST IN DIGITAL ECONOMIES VARY ACROSS THE WORLD

Bhaskar Chakravorti and Ravi Shankar Chaturvedi
The Fletcher School, Tufts University
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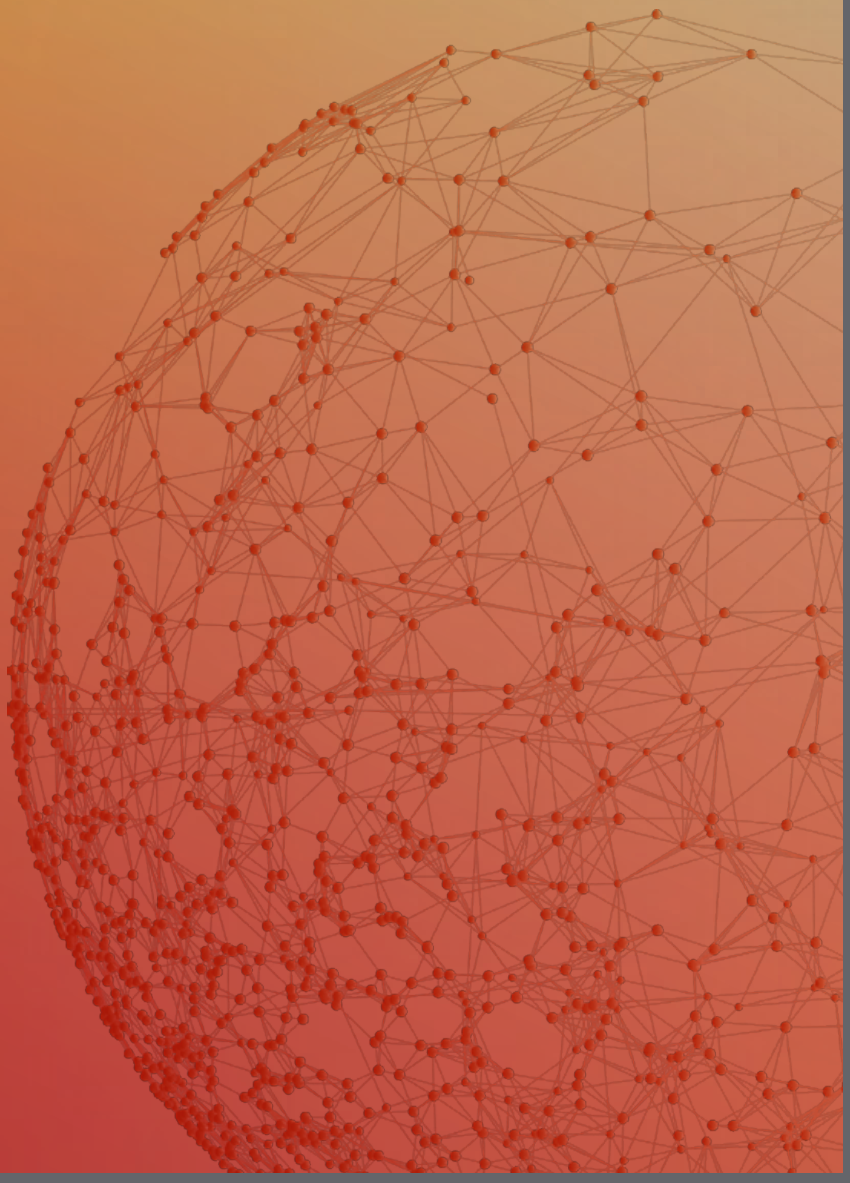

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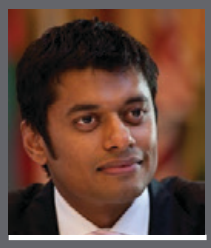

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ABOUT

DIGITAL PLANET

Digital Planet is an interdisciplinary research initiative of The Fletcher School's Institute for Business in the Global Context. Dedicated to understanding the impact of digital innovation on the world, Digital Planet provides actionable insights for policymakers, businesses, investors, and innovators.

INSTITUTE FOR BUSINESS IN THE GLOBAL CONTEXT

The Institute for Business in the Global Context (IBGC) connects the world of business to the world. It is the hub for international business at The Fletcher School, the oldest graduate school of international affairs in the United States. The Institute takes an interdisciplinary approach, preparing global leaders who can cross borders of many kinds and integrate business skills with an understanding of the geopolitical, legal, financial, security, macroeconomic, humanitarian, and environmental impacts on business. The Institute is organized around four core activity areas: education, research, dialogue and a lab. The Master of International Business degree and leadership development programs are at the heart of the education mission. These offerings, coupled with original research in multiple areas — inclusive growth, digitalization, innovation and economic development at scale, sovereign wealth and global capital flows, among others — facilitate a vibrant dialogue on contemporary global issues through conferences, symposia and speaker events. The lab creates opportunities for student teams to take knowledge into the "field" to effect change through entrepreneurial startups and consulting projects. The Institute also houses the Council on Emerging Market Enterprises, a think tank comprising distinguished practitioner-scholar experts, who collaborate with the Institute and The Fletcher School on a variety of initiatives, such as research programs, symposia, and conferences.

THE FLETCHER SCHOOL AT TUFTS UNIVERSITY

The Fletcher School of Law and Diplomacy at Tufts University is the oldest exclusively graduate school of international affairs in the US, working to solve the world's most pressing problems through a collaborative, cross-disciplinary approach to research and education. Since 1933, The Fletcher School has prepared the world's leaders to become innovative problem-solvers in government, business, and non-governmental organizations with strategic cross-sector networks. Through our ongoing commitment and rigorous approach to advancing world knowledge through research and scholarship, The Fletcher School continues to inform and build bridges to meaningful global solutions.

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The authors are grateful for the support and guidance of their colleagues and sponsors. Without the advice and critiques of many distinguished experts, this work would not have been possible. The views expressed in this report, the underlying analysis, and any remaining errors are the authors' alone.

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We would be remiss if we do not thank our colleagues behind the scenes whose administrative support and everyday acts of kindness have created a vibrant space for us and our team to think and conduct research on the global digital economy. Agnes Hatley, Katherine Round, Kristen Zecchi, Dorothy Orszulak, Dean James Stavridis, Dean Gerard Sheehan, James Rollins, Lupita Ervin, Dana Christensen, Susan Lagasse, Therese Vienot, Emily Rezendes, Akiyo Fujii, Ellen McDonald, Cyndi Rubino, Lee LaFleur, and Brad Macomber—we are grateful to you.

CONTENTS

EXECUTIVE SUMMARY

We live in a time of great resets. Even as globalization comes under attack in many parts of the world, the movement of data across borders is growing exponentially. Digital flows are now responsible for more GDP growth globally than trade in traditional goods. Automation, AI, the Internet of Things and business models such as the "sharing economy" are changing how we conduct business and our lives. It is in this context that The Fletcher School at Tufts University, in partnership with Mastercard, present the Digital Evolution Index (DEI) 2017. It follows up on the earlier DEI, the world's first pulse check of the global digital economy that was reported in the widely read 2015 Harvard Business Review article, "Where the Digital Economy is Moving the Fastest."[1]

The DEI 2017 is a data-driven holistic evaluation of the progress of the digital economy across 60 countries, combining more than 100 different indicators across four key drivers: Supply Conditions, Demand Conditions, Institutional Environment, and Innovation and Change. The resulting framework captures both the state and rate of digital evolution and identifies implications for investment, innovation, and policy priorities. DEI 2017 also highlights the evolving nature of the risks being created by our continuing reliance on digital technology. Towards this end, the study covers a key question of "digital trust." The DEI 2017 incorporates a newly devised analysis of digital trust that takes into account the trustworthiness of the digital environment for each country; the quality of users' experience; attitudes towards key institutions and organizations; and users' behavior when they interact with the digital world. This subject is of great interest to all participants in the digital economy, given the concerns about security of essential information, cyber-attacks, and consumers' apprehensions—about the digital systems and their reliability, the digital companies and their growing dominance, and about the leaders of digital companies.

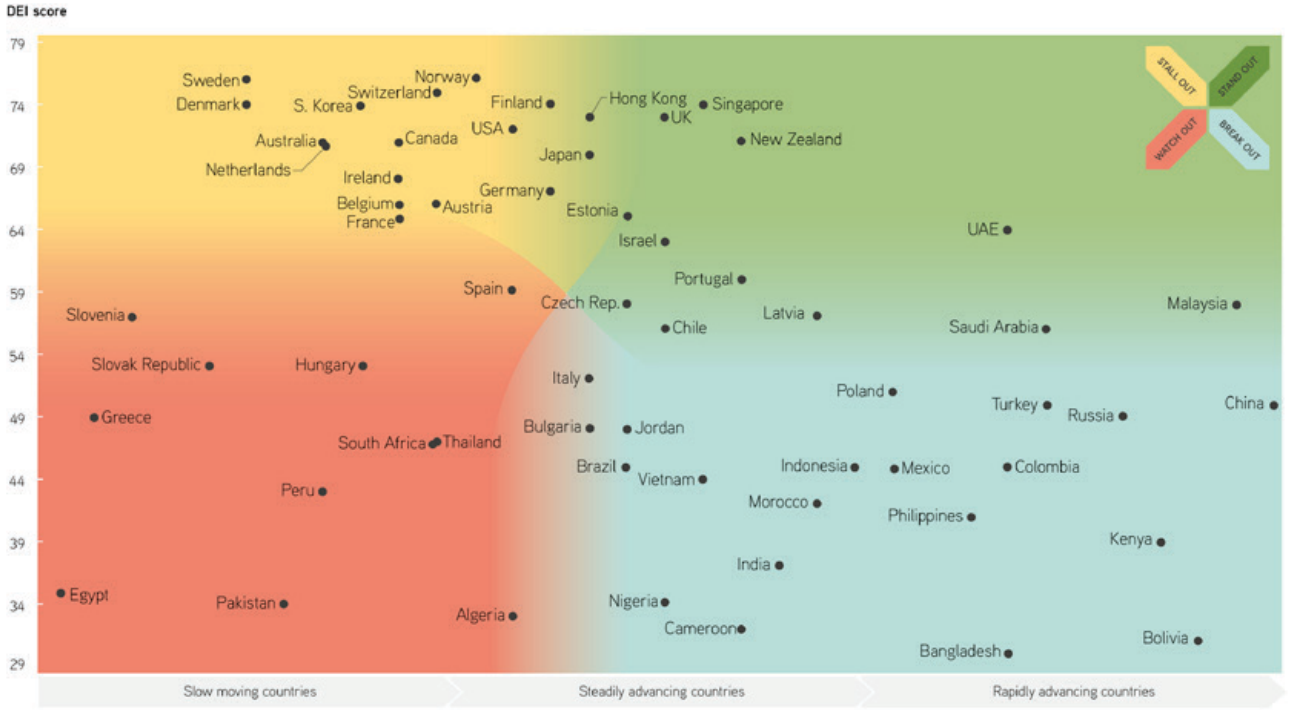
The DEI framework segments the 60 countries into Stand Outs, Stall Outs, Break Outs and Watch Outs. Three countries are notable as standouts even within the Stand Out segment: Singapore, New Zealand, and the UAE. Each has a unique policy-led digital strategy and a narrative that may be considered by other nations as worthy of emulation or adoption. The Nordic countries and Switzerland are at the top of the DEI 2017 rankings. China, once again, tops the list of countries in terms of the pace of change in its digital evolution, or momentum.

Our previous DEI study generated policy, executive, and investor interest worldwide. This edition offers new insights and directions for decision-makers at a time when the world is experiencing uncertainty on the geopolitical and economic fronts combined with the certainty of the steady incursion of digital technology into every aspect of human endeavor.

The following two visuals capture how competitiveness and trust in digital economies vary across the world.

The competitiveness of a country's digital economy is a function of two factors: its current state of digitalization and its pace of digitalization over time, as measured by the growth rate of a country's digitalization score over an eight-year period (2008—2015). We arrayed countries' latest year (2015) score (state of digitalization) on the vertical axis against the growth rate over an eight-year period (pace of digitalization) on the horizontal axis to create the DEI Chart—an atlas for the digital planet. This chart helps to classify countries into four distinct trajectory zones: *Stand Out, Stall Out, Break Out, Watch Out.*

THE BIG PICTURE: DEI CHART



Stand Out countries are both highly digitally advanced and exhibit high momentum. They are leaders in driving innovation, building on their existing advantages in efficient and effective ways. However, sustaining consistently high momentum over time is challenging, as innovation-led expansions are often lumpy phenomena. To stay ahead, these countries need to keep their innovation engines in top gear and generate new demand, failing which they risk stalling out.

Stall Out countries enjoy a high state of digital advancement while exhibiting slowing momentum. The five top scoring countries in the DEI 2017 ranking—Norway, Sweden, Switzerland, Denmark, and Finland—are all in the Stall Out zone reflecting the challenges of sustaining growth. Moving past these "digital plateaus" will require a conscious effort by these countries to reinvent themselves, bet on a rising digital technology in which it has leadership, and eliminate impediments to innovation. Stall Out countries may look to Stand Out countries for lessons in sustaining innovation-led growth.

Break Out countries are low-scoring in their current states of digitalization but are evolving rapidly. The high momentum of Break Out countries and their significant headroom for growth would make them highly attractive to investors. Held back often by relatively weak infrastructure and poor institutional quality, Break Out countries would do well to foster better institutions that can help nurture and sustain innovation. Break Out countries have the potential to become the Stand Out countries of the future with China, Malaysia, Saudi Arabia, Kenya, and Russia leading the pack.

Watch Out countries face significant challenges with their low state of digitalization and low momentum; in some cases, these countries are moving backwards in their pace of digitalization. Some of these countries demonstrate remarkable creativity in the face of severe infrastructural gaps, institutional constraints, and low sophistication of consumer demand. The surest way for these countries to move the needle on momentum would be to improve access to the internet for their masses by closing the mobile internet gap—that is, the difference between the number of mobile phones and the number of mobile phones with internet access.

Through combining the Experience and Environment scores, we capture the overall trust ecosystem supplied by governments and businesses—the guarantors of trust. We contrast these scores with how users—the givers of trust—behave in each digital trust system. Countries fall into four zones:

TRUST INDEX LANDSCAPE

High Trust Equilibrium: Much like Stand Out nations, these countries are rare. Singapore, Spain, Norway, Hong Kong*, and Finland all have users that exhibit patient and engaged behavior online combined with a more trustworthy environment and relatively seamless experience. They are in equilibrium because their level of trust—as exhibited through their behavior—matches the environment.

Low Trust Equilibrium: Among countries in the Low Trust Equilibrium zone such as Pakistan, Jordan, and Egypt, user trust—as exhibited through their behavior—matches the less trustworthy and more friction-laden environment. This could cause users in these countries tend to be less engaged and less patient with friction online.

Trust Surplus: Countries like China, Turkey, and Malaysia enjoy a Trust Surplus. They have patient and engaged users despite high friction experiences online and relatively less trustworthy environments. This Trust Surplus may be partially due to the high momentum many of these countries are experiencing—for many users, a slow smartphone is far superior to the lack of connectivity they may have lived with just a few years prior.

Trust Deficit: Countries in the Trust Deficit zone are similar to High Trust Equilibrium countries in terms of their experience and environments; however, users in these countries such as South Korea, US, France, and Australia tend to be less patient and fickle when faced with friction online.

OUR DIGITAL PLANET 2017 REPORT HAS 6 KEY TAKEAWAYS:

1. Use Public Policy as Key to the Success of the Digital Economy

Highly evolved countries typically have had strong government/policy involvement in shaping their digital economies. High momentum countries typically also have strong government/policy involvement. A sophisticated understanding of the state and drivers of the digital economy and its impact on the overall economy are essential for the success of a wide range of prominent policy imperatives such as: how Brexit negotiations are conducted; how India nudges its society towards a "less cash" future; and how the US and China compete for economic dominance.

2. Identify and Amplify Drivers of Digital Momentum

Digital momentum is powered by different drivers depending on a country's level of digital evolution and economic advancement. This has different implications for what advanced economies and developing economies ought to prioritize: innovation and institutions, respectively.

3. Organize Digital Entrepôts As Linchpins of the Digital Planet

Smaller countries with strong institutions can create high value as early adopters and create a demonstration effect for the world by assembling the right ecosystem.

4. Reinvent the Digital Stalwarts through Re-focusing on Innovation

The digitally most advanced countries can put their maturity, scale and network effects to use to reinvent themselves and grow.

* Hong Kong is a Special Administrative Region of China.

5. Play Digital Catch-Up by Closing the Mobile Internet Gap

The digitally least advanced countries must allocate limited resources wisely. Enabling internet access on the mobile phone provides the highest bang for the buck.

6. Work Harder to Earn Users' Trust in More Digitally Evolved Countries

Technology providers and policymakers offering privacy, security, and accountability may need to prioritize their marginal resources towards the more evolved countries with slowing momentum, where they risk losing users experiencing a "trust deficit."

CONTEXT

In our 2014 Digital Planet report, recognizing the phenomenon of digitalization[2] as the defining source of competitiveness for countries in the global economy, we introduced the Digital Evolution Index. The purpose of the index was to understand how different countries are making the transition from a physical past to a digital future, and it offers a simple means to measure which countries are most ready for the transition, how quickly they are digitalizing, and whether some of them are better positioned than some others. We chose 2008 as the starting point for our research; this enabled us to study how countries coped in the aftermath of the Great Recession, a leveling event for the global economy. One of our conclusions, true then as it is now, was that while countries are on a journey toward a "digital planet," they are all traveling at different speeds.

In the years since 2008, the nature of globalization itself has been evolving:

- The free flow of trade (goods and services) and cross-border capital—drivers of globalization since the fall of the Berlin Wall—have ebbed in the aftermath of the great recession. This trend has been described by Sebastian Mallaby in a recent International Monetary Fund publication[3] and analyzed extensively by the McKinsey Global Institute.[4]
- The free movement of people—the other promise of globalization—has become a lightning rod issue in recent national elections, particularly on either side of the Atlantic. In the meantime, the absolute numbers of forcibly displaced people as of 2016 is the highest in history.[5] Much of the human displacement is the outcome of conflict, climate change, and unbalanced demographic bulges.
- The "rise of the rest"—the phenomenon of the developing world being the primary force behind global growth—has become less of a certainty. As the Chinese economy rebalances, India alternates between maintaining momentum and self-inflicting shocks to its system by demonetizing its currency or other policy experiments, Brazil struggles with a variety of crises in governance and politics, while Russia recedes into a pariah status. Africa, a continent that was expected to be the next growth frontier, struggles to maintain a consistent pattern of high growth due to a combination of lower demand for commodities, governance issues, and drought conditions, among other challenges.
- The benefits of globalization itself have been shared unevenly, causing many to wonder whether inclusive growth rather than fast growth ought to have been the central objective of globalization. The role of globalization—combined with technology and trade in transforming human activity, leading to displacement of labor without a corresponding increase in total factor productivity—has gained prominence as a source of concern.[6]

- With 2016 as the hottest year on record, carbon dioxide levels at record highs, and sea levels rising at a rate of about one-eighth of an inch per year, the effects of climate change have never been more self-evident.[7,8] Despite a landmark agreement among 195 nations in Paris to take action, the follow-through has been uneven; while some countries, such as China and India, are on track to overshoot their Paris goals, the US has declared it is pulling out of the agreement.

In the meantime, the rise of digitalization has continued unabated and has become more central to the global economy. Cross border flows of technology, ideas, news, entertainment, and data have grown manifold, accounting for more than a third of the increase in global GDP in 2014 (US$2.8 trillion),[9] prompting some researchers to call this the "fourth channel for globalization" and "the era of digital globalization."[10]

With the digital economy now firmly in the driver's seat of globalization and exerting a "larger impact on growth than merchandise goods trade"[11] the notion of "digital competitiveness" has become front and center for countries, their policymakers, businesses, and indeed their citizens—to whom digital platforms are a ticket to inclusion into the global marketplace. Two important themes emerge as distinctive features of this report: one is the role of the digital system in redefining competitive advantage, especially in smaller countries; and the second is the role of user trust in the digital system.

First, consider the countries and corporations that are embracing digitalization and upending traditional sources of competitive advantage. In some instances, even small countries discovered that their digital prowess gives them an ability to punch above their weight in having an impact, often leapfrogging more established countries in finding creative solutions around constraints; this would not have been possible in the traditional, physical economy. Tiny Estonia, for example, a country constrained in its ability to attract global talent owing to its physical size, innovated its way out of the problem through its e-Residency initiative.[12] New Zealand, another small but digitally highly evolved country, is attracting resources and technology talent by showcasing its physical distance from the rest of the world as a plus.[13] And then, consider the case of Malaysia, which signed an unusual bilateral trade deal not with another country, but with a company, Alibaba, to establish a partnership for fostering frontier-free digital commerce.[14]

Second, consider the fact that, as digital platforms increasingly become a part of people's lives, and as businesses, and governments embrace digitalization, there is a need to understand the nature and state of trust in the digital economy. As would be widely acknowledged, trust is key to successful and sustainable relationships in the physical world; with our growing reliance on the digital economy, trust is as important, if not more, in nurturing and growing productive relationships in commerce, communications or collective action. While in theory, the near-zero marginal costs of digital communications and commerce open up a world of possibilities, the persistence of friction—that is, hindrances to the seamless and lag-free completion of transactions or interactions online—can result in an erosion of trust. Further, as technology improves, more complexity is being embedded into algorithms resulting in consumers' data being used in ways that are not fully understood by consumers themselves. This opacity can also create questions about the trustworthiness of what happens behind the scenes, how the increasingly powerful digital

players are using the information, and whether privacy, security and accuracy are being maintained as consumers' reliance on digital technologies grows. The increasing security layers, sometimes involving multiple stages of authentication and passwords, can also add to the dimensions of trust in ways that are novel and unique to the digital world.

In this edition of the Digital Planet report, in addition to assessing digital evolution around the world, we also provide an approach to measuring "digital trust." It is our first attempt to comprehend the fuller implications of digital evolution—both on how technologies are shaping the world and how humans are responding to and shaping those technologies.

It is within this changing context that we present the 2017 edition of the Digital Planet report, which builds on our earlier work, published in 2014. The questions that guide our work include:

- What are the patterns of digital evolution around the world? What factors explain these patterns, and how do these factors vary across regions and across levels of economic development?
- Which countries are the most digitally competitive? Who are the primary drivers of competitiveness: public or private sector?
- How do countries accelerate their digital momentum and unlock the dividends?
- What is digital trust? Are there measures of digital trust that allow for a comparison across countries? What is the state of digital trust around the world?
- What is the relationship between digital trust and digital momentum?

We attempt to answer these questions through the Digital Evolution Index 2017. To explicitly get at the questions of trust, we expanded on different dimensions of trust, some of which were implicit in the earlier edition of our index. As a result, we have a "State of Digital Trust" model to explain the dimensions and nuances of trust.

DIGITAL EVOLUTION INDEX 2017

DIGITAL PLANET 2017

THE DRIVERS OF DIGITAL EVOLUTION

The Digital Evolution Index analyzes the underlying drivers that govern a country's digitalization: Supply Conditions, Demand Conditions, Institutional Environment, and Innovation and Change. To gain a comprehensive view of digital readiness and competitiveness of countries, we further divided these drivers into 12 components measured using a total of 108 indicators. The four drivers, 12 components, and sample indicators are illustrated below (Figure 1).

Digitalization is the outcome of the complex interplay of the four drivers and related factors often taking place in different combinations in different countries. No single trend or data related to consumer demand, government actions and policies, investments, innovation, or infrastructure can offer a measure or a complete picture of the myriad ways the internet and digital platforms are integrating into the lives of billions around the world. Insights into the drivers of digitalization help us move beyond a static snapshot and appreciate the systemic nature of forces at play. Such insights help us understand why some countries are experiencing greater momentum than others and outline the contributions that specific actors in the private and public space can make to unclog bottlenecks and to get innovation moving. Finding these key leverage points could propagate changes through the entire system. This systemic approach also helps explain why change may be slower than expected: The interlocking nature of these indicators could keep the status quo frozen until certain essential barriers are overcome. The drivers are as follows (Figure 1):

FIGURE 1: FOUR DRIVERS OF DIGITAL EVOLUTION

SUPPLY CONDITIONS

Access Infrastructure
Communications sophistication and coverage; security

Transaction Infrastructure
Access to financial institutions; electronic payment options

Fulfillment Infrastructure
Quality of transportation infrastructure; logistics performance

DEMAND CONDITIONS

Consumer Capacity to Engage
Consumer ability and willingness to spend; gender digital divide

Digital Payment Uptake
Degree of financial inclusion and use of digital money

Digital Uptake
Device prevalence and density; technology, internet, and mobile connection uptake; digital consumption

INSTITUTIONAL ENVIRONMENT

Institutions and the Business Environment
The legal environment including efficiency in settling disputes, IP and investor protections; and Bureaucracy

Institutions and the Digital Ecosystem
Government uptake and use of ICT and digital technology; telecom competition

Institutional Effectiveness and Trust
Transparency; rule of law; regulatory quality

INNOVATION AND CHANGE

Inputs
Financing options and opportunity; start-up capacity; ability to attract and retain talent

Process
Sophistication of business practices; R&D

Output
Depth of mobile engagement; reach of innovation; use of social networks and digital entertainment

Supply Conditions: How developed is the infrastructure to facilitate digital interactions and transactions? This driver measures the quality and readiness of digital and physical infrastructure such as bandwidth availability and quality of roads. Developing countries with fledgling infrastructure comprise the low end of the scores on the Supply driver.

Demand Conditions: Are consumers willing and able to engage in the digital ecosystem? The indicators underpinning Demand Conditions help address additional questions, such as:

- Do consumers have the means and instruments necessary to plug into the digital economy?
- Do consumers have the willingness and continued interest to remain actively engaged in the digital economy?

While high demand is always a welcome sign, low demand scores can be interpreted as an indication of untapped market potential that investors and businesses can take advantage of in an enabling institutional environment; stagnant demand over time, particularly in advanced markets, can be a sign of market saturation pointing to a need for innovation that can help restart the engines of demand.

Institutional Environment: In addition to directly investing in infrastructure and establishing laws and regulations, government actions and policies play an essential role in either supporting or hindering the business engine that creates and distributes digital technologies. At the same time, governments are key to determining the climate for investment and innovation in digital technologies and their applications. By providing a stable environment that encourages investment and protects consumers, governments create enabling conditions or even the technologies themselves that foster digitalization. The indicators underpinning the Institutional Environment driver also help address questions, such as: Are governments taking deliberate steps towards advancing and adopting digitalization? Do they have policies and regulations in place to foster digital ecosystems?

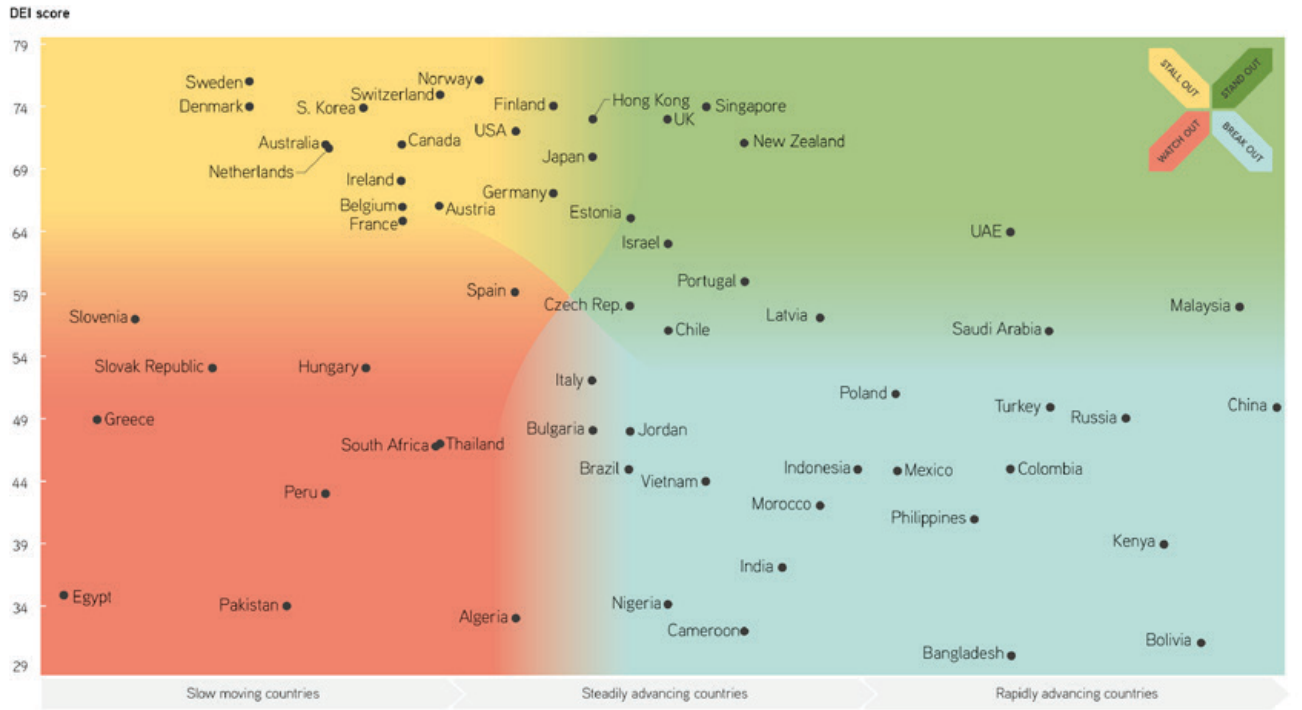
Innovation and Change: Innovation is the key to finding new solutions to global, national, and local challenges. Innovation and the resulting change push the boundaries of the digital ecosystem and what it can do; it is in equal parts the most impactful and challenging driver to jumpstart. By breaking down the systems of innovation into inputs such as availability of talent and capital; processes, such as university and industry collaboration in R&D; and outputs, such as new digital products and services created, we measure the vitality of innovation in a country and identify opportunities for improvement. The indicators associated with this driver focus on the core issue of: What is the extent of innovation taking place in the country's digital economy?

MAPPING DIGITAL MOMENTUM

The competitiveness of a country's digital economy is a function of two factors: its current state of digitalization, as determined by the interplay of the four drivers mentioned above, and—more importantly—its pace of digitalization over time, as measured by the growth rate of a country's digitalization score over an eight-year period (2008—2015). This pace of digitalization, which we refer to as momentum, is a lead indicator of a country's future digital potential and prospects.

We arrayed countries' latest year (2015) score (state of digitalization) on the vertical axis against the growth rate over an eight-year period (pace of digitalization) on the horizontal axis to create the DEI Chart—an atlas for the digital planet. This chart helps to classify countries into four distinct trajectory zones: Stand Out, Stall Out, Break Out, Watch Out. Each of these is described in Figure 2. Countries may display characteristics of two zones, particularly when in transition.

FIGURE 2: THE BIG PICTURE: DEI CHART



MOMENTUM ZONES DEFINED

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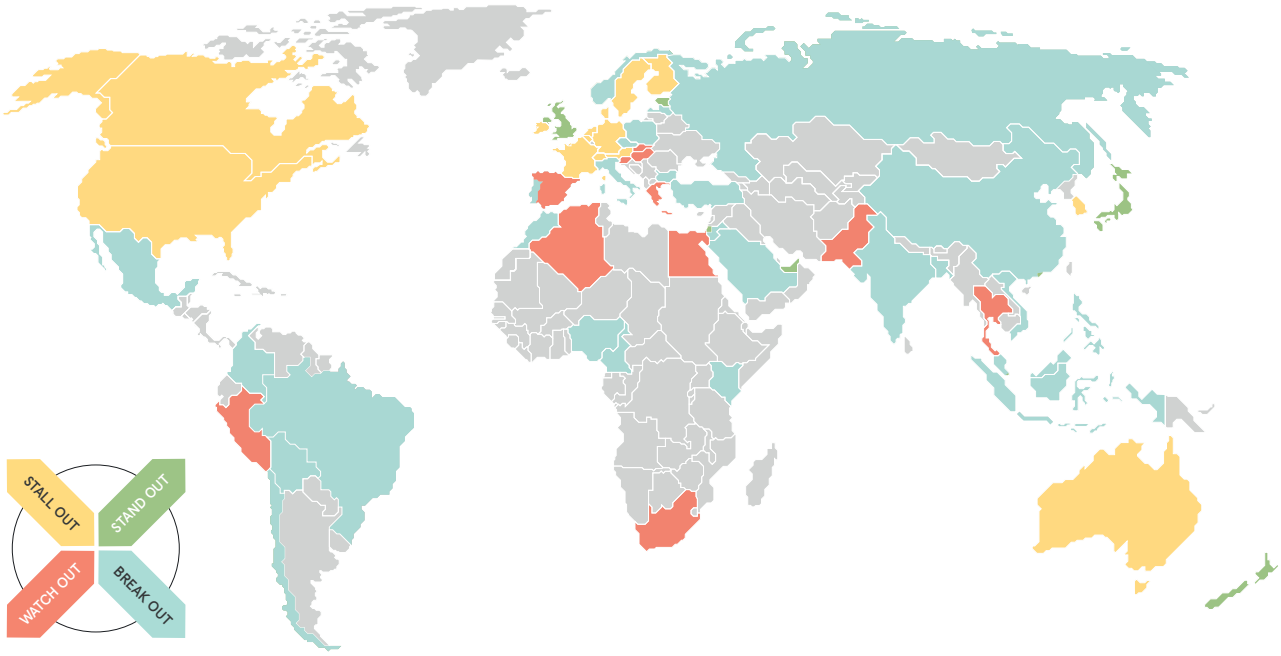
SCORES AND RANKINGS

The tables in this section list the 60 countries in the order of their DEI scores and their momentum scores, respectively. A higher score represents a higher level of digital evolution.

While the resulting rankings convey important information, given the breadth of countries covered our recommendation is to consider the two sets of rankings in combination. This is where the DEI Heat Map (Figure 3) is most helpful in visualizing how countries are distinct from one another and the major clusters in which they belong.

FIGURE 3: THE DEI HEAT MAP



While the rankings offer a view of the so-called bottom line, in terms of how a country stands relative to its peers along measures of digital evolution and momentum, it is essential ask the questions: Why is a country ranked where it is? What can be changed to boost a country's scores? Where are the leverage points, and which actors in the economy—the public sector, private sector players, partnerships —have the greatest potential to make a difference?

At the heart of how readily a society embraces and is served by digital technology is the notion of "digital trust." We turn to this topic in the next section.

TABLE 1: DIGITAL EVOLUTION INDEX 2017 SCORE

COUNTRY	RANK	SCORE
Norway	1	3.79
Sweden	2	3.79
Switzerland	3	3.74
Denmark	4	3.72
Finland	5	3.72
Singapore	6	3.69
South Korea	7	3.68
UK	8	3.67
Hong Kong*	9	3.66
USA	10	3.61
Australia	11	3.55
Canada	12	3.55
Netherlands	13	3.55
New Zealand	14	3.54
Japan	15	3.52
Ireland	16	3.41
Germany	17	3.36
Belgium	18	3.32
Austria	19	3.28
France	20	3.25
Estonia	21	3.24
UAE	22	3.22
Israel	23	3.14
Portugal	24	3.01
Spain	25	2.95
Malaysia	26	2.91
Czech Republic	27	2.90
Latvia	28	2.86
Slovenia	29	2.86
Chile	30	2.81

COUNTRY	RANK	SCORE
Saudi Arabia	31	2.80
Hungary	32	2.66
Slovak Republic	33	2.65
Italy	34	2.58
Poland	35	2.53
China	36	2.49
Turkey	37	2.49
Greece	38	2.44
Russia	39	2.44
Jordan	40	2.41
Bulgaria	41	2.41
Thailand	42	2.35
South Africa	43	2.33
Colombia	44	2.27
Indonesia	45	2.25
Brazil	46	2.24
Mexico	47	2.23
Vietnam	48	2.19
Peru	49	2.15
Morocco	50	2.12
Philippines	51	2.05
Kenya	52	1.97
India	53	1.85
Egypt	54	1.74
Nigeria	55	1.72
Pakistan	56	1.69
Algeria	57	1.64
Cameroon	58	1.61
Bolivia	59	1.54
Bangladesh	60	1.51

TABLE 2: DIGITAL EVOLUTION INDEX 2017 MOMENTUM SCORE

COUNTRY	RANK	SCORE
China	1	3.95
Malaysia	2	3.81
Bolivia	3	3.63
Kenya	4	3.50
Russia	5	3.43
Turkey	6	3.18
Saudi Arabia	7	3.18
Bangladesh	8	3.14
Colombia	9	3.11
UAE	10	3.06
Philippines	11	3.01
Poland	12	2.82
Mexico	13	2.80
Indonesia	14	2.66
Morocco	15	2.64
Latvia	16	2.63
India	17	2.53
Cameroon	18	2.43
Portugal	19	2.43
New Zealand	20	2.38
Singapore	21	2.35
Vietnam	22	2.28
UK	23	2.24
Chile	24	2.23
Nigeria	25	2.18
Israel	26	2.17
Jordan	27	2.13
Estonia	28	2.10
Czech Republic	29	2.07
Brazil	30	2.06

COUNTRY	RANK	SCORE
Bulgaria	31	2.05
Italy	32	2.04
Hong Kong	33	2.02
Japan	34	1.96
Finland	35	1.86
Germany	36	1.86
USA	37	1.83
Algeria	38	1.83
Spain	39	1.79
Norway	40	1.73
Thailand	41	1.63
Switzerland	42	1.59
South Africa	43	1.59
Austria	44	1.56
France	45	1.55
Belgium	46	1.51
Ireland	47	1.49
Canada	48	1.46
South Korea	49	1.42
Hungary	50	1.41
Netherlands	51	1.33
Peru	52	1.29
Australia	53	1.25
Pakistan	54	1.24
Sweden	55	1.09
Denmark	56	1.06
Slovak Republic	57	1.01
Slovenia	58	0.79
Greece	59	0.67
Egypt	60	0.56

WHY DIGITAL TRUST MATTERS

The internet is the custodian of interactions and transactions of nearly one half of humanity today, having doubled its reach in under a decade. Digital platforms are increasingly permeating the essential functions of society. Businesses and governments are either leading the way or are being led by their stakeholders and consumers towards digitalization. As these technologies continue to evolve faster than our human and organizational capacities, our willingness and ability to trust these digital innovations and act on the basis of said trust to fully comprehend and get comfortable with them is a crucial ingredient for the continued onward march of digitalization writ large. Trust is truly the keystone of the global digital economy.

Currently, there is no comprehensive measurement of the systems that affect digital trust. There are certainly studies and reports aimed at explaining key elements to trust. The Edelman Trust Barometer measures trust levels across countries in various industries and institutions. Transparency International's Corruption Perceptions Index quantifies how citizens view their public sector. There are several well-known cybersecurity indices, which offer different views on how to measure security online. More to the point, there are no models or measures of digital trust that offer a meaningful comparison across more than a handful of countries.

In our 2014 study, we included some measures of trust into the DEI. With the growing importance of trust to the digital economy and its impact on digital behavior, we decided to highlight and expand those elements of the DEI that speak to the issue of trust and create a separate, explicit framework which moves toward answering the questions, "What is digital trust?" and "How does digital trust relate to momentum and digital competitiveness?"

Just as important as answering the above-mentioned questions is explaining why trust matters. Through analyzing our framework for Digital Trust in the context of the DEI, we begin to see why and how trust matters.

THE STATE OF DIGITAL TRUST

"At present, we know much better what trust does than what trust is."

Sandro Castaldo

DIGITAL PLANET 2017

UNDERSTANDING TRUST AND ITS MANY DIMENSIONS

What is trust? Is it the "currency of the new economy"?[15] The "glue that holds people together"?[16] Or simply the "lubricant" of social and economic systems?[17]

In the context of the digital economy, trust is all these things and more: It's the leap of faith when users choose to transact, interact, and consume online. Fundamentally, it determines the quality of the interaction between those who give trust and those who guarantee to uphold that trust.

To capture some of digital trust's complexity and the interplay between the givers (users) and guarantors, we studied trust along four key dimensions: Environment, Experience, Attitudes, and Behavior. These four elements comprise the major axes around which digital trust between the givers and guarantors revolve.

Central to our Digital Trust model is the notion of "friction" which we define in the context of a digital interaction or transaction as "hindrances to the seamless and lag-free completion of an online activity." There are many causes of friction—some infrastructural, such as low bandwidth and slow loading of a web page; some systemic, such as regulations that insist on, for example, two-factor authentication for an online transaction; some owing to poor design and functionality of the interface; and some absolutely necessary, such as user authentication and identity. The extent of friction present in the environment, which the guarantors of trust are responsible for, and the users' reaction to said frictions are useful proxies for trust in action.

GIVERS OF TRUST

In order to focus our analysis, we narrowed our universe of "givers" to those who interact with the digital economy as consumers. In this capacity, the givers of trust could include a range of possible consumer types: a user searching on Google or accessing email on Outlook; a member of a social network interacting with other members on Facebook; a user calling up a ride on Uber, making an online purchase using Amazon, or streaming video on Netflix. In some of these situations—especially in the case of seeking a ride on Uber, purchasing on Amazon, or streaming via Netflix—the user also makes a payment in exchange for the services. In all of these situations, the user is making a "virtual payment" in the form of transmitting data that can be monetized by the recipients. In some cases, the user has to transmit or store essential identifying information, personal or financial.

In the distinct situations in which the user interacts with the digital economy, several issues are relevant. Am I getting the information I need in a relevant and timely manner? Am I being connected to the right counterparty? Is my essential information secure? How long does it take,

or how complex is the process for completing the transaction? The phrase "buyer beware" has been around since at least the Middle Ages,[18] when *"caveat emptor"* was coined.[19] Any concerns a user might have are amplified in situations that involve asymmetries of information. Asymmetric information has always been inherent in any transaction: often, the seller has better information about the quality of goods or services than the purchaser, causing a degree of uncertainty for the purchaser; conversely, the purchaser has information about her preferences, identity, and financial data. While information asymmetry can be alleviated in person, such as by personally inspecting goods, the online world is much more reliant on signals, reputational systems such as ratings and rankings, or authentication procedures. Before purchasers are willing to hand over their money, they must first trust that the sellers will fulfill their obligations. Correspondingly, the sellers must verify that the purchasers are who they say they are.

As our research illustrates, users are not only evaluating and reacting to the trustworthiness of the counterparties that offer digital products and services, but they are bringing their unique knowledge, experiences, biases, preferences, and backgrounds to each interaction.

GUARANTORS OF TRUST

On the other side of a digital relationship from a user are businesses and institutions charged with fulfilling the trust of users.

For a guarantor to be successful, first, there must be a reliable ecosystem with which the users interact. Just as few would elect to go to a hard-to-reach, unsafe, unreliable, or inconvenient neighborhood for their shopping or socialization, few want to go online unless they feel that there is some degree of ease of access, safety, and recourse.

Guarantors of trust face the challenge that even when they have met the basic environmental and experiential needs of users, givers of trust may have other biases or reasons for not engaging. The degree of friction—inadequate bandwidth; authentication procedures; recalling multiple passwords or pins; or other concerns about fraud, hacking or government snooping—in the digital system may cause users to hesitate to engage or to abandon a transaction. Further, a successful offline guarantor of trust may not be able to directly translate their success online. Banks have discovered this the hard way: the brands Egg and First Direct created distance from their owners Citigroup and HSBC (respectively), enabling the creation of new trust relationships between givers and guarantors, unique to the digital context.[20] Of course, many digital providers of products and services are ones that "disrupted" an offline provider; in many cases, the consumer may use the offline experience as a benchmark unless the digital provider takes the initiative to reinvent the notion of online trust altogether.

The trust relationship between givers and guarantors is a dynamic one. As the society gets more digitally evolved, the expectations for what trust entails go up.

Guarantors have to ensure that their digital services are offered speedily and in a convenient manner, and any confidential information is kept private and secure. At the same time, guarantors also have to continue to enhance the consumer's experience by applying the analyses of data

and artificial intelligence to learn about the consumer and deliver even more targeted, quick, and convenient digital services. Moreover, the modality of the user's interactions with what the guarantor provides also evolves, which create new trust issues.

To get a sense of the dynamic nature of the giver-guarantor relationship, consider the example of a user interacting with Amazon. As the user makes online purchases, she relies on Amazon's product inventory; logistics that ensure safe, convenient, and timely delivery; and ability to keep financial and personal data secure. With each purchase, the user's data are expected to translate into more targeted, timely, and convenient offers from Amazon. In the meantime, as Amazon expands into new modalities for interacting with the user, such as with its voice-activated Echo device, there are new trust-related issues that become relevant: Does Echo recognize the user's requests? How secure is the personal information that is being recorded, stored, and transmitted using a voice-/sound-activated device? How seamless are the interconnections between requests made on the device with the Amazon.com website?

We turn next to the question of identifying the dimensions of digital trust in order to build a model that permits comparisons across countries.

A DIGITAL TRUST FRAMEWORK

We evaluate the trust between givers and guarantors in terms of four parameters (Figure 4): the nature of the digital environment; user experience, in terms of the facets that help engender trust; user attitudes; and the actual behavior of users when they interact with the digital environment, in terms of their degree of tolerance for friction in the system.

FIGURE 4: DRIVERS OF DIGITAL TRUST

Digital Environment

What are the mechanisms to build trust in the digital environment, and how robust are these mechanisms?

Through evaluating privacy, security, and accountability measures, we estimated the maturity and extent of trust-building features of the digital environment as provided by the guarantors.

Privacy is one of the foremost areas of concern for users. Concerns around privacy have been amplified by many converging factors: the Edward Snowden revelations in 2014 about US government initiatives to tap into digital networks; hacks of sensitive information; and increasing government and private sector abilities to track the digital activities, identities, and locations of users. At the heart of the ongoing debate on net neutrality in the United States are concerns around privacy practices of internet service providers.

Online privacy is not only dependent on these external factors but also on user decisions to disclose or share data online. Moreover, some users seek anonymity, in which the identity but not actions are shielded from outside view. For our trust measures, we sought to capture the legal protections that users have for their privacy, as well as the support for anonymity from institutions.

Online security is an ongoing challenge for many guarantors of trust. With growing attack surfaces available to malicious actors, and a range of tools easily obtainable, cyber-attacks and repeated use of ransomware have continued to escalate. Needless to add, data on attack incidents are a useful proxy for the extent of risks faced by users when engaging online.

Accountability is the third factor in the digital trust environment. As the risk of incidents increases, users need recourse options. These options exist in systems that take action in the aftermath of incidents that expose vulnerabilities in the security and privacy frameworks. Such recourse options could include legal frameworks that enable users to hold businesses and institutions accountable. Recourse systems can also act before, during, and after online engagements; the latter include identity management systems, which help mitigate misuse of the user's digital identity.

These three features—privacy, security, and accountability—are fundamental trust-building elements that contribute to the digital trust environment. Additionally, they are elements that businesses and institutions are able to shape in meaningful ways. That said, enhancing these features involves a tradeoff: the guarantors of trust must ensure that as users interact and transact online, the privacy, security and accountability measures do not unduly hamper users' experience by causing unwanted friction. The users' digital experience should also play a part in our overall evaluation of digital trust. We turn to this question in the next section.

Digital User Experience

How do users experience the digital trust environment?

The upholders of the trust environment (businesses and institutions) face a constant tradeoff between providing the highest level of privacy, security, and accountability and ensuring a seamless, friction-free experience. Some frictions, as detailed above, exist to guarantee safety, security, and privacy, and are therefore necessary. However, when overused, these "positive" frictions can make the user less willing to engage online. In addition, the clearly negative frictions can make users question the reliability of the service and their willingness to go through with online interactions or transactions. The ultimate goal ought to be "intelligent friction": balancing a seamless experience with proper security protections.

In this analysis, we have focused on the extent of friction present in the digital environment of a country: the speed and ease of use when interacting and transacting online, which is an aggregate of many sources of friction—regulatory, infrastructural, and identity—and interface-related. We use this aggregate as a proxy for the quality of the users' digital experience in a country.

Eventually, we shall combine the environment and experience scores to analyze how countries rank in managing the two imperatives and striking a balance.

Attitudes

How do users feel about the digital trust environment?

A different approach to measuring trust is to simply ask consumers. Most of us, in the natural course of day-to-day life, experience trust as a "gut feeling." This feeling can be about the people associated with the digital industry, those associated with science and technology, the value we place on technology as an integral part of life, or the credibility of institutions. These perceptions and beliefs can span a wide range of questions: How do users say they feel about the digital environment? Do they trust and find value in their transactions and interactions? Do they trust the leaders of major technology companies? Do they trust their governments to keep their data secure? Do they trust technology companies to use their data in an ethical manner?

It is worthwhile pointing out that these questions cover many aspects of the digital context: not just how the user feels about the technology or the transactions, but about leaders and governments as well. This richness is particularly germane to the digital context. While digital technology seems to have become firmly embedded in the lives of people around the world, it still retains its novelty. Moreover, because of the continuing waves of innovation that promise new forms of interactions between users and the digital systems, the roles of digital players, technologists, entrepreneurs, and government agencies overseeing the digital ecosystem are paramount in the average users' conception of trust.

Arguably, no other industry generates as much focus on the leaders themselves; consider the obsessions with Apple's Steve Jobs, Microsoft's Bill Gates, or Facebook's Mark Zuckerberg as cases in point. Some of these leaders even become national heroes, which contributes to the trust they engender: Alibaba's Jack Ma and Infosys's Narayana Murthy are good examples. Then, there are leaders who evoke a negative reaction, or a mixed reaction at best, and they, too, contribute to the sense of user trust: Uber's Travis Kalanick comes to mind.

We compiled the most relevant and credible survey data on questions that help us to gain insight into digital trust in a way that consumers express it, in order to develop a measure of "attitudes" that convey user sentiments about digital trust. Of course, what users say and what they do are two different things. We focus on the latter in the next portion of the digital trust framework.

Behavior

How do users react to their digital experiences and environment?

One could reasonably make the case that users who are engaging online, particularly those who make transactions online, can be seen as demonstrating a higher level of trust behavior than those who do not. Moreover, such engagement behavior does not correlate with attitudes; one is not a proxy for the other. This is an important distinction.

Users may—and often do—engage online despite negative sentiments about the digital world. While the bad news about Uber has mounted during 2016-17, the company continues to remain the dominant ride-sharing platform in the world and commands close to a $70 billion valuation. Similarly, there are those who profess positive attitudes towards matters and people that have to do with technology but may have never engaged in an online transaction. As a proxy for such behavior, with an eye towards ensuring comparability across countries, we use a measure that captures how tolerant users are to a given level of friction in the digital system and persist in completing a transaction. The higher the proportion of users that complete a transaction in a country for a given level of friction, we interpret it as behavior that is more trusting through an application of the principle of "revealed preference"—that is, the users' preferences with regard to interacting with the digital system are revealed by their actual actions.[21] One could also interpret this as "digital trust-in-action".

When considered all together, these four dimensions provide a comprehensive framework for calibrating digital trust in a country. This structure allows analysis beyond narrower notions of trust that might be limited to the degree of security and privacy in the environment or user attitudes, as reflected in survey responses. Analyses of these four dimensions show that trust is a systemic phenomenon, and more holistic policy and strategic approaches are needed to understand the full range of complexities in evaluating digital trust and taking actions to improve it.

Scores and Rankings

Our analysis of digital trust was restricted to a subset of the 60 countries on which appropriate data were available on all the relevant indicators. The tables in this section list 42 countries in the order of their scores along each of the trust dimensions. A higher score represents a more positive outcome.

TABLE 3: DIGITAL TRUST ENVIRONMENT

COUNTRY	SCORE	COUNTRY	SCORE
Estonia	3.66	India	2.83
Netherlands	3.64	Australia	2.73
Switzerland	3.55	Russian Federation	2.73
Finland	3.47	Canada	2.71
Sweden	3.45	Ireland	2.70
Norway	3.43	Chile	2.66
Germany	3.30	Peru	2.56
South Korea	3.29	Bulgaria	2.39
Italy	3.23	Philippines	2.38
Hong Kong	3.21	Thailand	2.37
Japan	3.15	Colombia	2.33
Singapore	3.13	Brazil	2.32
Slovenia	3.12	Jordan	2.29
Hungary	3.02	Indonesia	2.27
Poland	3.01	Mexico	2.26
United Kingdom	2.97	Turkey	2.21
New Zealand	2.96	Saudi Arabia	2.18
United States	2.95	Vietnam	2.07
Malaysia	2.90	Egypt	1.95
Spain	2.85	Pakistan	1.87
France	2.83	China	1.73

TABLE 4: EXPERIENCE

COUNTRY	SCORE	COUNTRY	SCORE
Switzerland	3.79	Estonia	2.74
Japan	3.51	Peru	2.61
South Korea	3.49	Italy	2.53
Norway	3.34	Turkey	2.49
Finland	3.31	Hungary	2.43
Sweden	3.31	New Zealand	2.29
Australia	3.25	Saudi Arabia	2.24
United Kingdom	3.22	Mexico	1.91
Netherlands	3.15	Thailand	1.88
Spain	3.13	Brazil	1.61
Singapore	3.09	Vietnam	1.60
Slovenia	3.02	Jordan	1.58
Canada	3.01	Colombia	1.53
France	2.96	Philippines	1.53
Germany	2.94	Malaysia	1.38
Bulgaria	2.91	Chile	1.31
United States	2.89	China	1.27
Hong Kong	2.84	Egypt	1.05
Russian Federation	2.81	Indonesia	0.98
Ireland	2.80	India	0.74
Poland	2.77	Pakistan	0.40

TABLE 5: ATTITUDES

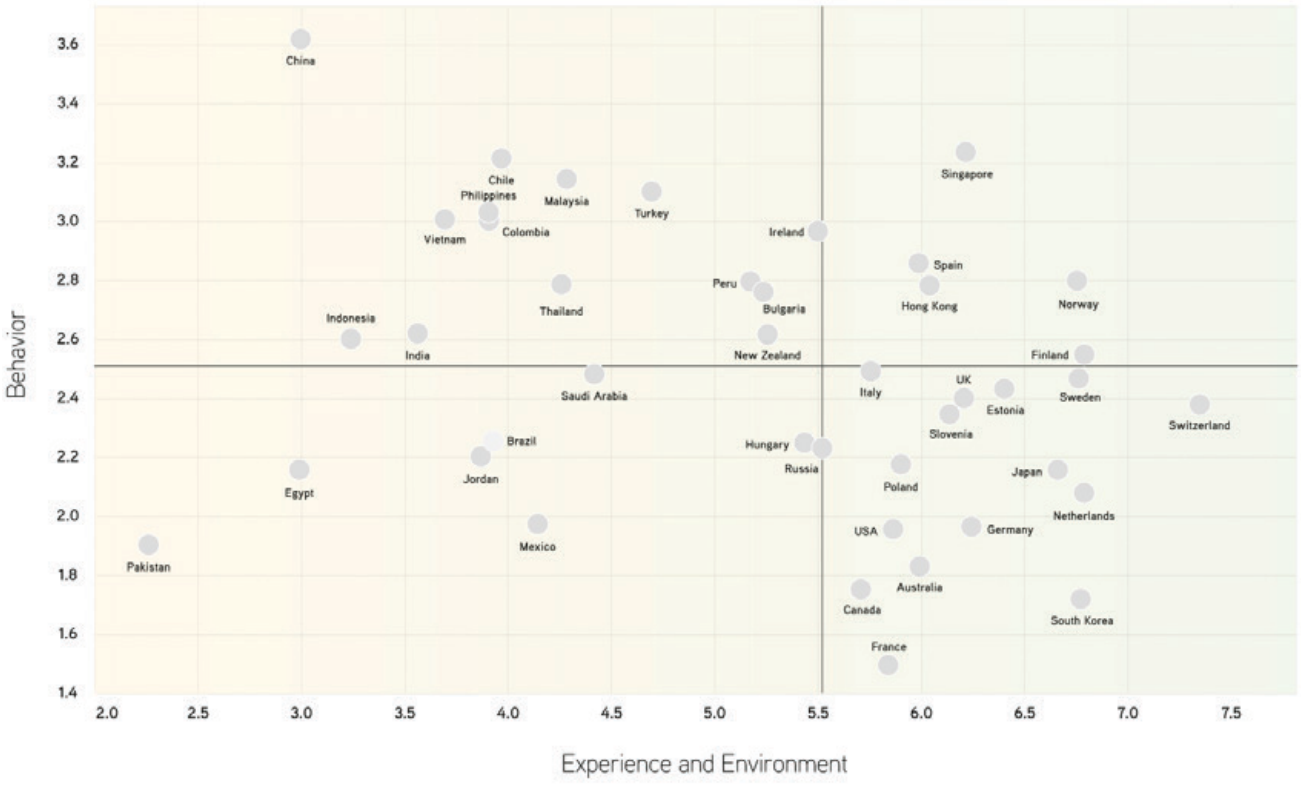
COUNTRY	SCORE	COUNTRY	SCORE
Sweden	3.34	Vietnam	2.45
China	3.04	France	2.41
Indonesia	2.91	Hungary	2.41
Australia	2.90	Norway	2.41
Netherlands	2.75	South Korea	2.40
Germany	2.73	Bulgaria	2.34
Thailand	2.73	Mexico	2.31
Egypt	2.71	United Kingdom	2.29
Canada	2.66	Ireland	2.27
Pakistan	2.66	Jordan	2.27
Switzerland	2.65	Japan	2.25
Hong Kong	2.62	Brazil	2.24
India	2.58	Saudi Arabia	2.22
Russian Federation	2.58	Spain	2.21
Estonia	2.57	Turkey	2.21
Finland	2.57	Malaysia	2.14
Poland	2.52	Chile	2.12
Italy	2.51	Slovenia	2.11
New Zealand	2.51	Philippines	2.10
Singapore	2.45	Peru	2.07
United States	2.45	Colombia	1.96

TABLE 6: BEHAVIOR

COUNTRY	SCORE	COUNTRY	SCORE
China	3.62	Italy	2.50
Singapore	3.26	Estonia	2.45
Chile	3.22	United Kingdom	2.40
Malaysia	3.14	Switzerland	2.38
Turkey	3.10	Slovenia	2.34
Philippines	3.02	Brazil	2.27
Colombia	3.01	Hungary	2.25
Vietnam	3.01	Russian Federation	2.24
Ireland	2.96	Jordan	2.20
Spain	2.87	Poland	2.18
Norway	2.80	Egypt	2.17
Hong Kong	2.79	Japan	2.16
Thailand	2.79	Netherlands	2.12
Peru	2.79	Mexico	1.98
Bulgaria	2.76	United States	1.96
New Zealand	2.66	Germany	1.93
India	2.64	Pakistan	1.89
Indonesia	2.60	Australia	1.85
Finland	2.53	Canada	1.76
Saudi Arabia	2.52	South Korea	1.73
Sweden	2.52	France	1.49

Given that each country must strike a balance between the digital experience and the environment, we created a combined score that reflected the balance and mapped them against user behavior (Figure 5). We then contrasted user behavior with stated attitudes (Figure 6).

FIGURE 5: TRUST INDEX LANDSCAPE: BEHAVIOR VS. EXPERIENCE AND ENVIRONMENT



As is evident from the chart, there are few countries that exhibit consistent and uniform strength across all dimensions. Some, such as Hong Kong, Sweden, Finland, and the UK, are moderate-to-strong on all dimensions, while Saudi Arabia, Mexico, Brazil, and Jordan are moderate-to-weak on all dimensions. China and South Korea occupy two polar extremes: while China scores poorly on experience and the environment, it comes out very strongly on the behavior dimension; for South Korea, the reverse situation holds. The former is the most tolerant of friction, while the latter is among the least tolerant.

Watch what they do, not just what they say: the attitudinal minefield.

As is evident, "trust" embraces many different elements. Ultimately, trust is based on belief: faith that someone or something will fulfill expectations. Nobel Laureate Kenneth Arrow called trust "an essential lubricant"—the special ingredient needed to move along transactions and interactions in a world that always holds some degree of risk and incompleteness of information.

Since trust is part of belief, trust researchers have leaned heavily on surveys asking respondents the degree to which they trust various people, institutions, technologies, and processes. Yet these surveys fail to fully capture the complexities of trust for a few reasons:

1. **Lack of candor**

   Consumers are often not completely honest on surveys for several reasons: they want to please the researcher, they want to reflect positive social values, or they are simply in a rush and less concerned with accuracy.

2. **Lack of specificity**

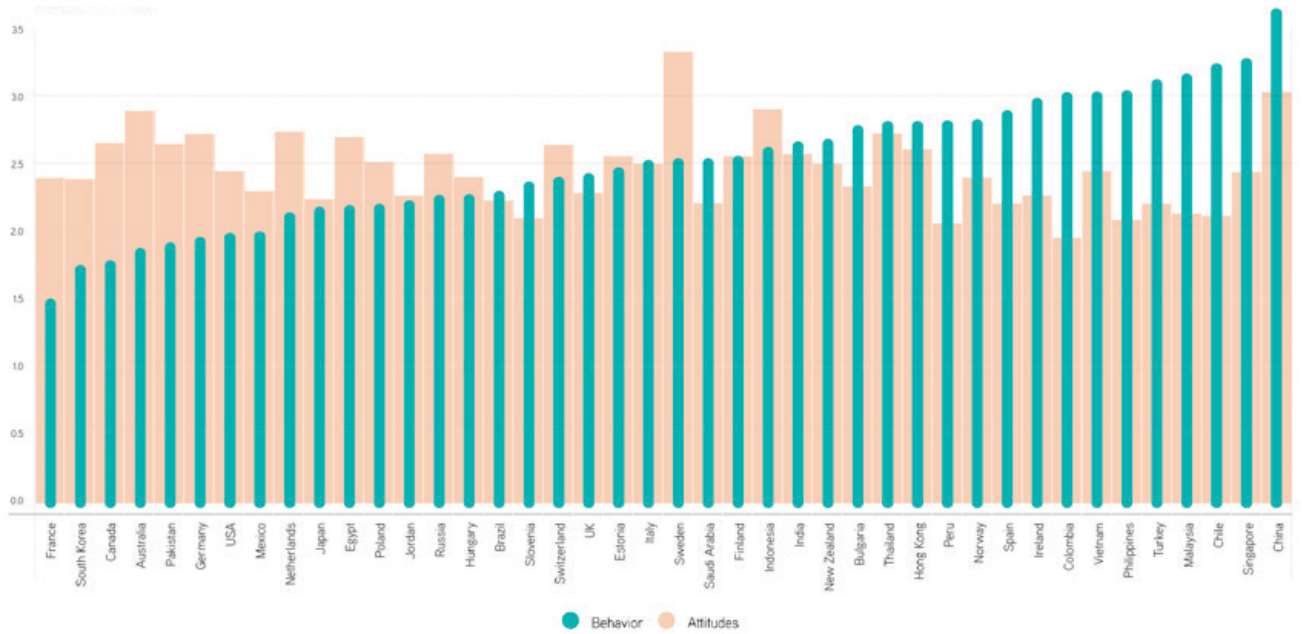
   Trust surveys fail to ask the simple follow-up question: "Trust them to do what?" When researchers ask whether consumers trust governments, companies, institutions, and individuals, they often fail to specify exactly what they should be trusting them to do.

3. **The misguided belief that more trust is always better**

   As the philosopher Onora O'Neill argues, "More trust is not an intelligent aim in this life. Intelligently-placed and intelligently-refused trust is the proper aim." Matching trust and trustworthiness in a form of an equilibrium between the giver and the guarantor of trust is a better aim than the simple goal of inquiring if there is "more" or "less" trust.

For all the above-mentioned reasons, attitudinal measures of trust based on survey data may be rightly viewed with a degree of caution and skepticism. In the digital realm, behavior is a better determinant of user trust, as it reflects how users spend two of their most valuable assets: their time and their money. In our model, we assess behavior through two proxies: data on tolerance for friction and on e-commerce engagement. The exhibit below shows the differences between how attitudinal and behavioral—or stated vs. revealed trust—scores vary across countries.

FIGURE 6: DIGITAL TRUST: ATTITUDES VS. BEHAVIOR



In light of this discussion, if we were to focus exclusively on the objective data and put aside the information on attitudes drawn from various surveys, a clearer picture of digital trust emerges, as shown in Figure 5. Here, the countries in the top right represent strong giving and guarantee of trust, while the countries in the bottom left represent weak giving and guarantee of trust. We refer to these zones as "High Trust Equilibrium" and "Low Trust Equilibrium," respectively. The remaining two quadrants involve a lack of balance between givers and guarantors of trust: the top left represent countries where givers exhibit a "Trust Surplus," while the bottom right represent countries where givers exhibit a "Trust Deficit."

TAKEAWAYS: INSIGHTS AND IMPLICATIONS FOR ACTION

This section provides some of the primary implications of DEI 2017 and the Digital Trust framework for decision-makers, innovators, investors and analysts.

USE PUBLIC POLICY AS KEY TO THE SUCCESS OF THE DIGITAL ECONOMY

"The internet is changing the way we work, socialize, create and share information, and organize the flow of people, ideas, and things around the globe. Yet the magnitude of this transformation is still underappreciated."
—James Manyika and Charles Roxburgh, McKinsey Global Institute

The DEI Chart reveals some interesting patterns. The highly evolved countries—for example, those in the EU—have had a significant contribution from strong institutions: high levels of involvement by the government and policymakers in the shaping of the digital economies. A similar pattern emerges among most of the countries that are experiencing high momentum, where the roles of government and policy are also significant. In fact, several of the countries with the highest momentum rank low on measures of "freedom"—political rights and civil liberties: that is, government plays a very strong hand in all aspects of the society and economy.

Given the dynamism of digital technologies and their applications, it is essential to recognize their potential and develop a nuanced understanding of the digital economy. Such an understanding helps shape policy priorities in more specific and strategically deliberate ways. This is important for each country's competitiveness, because the incursion of the digital economy into the traditional economy is only going to grow.

To appreciate the growing significance of digital technologies on the overall economy, consider a few of the dominant trends that are affecting economies around the world.

On the one hand, we stand at the threshold of the so-called "second machine age," whereby various forms of automation and artificial intelligence enabled by the application of digital technologies could affect 50 percent of the world economy,[22] according to projections by McKinsey. The impact of these changes would be felt by 1.2 billion workers whose jobs could be displaced, and the corresponding impact on wages could be to the tune of US$14.6 trillion.

At a more elemental level, digital technologies are among the most pervasive in human history. The number of mobile telephone connections[23] is greater than the number of people on the planet; while not everyone has a phone, more people have access to a mobile phone today than to a toilet.[24]

The sheer number of people touched by the digital megasites are staggering. Google's search bar is one of the world's most essential products; it processes more than 1.2 trillion searches a year[25] worldwide. As a platform, Facebook alone has 2 billion monthly active users,[26] two other digital platforms have a billion plus users, while yet another six platforms have more users than the population of the US.

Consider just the "app economy," itself a subset of the digital economy: it is expected to grow to five times its current size in the next five years to US$6.3 trillion, according to analytics firm App Annie. The user base for the app economy is projected to exceed 6 billion people in the next five years.[27]

These factors show in the GDP statistics. In the US alone, the internet sector was responsible for six percent of real GDP in 2014.[28] While in absolute terms this contribution seems small, consider the role of the digital economy in the growth of the economy overall. According to a widely cited 2011 McKinsey Global Institute study, the internet accounted for 21 percent of the GDP growth in mature economies over the five years prior to 2011.[29] This contribution has only grown in recent years and will continue into the future.

While there is a general appreciation for the dynamism, potential, and significance of the digital economy, its true role has yet to permeate in an explicit way in policy priorities, particularly in advanced economies—and this ought to change. On the one hand, there are countries such as China and India, both in the Break Out zone, where the digital economy has been given high priority by their policy makers. China, for example, is taking the lead in artificial intelligence (AI), which by 2030 is expected to increase global GDP by 14 percent, or US$15.7 trillion.[30] As for the manufacturing advantage that often propels China to the forefront, there is a new (digitally led) frontier emerging that will continue to drive a competitiveness wedge between US and China. While there are still only 36 robots per 10,000 manufacturing workers in China, Beijing has set a goal[31] of raising the robot-to-worker ratio to more than 100 by 2020. India, for its part, reframed a drastic policy move that demonetized 86 percent of its currency overnight. While it may not have been the original objective of the government, the move had the effect of nudging consumers and businesses towards digital payments—albeit with mixed results.[32]

In the meantime, it appears that the role of the digital economy is downplayed or not fully appreciated in the policy discourse in advanced countries. The role of the digital economy was virtually a non-factor in the 2016 US presidential elections, for example.[33] This is ironic, because aspects of the digital economy featured heavily in the election outcomes through email leaks and news about fake news spread on digital platforms.

A lack of understanding of the digital economy can have significant consequences. An interesting—and highly topical—example is the Brexit negotiations process.

The details of the separation and the form of the post-exit scenario—"hard" or "soft," with variations in between—will be critical in the negotiations to come. One issue that will be key to the negotiating leverage exerted by either side is an answer to the question: Will the EU be losing a star from its lineup? Some analysts have argued that Britain's economic performance as measured by economic growth per capita, literacy, growth in wages, and infrastructure investments is mediocre when compared to other major European nations, such as France, Germany, Italy, and Spain. To make matters worse, the British economy is showing signs of pre-traumatic stress, including low growth and rising inflation.

If one considers the digital economy alone, the EU would be losing a genuine star. This is an essential consideration, since the digital sector is one of the most dynamic and innovative elements of the economies of the UK and the EU, and of countries anywhere; in the UK alone the digital sector accounts for 16 percent of domestic output, 10 percent of employment, and 24 percent of exports.

The exhibit below summarizes how the UK compares with its most significant peers, Germany, France, Spain, and Italy along each of the four pillars on which the DEI scores rest. The next exhibit shows the same picture with the Nordics' (Denmark, Finland, Norway, and Sweden) average included. In the absence of the Nordics, the four major EU powers fare poorly, digitally speaking, in contrast to the UK.

FIGURE 7: UK, GERMANY, FRANCE, SPAIN, AND ITALY: A COMPARISON

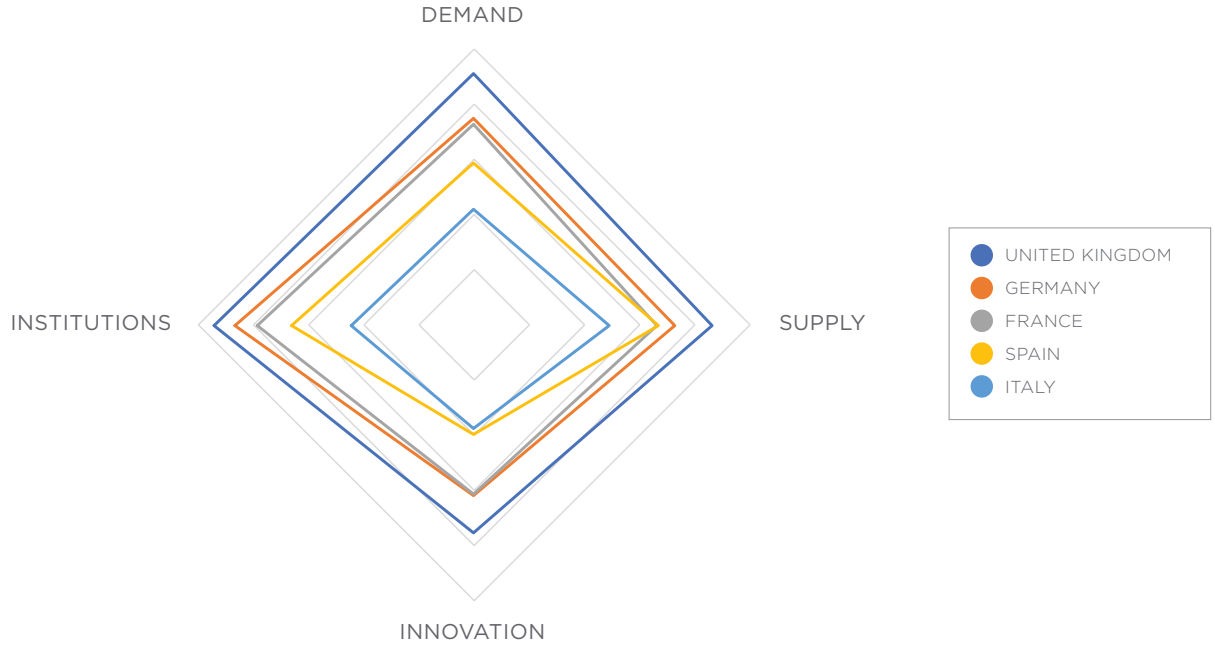
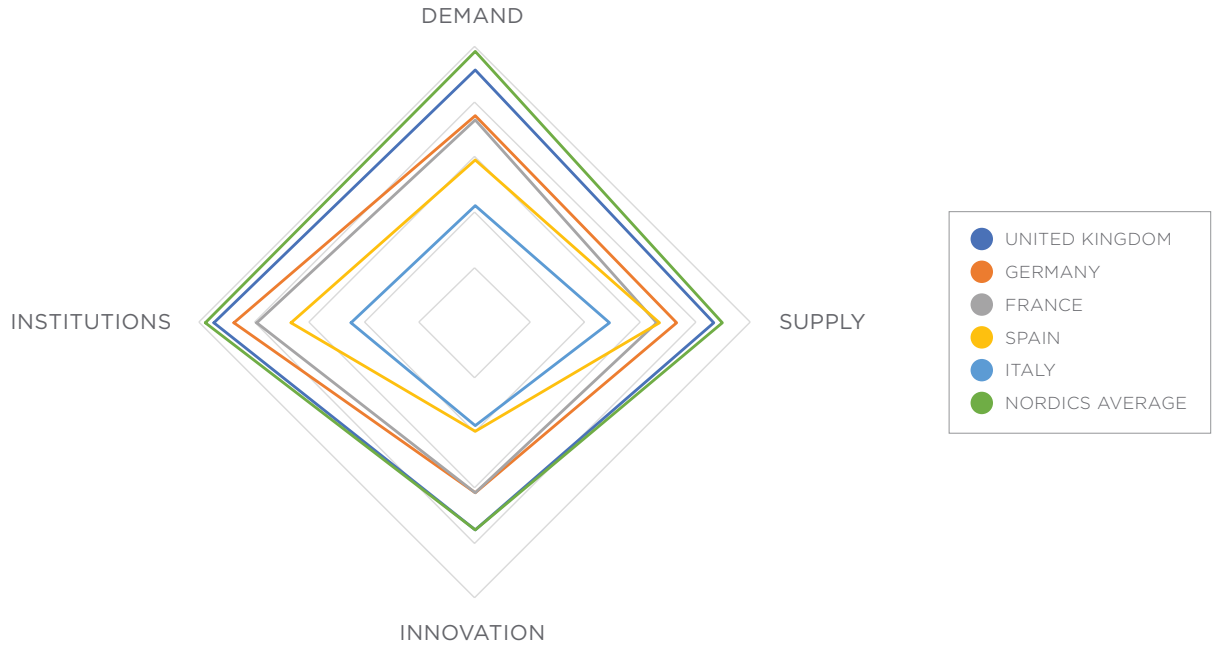


FIGURE 8: UK, GERMANY, FRANCE, SPAIN, ITALY, AND NORDICS: A COMPARISON



When one factors in how the UK's digital economy performs over time, its strengths become even more apparent. The DEI Chart shows the rate of change in the Digital Evolution Index over 2008-15 and how the UK performs in comparison to Germany, France, Spain, Italy, and the Nordic countries. This is an indicator of the momentum of the digital economy overall and leaves little doubt that the UK is a digital powerhouse. These analyses ought to influence how the UK and the EU consider the negotiations; the DEI could provide the UK some more leverage in the discussions at a time when it needs as many bargaining chips as it can assemble.

IDENTIFY AND AMPLIFY DRIVERS OF DIGITAL MOMENTUM

"In the 1960s we had a space race. Today it is a robot race."
—Danish Technological Institute[34]

In the digital economy, it is even more important to understand where the world is going than where it stands today. As we write this report, some technologies would have been made obsolete, some are reborn, and some new ones are probably being developed in the most far-flung places around the world. Regardless of whether we are looking at the digitally advanced or those countries that are still working on their digital inclusion challenges, momentum is a key differentiator and a determinant of competitiveness. There are, without question, strong benefits to being a Break Out country, as it provides strong incentives for innovators and investors to explore opportunities to reap the gains from the upside potential. There are, potentially, even greater benefits to being a Stand Out country, as it has a combination of upside potential and the strong, highly evolved digital foundation that can offer network effects, scale, and a mature ecosystem along with lower risk.

For digitally advanced countries, the momentum divide delineates growth and stagnation. In the top half of the DEI Chart, we see the Stand Outs and Stall Outs. Whereas both groups are comprised of countries that score highly on digital evolution and have comparable scores on supply conditions and institutional environment, the Stand Outs have special characteristics that keep them growing at faster rates: our research shows that their innovation capacities help set them apart. Innovation creates new demand in these countries, with supply elements that help devise solutions to meet the demand, giving them the forward momentum.

For emerging markets in the Watch Out and Break Out zones, given their low levels of digital evolution, momentum can be spurred in a variety of ways and by working across any or all of the four drivers. Investing in supply infrastructure would help enhance momentum, as would improving institutional quality which, in turn, is a signal for investors to make investments into building supply infrastructure and innovation ecosystems; while such moves have significant and sustainable payoffs in the medium to long term, these changes are tougher to implement. In the near term, an efficient and cost-effective way for these countries to enhance momentum is by leveraging the existing mobile infrastructure to bring more of their citizens online. Given that these countries have a persistent digital inclusion problem, bridging this gap could help spur momentum.

ORGANIZE DIGITAL ENTREPÔTS AS LINCHPINS OF THE DIGITAL PLANET

"That technology has cancelled geography contains just enough merit to be called a plausible fallacy..."
—Robert D. Kaplan, The Revenge of Geography

The twin forces of digitalization and globalization, aided by the seamless flows of information and ideas across borders, have forged a world that is more interconnected than ever—digital platforms such as eBay, Amazon, Alibaba, Facebook, and Tencent are enabling small businesses and individuals to participate in globalization. Most internet businesses are born location-independent and by extension are global from the start. These forces are also reshaping value chains and creating new hubs of economic activity. To take advantage of the opportunities created by digital globalization,[35] and to cater to demand both at home and beyond borders, countries need to cultivate enabling institutions and policy environments, invest in supply infrastructure for the future, and foster innovation.

Countries that stand out in DEI 2017 fall into two broad groups: a) Traditional entrepôts—that is, international trade and communication nodes in the previous era of globalization with embedded geographic advantages such as Singapore, UAE, and Hong Kong—that are reinventing themselves into digital economy hubs; b) E-entrepôts—that is, four of the Digital 5[36] nations: UK, Estonia, New Zealand, and Israel—joined in a collaboration to foster advanced digital societies that adhere to open markets, open standards, and open government as well as to the highest standards of digital connectivity.

"Digital entrepôts" are among the best positioned to compete by establishing a self-reinforcing ecosystem with the attendant network effects, fostering smart societies of the future, attracting global investments and talent, creating a demonstration effect for the rest of the world as to what the future might look like, and exporting their digital innovations around the world.

These emerging linchpins are embracing digitalization to upend traditional sources of competitive advantage and create new ones. Consider some examples. As noted earlier, the UK's digital strengths ought to give it leverage in negotiations with the EU and the rest of the world. Also, as noted earlier, Estonia innovated its way out of its talent pool constraints through its e-Residency initiative[37] and New Zealand is attracting tech talent by showcasing its physical distance from the rest of the world[38] and its superior and forward-looking institutions as a plus. Singapore is pursuing a variety of developments to make the city-state a "smart nation," a center for internet of things technology and a destination for start-ups. It is leading the world in placing digital technology at the core of key industries, such as financial services and healthcare. The UAE is using numerous free-

trade zones, next-generation infrastructure, tax breaks, low import duties, and a strategic location to become an early adopter of a range of futuristic technologies, from self-driving cars to robot policemen. Yet another example of a resurgent entrepôt is the case of Tel Aviv-Jaffa, the city driving Israel's digital momentum. A hub for trade spanning at least three millennia, the city has been hailed by the Executive Chairman of Alphabet, Eric Schmidt, as second only to Silicon Valley in its start-up and technology initiatives.[39] Producing globally renowned companies from Waze to Wix, the small nation of Israel punches way above its weight in the technology startup realm.

REINVENT THE DIGITAL STALWARTS THROUGH RE-FOCUSING ON INNOVATION

"Success breeds complacency."
—Andy Grove, former CEO of Intel

The highest scoring countries in DEI 2017—Norway, Sweden, Switzerland, Finland, and Denmark—have an essential paradox in common: their past success in digitalization is not translating into momentum. While their governments were early investors in digitalization and in the creation of institutions and infrastructure necessary to build up their digital economies—a truly remarkable achievement, given how competitive the space is—they suffer today from a combination of demand saturation, clogged innovation engines, and institutional inertia.

Much of Western Europe is comprised of countries that were digital stalwarts but find themselves in the Stall Out zone today. As we articulated in our October 2015 Harvard Business Review article, "Europe's Other Crisis: A Digital Recession,"[40] these countries would do well to make focused investments in innovation capacities and make themselves attractive to global talent again. Overall, EU investment levels in R&D are lower than R&D levels in the US and Japan.[41] While the EU struggles with its level of overall investment, it does, however, have a strong record of public-private partnerships.[42] Such partnerships are powerful levers, as they can help spur momentum. While at it, the EU would do well to borrow best practices from the smaller and more nimble emerging linchpins of digital globalization noted earlier, such as New Zealand and Singapore, and even from the UK, a country that is in the process of exiting the EU.

Creating the right climate for innovation is key to breaking out of the Stall Out zone. This involves many factors: empowering the private sector; retooling existing talent and attracting new talent; enabling a favorable entrepreneurial and investment environment; creating conditions, culture, and incentives for greater risk-taking: these are all crucial to regaining momentum.

The good news as far as Stall Out countries are concerned is that they have advanced economies, good governance, and strong geopolitical ties, enabling them to use collaboration within countries and across to spur innovation. Such collaboration, whether through technology parks, university-private sector relationships, or incubators, has been shown to enable growth and create competitive market leaders in a range of fields.[43] These innovation hubs thrive because of collaboration among participants that constitute a supportive ecosystem, reinforced further by advances in digital technologies.

As businesses, industry sectors, and countries look at their innovation strengths and gaps, they would do well to explore opportunities for using innovation hubs that can pivot towards new growth

opportunities as technology and demand patterns change. The post-Nokia transition in Finland is a case in point: the Finnish government created incentives to reinvest in its human capital through a combination of grants for start-ups, new job training, and enabling former employees to use Nokia's unwanted intellectual property free of charge.[44] Now, in 2017, we see Nokia back on the smartphone scene with the Finnish HMD in charge. A start-up sans the steep learning curve, the less-than-one-year-old Finnish company is bringing a reinvented favorite back on the scene and bringing the smartphone design and manufacturing home. Nokia's R&D teams sit in Oulu, Finland, a city famous for leveraging local talent, universities, and businesses to transform itself into a hub for connected health initiatives.[45] Rather than simply propping up a business that was no longer competitive, the government and Nokia collaborated to provide options and opportunities for workers that were made redundant.

Europe's innovation renaissance may lie in the Industrial Internet of Things and smart manufacturing, given the high-tech manufacturing expertise in the region. This "Fourth Industrial Revolution," sometimes called Industry 4.0,[46] is an opportunity for these markets to invest in digital technologies to reinvent the traditional manufacturing sector.

Finland leads the way among the highly evolved Stall Outs in exploring ways to reinvent its way out of its growth paradox. Stall Out countries can look toward the examples of 'Finland close to home and to those of others' to pivot on their core strengths. While the prevailing political pressures and slow-growing economy might make the process of pivoting more difficult, states, institutions, and businesses must embrace opportunities to build new momentum and lay pathways for the future.

PLAY DIGITAL CATCH-UP BY CLOSING THE MOBILE INTERNET GAP

"The greatest rise of information and communications in history will not be truly revolutionary until it benefits everyone in every part of the world."
—Jim Yong Kim, 12th President of World Bank

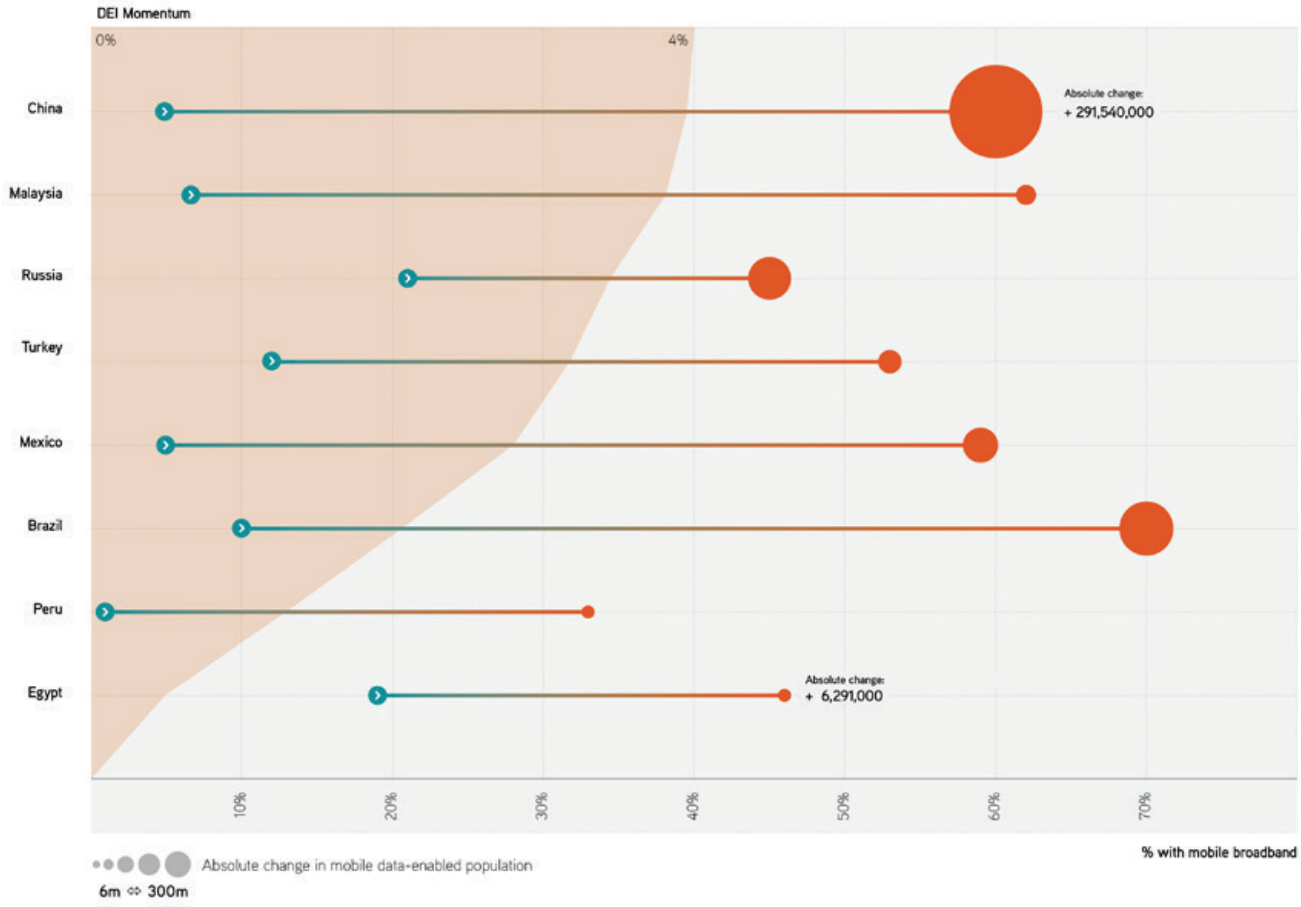
Our palms, pockets, and purses are increasingly the new homes of the internet; this is particularly true of the two billion new users since 2009[47]—whose primary window of access to the internet is the mobile phone—and is likely to be true of the next two billion users as well. In absolute numbers, the world has seen internet users double since 2010, reaching 3.7 billion people.[48] Since 2010, global e-commerce has also doubled, and commerce conducted on a mobile device has, on average, increased tenfold.[49] In the meantime, as of the time of the writing of this report, there were 8.1 billion mobile connections and 5 billion unique mobile subscribers—not all of them with access to the internet.[50]

The growth in the so-called mobile internet is a handy proxy for the potential growth of internet-enabled applications that can contribute to the digital economy. Measuring the "mobile internet gap"—the difference between the total number of users in a country with mobile subscriptions and users whose mobile phone subscriptions also provide access to the internet—puts the challenges of and opportunities from connecting the next billion into perspective. A selection of countries arrayed according to the size of their respective mobile internet gaps is shown in the exhibit on the next page (Figure 9).

The closing of the mobile internet gap has contributed to the high momentum demonstrated by countries in the Break Out zone such as Russia, Turkey, and Mexico. China leads the pack globally on this metric, thanks in no small part to a combination of economic growth, massive investments in 4G infrastructure, and a competitive mobile handset marketplace shaped by the likes of Xiaomi, Oppo, Huawei, and Vivo.[51] As such, China is pulling ahead of Western competition in mobile technologies. By outpacing the rest of the world in mobile payments, online dating, and peer-to-peer lending via mobile services, China is expected to lead in the creation and export of mobile technologies in the years to come.[52]

The mobile internet gap is the largest today in countries such as Indonesia, Nigeria, Pakistan, and India, causing their lower absolute DEI scores and relatively slower momentum compared to their Break Out peers. Unlocking the full potential of their internet economies requires investments in digital inclusion first, to bring more of the population online to spur growth across the drivers. Leveraging the accessibility and popularity of mobile devices is an efficient and effective way to bring the next billion online. This is particularly important for countries whose economies are still developing; this means they have limited resources and must focus on a few levers to effect widespread change.

FIGURE 9: DIGITAL EVOLUTION INDEX 2017: MOBILE INTERNET GAP



WORK HARDER TO EARN USERS' TRUST IN MORE DIGITALLY EVOLVED COUNTRIES

"The digital revolution needs a trust revolution."
—Marc Benioff, CEO Salesforce

Users in developing countries with relatively high momentum are not only getting online but are exhibiting some interesting behavior online. Despite high levels of friction—a less trustworthy experience and environment, including unreliable technologies, unfamiliar online terrain, and slow loading times—users are more likely to put up with these frustrations than those in digitally evolved countries.

The distinct behaviors of users in high-momentum developing countries, generally in the Break Out zone, are evident from their embrace of social media. Despite having a smaller proportion of overall users online, those who are online are "early adopters, and they are enthusiastic to try the newest digital technology adaptations."[53] In other words, these are users who are anticipating that there will be problems with the technology, the devices, or their usage, and are willing to work with them. While there are still some struggles in supply side factors, such as coverage quality, users are flocking online. In emerging markets, users who are online are more likely to be engaged on social media than online adults in developed countries.[54] These users are also more likely than their developed country counterparts to see social media as a tool to improve social bonds.[55] Using social media spurs users to buy more digital services and mobile devices, bringing them further into the digital fold.[56] Despite challenges in device access or service reliability, emerging market users are willing to handle these challenges in order to get online.

Why are users in many developing countries exhibiting a Trust Surplus—i.e., why are they much more patient online and willing to engage with new technologies?

The measures of momentum from our Digital Evolution Index hold some clues. When we paired momentum with user behavior in the Digital Trust model, we found that a fifth of internet users' willingness to engage online and tolerance for online challenges is shaped by momentum—that is, how quickly the digital environment in their countries is changing (Figure 10).

In places with high digital momentum, users on the whole are still willing to put up with slower loading speeds, technology hiccups, or other forms of friction. By contrast, users in more developed countries with higher DEI scores, who have come to expect high speeds and reliability, have much lower demonstrated tolerance to engage online in the face of any friction. These countries have

users who exhibit a Trust Deficit. Here, technology providers have to ensure that there are lower levels of friction in the user experience and environment to maintain the quality of behavior on the part of the users when compared to high momentum countries. What this means is that the privacy, security, and accountability aspects of their digital environments have to work more efficiently, with less complexity and in a way that is perceived to be more convenient and faster. Users get more demanding as their countries go up the digital evolution curve. Trust Surplus country users are likely to cut the technology provider—that is, the guarantors of trust—some slack; in Trust Deficit countries, users are likely to be more intolerant and impatient, so it is better, in the near-term, to invest the marginal dollar here. The higher momentum in a country helps "buy" some user trust.

As countries in the Break Out zone continue their digitalization momentum, businesses and governments will, in the near term, be able to take advantage of their internet users' favorable tolerance for technology glitches and challenges and their willingness to engage. Of course, in keeping with the Andy Grove observation quoted above, it is important not to get too complacent. In the medium and long term, however, technology providers would do well to continue to invest in bettering the digital trust environment and experience. These consumers will not be patient forever. Failure to cater to users' changing expectations and increasing demand sophistication might make them less tolerant of friction, like their counterparts from the developed world.

FIGURE 10: DIGITAL EVOLUTION INDEX 2017: MOMENTUM AND BEHAVIOR

METHODOLOGY

WHAT CHANGED?

Ahead of detailing the changes we made to our methodology, a quick word on what hasn't changed in DEI 2017: our core framework for measuring digitalization—that is, the four drivers: Supply Conditions, Demand Conditions, Institutional Environment, and Innovation and Change—remains intact. Like in DEI 2014, our temporal data set stretches back to 2008. Our approach of finding intelligent proxies and deriving intelligence from proxies also remains unchanged. The changes are primarily in the measures we deployed, thanks to more and better data becoming available in the years since.

After releasing DEI 2014, we revisited the innards of our framework and began reworking them to better reflect the broader trends and changes occurring in the global digital economy. Where data were either patchy or unavailable, we deployed proxies and estimations. We rebuilt the model, going back all the way from 2008 to 2015, retiring indicators that are now redundant (example: 2G coverage); adding data (that were hitherto unavailable to us); replacing some of the earlier approximations with newly available robust data; and blending in some best-approximation measures.

For DEI 2017, we also actively cultivated data partnerships with proprietary organizations such as Akamai Technologies, Blue Triangle Technologies, and Mastercard as well as with other research institutions such as the Private Capital Research Institute to gain access to better, granular data that aren't available in the public realm. In this latest 2017 iteration of the DEI, we:

- expanded the scope of the index to get a more holistic view of the digital readiness of countries along a variety of dimensions such as:
    - Digital and financial inclusion by gender
    - Education and literacy
    - Ability of countries to nurture, attract, and retain talent
    - Research and development investments
    - Use of social media
    - Technology usage by governments
    - Software piracy
- and introduced several new indicators including the extent of friction in digital commerce transactions, the extent of reliance on mobile technologies, bandwidth consumption, in innovation capacity, and more.

These enhancements to the DEI are an outcome of our extensive ongoing literature review on this topic and investigation into the many factors that influence digital readiness and facets of the economy and society that are impacted by digitalization. For example, one of the sources we reference in our study, a recent OECD report entitled "Measuring the Digital Economy: A New Perspective," outlines significant relationships between certain indicators mentioned above and digital uptake at a country level. These new dimensions, indicators, proxies, and methodological tweaks have enabled us to make the DEI 2017 more robust and comprehensive than its predecessor in describing the state and pace of digitalization around the world.

Perhaps the biggest change in this edition is our decision to explicitly unpack and study the "State of Digital Trust" around the world: specifically, how countries protect—or fail to protect—user trust through important privacy, accountability, and security measures, while also exploring how humans reveal their perceptions and demonstrate their levels of trust through behavior.

While our earlier iteration of the DEI had important measures of trust embedded, recent global events that put trust front and center and continue to reiterate its indispensability to the global digital economy shaped our decision to create a separate explicit framework to answer the questions: "What is digital trust?" and "What are the drivers of digital trust?"

The DEI model has a total of 108 indicators, up from 83 indicators in the previous edition. Our Digital Trust model has 74 indicators. A total of 12 indicators are common to both the DEI and Trust models. Of the 170 unique indicators across both models, 15% (26 indicators) are courtesy our data partners mentioned above. The rest are sourced from publicly available databases.

COUNTRY SELECTION

While we would have liked for our study to cover every country in the world, the two greatest limiting factors are data availability and data quality. Despite the constraints, we have been successful in expanding our country coverage on the DEI by 10 countries over the earlier edition—from 50 to 60. This group of 60 countries represents a wide range between developed and emerging economies and together represent nearly four-fifths of the global population. In our Digital Trust model, we covered 42 countries.

Our country selection methodology for both the DEI and the Digital Trust models was guided by three factors weighted equally: size of economy, size of population, and data availability.

The unfortunate reality is that data availability and quality are the lowest among countries where the need for digital inclusion is the highest. Many countries, especially in Africa and in parts of Asia and Latin America, suffer from significant data gaps across drivers, making comparisons difficult. The added complexity that the digital economies of "mobile first" countries are evolving differently from each other and from those of developed economies poses a great challenge for making any intelligent estimations of missing data. By contrast, we found that it is much easier to add countries with stronger economies, despite their smaller sizes of population, given their better data quality and availability. Further, estimating missing data for these countries is less onerous given an element of comparability with their peers.

METHODOLOGY, STRUCTURE, AND COMPUTATION

Digital Evolution Index

The central hypothesis of the Digital Evolution Index is that digitalization of a country, which we define as "a process where every day human interactions and transactions—with the government, businesses, and fellow humans—and consumption of goods, services, information, and ideas are primarily conducted through the use of the internet and internet-based technologies and services," is governed

by four drivers of equal importance: Supply Conditions, Demand Conditions, Institutional Environment, and Innovation and Change. Our model, therefore, accords equal weights to all four drivers.

The Digital Evolution Index uses a total of 108 indicators to measure the state and quality of digitalization in a country. It is structured at four levels: indicators, clusters, components, and drivers. Indicators are data points that answer a specific question. Clusters are a statistical grouping of indicators that are normalized, scaled, and weighted to create standardized values for the purposes of analysis and comparison; they combine and capture information from several indicators to illuminate a particular aspect that impacts digitalization as defined above. Combinations of clusters roll up to form components, which are the building blocks for the drivers. Components are built to provide a comprehensive understanding of factors that shape and define the drivers.

The table below explains the structure of the Index, with specific examples from the Supply Conditions driver and Access Infrastructure component.

The State of Digital Trust

Our State of Digital Trust model (Digital Trust) has four pillars: Attitudes, Behavior, Environment, and Experience. In contrast to the DEI, the four pillars are not simply added up for a final score but are compared and contrasted with one another to illustrate how countries vary across specific dimensions and to identify which countries are more or less balanced across these pillars.

We used a total of 74 indicators in this model. Structurally, the Digital Trust pillars, like the DEI, are composed of indicators, clusters, and components, where the indicators are normalized, scaled, and weighted to create standardized values for the purposes of analysis and comparison.

Weightings

Indicators are given weights depending on a variety of factors, such as:

- **Data quality:** Indicators that required more estimations, owing to patchy coverage across countries or years or both, were weighted lower than those with fewer estimations.
- **The strength of the data collection methods:** Since we only use secondary data, we studied the data gathering processes deployed by the sources of said data. We assigned greater weights to indicators that had more robust processes of data collection. Similarly, we assigned greater weights to observational data over survey data.
- **Centrality:** The importance of the indicator within its cluster/cluster within its component. Foundational measures, on which many other measures are dependent, were weighted more highly than those that had fewer multiplicative effects.

In both the DEI and Digital Trust, the indicators are weighted first using a robust process to minimize correlations and covariance within clusters, components, and at the driver level. After making considerations for these effects, the weightings are then determined based on rigorous social science reasoning. Where possible, we tested for interaction effects to ensure that we are capturing the correct measures and in the right ratios. Further, we subjected our weighting approach to a range of stress tests to minimize conceptual biases.

The weightings of the components and drivers are important aspects for determining the overall score. Minimizing covariance and ensuring that the weightings are representative of the real world are crucial to the accuracy of the index. Robust checks to make sure that components are not over-weighted or under-weighted is an essential part of this process. Furthermore, minimizing covariance guarantees that no component is either double-counted or over-emphasized in the model.

Computation of Scaled Data Scores

Indicators drawn from a variety of sources are scaled to a five-point scale for comparability, to arrive at a high score and a low score. Data scaling is executed by multiplying the data point of a given country by a scale factor. The scale factor is calculated by finding the ratio of the difference between the data point and the minimum value data point in the set and the overall range of the data. This ratio is then multiplied by a factor of 5. In this way, the maximum determined data point in a set will have an index value of 5, while the minimum value in the data set will have an index value of 0. The scaling formula we deployed:

Scaled Value = 5(data value-minimum)/(maximum-minimum)*

The maximum value data point in the set is determined by examining the maximum value data point in a given set excluding any extreme outliers. If there is an extreme outlier in the data set, a maximum value is set as the next highest data point value, and the outlier is given the maximum possible score of a 5.

One example of this is the data indicator that measures how long it takes to file taxes. In Brazil, the World Bank puts the time it takes to do taxes at 2,038 hours,[57] a global outlier. We set the maximum data point to be the next reasonable maximum in our data set. The minimum data point in the set is determined in the same manner as the maximum. Excluding outliers, the "minimum" point is the lowest value for a given indicator in the data set. Different data sets have very different ranges of values. In order to be able to compare and index the different pillars for each country, all data sets are scaled in the same manner. The favorableness of the scores is context dependent: that is, if the indicator in question is time taken to file taxes, a high score is undesirable, whereas if the indicator in question is international internet bandwidth per internet user, a high score is desirable.

Calculating Pillar (Trust) and Driver (DEI) Scores

To determine the pillar (Trust) and driver (DEI) scores, the component scores within each pillar or driver are calculated using a weighted average formula; clusters with lower weights have less impact on the overall mean of the pillar or driver. The component scores are then averaged together to make up the final pillar or driver score. An arithmetic weighted average of the components provides us with the most accurate score and assures that the pillar or driver mean values reflect the way that the components are weighted in the index.

CALCULATING THE FINAL INDEX SCORE AND RANKING

All four driver scores—Supply Conditions, Demand Conditions, Institutional Environment, and Innovation and Change—are averaged together using an arithmetic average and multiplied by 20 to calculate the final index score, for each given country in each given year; having a final index score out of 100 makes it easier for readers to comprehend and compare scores with ease.

The calculated final index score determines a country's overall ranking in the index. The country with the highest final index score will have a ranking of #1, while the country with the lowest final index score will be ranked at #60. Ranking the final index scores demonstrates a broader perspective on how countries are performing relative to their peers and serves as a basis for comparison, particularly at a regional level.

As stated earlier, the Digital Trust model does not include a cumulative score of the four pillars or related country ranks; such scores and ranks would be misleading and unhelpful in understanding the dimensions of Trust and their impact. Rather, countries are ranked by each of the four pillars.

CALCULATING THE MOMENTUM SCORES (DEI)

Momentum scores are generated using the compound annual growth rate formula (CAGR). This value represents the mean annual growth rate of the scores over the period of time that the index covers (in this case 2008-2015). The CAGR method, by smoothing out changes in the growth rates over the years, allows us to describe the rate at which the index score is changing for a particular country over time. We like this method because it is a well-tested and robust approach that stakeholders in business and public policy can easily understand and utilize. After calculating the rates using the formula, we scaled the CAGR percentages on a 20-point scale that ranges from -10 to 10. This means our momentum scores, like the final index scores, are relative scores. As such, they measure which countries are growing "relatively fast" or "relatively slow." A negative momentum score does not mean that a country is experiencing declining digital growth; rather, it indicates that that country is experiencing growth that is relatively slower than the other countries in the index. Our formula to calculate the scaled scores:

Scaled Momentum Score=[(20)(CAGR Value-Minimum CAGR Value in Data Set)/ (Maximum CAGR in Data Set-Minimum CAGR in Data Set)]-10

Momentum scores are only applicable only for the DEI and not for the Trust model. The Trust model does not currently include time-series data, though we do hope to achieve this in the future.

ESTIMATING MISSING DATA POINTS

Given our sole reliance on secondary data to build the DEI and Digital Trust models, we had to make estimations to compensate for missing and incomplete data. We created a logic, and a systematic process for estimating missing data points. We followed a three-step process, in order of difficulty, which enabled us to ensure that our estimates are reliable.

1. The first step in our estimation process is for missing data points that do not require mathematical estimations but can be found by simple research or common knowledge. For every indicator that is estimated in this way, we explicitly recorded the justification for the estimated value. For example, although the data set did not include the literacy rate for Finland, we established through literature review and alternate data sources that it was justifiable to estimate this data point to be 100%.
2. If the missing value of the indicator for a given country was not clear and could not be determined through literature review, we deployed mathematical estimation. For an individual data point associated with a country-indicator pair in a given year, our first step was to ascertain whether the other years associated with this country/indicator pair also needed to be estimates, or whether there were data available. If data were available for other years for said country/indicator pair, then our estimation was a simple interpolation approach.
3. For situations where the previous two methods did yield results, we needed a more rigorous mathematical estimation approach. In this case, we used Harvard economist Gary King's estimation software program Amelia 2.0, which estimates missing data by performing multiple imputations, as a general-purpose approach to missing values. The multiple imputations method has been shown to reduce bias and increase efficiency. The imputations we used are benchmarked based on country GDP per capita values, a standard operating procedure adopted by most indexes.

QUALITY ASSURANCE PROCESS

Throughout the weighting, scaling, and scoring processes, we adopted several quality assurance measures to ensure the validity and robustness of the index. By deploying different statistical tools throughout the process, including data cleaning, variance analysis, regression analysis, and simulations, we stress-tested the index scores at multiple levels to produce the most comprehensive and robust numbers possible.

Additionally, we consciously sought to include a broad number of indicators from across a variety of sources to limit the effect of any errors or biases in the data.

To test how final index scores compared to established indices in related areas, we compared the Digital Evolution Index to the Global Competitiveness Index by the World Economic Forum, the Networked Readiness Index by the World Economic Forum, and the Global Innovation Index by the World Intellectual Property Organization. Scores trended similarly, with correlations varying between r2=0.86 to r2=0.96.

Any country's scores that jumped out as outliers in the index in the QA process were rigorously checked to make sure that the data in that country are accurate and robust. This mitigates the chances of systematic errors in the process.

LIMITATIONS AND FUTURE ENDEAVORS

As with any indexing exercise, we have made a range of assumptions and simplifications in the creation of these models. While we have sought to build models that are wide ranging and comprehensive, we would like to add the caveats that their use should be guided with the understanding that models inherently simplify what they measure, they are dependent on the quality and accuracy of the data that are fed into them, and the assumptions we built into them are subject to biases and errors despite our best efforts. Despite our numerous stages of quality assurance, human error may have crept in. We invite anyone who spots an error to kindly contact us directly.

In our fifth year of studying the phenomenon of digitalization globally, our greatest limitations have been the availability and quality of data. Despite these limitations, we have made every effort to be broad and inclusive in our data capture and to evolve our methodology in a manner that is respectful of and relevant to the evolutionary phenomenon we are trying to measure.

We recognize in all humility, however, that there are many facets to and outcomes of digitalization writ large that we are yet to record and many more that the world is yet to discover. We hope to capture at least some of them, as better data become available, in our next edition.

GLOSSARY

Ability to Adopt: The extent to which people have the skills needed to engage online. A cluster under the component Consumer Capacity to Engage, under the driver Demand.

Ability to Demand: The extent to which people have the wherewithal to engage in consumption. A cluster under the component Consumer Capacity to Engage, under the driver Demand.

Access Availability: The extent to which there is telecommunications infrastructure access. A cluster under the component Access Infrastructure, under the driver Supply.

Access Infrastructure: The extent and quality of telecommunications infrastructure needed to get connected. A component under the driver Supply.

Access to Financial Institutions: The extent to which people can access traditional financial institutions. A cluster under the component Transaction Infrastructure, under the driver Supply.

Accountability: A component under the pillar of Environment. The extent to which there are opportunities for recourse when things go wrong.

Attitudes: One of the four pillars of Trust. The sentiments and judgments expressed by givers of trust (users).

Behavior: One of the four pillars of Trust. User trust online is revealed through behavior in two key ways: the willingness of users to transact online, and their tolerance for friction. Users that are more willing to transact online are more likely to purchase online. Users with a high tolerance for friction are more likely to purchase across borders, and are more likely to stay with a website during a longer check out process or a slower load speed.

Bureaucracy: The extent to which there exists government bureaucracy that may inhibit businesses and individuals from operating. A cluster under the component Institutions and the Business Environment, under the driver Institutional Environment.

Business Practices: The extent to which businesses actively engage in using innovative practices. A cluster under the component Process, under the driver Innovation and Change.

Cluster: A group of indicators answering a key question about digital evolution. Clusters form components, which form drivers.

Communications Sophistication: The extent to which people are covered by telecom infrastructure. A cluster measure under the component Access Infrastructure, under the driver Supply.

Component: Groups of clusters answering a key question about digital evolution. Clusters form drivers.

Connection Uptake: The extent to which people and households are connected to the internet. A cluster measure under the component Digital Uptake, under the driver Demand.

Consumer Capacity to Engage: The extent to which people have the means, skills, and willingness to engage online. A component under the Demand driver, which encompasses Ability to Demand, "Willingness" to Spend, Ability to Adopt, and the Gender Digital Divide.

Demand: Answers the question of whether consumers are willing to and able to transact in the digital environment. One of the four main drivers of digital evolution.

Depth of Mobile Engagement: The extent to which people are using mobile technology in new ways. A cluster under the component Output, under the driver Innovation and Change.

Digitization: The process of converting a good or a product (example: money, music, photographs) from its physical form to digital form.

Digitalization: A process where everyday human interactions and transactions—with the government, businesses, and fellow humans—and consumption of goods, services, information, and ideas are primarily conducted through the use of the internet and internet-based technologies and services.

Digital Consumption: How much digital content are people consuming when online? Digital consumption encompasses non-tangible goods and services consumed online, such as web browsing. A cluster under the component Digital Uptake, under the driver Demand.

Digital Footprint of Businesses: The extent to which businesses use internet-enabled technologies, particularly in business-to-consumer and business-to-business transactions. A cluster under the component Transaction Infrastructure, under the driver Supply.

Digital Payment Uptake: The extent to which people have access to, and use, digital payment technologies, such as cards, or payments via mobile phone. A component under the driver Demand.

Digital Uptake: The extent to which people have and are using new technologies. A component under the driver Demand.

Driver: A main factor in digital evolution. In the Digital Evolution Index, there are four drivers: Supply, Demand, Institutional Environment, and Innovation and Change. Together, these encompass the main factors behind and resulting from digital evolution

Effectiveness of Institutions: How effective institutions are at delivering services, and maintaining security, and upholding the rule of law. A cluster under the component Institutional Effectiveness and Trust, under the driver Institutional Environment.

Electronic Payment: The extent to which electronic payments are accepted. A cluster under the component Transaction Infrastructure, under the driver Supply.

Environment: One of the four pillars of Trust. The security, privacy, and accountability measures fostered by the guarantors of trust (institutions and businesses). The digital trust environment is the context in which trust interactions occur. Like Experience, it is shaped by institutions and businesses, which act as the guarantors of trust.

Experience: Together with the Environment, it is one of the four pillars of Trust. The reliability and speed of user encounters and transactions.

Financial Inclusion: The extent to which people have access to, and are actively part of, formal financial institutions. A cluster under the component Digital Payment Uptake, under the driver Demand.

Financing: The extent to which money is available for new ventures, particularly those which focus on technology. A cluster under the component Input, under the driver Innovation and Change.

Friction: Anything that hinders the seamless completion of transactions or interactions online. This can range slow loading speeds, unnecessary pages, or password re-entry. Online experience will never be frictionless, and some forms of friction are necessary for security: it's all about finding the right balance.

Fulfillment Infrastructure: The extent to which consumers and businesses can reliably and affordably order and deliver goods. A component under the driver Supply.

Gender Digital Divide: The gap between men and women's internet usage. Historically, men are more likely to get online than women. Particularly in emerging economies, women are less likely to go online and less likely to engage extensively online. A cluster under the component Consumer Capacity to Engage, under the driver Demand.

Government Digital Uptake: The extent to which governments use technology. A cluster under Institutions and the Digital Ecosystem, under the driver Institutional Environment.

Government Facilitation of ICT: The extent to which governments prioritize technology and telecommunications, and implement policy around it. A cluster under Institutions and the Digital Ecosystem, under the driver Institutional Environment.

Government Facilitation of Trust: The extent to which governments are reducing corruption and crime. A cluster under Institutional Effectiveness and Trust, under the driver Institutional Environment.

Incidents: The extent to which digital security incidents occur. A cluster under the component Security, under the pillar Environment (in Digital Trust).

Indicator: The base level of measure in the Digital Evolution Index. Measures a specific aspect related to the digital world, examples including the percentage of people in a country with a smartphone, or R&D investment as a percentage of GDP. Groups of indicators form clusters.

Infrastructure Innovation: The extent to which countries are updating and developing their infrastructure. Update lags means that legacy systems may open vectors for attack. A cluster under the component Security, under the pillar Environment (in Digital Trust).

Innovation and Change: Answers the question of to what extent new ideas and ventures are being created and adopted in digital commerce. One of the four main drivers of digital evolution.

Innovation Reach: The extent to which innovative technologies are being developed and are reaching a wide range of people. A cluster under the component Output, under the driver Innovation and Change.

Inputs: Inputs encompass elements needed to drive innovation and change, such as creating the right talent pool, having sufficient investment, and the creation of new ventures. A component under the driver Innovation and Change.

Institutional Credibility: The extent to which institutions seen as credible. A cluster under the component Accountability, under the pillar Environment (in Digital Trust).

Institutional Effectiveness and Trust: The extent to which institutions create an environment which enables trust. A component under the driver Institutional Environment (in the DEI).

Institutional Environment: Answers the question as to whether government policies and regulations are facilitating the creation of digital ecosystems. One of the four main drivers of digital evolution.

Institutions and The Business Environment: The extent to which institutions enable business through appropriate legal protections, as well as minimizing unnecessary bureaucracy. A component under the driver Institutional Environment.

Institutions and The Digital Ecosystem: The extent to which institutions enable the use of, and themselves use, digital technologies. A component under the driver Institutional Environment.

Legal Environment for Businesses: The extent to which institutions enable business through the rule of law and appropriate legal protections. A cluster under the component Institutions and the Business Environment, under the driver Institutional Environment.

Legal Protections: The extent to which there are there legal protections for consumers in the event of a digital security incident. A cluster under the component Privacy, under the pillar Environment (in Digital Trust).

Mobile Broadband Internet Subscriptions: Also referred to as Mobile Internet Subscriptions. Refers to active mobile cellular subscriptions with an advertised data speed of 256 kbit/s or greater that allow access to the greater internet via HTTP and have been used to make a data connection using Internet Protocol (IP) in the previous three months. Standard SMS and MMS messaging do not count as active internet data connections, even if they are delivered via IP. This includes mobile subscriptions that use mobile-broadband services on a pay-per-use basis. (ITU indicator i911mb_ active).

Mobile Cellular Subscriptions: We use ITU's measure of mobile cellular subscriptions, defined as the number of mobile cellular subscriptions per 100 population (ITU indicator I271).

Mobile Connection Uptake: The extent to which people connect via mobile internet, in particular through mobile broadband technologies such as 3G and 4G. A cluster under the component Digital Uptake, under the driver Demand.

Mobile Internet Gap: The mobile internet gap is the difference between the number of mobile broadband internet subscriptions and the number of mobile cellular subscriptions. In the most developed digital economies, those who have a mobile cellular plan have a mobile broadband data plan to go with it. In such a case, there is no gap. But even in some developed economies and emerging economies, not every mobile cellular subscription may have a corresponding mobile broadband subscription. For example, one may have a smartphone but because of cost or preference might not have mobile broadband data access on that phone. Similarly, one may have access to mobile internet data but be unable to get a device that can use it. Any number of reasons can exist for this gap: however, there is a marked difference in how this gap is closing across emerging economies.

Momentum: The rate at which a country's digital environment is changing over time. The DEI uses a compound annual growth metric based on an averaged base year of 2008/2009.

Output: The extent to which new ideas, products, and systems are created and used by users, businesses, and institutions. A component under the driver Innovation and Change.

Pillar: A main factor in Digital Trust. The Trust model is composed of four pillars: Attitudes, Behavior, Experience, and Environment.

Privacy: The extent to which there are protections for user privacy and anonymity. Privacy is the ability to control how much any other person or entity can see your actions or statements, whether or not those actions or statements are connected to a user's identity. Anonymity is the protection of individual identity, although actions may still be visible to others. Privacy is a component under Environment.

Process: The extent to which there are systems in place which can facilitate the development of innovative ideas and practices. A component under the driver Innovation and Change.

Research and Development: The extent to which governments, businesses, and universities engage in research and development. A cluster under the component Process, under the driver Innovation and Change.

Security: The extent to which users are affected by fraud or have recourse mechanisms in case something goes wrong and for which institutions and businesses are developing new mechanisms to meet emerging threats. Forms part of the pillar Environment, along with Privacy and Accountability.

Security Availability: The extent to which people can safely get online, as well as transact and interact online safely. A cluster under Access Infrastructure, under the driver Supply.

Social and Entertainment: The extent to which consumers use digital technologies to interact and for entertainment. A cluster under the component Output, under the driver Innovation and Change.

Start-up Capacity: The extent to which there are bureaucratic hurdles in creating a new start-up. A cluster under the component Input, under the driver Innovation and Change.

Supply: Answers the question of how developed digital and business infrastructure is. One of the four main drivers of digital evolution.

Support for Anonymity: The extent to which governments support anonymity online. A cluster under the component Privacy, under the pillar Environment (in Digital Trust).

Talent Availability: The extent to which the right talent pool is being developed, attracted, and retained. A cluster under the component Input, under the driver Innovation and Change.

Technological Reliance: The extent to which technologies are reliable for users. Trust is built on users believing that they will reliably be able to use their technology. A cluster under the component Accountability, under the pillar Environment (in Digital Trust).

Technology Uptake: The extent to which people or households have digital devices, including laptops, desktop PCs, tablets, mobile phones, and/or smartphones. Given the difference between device prevalence (the possession of devices overall) and device density (people owning multiple devices or multiple types of devices), the Digital Evolution Index 2017 was designed to capture both. A cluster under the component Digital Uptake, under the driver Demand.

Telecom Competition: The extent to which institutions facilitate telecom competition, such as competitive telecom pricing. A cluster under Institutions and the Digital Ecosystem, under the driver Institutional Environment.

Traditional Transport: The quality of air transport, port, rail, and road infrastructure operations and logistic performance. A cluster under the component Fulfillment Infrastructure, under the driver Supply.

Transaction Infrastructure: The extent and quality of financial transaction means within a country. A component under Supply.

Transparency: The extent to which governments and institutions allow people and companies to express themselves freely and provide enough visibility of internal operations to limit corruption. A cluster under the component Institutional Effectiveness and Trust, under the driver Institutional Environment (in the DEI).

Transport Bottlenecks: The extent to which traffic hinders the smooth and efficient transfer of goods and services. A component under Fulfillment Infrastructure, under the driver Supply.

Use of Digital Money: The extent to which people use electronic payments, including card payments, mobile wallets, and mobile payments to make transactions. A cluster under component Digital Payment Uptake, under the driver of Demand.

Verification and Utilization of ID: The extent to which electronic ID exists and is used. A cluster under the component Accountability, under the pillar Environment (in Digital Trust).

"Willingness" to Spend: The extent to which people are actively participating in the wider retail economy, both online and offline. The willingness of people to spend money is normalized by Purchasing Power Parity (PPP), population, and size of economy (GDP). A cluster under the component Consumer Capacity to Engage, under the driver Demand.

DATA SOURCES

DEI 2017 and the Digital Trust models were built using public and proprietary data from a variety of sources, including:

- Akamai Technologies
- Blue Triangle Technologies
- CIGI-IPSOS
- Edelman
- Euromonitor
- Freedom House
- Google
- GSMA
- ILO
- ITU
- Mastercard
- Numbeo
- PCRI
- Web Index
- Wikimedia
- World Bank
- World Economic Forum
- World Values Survey

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