SECTION ONE

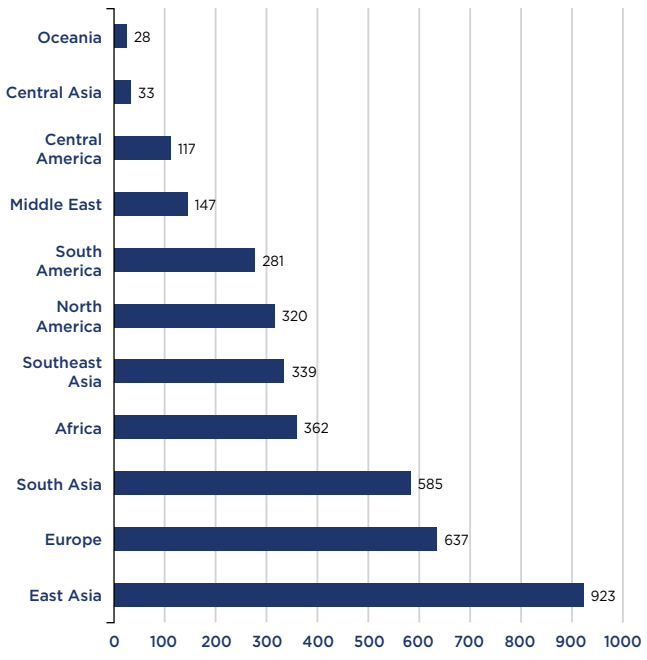
The United States, Europe and the Digital Frontier

The United States, Europe and the Digital Frontier

Ten years ago, the Apple iPhone was introduced. What was then a novelty is now one of the most ubiquitous appliances in the world. Ten years ago, less than 1.7 billion people were accessing the internet. Now 3.5 billion do.[1]

Ten years ago, Facebook had yet to go public, autonomous vehicles were a dream, and the App Economy didn't exist. Now Facebook is valued higher than IBM, autonomous vehicles are reality, and the App Economy employs over 1.6 million workers in both the United States and Europe. Ten years ago, the Rocket Internet start-up was launched in Germany. Today it has more than 36,000 employees.[3] On it goes.

TABLE 1.1: NUMBER OF WORLDWIDE INTERNET USERS, 2017 (IN MILLIONS)



Source: Statista.[2]

Every day, 7.7 billion searches are made on Google, 152 million calls are placed on Skype, 115 million videos are viewed on DailyMotion, 58 million Tweets are tweeted, 50 million users stream music from Spotify, 36 million purchases are made on Amazon, and 2.3 billion gigabytes course around the web.

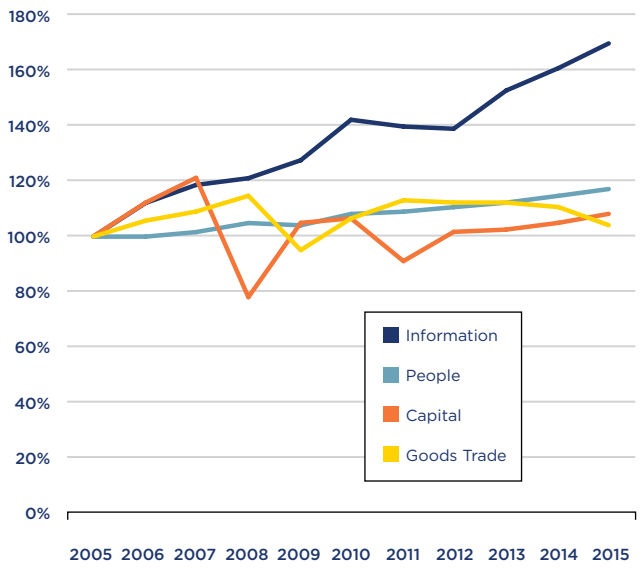
Every minute of every day, 204 million emails are sent, 2.4 million pieces of content are posted on Facebook, 72 hours of video are posted on YouTube, and 216,000 new photos are posted to Instagram.[4]

Digitization has become as important to traditional industrial firms as it is to internet start-ups. McKinsey estimates that three-quarters of the economic value of the internet is captured by manufacturing, financial services and other industries.[5] Moreover, the digital economy ranges far beyond the internet economy, e-commerce companies or the Information Communications Technology (ICT) sector. The digital economy includes these activities, but extends also to include non-internet, digital technologies, for instance software innovation and 'big data' collection and analysis. It encompasses cloud computing, mobile web services, smart grids, social media and many other activities, all of which are all radically changing the economic landscape and reshaping the nature of work.[6]

Digital information, services and products, and the ecosystems that supports them, have become the backbone of the modern global economy. They are transforming how we live, work, play, travel, interact, and do everything in between. They are changing how business is done, who is involved, and where economic benefits flow.[7]

At the heart of this transformation is data and the ability to analyze data, which today is spurring growth, innovation, productivity and competitiveness. In just the last two years,

TABLE 1.2: INTERNATIONAL INFORMATION FLOWS OUTPACING ALL OTHERS



Source: DHL Global Connectedness Index 2016.

90% of the world's digital data has been generated. Every year, the amount of digital data grows by 50%.[8] Global flows of information and communications, transactions, video, and intra-firm traffic underpin and enable virtually every other kind of cross-border flow. According to McKinsey, these global data flows now contribute more to global growth than global trade in goods.[9]

Table 1.2 makes the point. Since 2005, cross-border information flows have grown rapidly, while flows of people have grown modestly, flows of capital have been limited, and trade flows have been stagnant.

The pace of change is remarkable. Mobile data traffic has grown 4,000-fold over the past 10 years and almost 400-million-fold over the past 15 years. In 2005, mobile networks carried fewer than 10 gigabytes per month in 2000 and less than 1 petabyte per month in 2005. By 2016, global mobile data traffic had reached 7 exabytes per month (1 exabyte is equivalent to 1 billion gigabytes, and 1,000 petabytes). At the end of 2015, the mobile sector generated $3.1 trillion in economic value.[10]

Despite these incredible transformations, we're still in what Scott Cook of Intuit calls "the first minutes of the first day" of the digital revolution. Cisco projects that by 2020 monthly global mobile data traffic will grow nearly eightfold and mobile network connection speeds will increase more than threefold, there will be 1.5 mobile-connected devices per capita, 98% of mobile data traffic will originate from smart devices, and three-fourths of the world's mobile data traffic will be video.[11] In just two years, three-fourths of the world's population will be connected to a mobile network.[12] The number of jobs directly and indirectly generated by the ecosystem surrounding mobile technology alone will reach 20 million and 16 million respectively.[13]

That's just the beginning. The Internet of Things, 5G technologies, big data analytics, quantum computing, energy storage, precision agriculture, aquaponics, artificial intelligence and other innovations will further accelerate digital growth around the world.

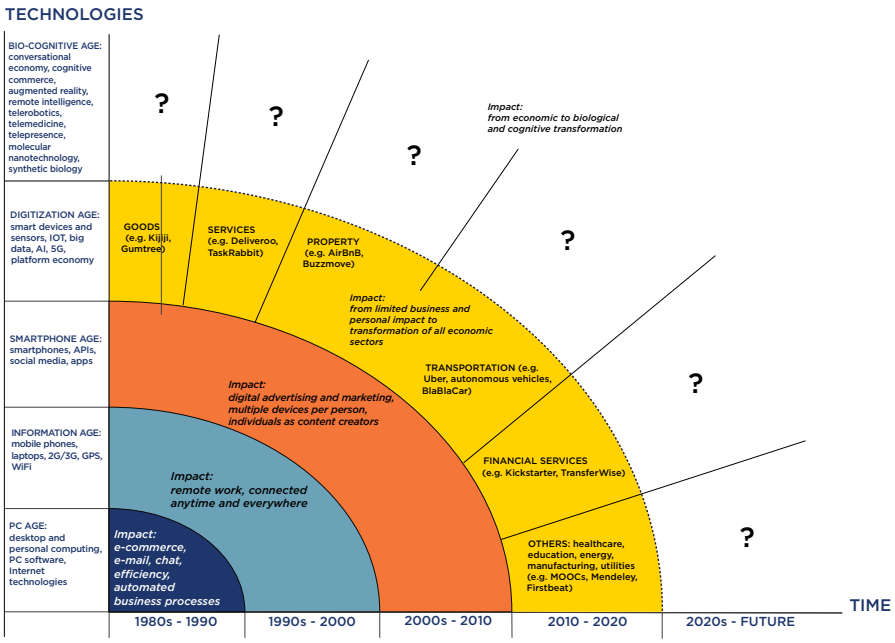
In their book *The Second Machine Age,* Erik Brynjolfsson and Andrew McAfee summarize digitization's impact. "Computers and other digital advances," they note, "are doing for mental power — the ability to use our brains to understand and shape our environments — what the steam engine and its descendents did for muscle power. They're allowing us to blow past previous limitations and taking us into new territory."[14]

Table 1.3 charts the digital frontier. We have moved into an age in which digitization is not just affecting our businesses and our personal lives, it is transforming all sectors of the economy. New enterprises are seizing digital opportunities in goods and services, property, transportation, financial services and a host of other areas ranging from healthcare and education to manufacturing and energy.

Moreover, there are many signs that our current "Digitization Age" will soon give way to a "Bio-Cognitive Age," yet another transformative period in which revolutionary advances in digitization, biology, nanotechnology, behavioral and cognitive sciences will combine to affect not only our economic and social lives, but life itself. Alec Ross states it succinctly: "The last trillion-dollar industry was built on a code of 1s and 0s. The next will be built on our own genetic code."[15] If, as Ross says, land was the raw material of the agricultural age, iron was the raw material of the industrial age, and data the raw material of the information age, then biology will be the raw material of the bio-cognitive age.

As the digital frontier continues to expand, it also continues to transform the basic dynamics of globalization. In his book *The Great Convergence*, Richard Baldwin discusses how globalization is essentially the story of falling barriers to goods, ideas, and people. Earlier waves of globalization were generated by the falling cost of moving goods. Today's globalization is largely due to the falling cost of moving

TABLE 1.3: THE EXPANDING DIGITAL FRONTIER



Sources: GMSA Intelligence; McKinsey Global Institute; Author's own estimates.[16]

ideas and information. In the coming bio-cognitive age, innovations such as holographic telepresence or telerobotics could also reduce the cost of moving people.[17] The implications will be profound.

Digital Globalization: Still Uneven

Digital globalization evokes the image of a seamless global marketplace in which unbridled data flows drive goods, services and money across national boundaries without friction. Reality is different. The digital economy may be more inclusive and closely connected, but it is not truly "flat."[18] The digital revolution is global in its reach but uneven in its effects. It has created global markets, but cannot erase local geographies. It has reduced many barriers to trade, investment, capital and ideas, but its impact has been greatest within countries, rather than between them. Most cross-border flows — including those of data — still take place within, rather than between, continents.[19]

Mainland Chinese online shoppers, for instance, buy heavily from Hong Kong and Japan, while German shoppers buy from their neighbors in Austria and the Netherlands.[20] To take another example, even though the intensity of international internet traffic and telephone calls has roughly doubled since 2005, only 22% of internet traffic actually crosses a border, and that is five times as high as telephone calls.[21] While the growth of Skype-to-Skype calls over the internet has outstripped the growth of international calls via fixed and mobile telephone networks, the international proportion of telephone call minutes (including Skype) between 2005 and 2014 only increased from about 3% to 5%. Both are far below the level one would expect in a flat world.[22]

Even in the digital world, distance can still matter.[23] So can connectivity.

The digital revolution places a premium on connectedness. In the Cold War, Tom Friedman recalls, the most frequently asked question was: "Whose side are you on?" Today, he says, the most frequently asked question is "To what extent are you connected to everyone?"[24] Parag Khanna drives home the point: "Today power derives from leverage exercised through connective reach. The paramount factor in determining the importance of a state is not its location or population but its connectedness — physically, economically, digitally — to flows of resources, capital, data, talent and other valuable assets."[25]

Digitization is certainly driving greater interactions among continents. But the breadth, depth and speed of those interactions vary considerably. Rising economies trade as intensively as advanced economies, but advanced

economies in 2015 were about four times more deeply connected into international capital flows, five times more with regard to people flows, and nine times more with respect to information and data flows.[26]

Despite the hype about the death of distance and the end of geography supposedly wrought by the digital revolution, the international movement of knowledge has in fact been very geographically concentrated — and those developing economies that have benefitted most from digitization are those who have been most deeply tied into the value chains of developed economies, particularly the United States and Europe.[27]

As we look to the expanding digital frontier, connectivity matters. And as we shall see, while digital connections are relatively "thin" between some continents and "thicker" between others, they are "thickest" between the continents of Europe and North America.[28]

Who is Connected to Whom?

According to the 2016 DHL Connectedness Index, Europe

BOX 1.1. FROM THE INTERNET OF THINGS TO THE INTERNET OF EVERYTHING

The digital economy is not just connecting billions of people to each other, it is connecting them to billons of things, and it is connecting those billions of things to each other as well — home appliances, buildings, smart meters, cars and trucks, planes and trains, oil rigs, manufacturing and farm equipment, even watches and clothing. By drawing on innovations in cloud computing, big data analysis, internet-linked radio frequency identification [RFID], and wireless sensor network technologies, together with falling costs of sensors and data storage, the IoT (Internet of Things) is ushering in a new phase of the hyper-connected society.[29]

In 2008 the number of objects connected to the internet surpassed the number of people online worldwide.[30] That same year, the U.S. National Intelligence Council identified IoT as one of the six primary "disruptive civil technologies'' that will most significantly impact national power through 2025.[31] Kevin Ashton, who is widely credited with coining the term Internet of Things, defines it like this: "The 'Internet of Things' means sensors connected to the Internet and behaving in an Internet-like way by making open, ad hoc connections, sharing data freely and allowing unexpected applications, so computers can understand the world around them and become humanity's nervous system."[32]

Today, up to 17.6 billion devices are connected to each other worldwide.[33] Global IoT spending has reached $700 billion, and is expected to total $1.3 trillion by 2019.[34] Across industries, 72% of businesses polled in 20 countries responded that they have already introduced IoT devices into the workplace for remote monitoring, indoor location-based services, and controlling building

temperatures and lighting.[35] Early IoT adaptors in both Europe and the United States have included the healthcare, automotive, and home appliances sectors. Most IoT applications are happening within rather than between countries, yet in such areas as shipping and package delivery the IoT is already having a transformative effect.[36]

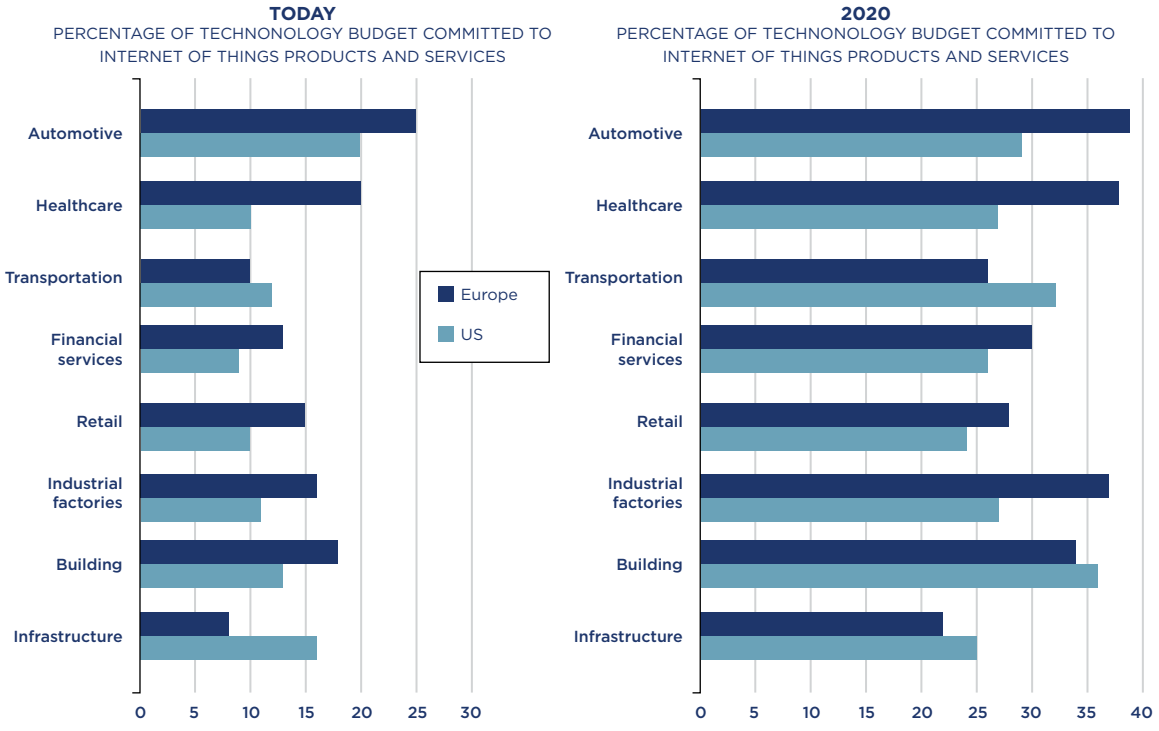
Most estimates project that there will be between 28 and 30 billion connected devices in 2020.[37] By the turn of the decade, the IoT is likely to affect nearly every industry, improving efficiencies. optimizing production processes, automating inventories, or enabling predictive maintenance and remote patient monitoring.[38]

The Boston Consulting Group estimates that companies will spend an incremental €250 billion on IoT in 2020 over and above their normal technology spending, and that IoT services and IoT analytics and applications will account for 60% of all economic growth derived from IoT by that time. They project that the value of each of these sectors will rise from $10 billion in 2015 to $60 billion in 2020.[39] Cisco projects that connected healthcare, with applications such as health monitors, medicine dispensers, first-responder connectivity, and telemedicine, will be the fastest-growing industry segment, at a 49% compound annual growth rate, and that connected car applications will have the second-fastest growth, at a 37% compound annual growth rate.[40] Boston Consulting predicts that other enabling components—identity and security, IoT backbone (cloud and platform), communications, and connected things—will also grow, but at a slower pace. McKinsey estimates that the IoT's potential economic impact on the global economy to be as much as $1.1 trillion a year by 2025.[41]

Ashton sums it up: "Since its inception in 1999, the Internet of Things has been ridiculed, criticised, and misunderstood. And yet here we are, less than two decades later, in a world where tens of thousands of organisations are saving and making hundreds of millions of dollars from the Internet of Things, using cars that drive themselves, subway stations that sense passengers, algorithms that diagnose deadly diseases using phones, and many other once apparently-impossible technologies. The future promises far more amazing things. The most important decision you can make now is how to be a part of it."[42] Cisco Chairman John Chambers goes even further, predicting that the globe is already moving beyond IoT to what he calls "the Internet of Everything: the penetration of the World Wide Web into the everyday aspects of our lives,"[43] where communications among people, devices, data and processes will be seamless and fully unified.

The IoT is a global phenomenon, but it is not unfolding evenly. Europe and the United States are leading in many areas.[44] In fact, despite media hype that the United States is leading the Internet of Things, research by Bain & Company finds that in many cases, executives in Europe are more ambitious and optimistic about their plans to deploy and integrate IoT solutions than their American peers, particularly in industrial and commercial applications. A greater percentage of European executives plan to deploy IoT solutions over the next few years than their colleagues in other regions. In a survey of 500 executives across industries in Europe and the United States, 27% of European executives said they are implementing or have already implemented IoT and analytics use cases, compared with 18% of U.S. executives. Fully one-quarter of the Europeans plan to implement IoT solutions in multiple cases and integrate them with their IT systems by 2020, compared with 16% of U.S. executives. The European automotive, retail, industrial production and building sectors are all allocating greater shares of the information technology budgets to IoT than their U.S. counterparts. Bain concludes that European firms are further along in their IoT journey from experimentation to a real commitment to integrate, scale and deploy IoT solutions.[45]

TABLE 1.4: IOT INVESTMENTS CLAIM GREATER SHARE OF IT BUDGETS IN EUROPE THAN THE U.S.



Source: Bain & Company.[46]

Enthusiasm for the Internet of Things has fueled more than $80 billion in M&A investments by major vendors and more than $30 billion from venture capital firms, with European and U.S. firms leading the way.

One study expects the number of IoT connections within the EU28 to increase to almost 6 billion by 2020, with IoT revenues totaling €1.18 trillion, including hardware, software and services, with those member states with higher accumulated information technology investments and advanced telecom networks, such as Sweden, Germany, the Netherlands and the UK to benefit most (Table 1.5).[47]

TABLE 1.5: EUROPEAN UNION IOT MARKET SIZE AND FORECAST (€ BILLIONS)

	2014	2020
UK	€ 78.68	€ 269.28
Germany	€ 71.11	€ 243.64
France	€ 55.44	€ 185.09
EU rest	€ 53.78	€ 157.15
Italy	€ 32.09	€ 97.93
Spain	€ 24.50	€ 65.57
Netherlands	€ 18.58	€ 57.92
Sweden	€ 13.46	€ 50.20
Belgium	€ 9.35	€ 28.33
Poland	€ 9.02	€ 26.49
Total	**€ 365.99**	**€ 1,181.60**

Source: IDC. [48]

Despite its rapid advance, the IoT is also facing challenges, particularly concerns about privacy protection and security risks. The swift growth of these technologies has also opened up new vulnerabilities and openings for cybersecurity threats. Aruba reports that 84% of firms it polled that had connected the IoT into their existing business networks has already experienced security breaches. National defense systems and critical infrastructures are also at risk.[49] We discuss these challenges in Section 4.

and North America are the two regions most connected to the rest of the world when it comes to cross-border flows of trade, capital, information and people. Europe leads in terms of trade and people connectedness, while North America leads in terms of information and capital connectedness. North America has the broadest international connections, while Europe has the deepest, although that reflects the intense interconnections European countries have with each other (Table 1.6).

Europe is not only the world's most globally connected region, 8 of the world's 10 most connected countries are European: the Netherlands, Ireland, Switzerland, Luxembourg, Belgium, Germany, the United Kingdom and Denmark. Of the top 10, only Singapore (2nd) and the United Arab Emirates (10th) are not European.[50] Europe and North America accounted for 21 of the top 30 most connected countries.

The Ties That Bind

Not only are Europe and North America the most connected regions in the world, they are more connected to each other than either is to any other region of the world.

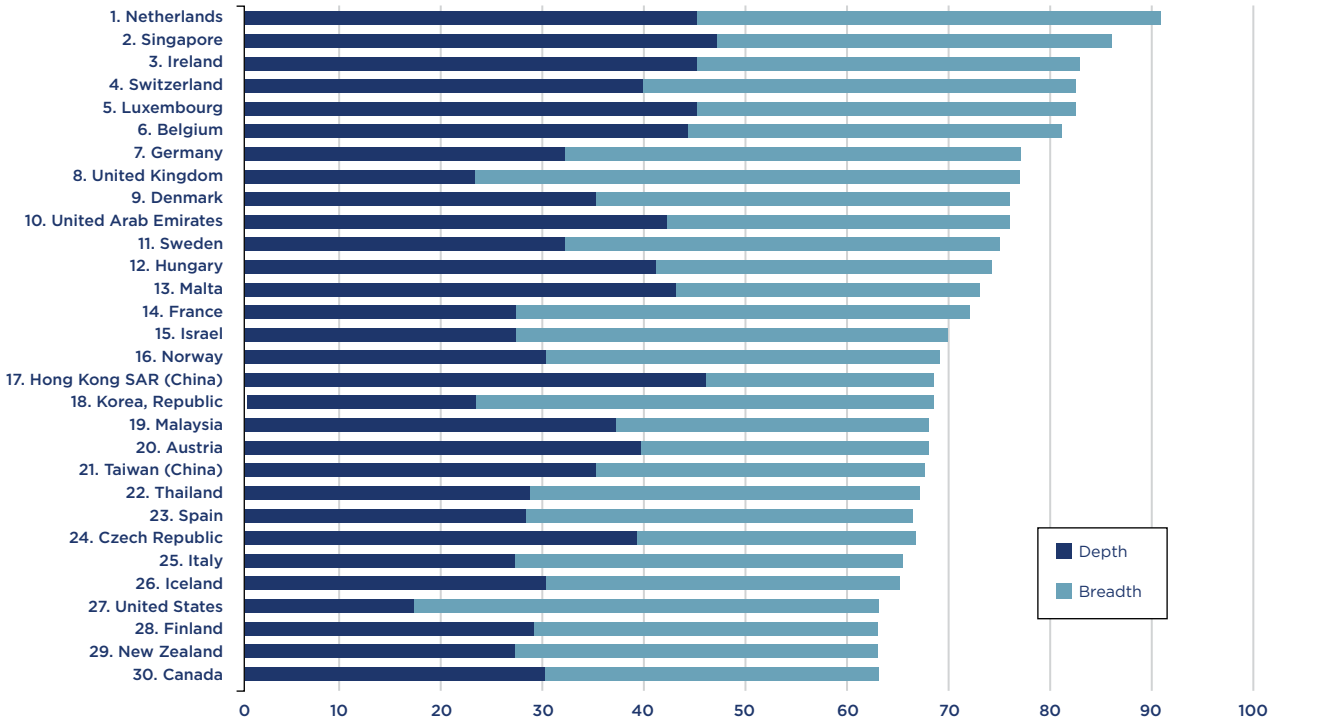
In our annual surveys of the transatlantic economy, we document the deep integrative forces binding together the two sides of the North Atlantic.[51] The U.S. and Europe remain each other's most important markets. The transatlantic economy generates $5.5 trillion in total commercial sales a year and employs up to 15 million workers in mutually "onshored" jobs on both sides of the Atlantic. Ties are particular thick in foreign direct investment (FDI), portfolio investment, banking claims, trade and affiliate sales in goods and services, mutual R&D investment, patent cooperation, technology flows, sales of knowledge-intensive services — and digital connections. No other commercial artery in the world is as integrated (Tables 1.7 and 1.8).

What is true for the transatlantic economy as a whole is true for the transatlantic digital economy. This study offers ways to understand the vital importance of the digital economy for the future health and vitality of both Europe and North America, and the extent to which each side of the Atlantic is deeply bound to the other as both explore the digital frontier.

Measuring the Transatlantic Digital Economy

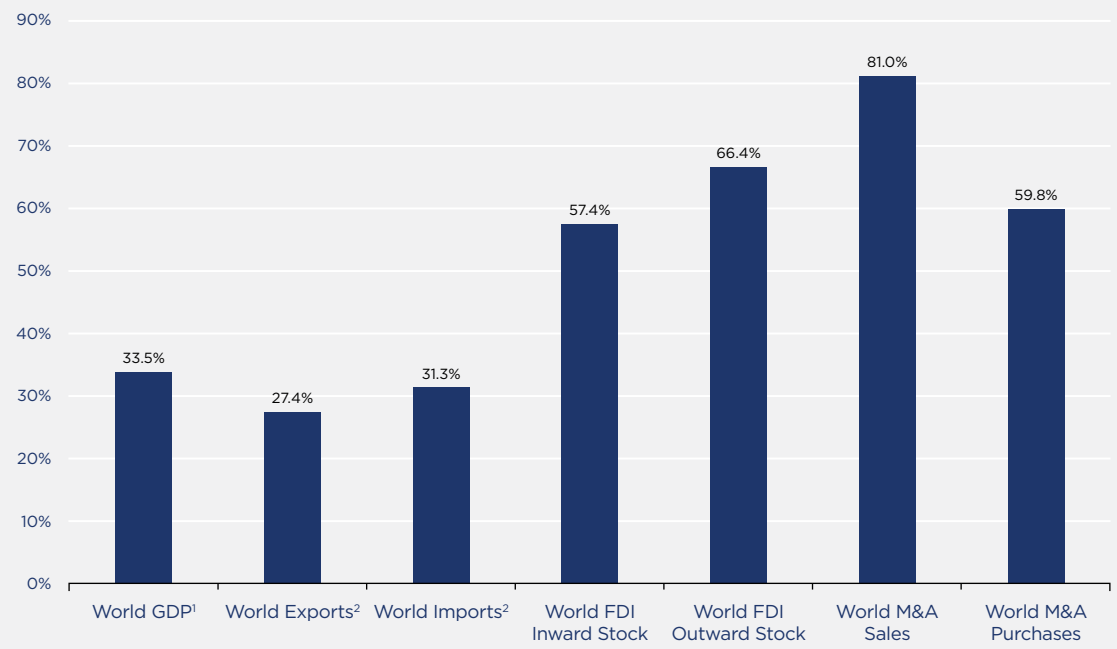
It is difficult to measure or define the digital economy. There are no consistent definitions of what comprises the digital economy or of the various types of cross-border data flows. Official metrics do not capture cross-border data

TABLE 1.6: TOP 30 MOST CONNECTED COUNTRIES



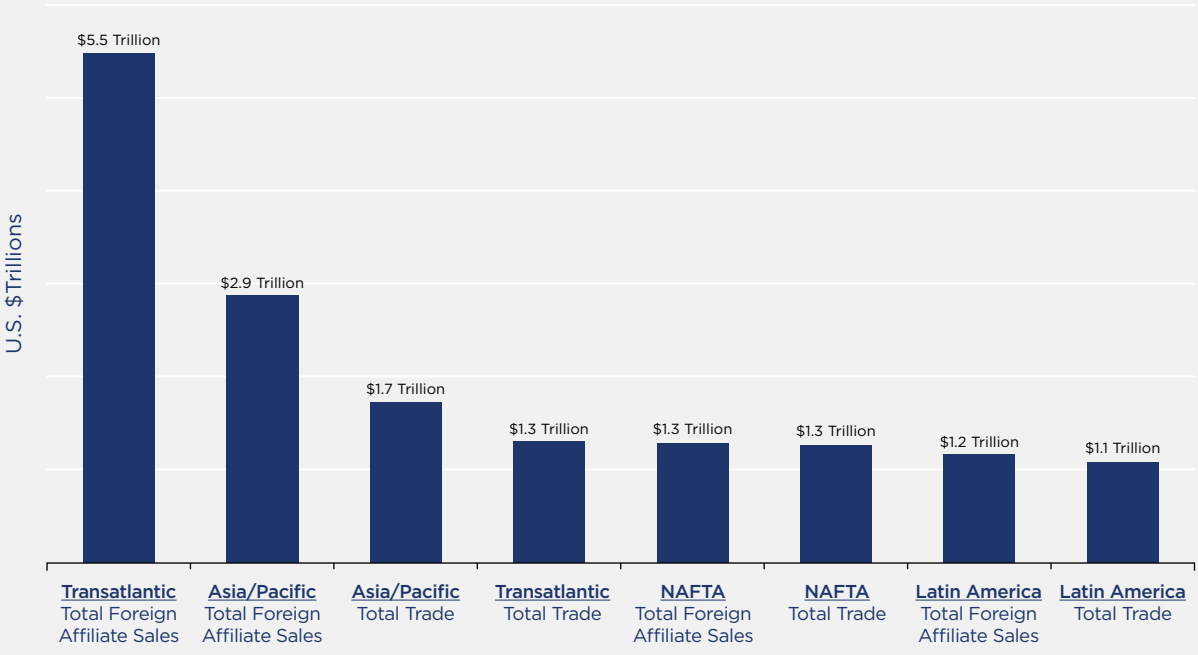
Source: DHL Global Connectedness Index 2016: The State of Globalization in an Age of Ambiguity

TABLE 1.7: THE TRANSATLANTIC ECONOMY VS. THE WORLD - SHARE OF WORLD TOTAL



Sources: UN, IMF, figures for 2015.
1. Based on PPP estimates.
2. Excluding intra-EU, Norway, Switzerland and Iceland trade.

TABLE 1.8: AMERICA'S MAJOR COMMERCIAL ARTERIES



Foreign Affiliate Sales: Estimates for 2015. Total Trade: Data for goods & services, 2015.
Source: Bureau of Economic Analysis.

flows and transactions where no money is exchanged, even though such connections, including within companies, are becoming increasingly valuable to the global economy as information moves from one country to another. Exchanges of goods and services over the internet are often untaxed, do not appear in official records, and can involve illicit activities that are difficult to measure.[52]

Many estimates equate the digital economy with the information and communications technology (ICT) sector. Yet as we will show, the ICT sector is an important yet insufficient significant measure of digitization, because, as McKinsey notes, digitization, like electricity, is a general-purpose technology that underpins a huge share of economic activity far beyond the sector that supplies it.[53]

Despite these definitional hurdles, there is massive evidence showing that the amount of data transversing the globe is rising much faster than the traditional exchange of goods and services. This is particularly true for data flows between the United States and Europe.

Because there is no single way to measure such a complex and diffuse phenomenon, this study offers various lenses

BOX 1.2. 3D PRINTING

3D printing (3DP), also known as additive manufacturing, is a process that creates physical objects directly from a digital file. 3D computer-aided design (CAD) data guide a 3D printer to add different materials, layer-by-layer, until an object is formed.

3DP is not a new technique, it originated in 1983 and came into commercial use in 1988. But it is now being deployed rapidly from the auto, aerospace and medical equipment sectors to the medical and dental sector, food, electronics, construction, clothing, and retail. It has the potential to transform product design, development and manufacturing, supply chains and trade.

3DP changes how production takes place, where manufacturing is done, what is being traded, where trade takes place, and who participates. It changes the production process by replacing intermediary goods with CAD files, making production lines shorter. Economies of scale are no longer needed; smaller numbers of customized products can be produced profitably and closer to customers. Small companies and even individuals — CAD file designers and niche producers — can profitably enter the market.

3DP is a prime example of how manufacturing and services are becoming intertwined. It is also an example of how the digital economy confounds traditional metrics for cross-border commerce. When a digital CAD file is traded, it can generate new manufacturing production, but since that process may take place locally, the 3DP production process registers only as trade in services rather than goods.[54]

TABLE 1.9: TOP 3D PRINT CITIES, 2017

	CITIES
1	New York
2	London
3	Paris
4	Amsterdam
5	Los Angeles
6	Berlin
7	Madrid
8	Chicago
9	Toronto
10	San Francisco

Source: 3DHubs.[55]

Despite its worldwide applications, 3DP remains primarily a transatlantic story. U.S. and European companies account for 9 of the top 10 3D printer companies in the world. Among the most popular 3D printers are those made by U.S. companies Makerbot, Robo 3D, and Printrbot, with Makerbot's Replicator 2 tops in North and South America, 2nd in the Asia-Pacific, and 4th in Europe. Top European models are produced by the Dutch company Ultimaker, the Polish company Zortrax, and Prusa models developed by Czech 3D innovator Josef Prusa. Ultimaker's 3D printer is the top seller in Europe and in the Asia-Pacific region, while Zortrax is 2nd in Europe and 3rd in the Asia-Pacific. China's Flashforge is the only one of the top ten companies not to hail from the United States and Europe. Its Creator Pro ranks 2nd in North America and 4th in the Asia-Pacific.

The top ten 3D printing cities are all either in North America or Europe (Table 1.9). New York reigns as the world's #1 3D Print City, followed by London, Paris, Amsterdam and Los Angeles.

through which we can bring greater focus to the digital economy, and then to see more clearly the importance the transatlantic digital economy.

In our annual surveys of the overall transatlantic economy, my colleague Joseph Quinlan and I go beyond standard trade metrics and use eight key indices to offer a clearer picture of the "deep integration" forces that bind the United States and Europe together. This study again goes beyond the limited view offered by metrics of the ICT sector or standard trade flows by offering a number of indices that can generate a clearer picture of the transatlantic digital economy.

These indices draw on the latest available data and a range of other studies, but given the "Five Is" I have noted — inconsistent definitions, inadequate categorizations, insufficient information, intransparent methodologies and irregular evaluations — these metrics should not be considered as entirely separate or equally comparable.[56] They cannot, nor are they intended to, serve as a standardized measure of the digital economy. There is some overlap among indices, and in some cases I have had to draw conclusions from best estimates. While each tends to highlight a specific aspect of the digital economy, together they offer a clearer picture.

This approach is akin to that of an eye doctor, who uses odd-looking instruments, flashes bright lights in your eyes, and asks you to look through an array of lenses so that in the end you have a much clearer view of the small word "digital" that is staring back at you from across the room.

As your digital ophthalmologist, I use two types of indices. In Section 2 I offer five ways to understand transatlantic digital connections. In Section 3 I then offer five ways to compare the U.S. and European digital economies, both with each other and with other digital economies around the world. In Section 4 I discuss challenges facing the transatlantic digital economy, and in Section 5 I offer some concluding thoughts about the opportunities and potential of the transatlantic digital economy.

Endnotes

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