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DIGITAL AMERICA: A TALE OF THE HAVES AND HAVE-MORES

DECEMBER 2015

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MGI is led by three McKinsey & Company directors: Richard Dobbs, James Manyika, and Jonathan Woetzel. Michael Chui, Susan Lund, Anu Madgavkar, and Jaana Remes serve as MGI partners. Project teams are led by the MGI partners and a group of senior fellows, and include consultants from McKinsey & Company's offices around the world. These teams draw on McKinsey & Company's global network of partners and industry and management experts. In addition, leading economists, including Nobel laureates, act as research advisers.

The partners of McKinsey & Company fund MGI's research; it is not commissioned by any business, government, or other institution. For further information about MGI and to download reports, please visit **www.mckinsey.com/mgi**.

DIGITAL AMERICA: A TALE OF THE HAVES AND HAVE-MORES

DECEMBER 2015

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PREFACE

The digitization of the US economy is accelerating and moving in new directions. Usage continues to skyrocket as businesses reinvent their operations, engage more deeply with customers and suppliers, and create entirely new products and services. Technology is transforming the nature of work and reshaping the economy before our eyes—and yet it is surprisingly difficult to pin down such a diffuse and fast-moving phenomenon that touches practically every company and sector.

This research represents the first major attempt to measure the ongoing digitization of the overall US economy at the sector level. It introduces the MGI Industry Digitization Index, which combines dozens of indicators to provide a comprehensive picture of where and how companies are building digital assets, expanding digital usage, and creating a more digital workforce. It reveals which parts of the economy are surging ahead and which could be part of the next wave of growth. Following MGI's signature micro-to-macro approach, we track how this is playing out within individual companies, across industries and commercial ecosystems, and finally at the macroeconomic level.

As the United States enters the next phase of digitization, the challenge is no longer about simply expanding participation; now it is about deepening capabilities to keep up with the digital leaders. While the majority of users struggle to stay current with the relentless pace of innovation, the sectors, companies, and individuals on the digital frontier continue to push the boundaries of technology use—and to capture disproportionate gains as a result. This growing gap between the digital "haves" and "have-mores" has profound consequences for business strategy, industry competition, the labor market and the future of work, and inequality.

This research was led by James Manyika, a director of the McKinsey Global Institute based in San Francisco; Sree Ramaswamy, an MGI senior fellow based in Washington, DC; Somesh Khanna, a McKinsey director based in New York and global leader for McKinsey Digital in financial services; Gary Pinkus, a McKinsey director based in San Francisco and the managing partner for McKinsey in North America; and Hugo Sarrazin, a McKinsey director based in Silicon Valley and the global leader of McKinsey Digital Labs. The project team, led by Guru Sethupathy and Andrew Yaffe, included Clyde Atkins, David Huang, Patrick Ndai, Marc Reinke, Akshay Shah, Barrett Sheridan, and Sophie Weihmann. Lisa Renaud served as senior editor. Sincere thanks go to our colleagues in operations, production, design, and external relations, including Tim Beacom, Marisa Carder, Matt Cooke, Deadra Henderson, Jason Leder, Julie Philpot, Mary Reddy, Rebeca Robboy, Margo Shimasaki, and Patrick White. Jonathan Ablett, Jaroslaw Bronowicki, Vivien Singer, and Jack Zhang provided invaluable research and analytics support.

Our efforts build on an extensive body of work by our colleagues. We are indebted to Jacques Bughin, Michael Chui, Susan Lund, and Jaana Remes, as well as previous teams that produced reports on big data, the Internet of Things, online talent platforms, and the automation of work. We are also grateful to the dozens of authors, researchers, and editors who produced insightful articles for the *McKinsey Quarterly* on all aspects of digital strategy. In particular, the work of Tanguy Catlin, Ewan Duncan, Tunde Olanrewaju, Jay Scanlan, Marc Singer, and Paul Willmott provided us with valuable insight. These sources are listed in full at the end of this report for further reading.

This project benefited immensely from McKinsey colleagues sharing their expertise and insights. We are grateful to Jim Banaszak, Roman Belotserkovskiy, Erin Braddock, Chad Bright, Shane Bryan, Rick Cavalo, Arnab Das, Aditya Dhar, Alex Frouman, Katy George, Kate Jackson, Tanay Jaipuria, Michael Keany, Richard Kelly, Björn Körtner, John Newman, Steven Pecht, Scott Perl, Joe Quoyeser, Kausik Rajgopal, Jimmy Sarakatsannis, Pamela Simon, Richard Sellschop, Vik Sohoni, Humayun Tai, Sri Velamoor, and Richard Ward.

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This report contributes to MGI's mission to help business and policy leaders understand the forces transforming the global economy, identify strategic locations, and prepare for the next wave of growth. As with all MGI research, this work is independent and has not been commissioned or sponsored in any way by any business, government, or other institution. We welcome your comments on the research at MGI@mckinsey.com.

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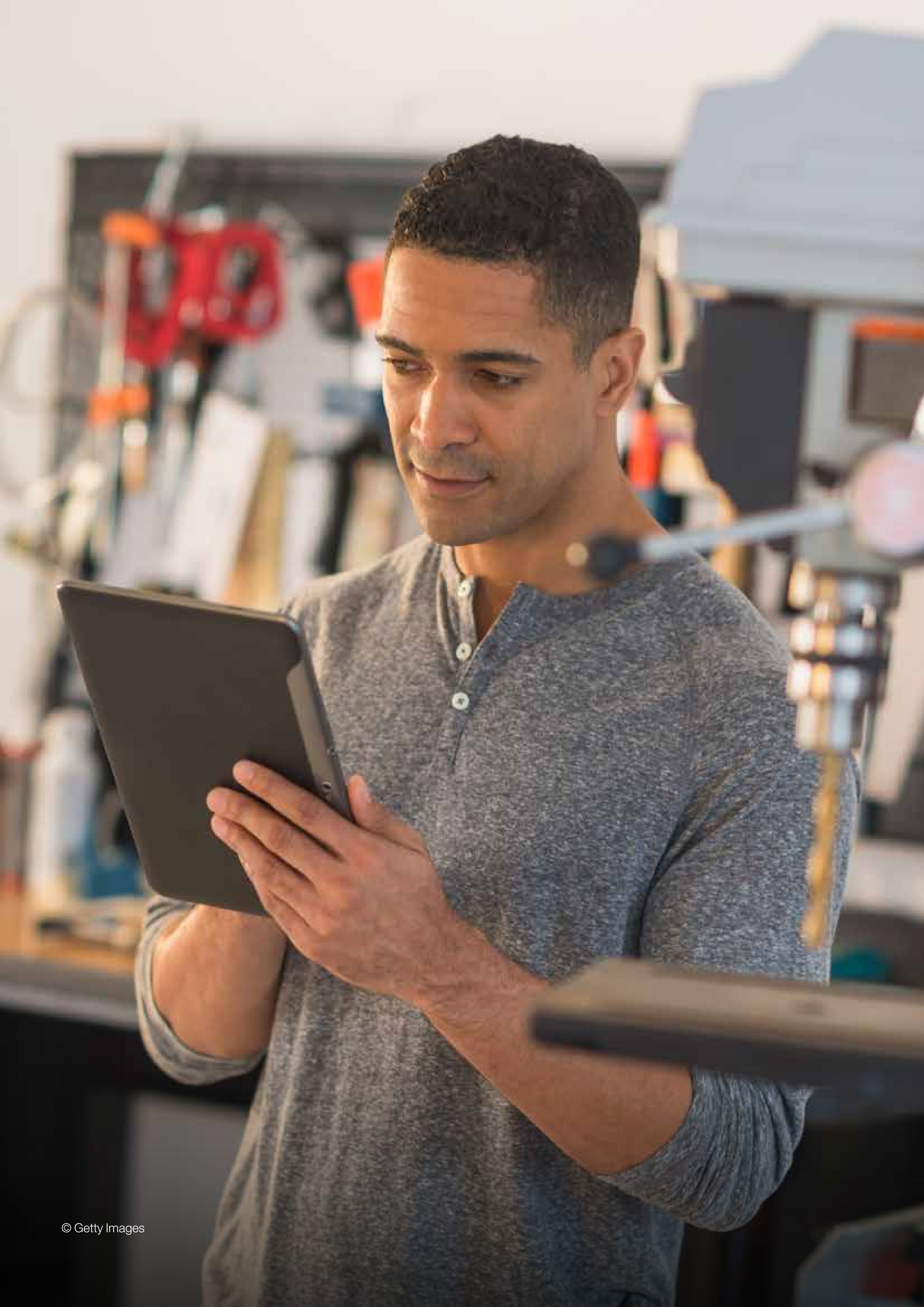

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IN BRIEF

DIGITAL AMERICA: A TALE OF THE HAVES AND HAVE-MORES

The United States is digitizing so rapidly that most users are scrambling to adapt. The race to keep up with technology and put it to the most effective business use is producing digital "haves" and "have-mores"—and the large, persistent gap between them is becoming a decisive factor in competition across the economy.

- Digitization is happening unevenly, and users with advanced digital capabilities are capturing disproportionate benefits. The companies leading the charge are winning the battle for market share and profit growth; some are reshaping entire industries to their own advantage. But many businesses are struggling to evolve quickly enough. Workers in the most digitized industries enjoy wage growth that is twice the national average, while the majority of US workers face stagnant incomes and uncertain prospects.

- Digitization is not just about buying IT equipment and systems. The most explosive growth is now in usage as companies continue to integrate digital tools into an ever-widening variety of business processes. MGI's Industry Digitization Index is the first major effort to capture how this activity is playing out at the sector level. It compiles dozens of indicators to provide a picture of digital assets, usage, and workers across the economy. In addition to the information and communications technology (ICT) sector, media, financial services, and professional services are surging ahead, while others have significant upside to capture. In fact, most sectors across the economy are less than 15 percent as digitized as the leading sectors. Despite a great rush of adoption, this gap has barely narrowed over the past decade. We see this pattern at the company level as well as the sector level.

- Digitization is changing the dynamics in many industries. New markets are proliferating, value chains are breaking up, and profit pools are shifting. Businesses that rely too heavily on a single revenue stream or on playing an intermediary role in a given market are particularly vulnerable. In some markets, there is a winner-take-all effect. For companies, this is a wake-up call—and an opportunity to reinvent every process with a fresh focus on the customer.

- As digitization accelerates, the United States has a major opportunity to boost productivity growth. Looking at just three big areas of potential—online talent platforms, big data analytics, and the Internet of Things—we estimate that digitization could add up to $2.2 trillion to annual GDP by 2025, although the possibilities are much wider. Some of the sectors that are currently lagging could be poised for rapid growth. Companies in manufacturing, energy, and other heavy industries are investing in digitizing their extensive physical assets, bringing us closer to the era of connected cars, smart buildings, and intelligent oil fields.

- But there will also be more economic dislocation. As digital technologies automate many of the tasks that humans are paid to do, the day-to-day nature of work will change in a majority of occupations. As companies redefine many roles and business processes, workers of all skill levels will be affected. Historical job displacement rates could accelerate sharply over the next decade. The United States will need to adapt its institutions and training pathways to help workers acquire relevant skills and navigate this period of transition and churn.

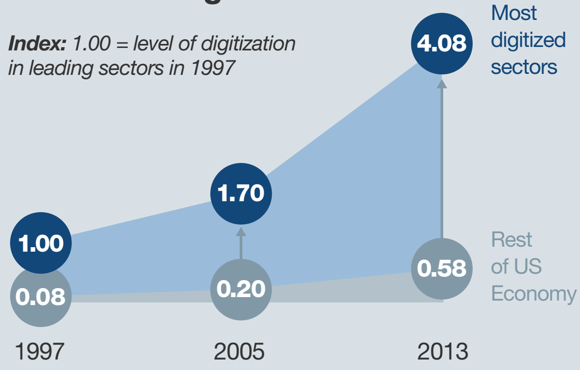
Today the race is on to capture value from data analytics and the Internet of Things, btut there is no finish line. Digitization involves continuously experimenting and adapting, whether the focus is on back-office processes, the customer experience, or the introduction of new products and services. It takes investment, agility, and relentless focus to stay ahead in this hypercompetitive new world, but there are outsized opportunities for the organizations and individuals that can establish themselves as digital leaders.

The accelerating digitization of the US economy

Digitization now touches most of the economy...

- **5%** Information and communications technology (ICT) as a share of GDP
- **28%** of payments are made digitally
- **64%** of adults use smartphones
- **84%** of adults use the Internet
- **98%** have access to high-speed Internet

...yet most sectors lag far behind the digital leaders



There is a large gap between the digital "haves" and "have-mores"

MGI's **Industry Digitization Index** combines 27 indicators to measure the digital assets, digital usage, and digital workers in each sector

High digitization

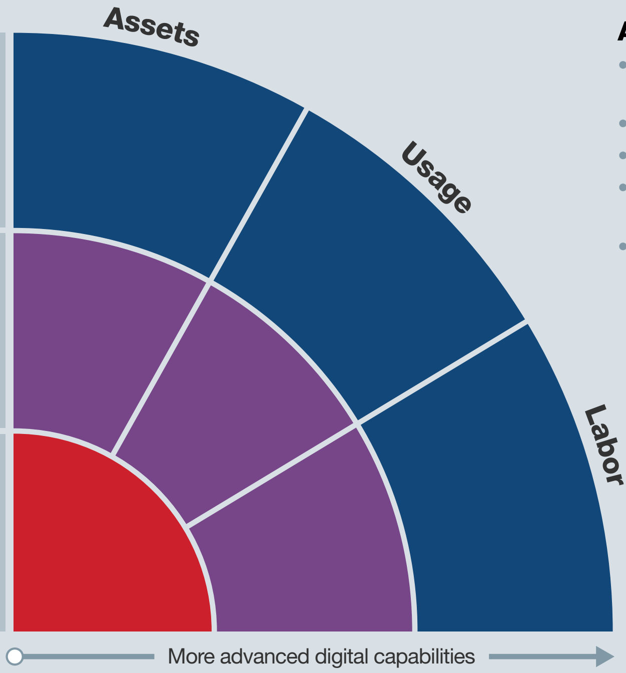
example sectors:
- ICT
- Media
- Finance and insurance

Medium digitization

example sectors:
- Advanced manufacturing
- Wholesale trade
- Retail trade

Low digitization

example sectors:
- Health care
- Construction
- Hospitality



Across industries:
- Digital assets create competitive advantage
- New intermediaries emerge
- Value chains break apart
- Winner-take-all dynamic develops
- Industry boundaries blur

As the digital frontier expands, there is constant pressure to **adapt and evolve**

Companies
- The digital leaders never stop inventing and experimenting; incumbents have to do the same. The biggest risk is being disrupted while sitting on the sidelines.
- Build a strong balance sheet of digital assets, and find a way to monetize consumer surplus.
- Use digital to reinvent every process and build a more customer-focused, productive organization.

Policy makers
- As more tasks can be automated, jobs at all skill levels will be redefined. New training pathways and institutional responses will be critical.
- The speed of innovation calls for a more agile, test-and-learn approach to regulation and policy.
- Government can expand participation by providing access and infrastructure, enhancing digital literacy, and digitizing its own services.

Digitization could add some **$2.2 trillion to annual GDP by 2025** in three areas alone—and this is only part of the potential

EXECUTIVE SUMMARY

Digital innovation, adoption, and usage are evolving at a supercharged pace across the US economy. As successive waves of innovation expand the definition of what is possible, the most sophisticated users have pulled far ahead of everyone else in the race to keep up with technology and devise the most effective business uses for it.

There is a pronounced and persistent gap between the digital "haves" and "have-mores." The companies with advanced digital assets and capabilities are capturing market share and profit growth; the true disruptors are even gaining the ability to reshape industries to their own advantage. The "have-mores" are not just large companies that dominate one sector. They can be small, innovative firms or companies whose digital assets enable them to play in multiple sectors. In the labor force, the workers with the most sophisticated digital skills are the "have-mores"—and they command wages far above the national average. Meanwhile, there is a growing opportunity cost for the organizations and individuals that fall behind.

Because the digital frontier is expanding on many fronts simultaneously, it is surprisingly difficult to pin down the extent of digitization in the US economy with any single metric. The information and communications technology (ICT) sector supplies the devices, software, and services that are fueling this shift. But at 5 percent of US GDP in the measured statistics, it is only a sliver of a much broader phenomenon. Beyond the ICT sector itself, usage is exploding as companies build new types of digital assets and connect them in ways that sometimes overturn existing business models. They are engaging more deeply with customers and suppliers, putting powerful tools in the hands of employees, and even devising new ways of working. Digitization now touches most of the population and every sector of the economy.

MGI's Industry Digitization Index provides a snapshot of this activity at the sector level. It brings together dozens of indicators for a comprehensive picture of digital assets, usage, and workers across the economy. It reveals that some sectors are surging ahead, while others have significant upside to capture. We also quantify the considerable gap between the most digitized sectors and the rest of the economy over time. Despite a rush of adoption, most sectors have barely closed that gap over the past decade. This pattern is also apparent at the company level. Within many industries, there is a stark difference in digital capabilities between leading firms and average firms.

As companies learn how to get the most out of technology and usage deepens in additional industries, the United States has a major opportunity to address one of its most critical economic challenges: accelerating productivity growth. Digitization could also produce even greater consumer surplus and societal benefits in the future.

But strains in the labor market could worsen as technology develops the capabilities to perform more human tasks. An analysis of the tasks that can be automated by adapting currently demonstrated technologies shows that a majority of occupations, at all skill levels, are likely to be affected to some degree. Over the coming decade, companies will redefine many roles, and the rate of job displacement could accelerate sharply. Addressing a shift of this magnitude will require much more than a business-as-usual approach to skills development.

The digital frontier is uncharted territory, full of exciting possibilities for innovation and productivity. At the same time, it creates more competitive pressure and the potential for businesses without the best digital assets and capabilities to be disrupted. Companies are aiming at a moving target, but there is no opting out of the imperative to go digital. The opportunities and operational benefits are too great—and the biggest risk of all is being disrupted while sitting on the sidelines.

Box E1. A broad view of digitization: Assets, usage, and people

Many observers who have tried to quantify the impact of technology have focused exclusively on the ICT sector. Our analysis begins there, but its primary focus is on how deeply digital technologies are penetrating the rest of the economy and the myriad ways they are being used to create value.

Official GDP statistics do not reflect the ICT sector's role as the engine of digitization for the broader economy. Overall, the sector made up approximately 5 percent of US GDP in 2014, on par with the size of the retail sector. Surprisingly, this is down slightly from its peak of roughly 5.5 percent in 1997. This decline, which seems at odds with two decades of rapid adoption, is partly due to the fact that prices for ICT goods and services tumbled by 63 percent between 1983 and 2010, even as the price of other durable goods and services steadily increased. More powerful and sophisticated technology became affordable for users across the economy, greatly benefiting companies in other sectors that purchase ICT goods and services. If we account for the price decline in ICT and its benefit to other sectors, adjusting for price elasticity of demand, the ICT sector would represent some 10 percent of US GDP in 2014.

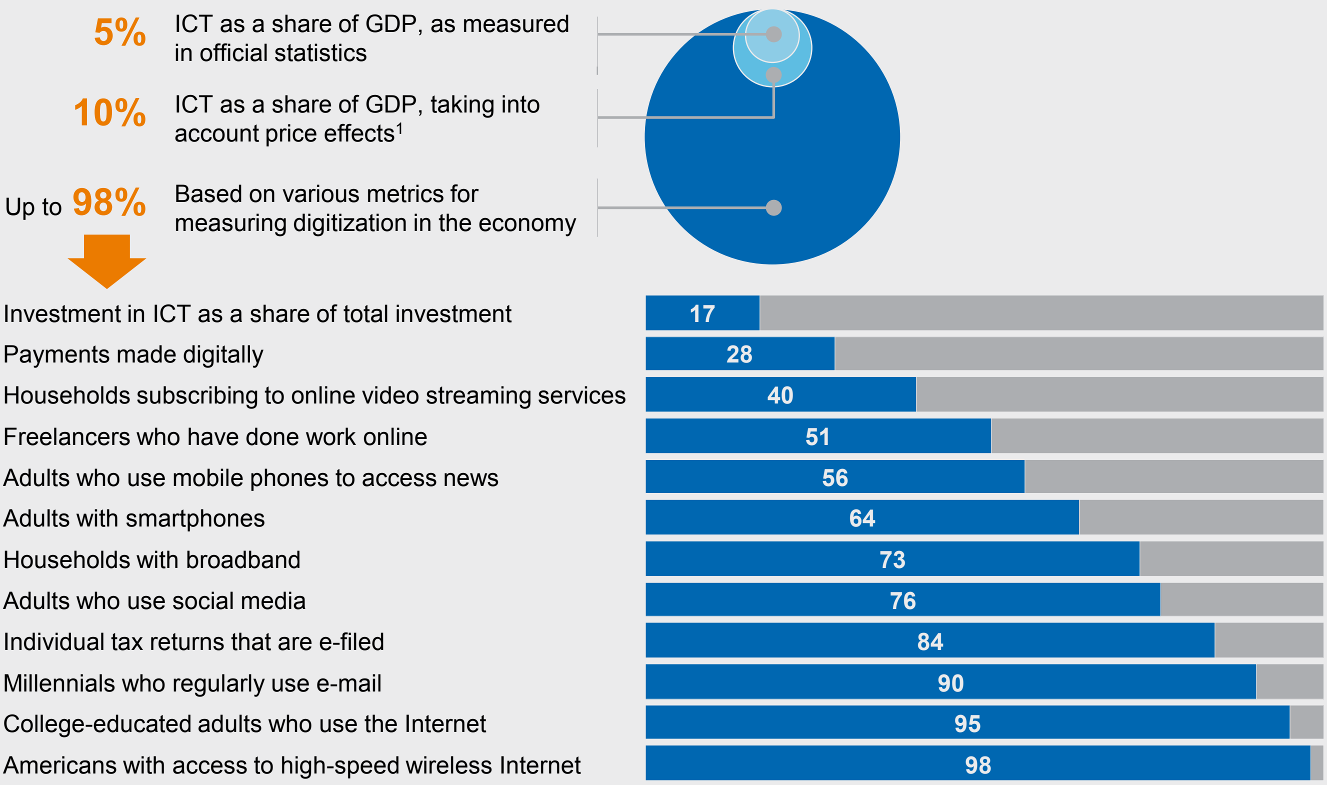
But even this adjustment does not capture the magnitude of technology's impact. Digitization, like electricity, is a general-purpose technology that underpins a huge share of economic activity beyond the sector that supplies it (Exhibit E1). More than two-thirds of US adults have smartphones, for example, and the shift toward mobile has led to skyrocketing usage in areas from e-commerce and digital payments to social media engagement.

Because there is no single way to measure such a complex and diffuse phenomenon, we need a view based on how various sectors are deepening digital assets, expanding digital usage, and creating a more digitally enabled workforce. The MGI Industry Digitization Index, which forms the heart of this research, offers a snapshot of how various parts of the economy are evolving along these three dimensions.

Exhibit E1

Digitization now touches most Americans and most of the US economy

Share of US economy impacted by digitization
Various metrics, 2014 or latest



1 Factoring in real price declines in ICT goods and estimating the benefits to non-ICT sectors based on their ICT purchases, adjusting for price elasticity of demand.

SOURCE: BEA; BLS; Pew Research Center; the White House; Nielsen; IRS; US Census Bureau; McKinsey social technology survey; McKinsey Payments Map; McKinsey Global Institute analysis

THE DIGITAL FRONTIER IS RAPIDLY EVOLVING, AND THOSE AT THE FOREFRONT CAPTURE DISPROPORTIONATE REWARDS

Digitization has advanced in a series of accelerating waves that touch more and more participants. As each one builds on and amplifies what has come before, the waves are hitting in faster succession and with greater impact. Today the focus is on connectivity, platforms, data, and software. These spread faster than classic computing hardware due to their network effects and the marginal cost economics associated with products and services in digital rather than physical form. Together these technologies have set off a virtuous cycle of innovation as they are combined and recombined in the form of new products. As consumers see the benefits and are quicker to adopt, businesses can take advantage of a built-in audience for yet more innovation.

For decades, digital innovation was focused on expanding business usage through advances such as enterprise software for managing operations. But beginning in the mid-1990s and especially over the past decade, the US digital transformation moved in new directions. The Internet, mobile connectivity, social media, and smartphone apps created a massive spike in consumer adoption. Meanwhile, businesses have steadily continued to invest. Today they are stepping into the age of analytics, using technology to analyze enormous troves of data for insights that can inform decisions and generate business insights. The Internet of Things can improve the utilization of machinery, boost the output of oil fields, and make buildings more efficient, potentially delivering a significant boost to productivity in the decade ahead. Even bigger possibilities are on the horizon with advances in artificial intelligence and new applications of digital technologies in fields such as synthetic biology.

The gap between those on the frontier and the rest of the economy is about the sophistication of digital usage. Much has been written over the years about the digital divide and the Americans who remain offline, but now a new and more pervasive dynamic appears to be at work. The gap between the digital "haves" and "have-mores" is growing as the most advanced users pull away from everyone else. They have moved beyond expanding access and adding users; now they are focused on deepening engagement and capabilities.

This gap between the "haves" and "have-mores" increasingly defines corporate competition in the United States. While it may seem that most companies went digital long ago, most are using only a fraction of the capabilities associated with technology and are far behind the digital leaders in using those tools to transform their core processes and customer relationships. In contrast, a small group of sectors, organizations, and individuals are far ahead of the curve.

The digital frontier is a high-risk, high-reward environment. At a broad level, the industries with the fastest profit margin growth tend to be those with the fastest growth in software intensity. And *within* these sectors, the margin spreads between the top-performing companies and the lowest performers are two to four times those in other sectors. In other words, the most digitized industries are developing a winner-take-all dynamic. But at the same time, digitization seems to intensify competitive churn.[1] Today's market leaders are vulnerable to being knocked off by the next wave of innovation.

[1] Andrew McAfee and Erik Brynjolfsson, "Investing in the IT that makes a competitive difference," *Harvard Business Review*, July-August 2008.

The same pattern affects individuals as well as the corporate sector. One study found that only 20 percent of individual users capture 60 percent of all consumer surplus, while the bottom 50 percent capture just 20 percent.[2] The typical person who uses a smartphone for communication, entertainment, or basic searches is not taking advantage of the full range of applications that produce real efficiencies. For workers, wage growth has been approximately twice as fast as the national average in the most highly digitized industries, such as ICT and professional services. Within these fields, too, a small group of workers at the leading edge command sharply higher compensation. Conversely, those who lack digital skills face narrowing job prospects.

SOME INDUSTRIES AND COMPANIES ARE MORE DIGITIZED THAN OTHERS

There is no single formula for going digital. Companies that buy ICT assets may assume they have made the leap and the benefits will start to flow. But the real value lies in combining digital assets and capabilities with ingenuity. It involves using these tools to engage with customers, to create new products and business models, and to improve operations. This process is happening unevenly, however, with some companies and some sectors pulling far ahead of the pack. Measuring this activity in various sectors requires a multidimensional view.

27
indicators show how companies and industries are digitizing

The MGI Industry Digitization Index examines sectors across the economy through the lens of digital assets, digital usage, and digital workers, compiling 27 indicators to capture the many possible ways in which companies are digitizing. To measure digital assets, for instance, we consider business spending on computers, software, and telecom equipment, as well as the stock of ICT assets, the share of assets such as robots and cars that are digitally connected, and total data storage. Usage metrics include an industry's use of digital payments, digital marketing, and social technologies, as well as the use of software to manage both back-office operations and customer relationships. On the workforce side, we evaluate more than 12,000 detailed task descriptions to identify those associated with digital technologies (such as database administration). We also estimate the share of workers in each sector in technology-related occupations that did not exist 25 years ago, and we determine digital spending and assets on a per-worker basis.

The index shows that the US economy is digitizing unevenly, with large disparities among sectors (Exhibit E2). Beyond the ICT sector, which often sets the standard for the highest level of digitization on various indicators, the most highly digitized parts of the economy are media, professional services, and financial services.

The index also highlights where there is room for growth in digital capabilities. Utilities, mining, and manufacturing, for example, are in the early stages of digitizing and connecting their physical assets, and they could be at the forefront of the next wave of digitization. Labor-intensive industries such as retail and health care are expanding digital usage, but substantial parts of their large workforces do not use technology extensively. Industries that are both highly labor-intensive and localized, such as construction, leisure, and hospitality, also tend to rank lower in usage, notably in the way they conduct customer transactions.

Lagging sectors could experience catch-up growth if the long tail of smaller and less digitized businesses begins to close the gap with leading companies. Thousands of small retailers have few if any digital operations beyond accepting credit cards, for example, in striking contrast with Amazon, Walmart, or Zappos. In manufacturing, many smaller firms use only basic enterprise software for administration, and they are years behind the largest aerospace or machinery manufacturers in their use of analytics.

2 *Consumers driving the digital uptake: The economic value of online advertising-based services for consumers*, IAB Europe, September 2010.

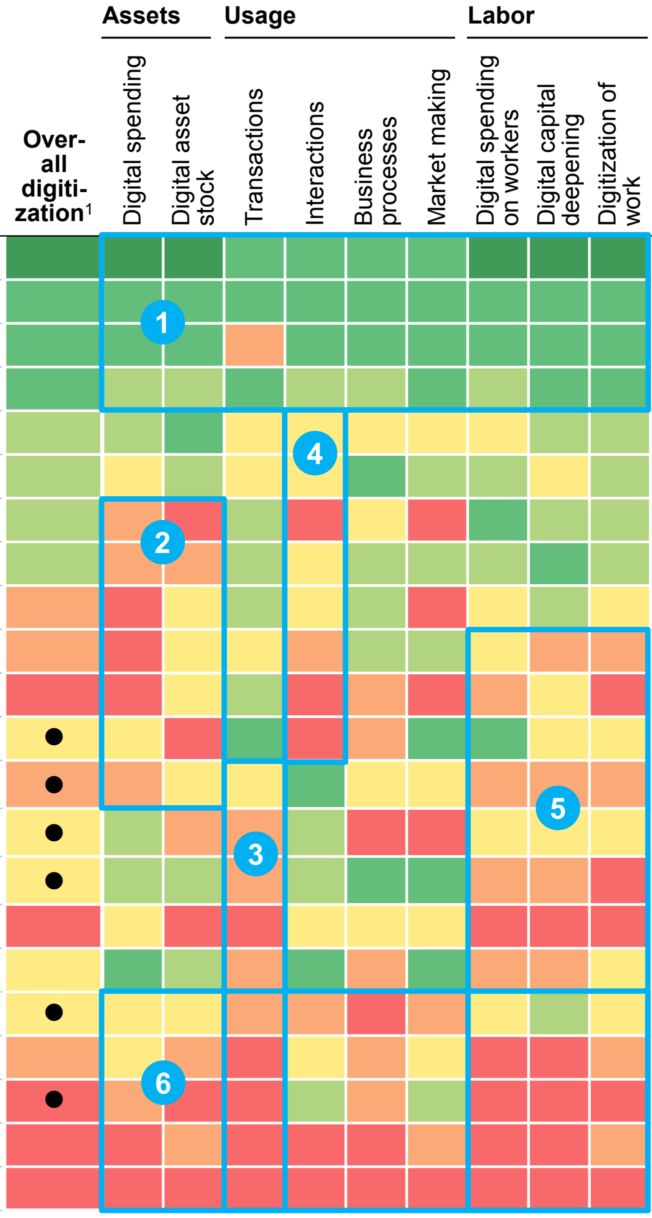
Exhibit E2

The MGI Industry Digitization Index

2015 or latest available data

Relatively low digitization — Relatively high digitization

● Digital leaders within relatively undigitized sectors



Sector	Overall digitization[1]	GDP share %	Employment share %	Productivity growth, 2005–14[2] %
ICT		5	3	4.6
Media		2	1	3.6
Professional services		9	6	0.3
Finance and insurance		8	4	1.6
Wholesale trade		5	4	0.2
Advanced manufacturing		3	2	2.6
Oil and gas		2	0.1	2.9
Utilities		2	0.4	1.3
Chemicals and pharmaceuticals		2	1	1.8
Basic goods manufacturing		5	5	1.2
Mining		1	0.4	0.5
Real estate	●	5	1	2.3
Transportation and warehousing	●	3	3	1.4
Education	●	2	2	-0.5
Retail trade	●	5	11	-1.1
Entertainment and recreation		1	1	0.9
Personal and local services		6	11	0.5
Government	●	16	15	0.2
Health care		10	13	-0.1
Hospitality	●	4	8	-0.9
Construction		3	5	-1.4
Agriculture and hunting		1	1	-0.9

1. Knowledge-intensive sectors that are highly digitized across most dimensions
2. Capital-intensive sectors with the potential to further digitize their physical assets
3. Service sectors with long tail of small firms having room to digitize customer transactions
4. B2B sectors with the potential to digitally engage and interact with their customers
5. Labor-intensive sectors with the potential to provide digital tools to their workforce
6. Quasi-public and/or highly localized sectors that lag across most dimensions

1 Based on a set of metrics to assess digitization of assets (8 metrics), usage (11 metrics), and labor (8 metrics); see technical appendix for full list of metrics and explanation of methodology.
2 Compound annual growth rate.

SOURCE: BEA; BLS; US Census; IDC; Gartner; McKinsey social technology survey; McKinsey Payments Map; LiveChat customer satisfaction report; Appbrain; US contact center decision-makers guide; eMarketer; Bluewolf; Computer Economics; industry expert interviews; McKinsey Global Institute analysis

The standard for what it means to be highly digitized today will be outdated tomorrow, and the digital leaders never stop devising new ways to use technology. Across every indicator in the index for which historical data is available, we compare the most digitized sector with the rest of the economy. This provides a proxy for understanding the size of the gap between the digital "haves" and "have-mores." We find that most sectors were only 12 percent as digitized as the leaders in 2005. Despite a massive rush of adoption and change since then, the rest of the economy was operating at only 14 percent of the leaders' digital capacity in 2013 (Exhibit E3).

18%
share of its digital potential that the US economy is actually realizing

The "have-mores" continue to push the boundaries of digitization, particularly in terms of augmenting what their workers do, while everyone else scrambles to keep up with them. This gap points to substantial room for much of the economy to boost productivity. In fact, since some of the lagging sectors are the largest in terms of GDP contribution and employment, we find that the US economy as a whole is reaching only 18 percent of its digital potential (defined as the upper bounds of digitization in the leading sectors).

The index results raise the question of why some sectors went digital sooner and more decisively than others. Four factors shape those outcomes: firm size, complexity of operations, knowledge intensity, and the threat of competition. Large firms are more likely to adopt digital tools than small firms (with the exception of small "digital natives"), in part to manage greater complexity. For a similar reason, firms with long supply chains or many establishments are also more likely to digitize. Companies with a large share of highly educated or specialized workers also tend to be more digitized since the productivity returns tend to be higher. Finally, the actual degree of competition in a sector does not seem to be a factor, but the *prospect* of competition is. Many firms digitized around the time their industries were deregulated. The digital leaders are the firms that have achieved this transformation more rapidly and effectively than their competitors, and this gap is changing the dynamics across various industries.

AS COMPANIES DIGITIZE, THE SPILLOVER EFFECTS ARE TRANSFORMING INDUSTRY STRUCTURES, PROFITABILITY, AND COMPETITION

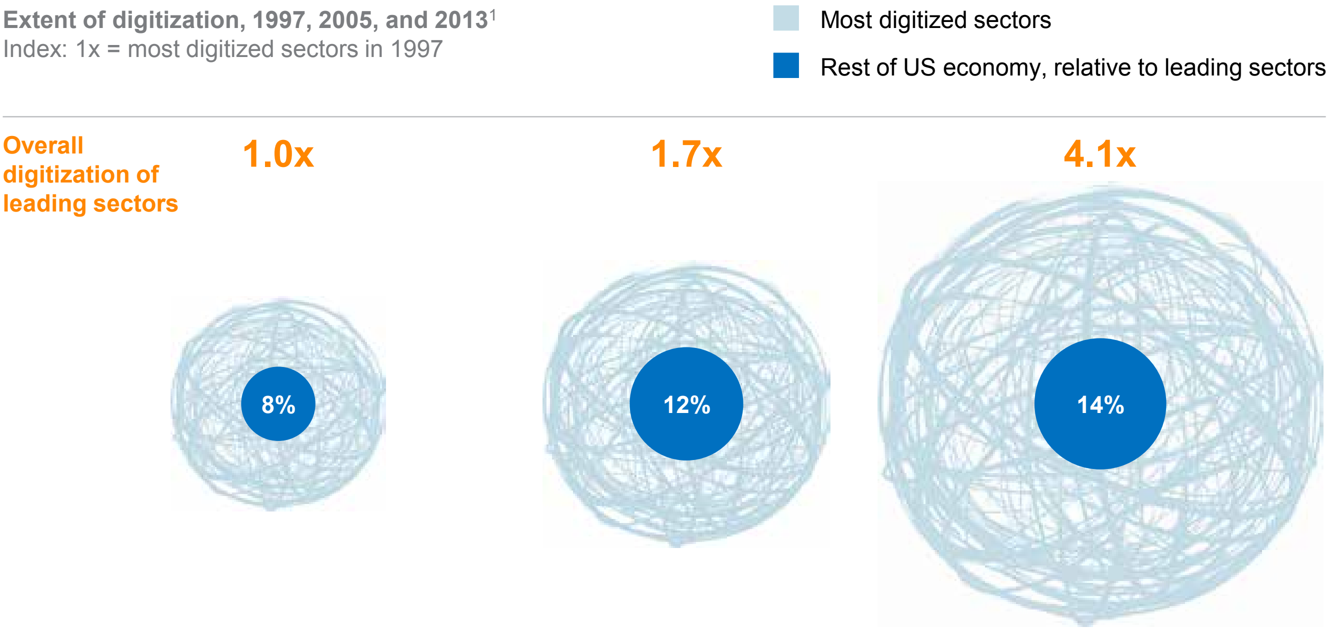
Going digital is an opportunity to reinvent core processes, create new business models, and put the customer at the center of everything. Companies are using digital tools to raise the bar in operational efficiency, customer engagement, innovation, and workforce productivity. But there is wide variation in how aggressively and effectively they are pursuing these opportunities. A recent McKinsey survey of 150 large companies evaluated respondents on 18 practices related to digital strategy, capabilities, and culture to arrive at a metric called the Digital Quotient—and the distribution curve illustrates the striking gap between the digital leaders and laggards (Exhibit E4).

When digitization reaches critical mass across industries, it can spark fierce price competition, shifting profits, and competitive churn across commercial ecosystems. Many industries are experiencing more than one of the dynamics described below, and even those that have been unaffected so far have to brace themselves. Disruption could hit anywhere as new technologies, business models, and competitors appear with incredible speed.

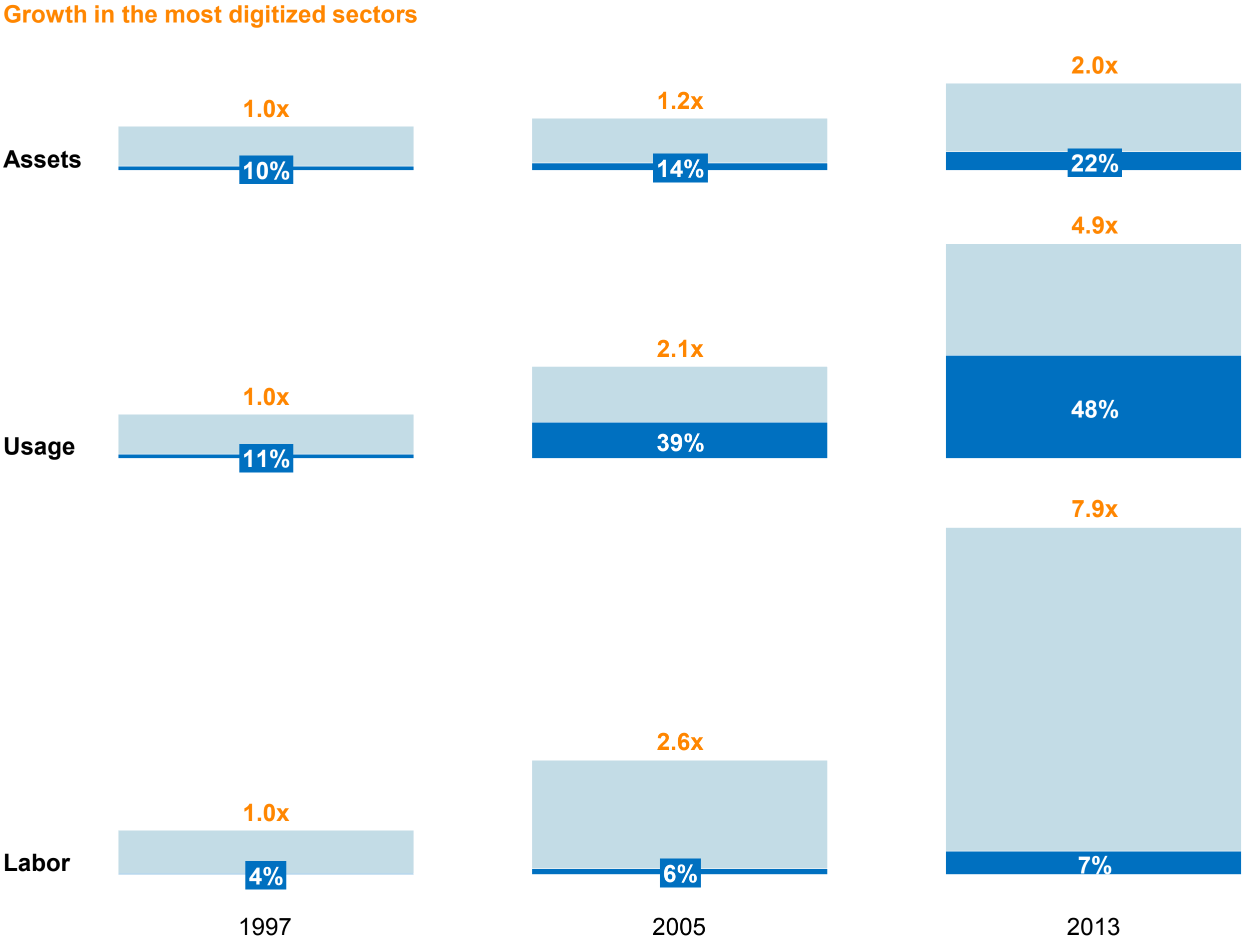
Exhibit E3

The most digitized sectors are maintaining a considerable lead over the rest of the US economy

Extent of digitization, 1997, 2005, and 2013[1]
Index: 1x = most digitized sectors in 1997



The leading sectors have increased their digital intensity four-fold since 1997, with the greatest gains coming in the past decade. Other sectors are barely keeping pace.



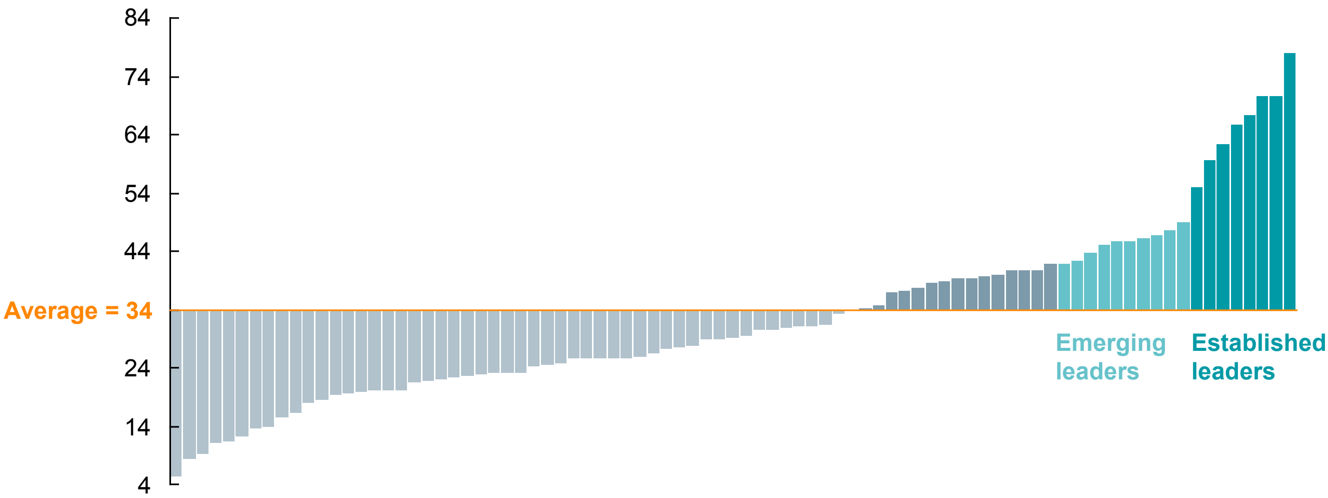
1 Measured using a set of 18 historical metrics spanning assets (6 metrics, including spending on digital assets and the stock of digital assets), usage (6 metrics, including digital transactions), and labor (6 metrics, including digital capital deepening).

SOURCE: BLS; BEA; McKinsey social technology survey; McKinsey Digital Payments Map; Gartner; ARP Research; DMA; eMarketer; McKinsey Global Institute analysis

Exhibit E4

Among large corporations, digital maturity varies widely—with a large gap between digital leaders and the rest

Digital Quotient score



SOURCE: 2014-15 McKinsey Digital Quotient company survey; "Raising your Digital Quotient," *McKinsey Quarterly*, June 2015

Digital assets determine competitive advantage

Competitive dynamics are increasingly determined by who develops the right digital assets.[3] Sectors such as media are moving from physical to digital products, and companies in all types of industries are building massive data repositories. Among the most prized assets are digital platforms, such those created by Facebook, iTunes, eBay, Amazon, LinkedIn, and Airbnb. Even beyond these well-known examples, companies in traditional sectors are beginning to focus on data, platforms, and connectivity as the key to interactions, transactions, and innovation. Consider the automotive industry, where digital platforms have transformed the customer decision journey. Consumers now save time and money by searching and comparing vehicles online before they make a purchase—and their online activity leaves a data trail that dealers can use to identify selling opportunities. Technology is also embedded within the physical product: cars now feature GPS and next-generation safety systems, maintenance alerts, Bluetooth connectivity, and entertainment systems. Tesla has pioneered some of the most sophisticated connected cars to date, using wireless software downloads to add new features and fixes—and now even self-driving capabilities—to existing cars.

Information becomes widely available, disrupting traditional intermediaries

In consumer-facing markets, digitization produces lower search and transaction costs, better matching of products to preferences, and greater transparency. A user can compare prices, features, service, and product satisfaction with a few clicks of a mouse. In addition to creating pricing pressures, this has consequences for middlemen, as digital platforms can replace localized, physical intermediaries and capture market power. In the hospitality sector, travel sites such as Expedia or Priceline allow users to instantly search, compare, and assemble the components of a trip, and they have cut into the fragmented network of travel agents that once brokered many transactions. From 2000 to 2014, online hotel booking revenue increased tenfold, but the number of US travel agents fell by 48 percent. Value is shifting from physical intermediaries and asset holders (including not only travel agents but also hotel owners themselves) to digital intermediaries and to consumers. This

[3] Jacques Bughin and James Manyika, "Measuring the full impact of digital capital," *McKinsey Quarterly*, July 2013.

shift could accelerate as information about both providers and consumers forms the basis of new digital marketplaces. By bringing together travelers with individual property owners who want to list their spare rooms or rental properties, platforms such as Airbnb, VRBO, Flipkey, and HomeAway monetize assets that might otherwise sit empty.

Value chains break apart, creating openings for specialization and new competitors

Digitization allows companies to split jobs into smaller and more specialized tasks to become more efficient.[4] Something similar happens at the industry level, as producers are better able to create specialized offerings for small markets within the ecosystem. In health care, for example, companies are going after very specific segments, as ZocDoc has done with scheduling. In financial services, the investment advisory business has become disaggregated, and small registered personal advisers, many of whom use "plug-and-play" systems, are the fastest-growing segment. Large retail banks similarly face a growing array of small, tech-enabled challengers in specific markets, from credit (NerdWallet, Credit Karma) and loans (Avant, Upstart) to personal financial management (Mint.com, BillGuard).

Low marginal costs and network effects create hyperscale advantages

In the pre-digital era, economies of scale were usually achieved by building large networks of factories or amassing equipment. While physical processes have marginal costs, digital platforms make the cost of doing one more transaction or creating one more peer-to-peer connection trivial, giving digital companies a distinct advantage. The combination of low-marginal-cost economics and platform architecture has allowed the most successful high-tech firms to achieve a scale that was once impossible—and to do so in record time. Facebook was launched in 2004; a decade later, its monthly active users outnumber the population of China. The power of platform economics is reflected in the gross margins enjoyed by software companies, which can run as high as 80 percent, the highest of any industry. Controlling a general-use platform allows companies to become primary digital touch points for millions of people. It gives them access to an extensive amount of data on their users, which can lead to yet more capabilities being added to the platforms.

Industry boundaries become blurred

Once digital players have established themselves as leaders in one market, they have a striking ability to move into new areas. Amazon went from selling books to adding virtually every retail category; later it created its own self-publishing platform and began to offer cloud-based business services. Tech firms are making forays into the automotive industry. Not only are they partnering with traditional manufacturers to integrate "infotainment" platforms into vehicles, but firms such as Google are even developing their own self-driving cars. In fact, Google has added so many wide-ranging ventures over the years that it recently split its core Internet search operations from its other ventures, which include longevity and biotech research, smart home products, venture capital investing, and high-speed Internet fiber services. Having already disrupted the traditional taxi industry, Uber has launched a food delivery service, UberEats, in several cities across the country. And Salesforce.com has teamed up with Philips to introduce a cloud-based health platform that can remotely monitor patients with chronic diseases.

DIGITIZATION CREATES HUGE BENEFITS FOR CONSUMERS AND MORE COMPLEX EFFECTS ON GROWTH AND EMPLOYMENT

The cumulative effect of digitization is felt across the entire economy. Consumers have captured a huge range of benefits, both tangible and intangible. But the productivity effect requires a nuanced view, and there are negative implications for employment and wages.

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4 *An economy that works: Job creation and America's future*, McKinsey Global Institute, June 2011. See also Thomas W. Malone, Robert Laubacher, and Tammy Johns, "The big idea: The age of hyperspecialization," *Harvard Business Review*, July-August 2011.

Digitization produces significant benefits to consumers and society

Consumers have been big winners in the digital economy, although most of this effect does not show up as GDP. The spread of smartphones has put vast computing power in their pockets. They can instantly sort through the entire store of human knowledge or access an endless stream of content and communication on social media—all for free.

Digital marketplaces create intense price competition. Consumers can hold out for bargains and get exactly what they want when they want it. Publicly posted user reviews can arm them with better information, heightening the pressure on businesses to provide quality and service. In addition, some tech firms are providing free products or services where traditional businesses once charged fees. In these cases, the consumer gains are siphoning value out of industries.

The annual benefits to consumers are enormous. Estimates vary from $5 billion to over $100 billion per year, in part because studies have approached this question in different ways.[5] Newer forms of surplus, from GPS navigation to personal financial tools, push this even higher. And beyond the consumer, the US economy has gained through better societal outcomes. Technology is fueling progress in areas from public spending and infrastructure to health care and education, although much more can be achieved in all of these domains.

Digitization has contributed to rapid GDP and productivity growth in the past, but recent gains are blurred

In the late 1980s, digital adoption grew in many sectors, and productivity growth soon followed. Total productivity growth among US businesses averaged only about 0.7 percent per year between 1975 and 1995, but over the next decade, it rose to an annual average of 1.6 percent, increasing nearly 2.5 times as fast as in the preceding 20 years.[6] These gains can be attributed at least in part to increased business investment in ICT tools, as the most digitized sectors (including the ICT sector itself) posted some of the largest productivity gains. This productivity surge was reflected in GDP growth, which averaged nearly 4 percent per year in real terms during this period, compared with 3.3 percent in the previous decade.

But after 2005, these effects vanish from the measured statistics. Total productivity growth has fallen by two-thirds since 2005, while real GDP growth has averaged about 2 percent per year—all during a period in which the digital economy has continued to grow. This new "Solow's paradox" phenomenon has led some to posit that the revolutionary nature of digital technologies has been overhyped.[7]

Moreover, the nature of productivity growth has also changed in the past decade. By definition, productivity growth stems either from improving efficiency (that is, reducing the inputs needed to produce a given output) or from increasing the volume and value of outputs relative to any given input. The productivity surge of the late 1990s reflected both of these factors. Firms in large sectors such as retail, wholesale, and financial services made ICT investments while simultaneously making innovative changes to business processes, organization, and management.[8] They not only became more efficient but were able to capitalize on strong GDP and demand growth as a result. In contrast, sectors that posted

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5 Across multiple studies, estimates based on time use tend to converge around $100 billion per year; monetary estimates converge around $5 billion per year; and willingness-to-pay estimates are in the middle of this range.

6 This refers to multifactor productivity growth in the non-farm business sector. Annual labor productivity growth shows similar trends; it grew at 1.8 percent from 1975 to 1995 and surged to 3 percent between 1995 and 2005.

7 Robert J. Gordon, "US productivity growth: The slowdown has returned after a temporary revival," *International Productivity Monitor*, number 25, spring 2013; and Tyler Cowen, *The great stagnation: How America ate all the low-hanging fruit of modern history, got sick, and will eventually feel better*, Dutton, 2011.

8 *US productivity growth: 1995–2000*, McKinsey Global Institute, October 2001.

the greatest productivity growth in the 2000s substantially reduced employment.[9] Some of these sectors, such as ICT and media, have highly digitized workforces.

Multiple factors may explain why measured productivity during the past decade has been less than stellar despite the digital innovations all around us. First, economic statistics do not reflect the full benefits of those innovations in the lives of consumers. Many tech firms provide valuable services to consumers for free from day one, and the benefits grow over time with rapid adoption—not from consumer price declines that are more easily measured. Statistics are not capturing an important and innovative part of the economy because the productivity advance flows to unmeasured consumer surplus. Consumer surplus has always been present, but the use of free digital platforms such as Google for search, Wikipedia for information, and Facebook for instant communication has expanded dramatically in the past decade. Estimates of this new wave of consumer surplus vary widely, but some are as high as 0.7 percentage points of annual GDP growth.[10]

Second, historical methods for estimating the real prices of ICT products may not adequately account for their expanding capabilities or for changes in pricing strategy within the ICT sector. Recent research argues that it is difficult for data to capture quality improvements and innovation in digital content and new capabilities in subsequent generations of advanced software.[11] This is a crucial point, since ICT and ICT-intensive industries contributed two-thirds to three-quarters of productivity growth between 1995 and 2005 and posted some of the steepest declines in measured productivity over the past decade.[12]

Finally, as digital technologies have made big leaps in capabilities in recent years, many companies have expanded their digital assets and usage. But it can take several years for large firms (and whole sectors) to make the many organizational and operational changes necessary to capture the full benefits of ongoing digital investments.[13] Today, for instance, some firms are already realizing the benefits of investing in the Internet of Things, but many others are grappling with issues such as interoperability, the difficulty of retrofitting legacy assets, cybersecurity, and data privacy issues. As with previous rounds of ICT-enabled productivity, it may take years for these types of issues to be resolved across entire sectors. Eventually, as large companies and broader value chains make the associated improvements in processes, organizational structures, supply chains, and business models, the effects could become substantial enough to register as sector-level and finally economy-wide productivity gains.[14]

Digitization polarizes the labor market, but can help to address some of its inefficiencies

It is difficult to tease out the impact of digitization from other trends that influence job creation, such as recessions and offshoring. But some effects are apparent. Previous MGI research found that digitization has contributed to increasingly jobless recoveries from recessions. The postwar US economy took roughly six months to recover lost jobs

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9 *Growth and renewal in the United States: Retooling America's economic engine*, McKinsey Global Institute, February 2011.

10 Erik Brynjolfsson and Joo Hee Oh, "The attention economy: Measuring the value of free digital services on the Internet," 33rd International Conference on Information Systems, 2012.

11 See Jan Hatzius and Kris Dawsey, "Doing the sums on productivity paradox v2.0," Goldman Sachs, US Economics Research, issue number 15/30, July 2015. See also David Byrne, Stephen Oliner, and Daniel Sichel, *How fast are semiconductor prices falling?* NBER working paper number 21074, April 2015.

12 John Fernald and Bing Wang, "The recent rise and fall of rapid productivity growth," Federal Reserve Bank of San Francisco, *FRBSF Economic Letter,* February 2015. Also see Bart van Ark et al., *Prioritizing productivity to drive growth, competitiveness, and profitability,* The Conference Board, 2015.

13 Erik Brynjolfsson and Lorin M. Hitt, "Computing productivity: The firm-level evidence," *Review of Economics and Statistics*, November 2003.

14 Martin N. Baily and James Manyika, "Reassessing the Internet of Things," Project Syndicate, August 2015; also see Michael Spence, "Automation, productivity, and growth," Project Syndicate, August 2015.

after every recession. But it took 15 months to restore lost jobs after the 1991 recession, 39 months after 2001, and 43 months after 2008. Large companies in particular now respond to downturns with a push to improve productivity—not by increasing output and innovation but by cutting employment. As discussed above, this approach distinguished the productivity gains of the 1990s from those of the 2000s. Changes such as automation tend to become permanent, as MGI found in a 2011 survey of 2,000 US companies.[15] As a result, slowdowns now tend to hit employment hard even as productivity is unaffected.

19%
share of US employment in the most digitized sectors

Digitization has also contributed to hollowing out the middle-skill portion of the US workforce. Since 2000, the United States has created eight million net new full-time-equivalent positions; two-thirds of those have been in low-skill interactive work and the remaining one-third in high-skill interactive work. But some 2.5 million net production and transaction positions were lost during this period. Robots have supplanted assembly line workers, and software handles many of the tasks once performed by bookkeepers, secretaries, and file clerks.

In terms of wages, digitization may have accelerated a divergence between the majority of workers and a smaller group at the top.[16] The most digitized industries have posted the fastest wage growth, but they make up only about 19 percent of total US employment; digitized companies are able to generate more output and capture more profit with fewer employees. Meanwhile, average hourly wages have stagnated in real terms. Since 1980, labor productivity has grown 2.5 times faster than wages, breaking historical patterns.

However, the digital shift has had some positive effects on jobs, including the creation of new occupations that did not exist before. It also raises the prospect of using online platforms to improve the way the labor market functions (see the projection below). These platforms are already giving individual workers more mobility. Over time, their ability to aggregate data about the skills that are in demand can help individuals map out education and career pathways. The common thread running through all of these changes is that skills and continuous learning matter more than ever.

BY 2025, THREE EFFECTS OF DIGITIZATION ALONE COULD BOOST GDP BY UP TO $2.2 TRILLION—BUT THE POSSIBILITIES ARE MUCH WIDER

We consider the impact on future economic growth by focusing on three areas: the labor market, capital efficiency, and multifactor productivity. Much of this potential stems from innovations that are already percolating through the economy and could soon return large dividends. But these are just three examples of the many avenues for digitization to generate growth. The digital frontier shows no sign of slowing, and we have barely scratched the surface of the many markets that could be transformed.

First, online talent platforms could make the US labor market more efficient and transparent. As these platforms grow in scope, their ability to accelerate job searches could lower the equilibrium unemployment rate, while better job matches could have a positive effect on productivity. New digital marketplaces for services are also creating flexible work opportunities that could boost labor force participation. Prior MGI research has estimated that these effects could add $500 billion to annual GDP by 2025.[17]

Second, the Internet of Things (IoT) can improve the utilization of fixed assets. Industries with extensive machinery and factories are beginning to install IoT systems but are only at

15 *An economy that works: Job creation and America's future*, McKinsey Global Institute, June 2011.

16 Daron Acemoglu and David Autor, "Skills, tasks and technologies: Implications for employment and earnings," in *Handbook of Labor Economics*, volume 4, part B, Orley Ashenfelter and David Card, eds., Elsevier, 2011; David Autor, *Polanyi's paradox and the shape of employment growth,* NBER working paper number 20485, September 2014.

17 *A labor market that works: Connecting talent with opportunity in the digital age*, McKinsey Global Institute, June 2015.

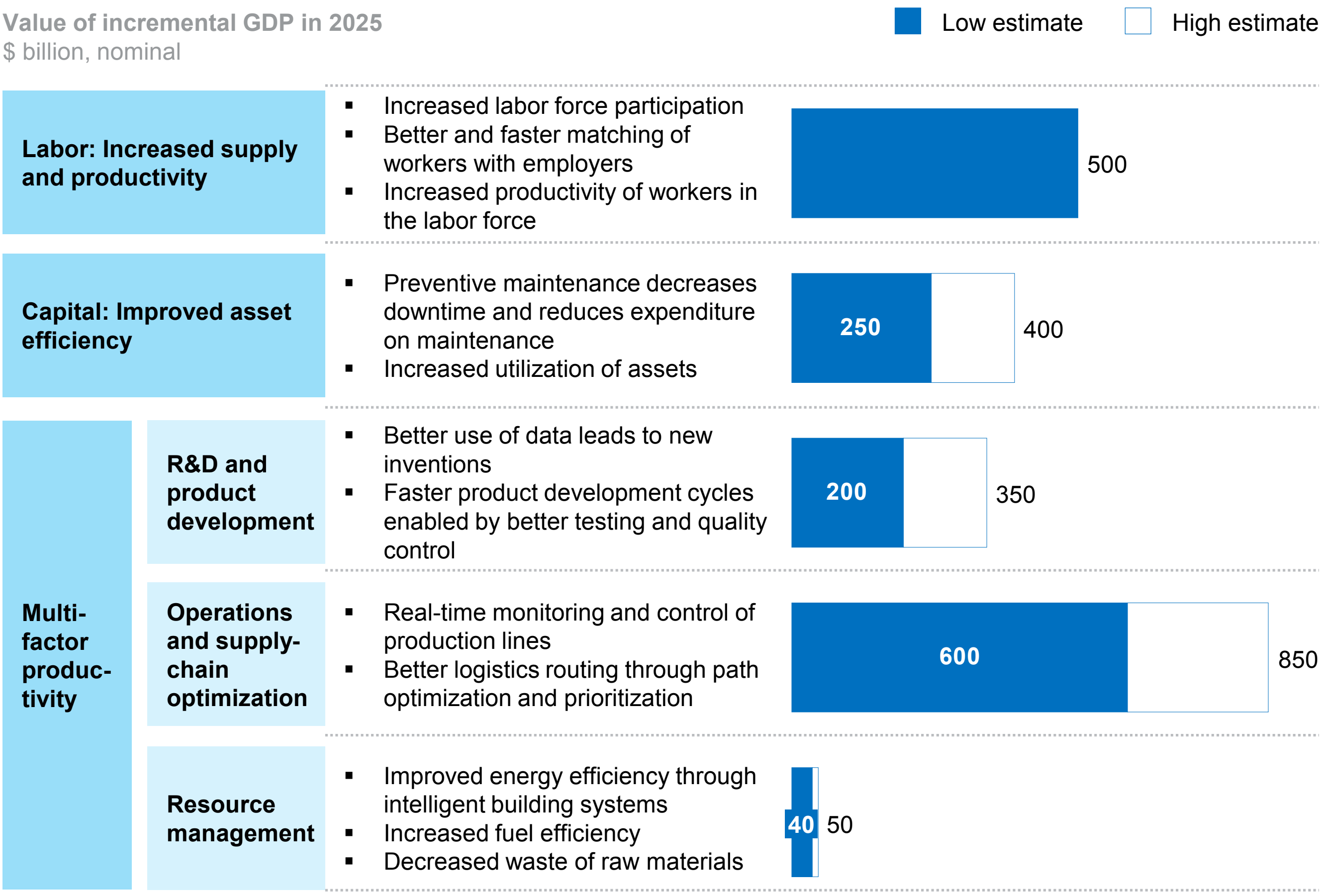
the beginning of exploiting the data they collect. Manufacturers, for example, can reduce downtime in factories with applications that signal when machinery needs preventive maintenance, while the use of sensors can boost recovery on oil rigs.[18] Improved asset efficiency could add $250 billion to $400 billion to annual GDP by 2025.

Third, companies that are investing in big data analytics and IoT technologies are still learning how to get the most out of these tools in their operations. This may involve managing the movement of costly supplies, machinery, and labor around complex worksites, or improving supply chain logistics. Mobile systems can connect employees in the field, while intelligent systems in office buildings can reduce energy use. We estimate that continued innovation in product development, operations and supply chains, and resource management could produce $900 billion to $1.3 trillion in annual GDP impact.

These impacts on labor, capital, and multifactor productivity alone could generate a combined annual impact of $1.6 trillion to $2.2 trillion by 2025 (Exhibit E5). This would lift GDP 6 to 8 percent above baseline projections for that year.

Exhibit E5

By 2025, three effects of digitization alone could boost annual US GDP by up to $2.2 trillion



These opportunities alone could add $1.6 trillion to $2.2 trillion to annual GDP by 2025. However, this sizing is not comprehensive and only reflects the applications we have analyzed in this report. The potential for technology-fueled growth is much wider.

NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

[18] For more on IoT technologies, their applications in various settings, and their economic potential, see *The Internet of Things: Mapping the value beyond the hype*, McKinsey Global Institute, June 2015.

Beyond the direct GDP impact, digitization also supports growth in more indirect ways. One of these is deepening US ties with the global economy as digital goods and services, digital platforms, and tracking technologies enable trade. And even more profound than the economic gains are the societal benefits digitization could deliver as it continues to penetrate the public and quasi-public sectors. Big data analytics in health care and government could produce some $150 billion to $300 billion in cost savings—and even bigger returns in the form of health, more effective public services, and improved quality of life.

AUTOMATION COULD REDEFINE MANY OCCUPATIONS AND ACCELERATE HISTORICAL RATES OF MIDDLE-SKILL JOB DISPLACEMENT

Historically, technological advances have usually created net jobs, but some argue that this time things are different.[19] Indeed, technology is beginning to encroach on human skills in ways once only written about in science fiction. As technology advances, there is growing anxiety about job losses, but it is important to consider that technology creates the need for new roles even as it renders others redundant. Two decades ago, occupations such as app developer, social media manager, SEO specialist, and big data analyst were not on the radar. Because many factors are in play, we do not attempt to quantify the impact of automation on net job creation. In the near future, some jobs will evolve, some will be eliminated, and others may be created—including, perhaps, entirely new roles that we cannot predict today.

Automation affects human work through its impact on individual activities and tasks, and we consider it through this lens. Some 60 percent of occupations could have 30 percent or more of their activities automated. This will affect skill requirements and the day-to-day nature of work for a large share of the labor force.[20] As companies in many industries integrate these technologies, jobs and business processes will be redefined on a large scale. Workers of all skill levels, including highly skilled professionals, will not be immune.

2x
potential increase in historical job displacement rate over the next decade

To illustrate what could unfold over the next decade, we take a closer look at the potential impact on middle-skill occupations such as clerical, sales, production, and operational roles—a segment of the workforce that has already experienced increasing job displacement over the past two decades. After analyzing a detailed list of tasks performed by these workers, we consider which ones could be automated by currently demonstrated technologies. We then map these tasks to jobs to estimate the share of employment that would be affected, applying historical adoption rates of comparable technologies. This approach considers only what is possible from a technological perspective, not whether this shift will be economically viable. Based on different adoption curves, we find that automation could displace anywhere from 10 to 15 percent of these jobs in the decade ahead. The median point of our scenario is 13 percent, which would represent a sharp acceleration of historical displacement rates (Exhibit E6).[21]

Automation is likely to lead to the creation of new products and services. Over the medium to long term, if displaced workers acquire the capabilities and training they need for new roles, the overall productivity of the US labor force could increase. But in the short term, this could be a wrenching shift for many workers.

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19 Erik Brynjolfsson and Andrew McAfee, *Race against the machine*, Digital Frontier Press, 2011.

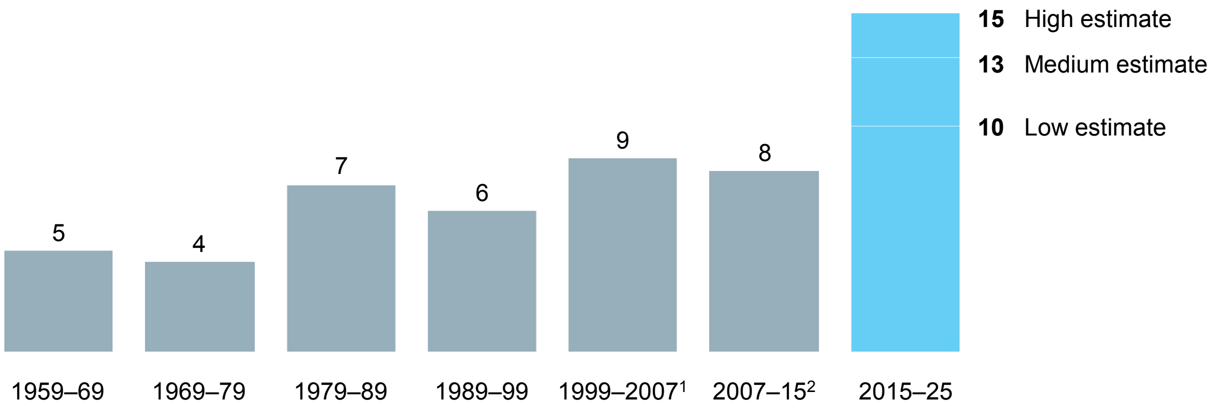
20 For more on this issue and the underlying analysis, see Michael Chui, James Manyika, and Mehdi Miremadi, “Four fundamentals of workplace automation,” *McKinsey Quarterly*, November 2015. Some 45 percent of work tasks can be automated with currently demonstrated technologies.

21 These historical displacement rates are based on Daron Acemoglu and David Autor, “Skills, tasks and technologies: Implications for employment and earnings,” in *Handbook of Labor Economics*, volume 4, part B, Orley Ashenfelter and David Card, eds, Elsevier, 2011.

Exhibit E6

Automation could accelerate the displacement of middle-skill jobs to nearly twice the rate of recent decades

Share of middle-skill jobs displaced in the US economy
%



	1959–69	1969–79	1979–89	1989–99	1999–2007[1]	2007–15[2]	2015–25
Millions of jobs displaced	2	3	5	5	6	6	8–12

1 Normalized to 10 years and adjusted for the 2008 recession.
2 Extrapolated 2015 total and middle-skill employment based on trends through 2014.

SOURCE: BLS; O*NET; Katz and Margo, 2013; Acemoglu and Autor, 2010; Brancheau and Wetherbe, 1990; McKinsey Global Institute analysis

COMPANIES HAVE TO ADAPT TO SURVIVE IN THE DIGITAL ECONOMY

Going digital can be daunting for large companies in more traditional, physical industries, and for SMEs that already find it challenging to attract talent and to invest. It demands a high level of coordination and a whole new set of capabilities. Conversely, this is an empowering moment for entrepreneurs; the barriers to entry have never been lower. The list below outlines some of the most pressing issues for companies in the areas of competition, customer engagement, and operations.

- **Prepare for tougher, 360-degree competition.** Geographic and sector boundaries mean very little in a more digital world. New competitors that look nothing like traditional industry leaders can become market leaders practically overnight. In particular, the pooling of thousands of small players in the largest marketplaces and ecosystems, such as small Chinese manufacturers on Alibaba, represents a new competitive force. Many of these small enterprises have the advantage of being “born digital.” Unburdened by legacy systems, they build digital into their business models from the outset rather than retrofitting it onto existing processes.

- **Build new assets and revenue streams.** Digital disruptors have often destroyed more value for incumbents than they have created for themselves, giving many of the benefits away to consumers. This trend may continue and even spread to additional industries. Companies have to figure out how to capture some of that surplus and create more sustainable business models. Businesses need to build a strong digital balance sheet, considering whether assets such as behavioral data or customer relationships could be monetized. Portfolio strategies can be a valuable hedge in such a fast-moving environment; businesses that rely too heavily on a single revenue stream or on playing an intermediary role in a given market are particularly vulnerable.

- **Build—or buy—the capabilities of the future.** In this competitive landscape, companies cannot afford to fall behind in critical capabilities. Some can be cultivated by establishing the right talent pipeline or building new business lines using existing resources. But sometimes companies need speed, and finding an outside partner with complementary strengths may make sense. Some larger players are turning to acquisitions to expand their portfolios and add new capabilities, talent, or a built-in user base. M&A is increasingly becoming a "land grab" as companies attempt to head off their future competitors by buying them. Some recent deals would not pass the traditional valuation filter, but the need to execute a rapid strategy, acquire high-value intellectual property, and stay on the cutting edge may call for different metrics.

- **Redefine customer engagement.** Companies can harness the data they generate from digital interactions to fine-tune marketing and customer engagement. Design is also playing a more central role in business strategy and product development; it can be critical to standing out in a noisy digital world with a multitude of distractions. As the largest platforms solidify their positions as customer gateways, many companies are forced to sell their products or services in someone else's ecosystem. That calls for careful strategies around pricing, value retention, and brand integrity.

- **Take advantage of new innovation models.** Data-sharing initiatives, crowdsourcing, and virtual collaboration can make R&D more productive. Companies are replacing closed and rigid R&D operations with more open processes involving teamwork across the organization and the supply chain. Users, too, can be engaged in co-creating brands and products. Creative partnerships may make sense so that companies from different sectors can bring distinct capabilities to technology projects. New technologies may also require cooperation with competitors and industry groups to set common standards; this is a major issue in the development of the Internet of Things and electronic medical records.

- **Emphasize agility and learning over forecasting and planning.** As technology-driven change continues to accelerate, long-term forecasting exercises are less relevant and reliable. But agility is more critical than ever. Large incumbents can't afford cumbersome decision-making processes and inertia. Borrowing a page from winning tech firms, they need a mindset focused on learning, experimenting, and iterating.

- **Think differently about your workforce.** The rapid-fire pace of technology means that companies are constantly in need of the latest skills. Investing in learning programs that allow proven employees to grow may make more sense than perpetually recruiting. Now that online hiring platforms make it easy for competitors to poach top talent, companies have to create growth opportunities and other incentives for valued employees to stay. Beyond the hiring process, leading companies are beginning to apply new types of technology tools to the goal of boosting workforce productivity.

POLICY CHALLENGES INCLUDE BUILDING PHYSICAL AND REGULATORY INFRASTRUCTURE AS WELL AS HELPING THE WORKFORCE TRANSITION

Governments have a dual challenge. In addition to setting policy, they have significant potential to digitize their own operations. South Korea, Singapore, Australia, France, the Netherlands, and Japan outscore the United States in the latest United Nations survey of e-government services, in part because the quality and extent of these services varies widely across US federal agencies and state and local governments. There is tremendous scope to deploy big data analytics in functions from procurement to tax collection and the administration of public benefits. Continuing to digitize can improve public-sector productivity and make government more transparent, responsive, and cost-effective. Policy makers can also harness digital technologies to improve societal outcomes in areas such as health care, education, and infrastructure.

- **Encourage participation.** The digital divide may be narrowing, but it still has to be bridged in order to connect the Americans who remain offline and are being bypassed by the digital economy. A crucial part of this is ensuring that the United States matches leading countries in coverage, download speeds, and affordability. But encouraging participation is about more than providing access and infrastructure; it is about enhancing digital literacy, increasing awareness of digital tools, and encouraging their adoption by consumers and workers. Government can also help entrepreneurs and small business owners develop exporting capabilities to boost their participation in global platforms and flows. Just as digital capabilities shape competition at the company and sector level, they also matter for national competitiveness in an interconnected—and increasingly digital—global economy.[22]

- **Set the rules of the game, but be prepared to learn and adapt.** Building a comprehensive policy framework will require attention to evolving issues such as privacy, data sharing, and industry concentration. Policy makers can also facilitate the development of common standards in areas such as medical data and the Internet of Things to create the foundation for innovation. Even more fundamentally, however, policy making for a more digital economy requires a new mindset. Regulatory bodies tend to presume that the rules they set will provide stability and clarity over the long term. But we are moving into uncharted territory. Ongoing innovation calls for a test-and-learn approach to policy.

- **Help individuals navigate the transition.** Policy makers cannot fend off automation, but they can support those who are affected and build the institutions and training pathways needed in a more digital economy. The first major area for action is skills development. Many of those already in the workforce will need access to short, concentrated training programs for acquiring new skills. In the longer term, there is an enormous opportunity to use the data now at our disposal to design a more effective and responsive system for education and training. Another major focus area is worker protections. If digital platforms for freelancers and on-demand service workers continue to expand, policy makers will need to clarify how project-based workers are treated under the law and consider how to modernize the system for delivering benefits.

•••

Keeping up with the relentless pace of digital innovation is both a sprint and a marathon. Individuals will have to keep developing their skills throughout their working lives and adjust to a fast-changing job market. Governments will have to build new capabilities if they hope to deliver public services more effectively and capture potential cost savings. Digitization is a gift to startups, disruptors, and small businesses—but an existential challenge for established companies. There is no room for inertia on the digital frontier. It takes investment, agility, and relentless focus to stay ahead, but the organizations and individuals that can establish themselves as digital leaders can find outsized opportunities.

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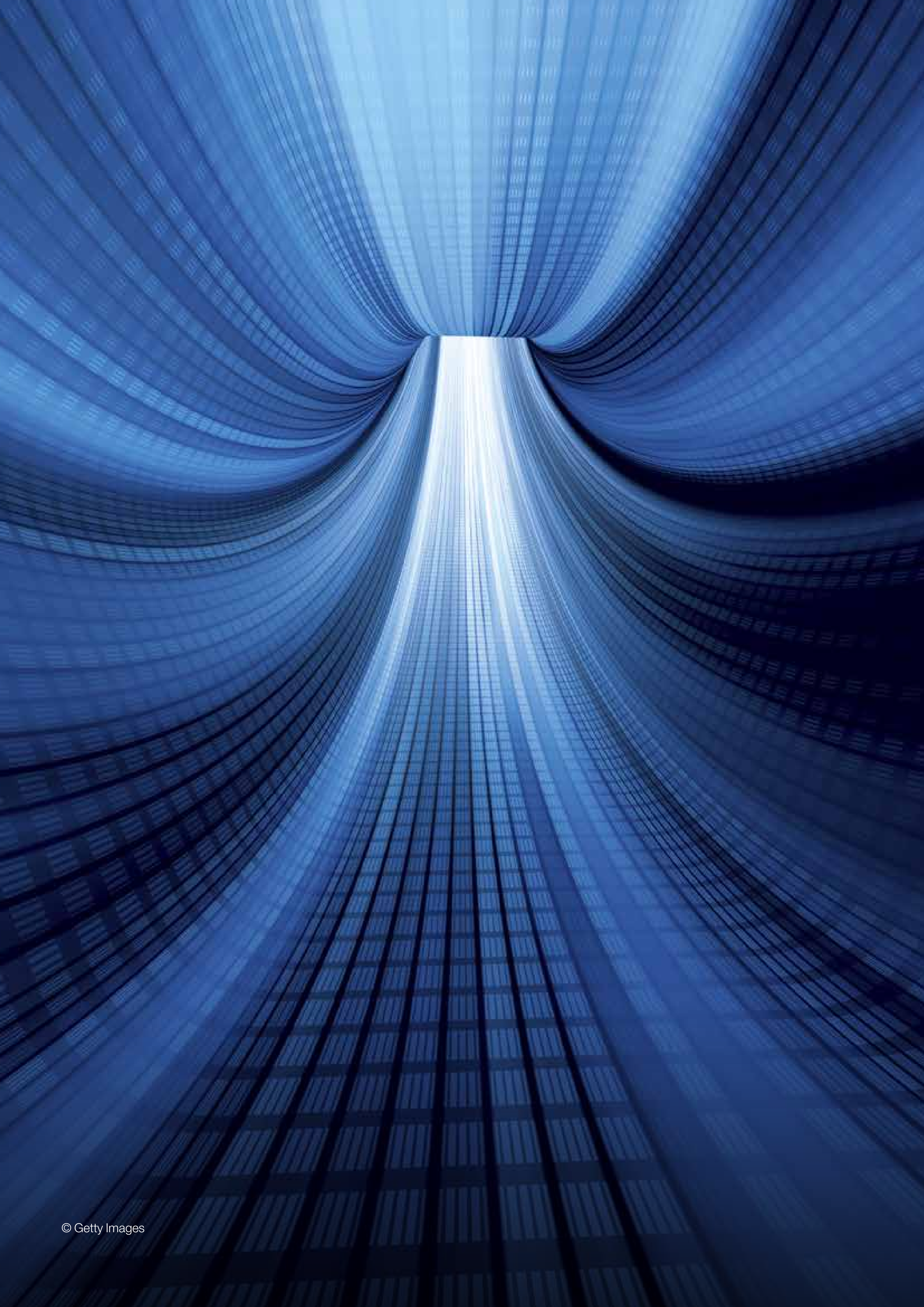
[22] See *Global flows in a digital age: How trade, finance, people, and data connect the world economy,* McKinsey Global Institute, April 2014, as well as upcoming MGI research into digitization and globalization.



1. THE US DIGITAL ECONOMY AND ITS EXPANDING FRONTIER

The United States is living through one of the most profound economic and societal transformations in its history. It is startling to step back and consider just how radically things have changed in two short decades. As recently as the early 1990s, most companies communicated via landline telephones, fax machines, photocopied memos, and the US mail. Contrast that with today's global connectivity, instant transactions, and real-time collaboration.

Technology is unleashing change at a supercharged and accelerating pace. As soon as we invest in a new digital technology and master it, a new one appears on the horizon. The speed of this phenomenon is even more remarkable when viewed in historical context. Just as the introduction of electricity shifted the world's industrialized economies into higher gear a century ago, digital technologies are fueling economic activity today. This time, however, the transformation is unfolding exponentially faster.

The ICT sector is the engine of digital innovation, but it represents only the supply side of the equation. Equally exciting but harder to quantify is what is happening on the demand side as companies, entrepreneurs, consumers, and governments acquire technology tools and put them to work. Digital is now embedded in every sector of the US economy, transforming the way companies run their operations, interact with customers, and innovate. This broader activity constitutes what we refer to as the "digitization" of the US economy.

This evolution is uneven. Our Industry Digitization Index offers a multifaceted view of how it is playing out by synthesizing multiple indicators to form a picture of how each sector is deepening its digital assets, expanding its digital usage, and creating a digitally enabled workforce. It shows that some sectors have surged ahead in the race to digitize. The rest of the economy is only about 14 percent as digitized as the most advanced sectors. In fact, given that some of the lagging sectors are the largest in terms of GDP contribution and employment, we find that the US economy as a whole is reaching only 18 percent of its digital potential (defined as the upper bounds of digitization in the leading sectors).

This wide gap between the digital "haves" and "have-mores" also applies to individual companies, workers, and consumers. Corporate competition is increasingly determined by which player makes the best use of technology. Even in less digitized sectors, there may be digital disruptors posting robust profit growth and establishing strong market positions while a long tail of small companies makes only limited use of technology. Digital skills are also becoming a prerequisite for success in the job market. The most sophisticated users operating at the frontier of technology are pulling away from everyone else and capturing a disproportionate share of the benefits associated with digitization—and those who fall behind face a growing opportunity cost.

SPEED AND CONTINUOUS ACCELERATION ARE THE MOST STRIKING ASPECTS OF THE US DIGITAL TRANSFORMATION

Technology-driven change now seems to be unfolding in faster and faster cycles. In accordance with Moore's law, computing power has doubled roughly every two years for decades. As pocket-sized gadgets with enormous processing ability have become affordable, adoption has grown along a steep exponential curve. Some 84 percent of US adults now use the Internet.[23] Smartphones have become ever-present personal command centers used by millions of Americans to manage their lives and access an endless stream of news, entertainment, and information.

58%
share of US adults who are on Facebook

The time it takes for a new digital innovation to spread widely has been steadily shrinking. The first online marketplaces were launched in the late 1990s, and by 2014, US e-commerce sales topped $300 billion.[24] Online dating similarly began to gain traction in the late 1990s, and less than two decades later, one study estimated that more than one-third of new marriages in America now begin online.[25] Facebook was conceived in a Harvard dorm room in 2004, and just a decade later, the site had attracted 58 percent of the entire adult population of the United States.[26] Six years after the first major mobile app stores opened, more than a million apps were available in the Google Play store.[27] Four years after the introduction of the iPad, 45 percent of US adults owned some kind of tablet.[28] Uber launched its ride-sharing service in mid-2010, and by the end of 2014, 160,000 of its drivers were behind the wheel in the United States—and the taxi industry had been shaken up in dozens of cities across the country.[29]

This acceleration is related to the nature of the technology itself. Digitization spread slowly at first, as early advances centered on computing power and affordability. While those trends continue, more recent innovation has focused on connectivity, platforms, data, and software—all of which have inherent network effects and can spread faster than hardware (see Box 1, "Accelerating waves of innovation"). Together these technologies have set off a virtuous cycle of innovation as they are combined and recombined in the form of new products. As consumers see the benefits and are quicker to adopt new technologies, businesses can take advantage of a critical mass of demand and a built-in audience to drive even more innovation.

BOTH FIRMS AND INDIVIDUALS OPERATING AT THE DIGITAL FRONTIER CAN CAPTURE DISPROPORTIONATE GAINS

Much has been written about the digital divide and those who remain offline, but now that digital technology has penetrated so widely, a different dynamic is taking hold. The gap between the "haves" and "have-mores" increasingly defines competition across the US economy.

Many businesses, institutions, and individuals use technology routinely and consider themselves highly digitized. But in reality, most are not even close to using digital tools to their fullest potential. Meanwhile, a smaller group of sectors, companies, and individuals operate on the digital frontier. They are first to adopt cutting-edge technologies and expand the boundaries of how they are used—and this advantage positions them for outsized gains in the form of profit growth, market dominance, wage growth, and consumer surplus.

The digital frontier is a high-risk, high-reward environment. In broad terms, the most digitized sectors in the US economy—especially software-intensive sectors such as media, professional services, and finance—tend to be highly profitable as well. Over the past 20 years, their average profit margins have grown two to three times as much as those in

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23 Andrew Perrin and Maeve Duggan, *Americans' Internet access: 2000–2015*, Pew Research Center, June 2015.

24 US Census Bureau, Quarterly Retail E-commerce Sales, 4th quarter 2014, released February 17, 2015.

25 John T. Cacioppo et al., "Marital satisfaction and break-ups differ across online and offline meeting venues," *Proceedings of the National Academy of Sciences of the United States of America*, volume 110, number 25, June 2013.

26 *Social media update 2014*, Pew Research Center, January 2015.

27 As of 2014, according to company website and Kenneth Olmstead and Michelle Atkinson, "Apps permissions in the Google Play store," Pew Research Center, November 2015.

28 "Technology device ownership: 2015," Pew Research Center survey.

29 Jonathan Hall and Alan Krueger, *An analysis of the labor market for Uber's driver-partners in the United States*, January 2015.

less digitized sectors (Exhibit 1).[30] Even *within* these sectors, the margin spreads between the top-performing companies and the lowest performers are two to four times as large as in non-digitized sectors.[31] In other words, the most digital sectors are developing a winner-take-all dynamic. But at the same time, digitization seems to intensify competitive churn.[32] Today's market leaders are vulnerable to being knocked off by the next wave of innovation.

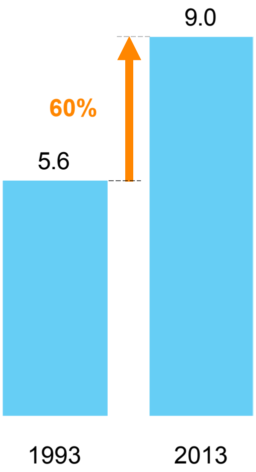
Digitized firms are typically positioned to capture more opportunities regardless of their size. Small firms that sell on digital platforms, for example, are significantly more likely to export than those that sell offline.[33]

Exhibit 1

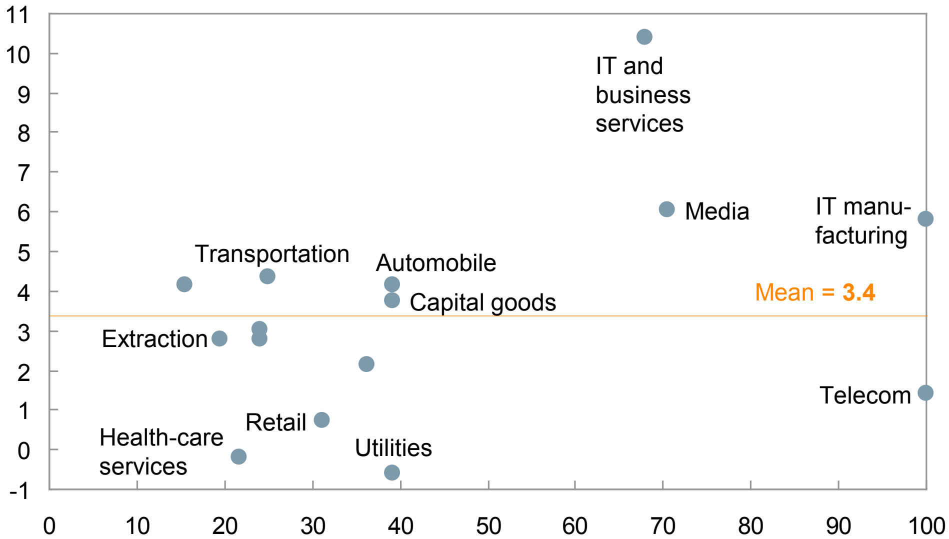
US profit margins have risen 60 percent in two decades, with industries on the digital frontier at the forefront

Growth in profit margin vs. digitization, select US non-financial industries

Profit margin growth, 1993 vs. 2013
3-year average for all non-financial industries
%



Change in post-tax profit margin, 1993 vs. 2013
3-year averages



Overall digitization[1]
Composite score measuring digitization of assets, usage, and labor (maximum = 100)

1 Measured using a set of 27 metrics spanning the three dimensions of digitization: assets (eight metrics, including spending on digital assets and the stock of digital assets), usage (11 metrics, including transactions, business process, interactions, and market making), and labor (eight metrics, including digital capital deepening, share of occupations that are digital, and share of tasks that are digital).

SOURCE: McKinsey Corporate Performance Analysis Tool; BEA; McKinsey Global Institute analysis

30 At the industry level, the impact of digitization cannot be easily separated from other factors such as demand growth, pricing power, competitive intensity, or industry structure. Yet the correlation between digitization and profitability is striking. However, some exceptions are worth noting: the pharmaceutical industry is highly profitable but not very digitized, and the retail industry is highly digitized but with relatively low average profit margins.

31 *Playing to win: The new global competition for corporate profits*, McKinsey Global Institute, September 2015.

32 Andrew McAfee and Erik Brynjolfsson, "Investing in the IT that makes a competitive difference," *Harvard Business Review*, July-August 2008.

33 *Global flows in a digital age: How trade, finance, people, and data connect the world economy*, McKinsey Global Institute, April 2014.

Box 1. Accelerating waves of innovation

The digitization of the US economy has occurred in a series of waves, each arriving faster than the last (Exhibit 2). The first waves were primarily concerned with business usage. The mid-1990s brought a huge spike in consumer adoption, which in turn supported more innovation aimed at deepening audience engagement.

The digital age got under way in the mid-1960s as large corporations adopted mainframes and databases. These giant machines might occupy entire rooms or floors, and they offered basic analytics capabilities that represented a leap forward at the time. Two decades later, the desktop and personal computer phase enabled greater business use—and introduced computers into American homes. Later in the 1980s came the spread of enterprise software, which turned the PC into a more powerful tool for enhancing business productivity.

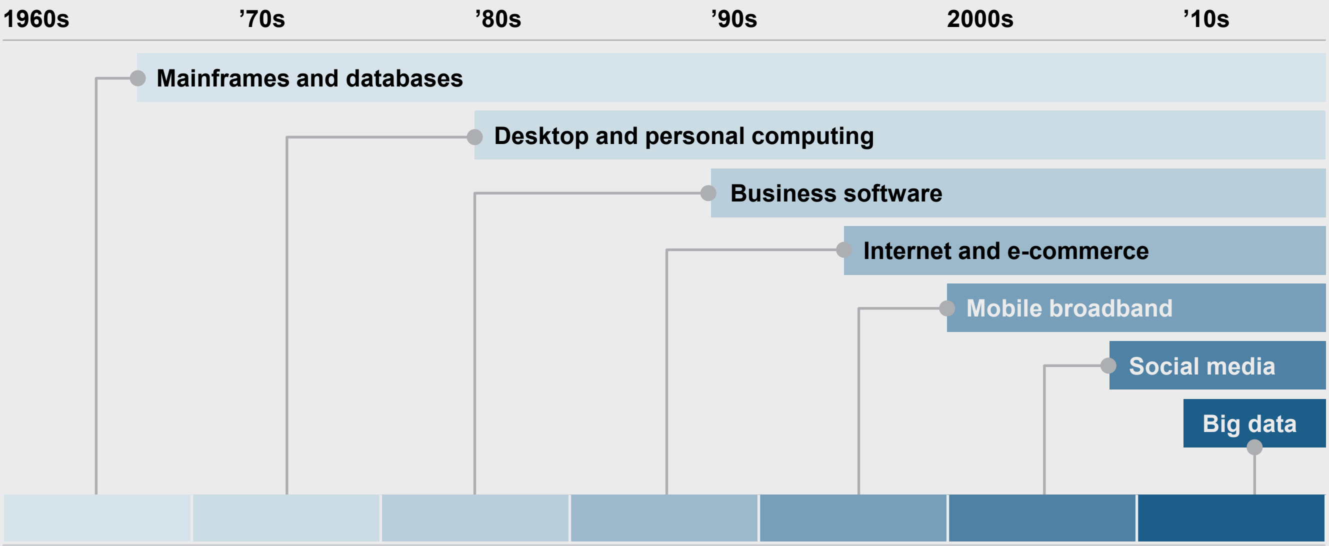
Connectivity and commerce came more fully into play in the mid-1990s, as the wired Internet began to change the way people communicated, shopped, and accessed information. The Internet went wireless in the 2000s, as the mobile broadband phase created 24/7 personal connectivity and the age of the mobile app. Hard on its heels came the rise of social media, which ushered in public sharing of the personal.

Today we are stepping into the age of big data, advanced analytics, and the Internet of Things. The ability to capture and analyze enormous troves of data and establish machine-to-machine connectivity has significant potential to improve the efficiency of fixed assets such as machinery, oil fields, and buildings; it can also help companies streamline their operations in ways that were not possible before. This development could deliver a significant boost to GDP and productivity in the decade ahead.

As each advance builds on what has come before and amplifies it, the waves are continuing to roll in faster succession and with greater disruptive force. The gap between the first two waves was roughly 15 years, while fewer than five years separated the two most recent waves. This rapid evolution is putting exciting possibilities within reach, but it also creates new stresses as individuals and organizations race to adapt to the next new thing.

Exhibit 2

Successive waves of innovation have shaped the digital economy



Assets/technologies							
	▪ Modern programming languages ▪ Algorithmic advancement	▪ Desktops and PCs ▪ Basic office software ▪ Games and visual graphics	▪ Enterprise software	▪ Internet technologies ▪ Personal computing	▪ GPS ▪ Wi-Fi, 2G/3G ▪ Laptops ▪ Mobile phones	▪ Social media ▪ Smartphones and apps	▪ Smart devices and sensors ▪ Predictive algorithms, machine learning
Business impact							
	▪ Business calculations, analyses ▪ Database management systems	▪ Document processing ▪ File storage	▪ Efficiency and automated business processes	▪ B2B and B2C e-commerce ▪ Email, chat	▪ Remote work and 24/7 connectivity	▪ Digital advertising and marketing	▪ Predictive analytics, natural language, big data, Internet of Things
People impact							
	▪ Limited	▪ Individuals with computers in larger firms ▪ Gaming and document processing	▪ Creative destruction of jobs	▪ Email, e-chatting, and VoIP ▪ E-commerce ▪ Remote work via VPNs	▪ Connected anytime, anywhere	▪ Multiple devices per person ▪ Individuals as content creators	▪ Data generation content creation ▪ Digital devices everywhere, consuming hours each day

SOURCE: McKinsey Global Institute analysis

This pattern of digital leaders winning big applies even to consumers. One study found that only 20 percent of individual users capture 60 percent of that surplus, while the bottom 50 percent capture just 20 percent.[34] The average consumers who use their smartphones for communication, occasional entertainment, and basic searches are not taking advantage of the full range of applications that can create real efficiencies and value.

Digital disparities are becoming especially stark in the world of work. Workers with the most sophisticated digital skills are in high demand (see Box 2, "The worker on the digital frontier"). In 2014, LinkedIn analyzed more than 300 million member profiles worldwide to determine the most important skills for improving job prospects. The top five skills, ranging from cloud computing to data mining and information security, all relate to the digital economy.[35] Wages in digital occupations (such as computer programming) are more than double the median annual wage.[36] In contrast, workers with more limited digital capabilities are concentrated in the sectors and occupations that have seen little job growth and increasing wage pressures. In industries with high penetration of digital tools and technologies, such as professional services and ICT, wage growth is much faster than the national average. As with profits, the wage spread is higher in industries with a high share of digitized tasks, indicating a similar winner-take-all dynamic for the small group of workers with advanced skills.

[34] *Consumers driving the digital uptake: The economic value of online advertising-based services for consumers*, IAB Europe, September 2010.

[35] Sohan Murthy, "The 25 hottest skills that got people hired in 2014," LinkedIn blog, December 17, 2014.

[36] Sara Royster, "Working with big data," *Occupational Outlook Quarterly,* Bureau of Labor Statistics, fall 2013.

Box 2. The worker on the digital frontier

The highly digital worker may be part entrepreneur, part free agent. She navigates the labor market with confidence and is willing to blaze a non-traditional career path. Because her skills are her currency, she invests time and money in e-books and online courses on sites like Coursera to make herself more valuable and stay up to date. She carefully cultivates her online profile on platforms such as LinkedIn, supplementing it with endorsements from former colleagues and work samples from previous jobs; she also uses it to network by participating and commenting in professional group discussions. Her profile catches the eye of recruiters and hiring managers even when she is not actively job hunting. When she is offered an opportunity, she goes online to read what anonymous current and former employees have to say about her potential employer and then negotiates on the basis of their salary data.

Her productivity is unmatched. She knows every keyboard shortcut in Microsoft Office and writes Excel macros and simple C# scripts to take care of repetitive, time-consuming tasks. She communicates with her team remotely through videoconferencing and platforms such as Slack or Yammer; they collaborate on projects in real time using file-sharing tools. When her team needs to call in additional help, she turns to a digital marketplace to hire an expert freelancer who is available on short notice.

But instead of working full-time for one employer, she may find that it is feasible to strike out on her own. New options are available for find freelance work via digital marketplaces. She can take on temporary assignments as a web developer, tutor, or translator by marketing her services on platforms such as Upwork or Freelancer.com. She can generate income in other ways as well: buying and selling on Craigslist, eBay, or Etsy; driving for Uber or Lyft; or renting out her spare room through Airbnb.

If she has an idea for developing a product or service, she has the ability to launch a full-fledged business. She can create her own storefront on one of the major e-commerce platforms, or she can develop and sell an app through iTunes or the Google Play store. She can market her product through social media or take advantage of those same freelance platforms to call in temporary project help for the product launch. She can get the start-up capital she needs through crowdfunding and microlending sites. The options have never been wider for individuals who value flexibility and have an entrepreneurial bent.

Digital innovation is also outpacing the ability of the public sector to keep up, in part because it is difficult to lure highly skilled technical talent away from more lucrative private-sector opportunities. Federal, state, and local governments have as many digital assets as the US financial sector, but the US ranking for e-governance has been falling in the past few years as other countries have poured resources into this area.[37] Some US federal agencies and local governments are standouts, pioneering new and innovative ways to engage with citizens and streamline services. But at a broad level, other countries are making faster progress in using technology to deliver government services. According to a 2014 survey, only 32 percent of US states offer online driver's license renewals, only 24 percent are capturing and managing big data, and only 12 percent have implemented a health and human services case management system.[38] See Chapter 4 for a more detailed discussion of digital use in the US public sector.

THE DIGITAL ECONOMY AND THE US ECONOMY ARE BECOMING SYNONYMOUS

Many observers who have tried to quantify the impact of technology have focused exclusively on the ICT sector. Our analysis begins there, but its primary focus is on how deeply these digital technologies are penetrating the rest of the economy and the myriad ways they are being used to create value.

The ICT sector, which includes IT hardware, software, data processing, Internet publishing, telecom, and IT services, forms the heart of the digital economy. The biggest US tech companies have defined the way the world uses the Internet. Silicon Valley is synonymous worldwide with digital innovation, and the ICT sector is an important engine of US competitiveness.

Having enjoyed years of spectacular growth, the US ICT sector accounts for 4.3 million jobs, or 3.2 percent of US employment, and it represents one of the economy's bright spots for wage growth. This relatively small workforce posts extraordinary productivity; it generated some $855 billion in value added in 2014. The sector drives one-third of US private-sector R&D spending and produces 40 percent of all US patents.

17%
share of business investment directed to technology

Official GDP statistics do not reflect the ICT sector's real impact on the broader economy. The sector grew from 2.5 percent of US GDP in 1965 to a peak of roughly 5.5 percent in 1997. Surprisingly, this share stood slightly lower in 2014, at about 5 percent of GDP. While this puts ICT on par with the size of the US retail sector, this slight decline seems fundamentally at odds with two decades of rapid digitization. But the direct GDP contribution of the ICT sector has been constrained by significant price declines that are sharper than those experienced in any other sector.

In real terms, the price of ICT goods and services tumbled by 63 percent between 1983 (near the beginning of the desktop and PC wave) and 2010. This decline was especially steep through the 1990s, and particularly so for digital hardware. This trend put more powerful and sophisticated technology within reach for users across the economy. If we account for this price decline and its benefit to other sectors that buy ICT goods and services, adjusting for price elasticity of demand, the ICT sector would represent some 10 percent of US GDP in 2014. This would make it the fourth-largest sector of the US economy after government, real estate, and manufacturing.

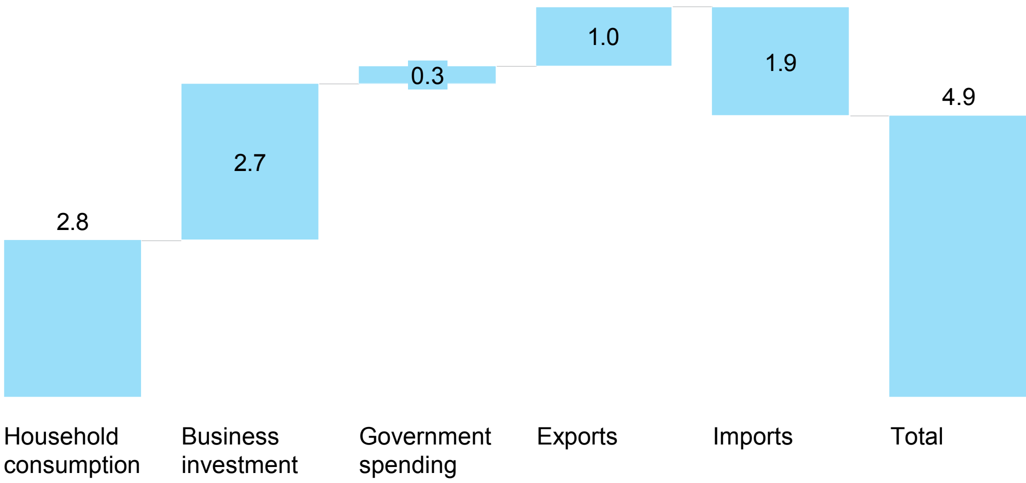
[37] UN e-government survey, United Nations, 2008 through 2014.
[38] 2014 digital states survey, Center for Digital Government, September 2014.

Breaking down the components of the sector's GDP reveals that consumers are a force propelling the digital economy just as they are in the traditional economy. Household consumption and business investment each account for 45 percent of the ICT sector's output, with government spending making up the rest (Exhibit 3). Moreover, household digital consumption has clear growth momentum, while both corporate and government spending in the digital economy have remained flat since 2000. This reflects the fact many recent innovations have focused on engaging individual users rather than boosting business productivity. However, business investment accounts for a much greater share of GDP in the ICT sector than it does in the overall economy (where it drives 15 percent of output). International trade is another driver of GDP, but US net trade in ICT goods and services is actually negative due to large and fast-growing imports of technology hardware.

Exhibit 3

The ICT sector represents 5 percent of US GDP, driven by a disproportionately large share of business investment

US ICT contribution, 2014
% of total GDP



ICT as a % of each component of US GDP	4	17	2	8	12	5

NOTE: Numbers may not sum due to rounding.

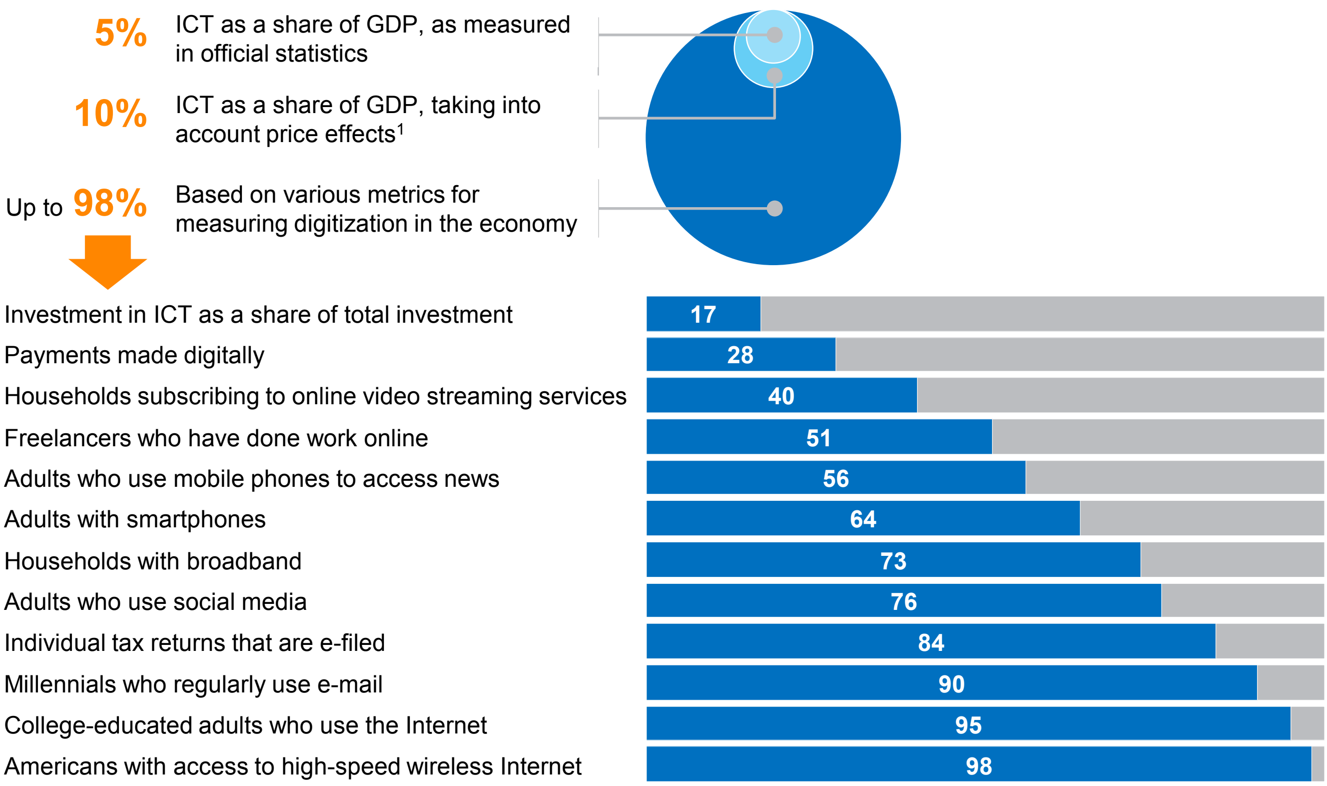
SOURCE: BEA; McKinsey Global Institute analysis

But the ICT sector is only a sliver of a far broader phenomenon. Like electricity, digitization is a general-purpose technology that underpins and enables a huge share of economic activity well beyond the sector that supplies it. The real story is what happens when the technologies and tools launched by the ICT sector are put into the hands of millions of users across the economy (Exhibit 4).

Exhibit 4

Digitization now touches most Americans and most of the US economy

Share of US economy impacted by digitization
Various metrics, 2014 or latest



1 Factoring in real price declines in ICT goods and estimating the benefits to non-ICT sectors based on their ICT purchases, adjusting for price elasticity of demand.

SOURCE: BEA; BLS; Pew Research Center; the White House; Nielsen; IRS; US Census Bureau; McKinsey social technology survey; McKinsey Payments Map; McKinsey Global Institute analysis

Over the past 30 years, digital assets in the US economy have grown five times faster in dollar terms than non-digital assets such as industrial machinery. This is particularly striking since the price of digital assets has fallen by more than half in this period. If their prices had simply stayed flat, digital assets would have grown more than 10 times faster than other assets. The ICT share of all private fixed assets has climbed from 2 percent in 1990 to 7 percent today, and some 17 percent of business investment is directed to technology.

Now that most companies have invested in ICT equipment, growth is being powered by expanding usage, which includes the myriad ways that users are creating efficiencies and value from digital. More than 80 percent of companies responding to a recent McKinsey survey, for example, report using digital social technologies such as online videoconferencing or social networking.[39] More than two-thirds of US adults have smartphones, and the shift toward mobile has led to skyrocketing usage in areas such as e-commerce and digital payments.

39 "Organizing for change through social technologies: McKinsey Global Survey results," November 2013.

SOME INDUSTRIES ARE HIGHLY DIGITIZED, WHILE OTHERS HAVE SIGNIFICANT UPSIDE TO CAPTURE

Companies that buy ICT assets may assume they have made the leap and the benefits will start to flow. But the real value lies in putting digital tools in the hands of the workforce and continuously expanding the way they are used. There is no single formula for successfully going digital, as a look across different industries reveals (Exhibit 5). Because this process is dynamic and complex, understanding how it is playing out across various sectors requires a multidimensional view.

Exhibit 5

Industries are digitizing in different ways

Indexed variables: 100 = maximum (most digitized industry)

SOURCE: BLS; BEA; McKinsey Digital Payments Map; McKinsey Global Institute analysis

The MGI Industry Digitization Index examines sectors across the economy through three different lenses: digital assets, digital usage, and digital workers. Within each of these categories, we compile multiple indicators to capture the many possible ways in which companies are digitizing (Exhibit 6).[40] To measure digital assets, for instance, we consider business spending on computers, software, and telecom equipment, as well as the stock of ICT assets, the share of assets such as robots and cars that are digitally connected, and total data storage. Usage metrics include an industry's use of digital payments, digital marketing, and social technologies, as well as the use of software to manage both back-office operations and customer relationships. On the workforce side, we evaluate more than 12,000 detailed task descriptions to identify those associated with digital technologies (such as database administration). We also estimate the share of workers in each sector in technology-related occupations that did not exist 25 years ago, and we determine digital spending and assets on a per-worker basis.

The index shows large disparities among various sectors (Exhibit 7). There are clear leaders across all metrics. Beyond the ICT sector, which often sets the standard for full digitization, the most highly digitized parts of the economy are media, professional services, and financial services. These industries typically have higher profit margins but also sharper variations in performance across firms, which indicates that a winner-take-all dynamic is emerging.

The index also highlights room to grow in other parts of the economy. Some asset-intensive sectors have significant catching up to do, and these are exactly the areas where companies are stepping up digital investment to improve productivity. Heavy industries such as utilities, mining, and manufacturing are in the early stages of connecting their physical assets, and their adoption of the Internet of Things may place them at the forefront of the next wave of digitization.

Some service industries do not yet conduct a large share of digital transactions. Many small local restaurants, entertainment establishments, contractors, and personal service providers still operate with cash or checks. Thousands of small retailers across the country have few if any digital operations beyond accepting credit cards—a striking contrast with Amazon, Walmart, or Zappos. Other industries have a B2B focus and may lag in digital transactions because they have relatively few large customers and suppliers—and a human touch has value in many B2B relationships.

Industries with large, relatively low-skill workforces rank lower on metrics for digitizing labor. In these industries, labor is less expensive, so it may be more cost-effective to hire additional workers rather than investing in digital tools for them. Many of these workers do use digital technologies (such as point-of-sale systems in hospitality and retail), but these tools typically require lower investment on a per-worker basis because they are shared by multiple employees.

40 The data for these metrics are primarily obtained from public sources such as the Bureau of Economic Analysis and the Bureau of Labor Statistics. It also draws on the publicly available Occupational Information Network (O*NET) database, which includes information obtained via worker surveys on the required skills, time spent on various tasks, and work settings for a wide range of occupations. Furthermore, we use McKinsey & Company proprietary data that were obtained in client and consumer surveys. See the technical appendix for further detail on the metrics and weightings used.

Exhibit 6

Metrics included in the MGI Industry Digitization Index

	Metric	Description
Assets		
Digital spending	**Hardware spending**	Share of total expenditures spent on ICT hardware (e.g., computers, servers)
	Software spending	Share of total expenditures spent on software (e.g., enterprise resource planning [ERP] software)
	Telecommunications spending	Share of total expenditures spent on telecommunications (e.g., broadband access, mobile data services)
	IT services spending	Share of total expenditures spent on IT services (e.g., IT consulting, IT architecture and implementation)
Digital asset stock	**Hardware assets**	Share of total assets made up of ICT hardware (e.g., computers, servers)
	Software assets	Share of total assets made up of software (e.g., purchased software licenses)
	Connected equipment	Share of equipment embedded with digital connections (e.g., oil rigs outfitted to transmit data on yield)
	Data storage	Data stored per firm, measured in terabytes, for firms with at least 1,000 employees
Usage		
Trans-actions	**Digital transactions**	Share of payments and transfers, both from consumers to businesses (C2B) and from businesses to other businesses (B2B) made through digital means (e.g., payments via ACH or wire)
Interactions between firms, customers, and suppliers	**Digital external communications**	Composite score based on share of firms reporting benefits from using social technologies to interface with customers and share of firms reporting benefits from using social technologies to work with partners
	Digital customer service	Composite score based on average number of customer service chats per month and share of total contact center calls routed by automated systems, i.e., integrated voice response (IVR) or automated speech recognition (ASR) technology
Business processes conducted internally	**Digitized back-office processes**	Composite score based on adoption of enterprise resource planning (ERP) software (e.g., SAP, Oracle) across the industry, and share of firms reporting that technology is very integrated into employees' daily activities
	Digitized front-office processes	Composite score based on adoption of customer relationship management (CRM) software (e.g., Salesforce.com) across the industry and digital marketing (e.g., email, banner and search engine advertisements) expenditures, as an estimated share of total marketing expenditures
	Product development software intensity	Intensity of software usage in product development process (e.g., for computer-assisted design)
Market making	**Digitally enabled markets**	Extent to which digital platforms are being used to connect supply with demand, calibrated using the relative size of digital bid-ask or auction-based markets (in terms of users, transactions, and/or revenues)
Labor		
Digital spending	**Hardware spending on workers**	ICT hardware (e.g., computers, servers) expenditures per full-time-equivalent employee (FTE)
	Software spending per worker	Software (e.g., enterprise software licenses) expenditures per FTE
	Telecommunications spending per worker	Telecommunications (e.g., broadband access, mobile data services) expenditures per FTE
	IT services spending per worker	IT services (e.g., IT consulting, IT architecture and implementation) expenditures per FTE
Digital capital deepening	**Hardware assets per worker**	ICT hardware assets (e.g., servers, computers) per FTE
	Software assets per worker	Software assets (e.g., worker software licenses) per FTE
Digitization of work	**Share of tasks that are digital**	Time-weighted share of worker tasks involving digital tools or processes (e.g., tasks requiring workers to input information via tablet, conduct online research, or perform analyses with spreadsheet software). Based on a search for digital keywords (e.g., data, computer, software) in a publicly available database of worker tasks
	Share of jobs that are digital	Digital jobs (e.g., computer and information systems managers, hardware engineers, telecommunications equipment installers and repairers) as a share of total jobs

SOURCE: McKinsey Global Institute analysis

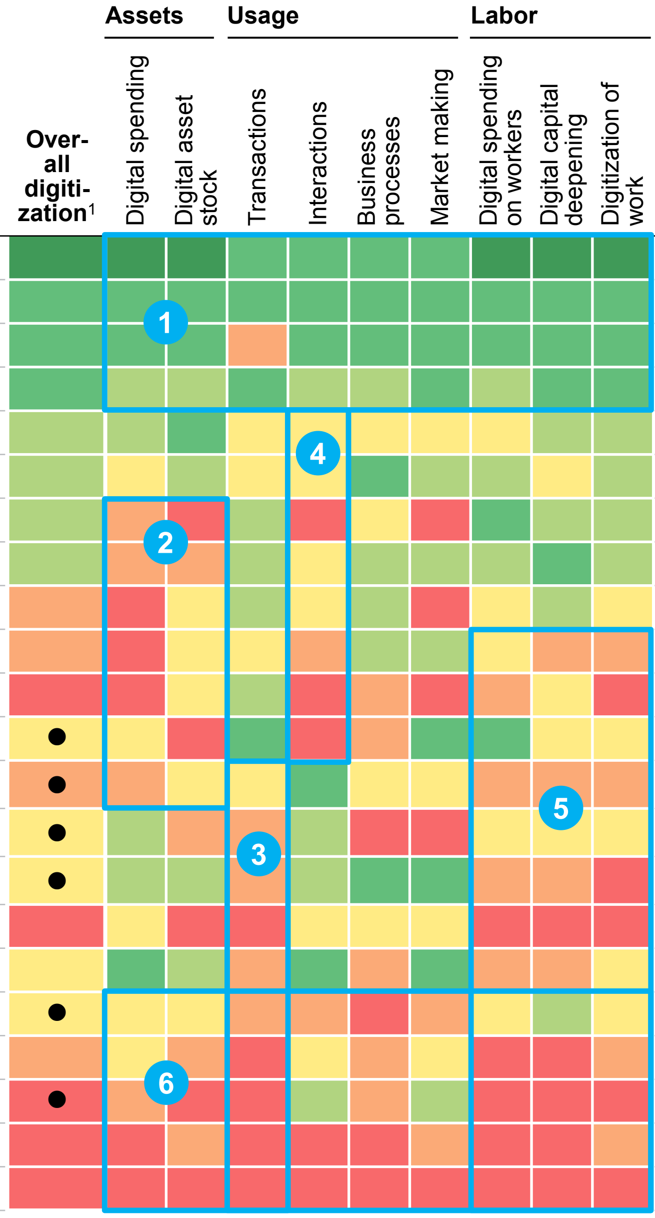
Exhibit 7

The MGI Industry Digitization Index

2015 or latest available data

Relatively low digitization — Relatively high digitization

● Digital leaders within relatively undigitized sectors



Sector	Over-all digiti-zation[1]	GDP share %	Em-ploy-ment share %	Produc-tivity growth, 2005–14[2] %
ICT		5	3	4.6
Media		2	1	3.6
Professional services		9	6	0.3
Finance and insurance		8	4	1.6
Wholesale trade		5	4	0.2
Advanced manufacturing		3	2	2.6
Oil and gas		2	0.1	2.9
Utilities		2	0.4	1.3
Chemicals and pharmaceuticals		2	1	1.8
Basic goods manufacturing		5	5	1.2
Mining		1	0.4	0.5
Real estate	●	5	1	2.3
Transportation and warehousing	●	3	3	1.4
Education	●	2	2	-0.5
Retail trade	●	5	11	-1.1
Entertainment and recreation		1	1	0.9
Personal and local services		6	11	0.5
Government	●	16	15	0.2
Health care		10	13	-0.1
Hospitality	●	4	8	-0.9
Construction		3	5	-1.4
Agriculture and hunting		1	1	-0.9

1. Knowledge-intensive sectors that are highly digitized across most dimensions
2. Capital-intensive sectors with the potential to further digitize their physical assets
3. Service sectors with long tail of small firms having room to digitize customer transactions
4. B2B sectors with the potential to digitally engage and interact with their customers
5. Labor-intensive sectors with the potential to provide digital tools to their workforce
6. Quasi-public and/or highly localized sectors that lag across most dimensions

1 Based on a set of metrics to assess digitization of assets (8 metrics), usage (11 metrics), and labor (8 metrics); see technical appendix for full list of metrics and explanation of methodology.
2 Compound annual growth rate.

SOURCE: BEA; BLS; US Census; IDC; Gartner; McKinsey social technology survey; McKinsey Payments Map; LiveChat customer satisfaction report; Appbrain; US contact center decision-makers guide; eMarketer; Bluewolf; Computer Economics; industry expert interviews; McKinsey Global Institute analysis

The standard for what it means to be highly digitized today will be outdated tomorrow—and the digital leaders are constantly adding new types of usage and using technology to augment what their workers can do. Across 18 indicators in the index for which historical data are available, we compare the most digitized sector with the rest of the economy. This provides a proxy for understanding the size of the gap between the digital "haves" and "have-mores." We find that most sectors were only 12 percent as digitized as the leaders in 2005. Despite a massive rush of adoption and change in the intervening years, the rest of the economy was operating at only 14 percent of the leaders' digital capacity in 2013 (Exhibit 8).

18%
share of its digital potential that the US economy is actually realizing

In other words, many sectors and companies have scrambled to keep up, but they have barely narrowed their considerable gap with the digital leaders. This underscores just how much the digital leaders are doing and the difficulty of keeping pace with them. But it also points to substantial room for much of the economy to generate additional productivity growth. Since some of the lagging sectors are the largest in terms of GDP contribution and employment, we find that the US economy as a whole is reaching only 18 percent of its digital potential (defined as the upper bounds of digitization in the leading sectors).

WHAT DRIVES SECTORS TO DIGITIZE?

Sectors such as finance, professional services, and retail were early movers, having begun a wave of IT investment in the 1980s that has continued ever since. Other sectors remain at an earlier stage of evolution. In many sectors, companies with extensive physical assets are in the initial phases of using digital tools to make those assets more efficient. This raises the question of why some sectors made a decisive and early shift toward digitization while others did not.

We find that four factors drive a sector to become digitized: firm size, complexity of operations, knowledge and skill content, and the threat of competition.

Across all sectors, large companies are more likely than small firms to adopt digital tools, especially when the small firms are mom-and-pop establishments rather than tech or tech-related startups (such as small online merchants that sell on Amazon or eBay). In digitally advanced sectors such as professional services or retail, large firms are three times more likely than small firms to make digital payments to their suppliers. In less digitized sectors such as health care or construction, large firms are eight to 10 times more likely to use digital payments than small firms (Exhibit 9).[41]

Business complexity also drives the decision to digitize. Digital usage is more common in sectors in which companies have multiple establishments. The average US retailer manages 157 establishments, while the average financial services company has 124 establishments.[42] This demands a level of coordination that digital tools can make vastly easier. Within the goods sector, where companies tend to have fewer establishments such as factories, supply chain length is an indicator of complexity. Digital usage is critical to large automotive or aerospace manufacturers, with their extensive supplier networks.

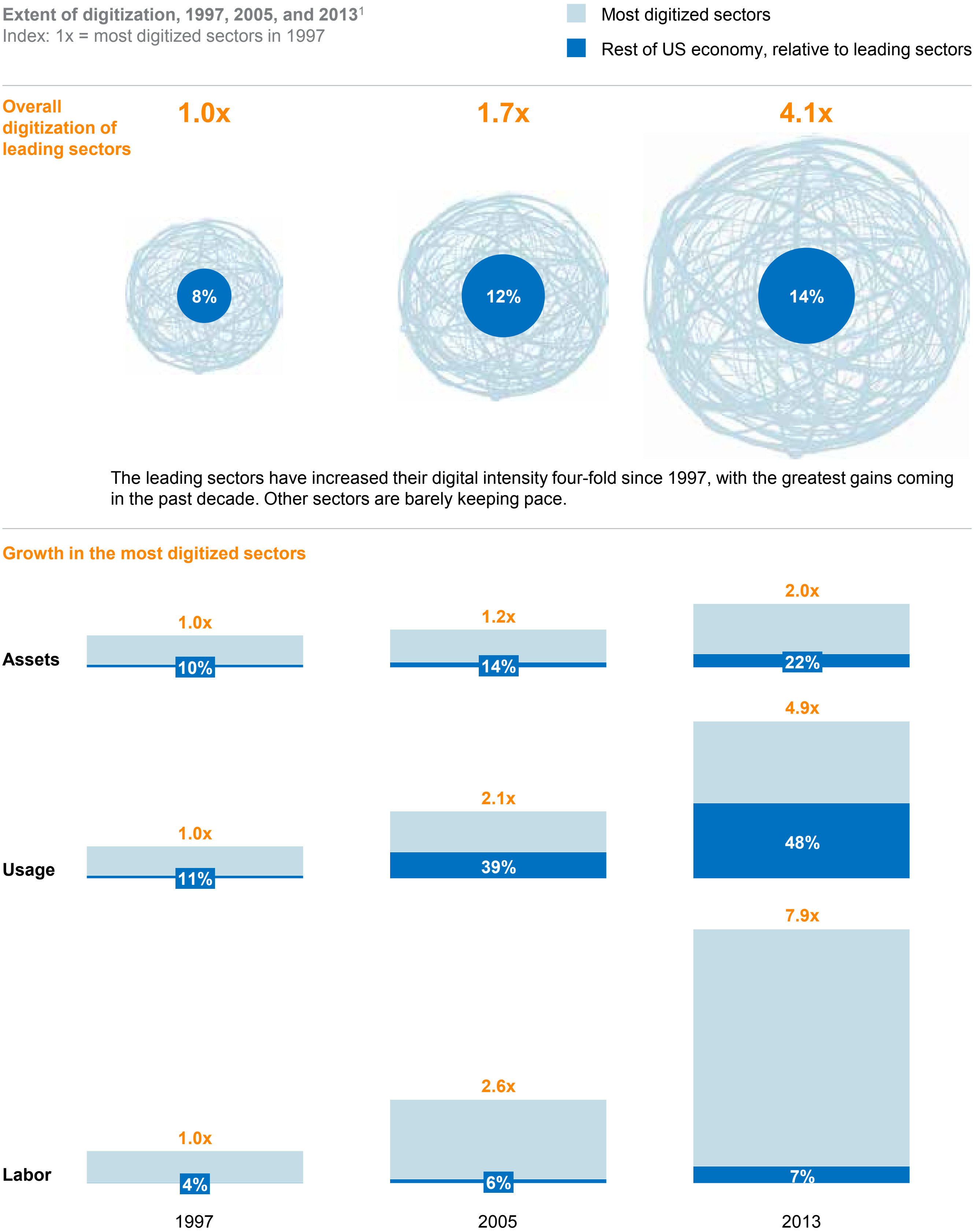
The importance of knowledge assets and human capital within a given industry is another deciding factor. In service sectors such as finance, professional services, and information, creative thinking, problem solving, and human interaction are the most important aspects of work. The use of digital tools to automate non-interactive, routine tasks in these sectors frees up highly skilled workers to focus on higher-value-adding work, improving overall labor productivity. Digital assets play a similar role in advanced manufacturing.

41 McKinsey Digital Payments map.
42 US Census Bureau.

Exhibit 8

The most digitized sectors are maintaining a considerable lead over the rest of the US economy

Extent of digitization, 1997, 2005, and 2013[1]
Index: 1x = most digitized sectors in 1997



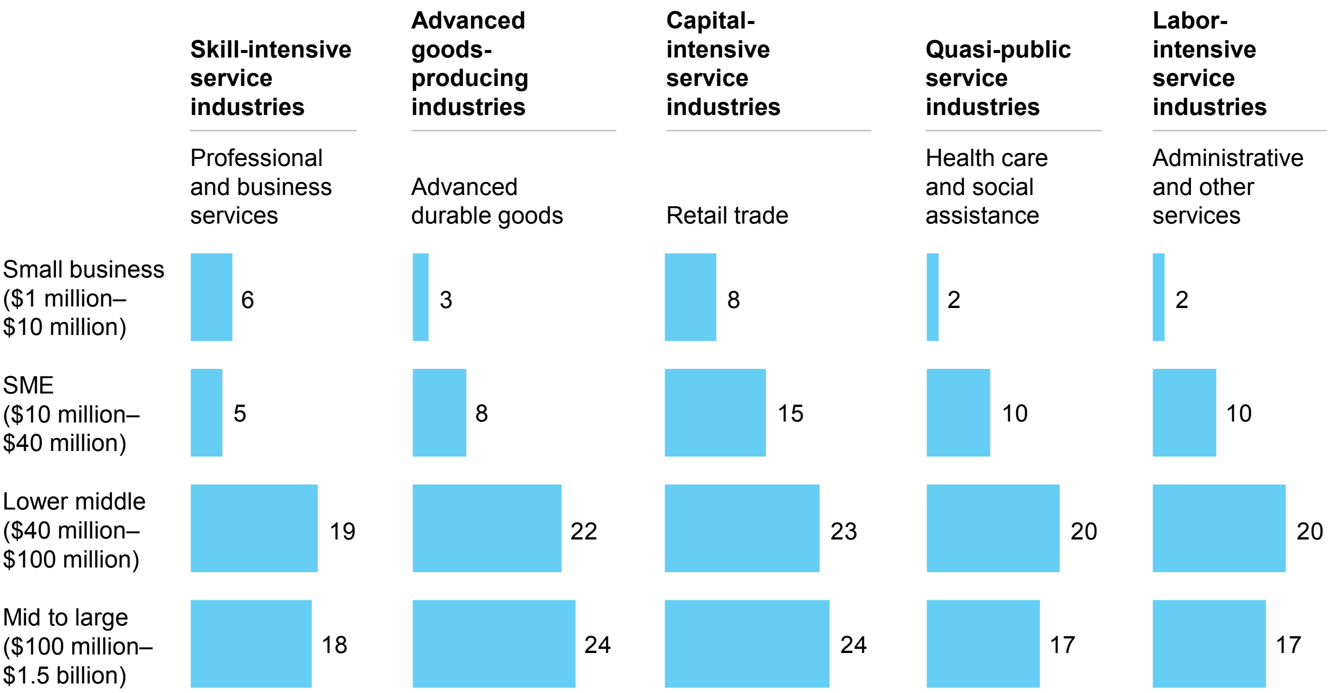
1 Measured using a set of 18 historical metrics spanning assets (6 metrics, including spending on digital assets and the stock of digital assets), usage (6 metrics, including digital transactions), and labor (6 metrics, including digital capital deepening).

SOURCE: BLS; BEA; McKinsey social technology survey; McKinsey Digital Payments Map; Gartner; ARP Research; DMA; eMarketer; McKinsey Global Institute analysis

Exhibit 9

Larger firms are more likely to be digitized

Digital payments as a share of total payments by firm size (by revenue)
%



SOURCE: McKinsey Payments Map; CTN Survey; McKinsey Global Institute analysis

Finally, the threat of competition, especially from disruptive new business models, prompts firms to digitize. Digital asset intensity rose sharply in telecom, transportation, utilities, and finance at the time that these sectors were deregulated. Tradable services such as finance, information and professional services are more exposed to global competition, and are also more digitized than other services. The threat of impending competition is a greater spur to digitize than actual degree of competition; for instance, business entry and exit rates in a sector (a measure of competitive churn) have no clear link to digitization intensity.

•••

Even as new waves of innovation expand what is possible on the digital frontier, existing technologies continue to become more deeply embedded into the US economic and social fabric. These sector-wide shifts represent thousands of firms reinventing the way they operate, hire, and compete. Industries are being shaken up by new business models and fast-moving challenges. Chapter 2 will take a closer look at how technology is changing the way the United States does business.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2. DIGITAL'S IMPACT ON COMPANIES AND COMMERCIAL ECOSYSTEMS

For companies, going digital is not just about purchasing IT systems and automating certain transactions. When done right, it involves questioning every process from end to end and potentially reinventing many of them. This is not an easy transition to manage, but the most successful firms have been able to realize a major payoff through digital initiatives that focus on streamlining operations, deepening customer relationships, taking innovation to the next level, and making their workforce more productive.

As the first movers push the frontier forward in a given industry, other companies are being forced to adapt in order to compete. When a critical mass of individual companies goes digital, the effects eventually ripple through entire industries. The dynamics are changing rapidly in many commercial ecosystems. This transformation is uneven, but no sector is unaffected by these sweeping changes.

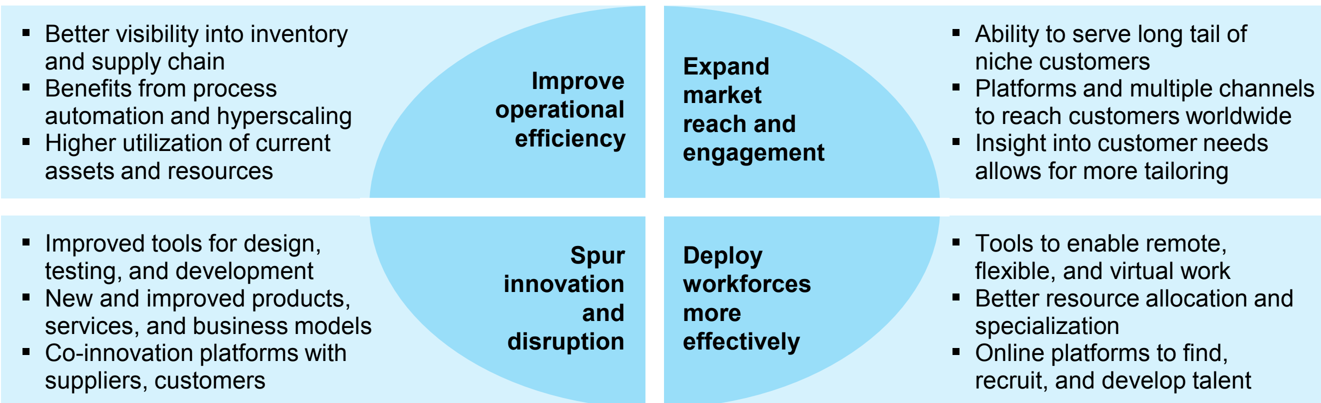
Across the economy, new marketplaces are proliferating, digital platforms are putting traditional middlemen out of business, and value chains are breaking apart. But this disruption is creating openings for competitors and creating channels for engaging more deeply with customers. Some of the most highly digitized industries are developing a winner-take-all dynamic as leading companies take advantage of the network effects and low marginal costs associated with controlling a major platform to expand their customer base and carve out a dominant market position. And traditional industry boundaries are becoming increasingly porous as highly digitized firms—small and large, new and established, domestic and foreign—branch out into new business lines and challenge incumbents in industries well beyond the tech sector.

DIGITIZATION ALLOWS INDIVIDUAL FIRMS TO OPERATE, INNOVATE, AND ORGANIZE MORE EFFECTIVELY

Digital involves a new way of doing everything. Precisely because it demands such wide-ranging and holistic changes, it can be difficult to pinpoint specific impacts. But across multiple industries, companies are successfully using digital technologies to raise the bar in four key areas: improving operational efficiency, reaching and retaining customers, enabling better innovation and collaboration, and organizing workforces more effectively (Exhibit 10).

Exhibit 10

Digitization allows firms to operate, innovate, and organize more effectively



SOURCE: McKinsey Global Institute analysis

Making a leap forward in operational efficiency

Many companies have followed a common pattern when aiming for efficiency gains through digital; they focus first on their internal operations, then shift the emphasis outward toward supply chains and customers. Retailers, for example, have been in the vanguard of deploying technology to manage complexity. The sector's first wave of digitization in the 1980s included database management systems, client-server platforms, and enterprise resource planning software to manage operations across multiple stores, with all of the information linking back to centralized platforms for functions such as payroll and billing.

Up to
15%
potential productivity gains from selling through digital channels

In the 1990s, Walmart pioneered the use of handheld computers for tracking thousands of SKUs as well as satellite-based tracking technology in delivery trucks.[43] It eventually became common practice across the industry to monitor inventory and returns in real time with RFID (radio-frequency identification) tags, and these systems were expanded to include suppliers. Digital tools also made it possible to source from a wider array of vendors.

In the past two decades, e-commerce has steadily grown, injecting new efficiency into the retail sector (Exhibit 11). Previous MGI research estimated that selling through digital channels could produce productivity gains of 6 to 15 percent.[44] In addition to offering customers a streamlined and convenient user experience, companies can use digital tools to trim costs, positioning themselves to offer competitive prices.[45] Amazon, conceived from the beginning as a fully digital retailer, has pushed the boundaries on this front with innovations such as predictive algorithms for related products, bundled promotions, and dynamic pricing. It has also heavily digitized logistics, with robots deployed in its warehouses. Following Amazon's lead, all of the major players have boosted analytics investment in recent years, and traditional brick-and-mortar names have transformed themselves into multichannel retailers.

This pattern is apparent in other sectors as well. McKinsey analysis has shown that for retail banks, the cost savings associated with improved operational efficiency represent the biggest financial gains from digitization (Exhibit 12). Banking institutions have created automated digital systems such as process apps to transform low-risk back-office functions into paperless workflows. Retail banks have shifted many in-person transactions to ATM, online, and mobile channels, which involves creating seamless customer interfaces across these platforms.[46] Credit card issuers and banks alike are tapping into extensive customer data to detect fraud and improve risk management in lending.

Industrial and energy companies are now similarly digitizing to streamline operations. GE, for example, is building passenger jet engines using 3D printing to produce parts from digital files. More broadly, the company is rolling out a "Brilliant Factory" concept across all of its manufacturing facilities, collecting data that can be analyzed to minimize downtime, inform product development, and tighten coordination with suppliers.[47] Energy firms are creating "intelligent" oil and gas fields using big data analytics, sensors, and control systems to monitor well integrity and environmental conditions, conduct preventive maintenance on machinery, and maximize recovery.[48]

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[43] Natalie Berg and Bryan Roberts, *Walmart: Key insights and practical lessons from the world's largest retailer*, Kogan Page Limited, 2012.

[44] *Disruptive technologies: Advances that will transform life, business, and the global economy*, McKinsey Global Institute, May 2013.

[45] Shahar Markovitch and Paul Willmott, "Accelerating the digitization of business processes," *McKinsey.com Insights & Publications*, May 2014.

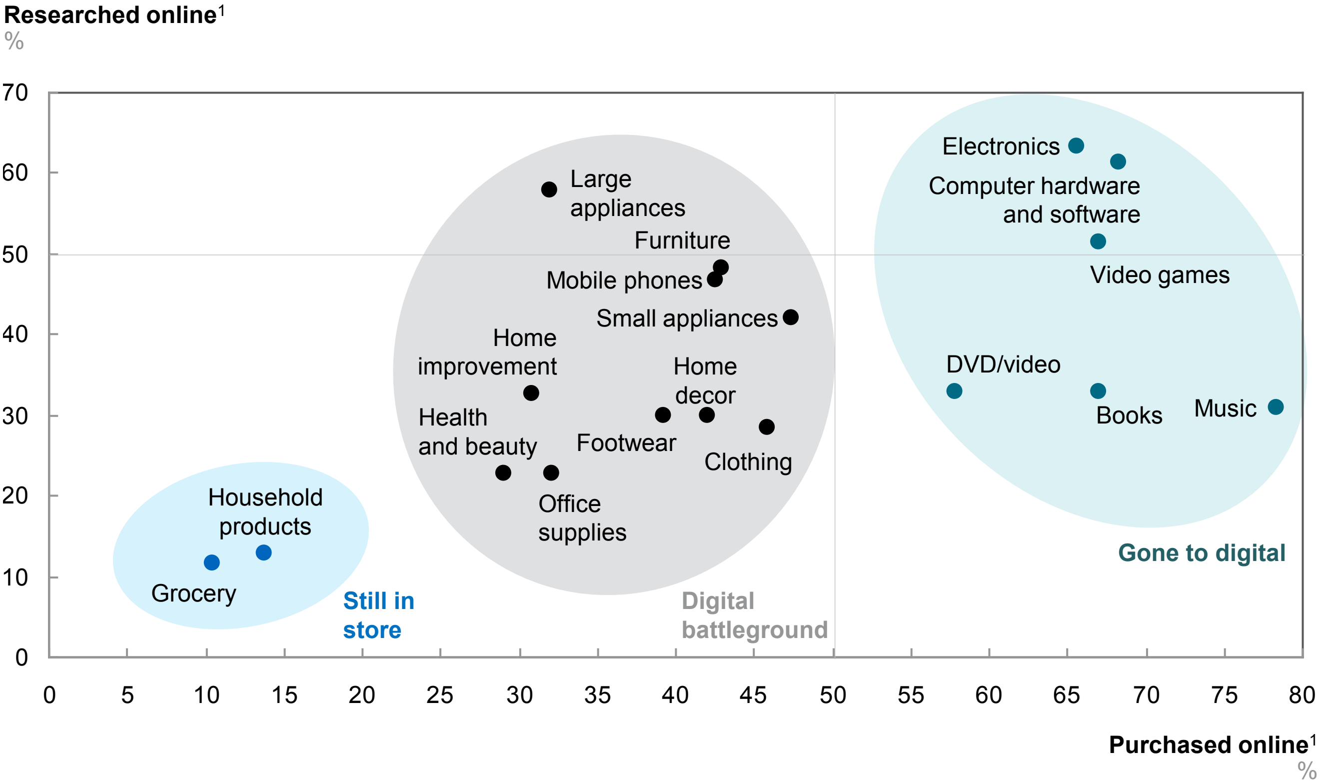
[46] Henk Broeders and Somesh Khanna, "Strategic choices for banks in the digital age," *McKinsey.com Insights & Publications*, January 2015.

[47] Tomas Kellner, "Personalized production: The Brilliant Factory will match the right parts with the right tools, says GE manufacturing maven Christine Furstoss," GE Reports corporate blog, March 27, 2015.

[48] Stefano Martinotti, Jim Nolten, and Jens Arne Steinsbe, "Digitizing oil and gas production," *McKinsey.com Insights & Publications*, August 2014.

Exhibit 11

Customers are going online to make purchases in a broad range of product categories

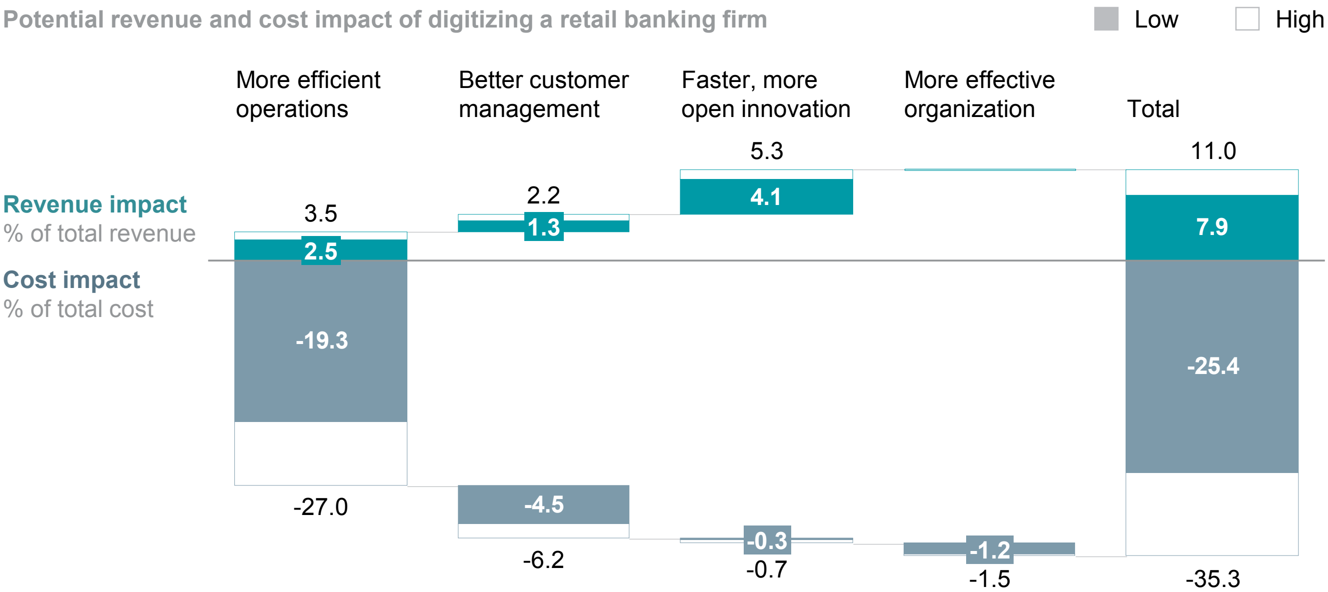


1 As a percentage of those who bought a product in the respective category in the last 6 months.

SOURCE: McKinsey TMT Digital Insights 2014 US yearly survey

Exhibit 12

Digitizing a retail bank can yield substantial cost savings, notably in back-office processes



NOTE: Revenue growth based on flow increase over 3-5 years, excludes disruptive plays and growth of stock. Bottom-up impacts estimates are based on 16 initiatives spanning organization and talent, enhanced data analytics, customer engagement and marketing, end-to-end customer journey transformation, and agile development and delivery processes. Numbers may not sum due to rounding.

SOURCE: McKinsey Digital and Financial Services practice

Expanding market reach and deepening customer insights and engagement

Digitization is about much more than automating transactions; it can also help companies reach new markets. E-commerce, for example, makes it possible for companies to serve "long-tail" demand for niche or customized products and services.[49] Similarly, digitization is allowing content providers to focus on niche audiences. The share of independent labels in Billboard's top 200 albums rose from 13 percent in 2001 to 35 percent in 2010.[50]

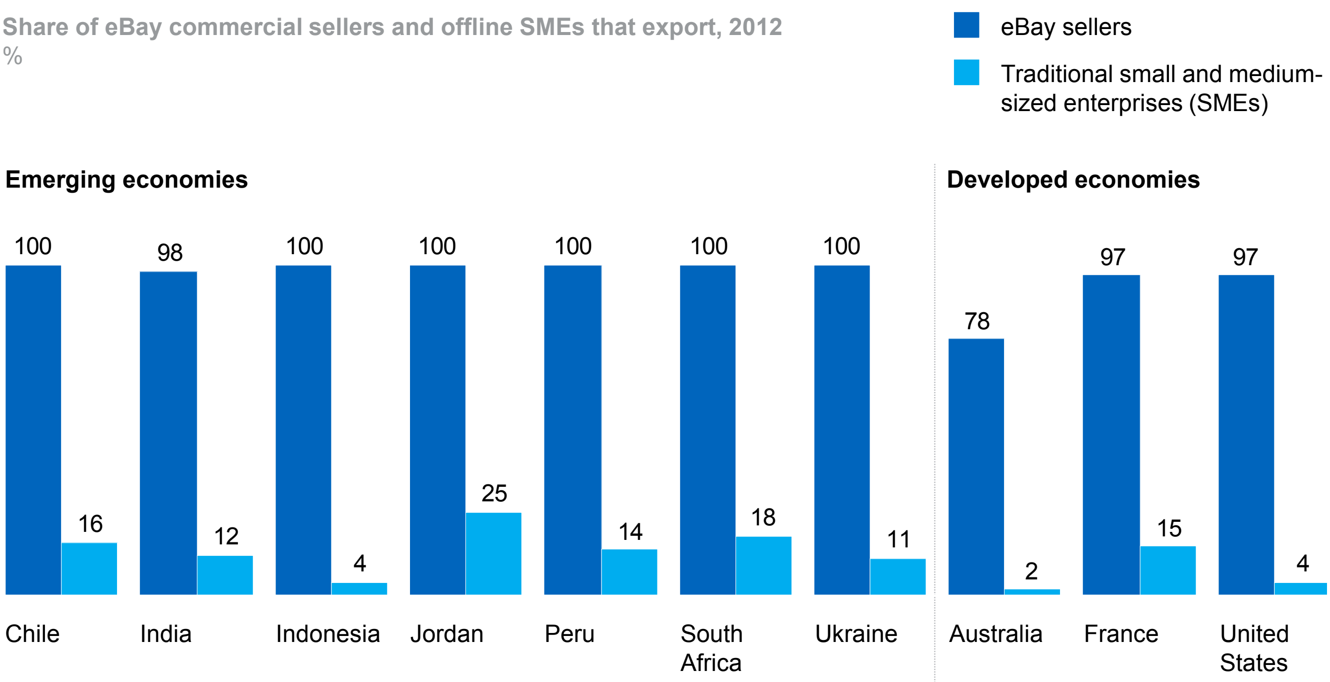
Conversely, digitization allows companies to connect with a broader base of customers, unconstrained by geography. Netflix expanded its business model from mailing out DVDs to selling subscriptions for online streaming, and it has become an increasingly international business in the process. By 2014, almost a third of its streaming customers were outside the United States.[51]

Small firms can become global players overnight by joining one of the biggest e-commerce platforms, such as Amazon or eBay. These digital marketplaces offer entrepreneurs a way to scale up with minimal startup costs; they provide "plug-and-play" solutions that include the kind of secure payment systems, logistics support, and global visibility once reserved for large firms. On eBay, for instance, more than 90 percent of commercial sellers export goods to customers in foreign countries, compared with less than 25 percent in the case of traditional small businesses in most countries (Exhibit 13).[52] Even individuals can position themselves to sell to global customers. Etsy, a digital market for goods made by artisans and small producers, supported $2 billion in sales in 2014, more than one-third of which were international.

Exhibit 13

Online platforms enable businesses to attain global reach that comparable offline businesses have not achieved

Share of eBay commercial sellers and offline SMEs that export, 2012
%



SOURCE: Enterprise surveys, World Bank, 2012; Australia Bureau of Statistics, 2012, 2007; eBay; McKinsey Global Institute analysis

[49] Erik Brynjolfsson, Yu (Jeffrey) Hu, and Michael D. Smith, *The longer tail: The changing shape of Amazon's sales distribution curve*, September 2010.

[50] Joel Waldfogel, "Digitization and the quality of new media products: The case of music," in *Economic analysis of the digital economy*, Avi Goldfarb, Shane Greenstein, and Catherine Tucker, eds., NBER, 2015.

[51] Netflix 10K filing, 2014.

[52] *Global flows in a digital age: How trade, finance, data, and people connect the world economy*, McKinsey Global Institute, April 2014.

Digitization is not just about reaching customers, however; it allows companies to learn more about them and use those insights to engage with them more deeply. Here again retailers have been at the forefront, gathering data from point-of-sale information, smartphone tracking, in-store customer behavior analysis, and online searches and reviews. The insights gleaned from this information can be used to fine-tune pricing strategies, store layouts, and merchandising assortments. Discount offers, for example, can be personalized based on demographics, purchasing history, and other factors.[53]

Beyond the retail sector, the insurance business has always been built on gathering and understanding actuarial data. Now insurers are just beginning to look for ways to apply next-generation technologies to expand these capabilities and use them to shape product offerings. Progressive Insurance, for example, has started using telematics via a small device plugged into a car to analyze its customers' actual driving patterns. It can then provide additional discounts for drivers it deems "safe" and raise prices on those who appear more likely to be involved in accidents.

Spurring innovation and open collaboration

Digital tools open up new modes of collaboration. For manufacturers, product life-cycle management systems can combine the large data sets generated by computer-aided design, engineering, and production systems. These platforms allow engineers to test different designs and components, creating huge savings in product development. Industrial manufacturers can capture data on post-sales usage and functionality and weave those insights into the design-to-value process.

In aerospace and defense, innovation needs to span an enormously complex supply network. A modern jet turbine engine, for instance, has hundreds of individual parts, some made by the primary manufacturer and others sourced from dozens of vendors. Making one design modification can affect many components. Cloud computing–based tools can allow suppliers to collaborate more efficiently: an engine maker can share three-dimensional models of component design within its network, and each supplier in turn can share information about price, delivery, and quality. This type of information sharing can reduce risk and speed workflow. Boeing developed airframes for its 777 and 787 jets using all-virtual design, reducing time to market by more than 50 percent.[54]

Using digital tools to improve R&D productivity has particularly exciting applications in the pharmaceutical industry. The vastly bigger data sets available from electronic medical records, remote monitoring devices, and clinical settings can accelerate drug development. Statistical tools and algorithms can improve recruitment and protocol design in clinical trials; they can also analyze the results and spot potential side effects earlier on.

Digitization also makes crowdsourcing possible. Pharmaceutical companies such as Boehringer Ingelheim and AstraZeneca have used innovation platforms to stage data-analysis contests or work with academics, nonprofits, and other partners across all stages of drug discovery.[55] More broadly, many major pharmaceutical firms are beginning to share data from clinical trials.[56] In fact, the crowdsourcing model has applications in many sectors, from product development in consumer packaged goods to financing startups via platforms such as Kickstarter and Kiva.

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53 *The social economy: Unlocking value and productivity through social technologies*, McKinsey Global Institute, July 2012.

54 Brian Hartmann, William P. King, and Subu Narayan, "Digital manufacturing: The revolution will be virtualized," *McKinsey.com Insights & Publications*, August 2015.

55 Jacques Bughin, Michael Chui, and James Manyika, "Ten IT-enabled business trends for the decade ahead," *McKinsey Quarterly*, May 2013.

56 See, for example, projectdatasphere.org.

Deploying workforces more effectively

Digitization also allows firms to organize themselves in new and more efficient ways. Technology is automating many repetitive tasks, which can free up employees for higher-value work. Data insights can also help companies identify productive workers and combine demand forecasting with scheduling tools so that staffing is adequate at peak times. Companies in fields ranging from technology to health care have used digitization to split multifaceted jobs into more discrete tasks, enabling flexible and virtual work arrangements.[57]

The ability of talent platforms to codify skills can improve the way resources are allocated. Consider its uses in hospital systems, for example. Nurses must be continuously matched to departments and cases based on specialized training, doctor preferences, availability, and technical requirements. Sophisticated software can better deploy the substantial “float pool” of nurses and per diem physicians. Real-time communication tools can help front-line medical personnel immediately access specialists.[58]

Digital tools such as broadband, cloud computing, VoIP phones, internal social networking platforms, file sharing, and video conferencing can help people work more efficiently from wherever they happen to be. This enables remote, flexible, and virtual work that was never before possible—and that capability is extremely valuable for professional services firms.

Above all, online talent platforms have changed the way companies find the talent they need. The individual profiles aggregated on sites such as LinkedIn, Monster.com, and Indeed.com make it possible to recruit “passive” candidates who may not even be job hunting. There are also sophisticated digital tools for applicant screening and testing, onboarding, team formation, and performance feedback. Digital marketplaces for freelancers make it easier for employers to call in outside help for specific assignments—and they can dramatically lower costs for small companies that need specialized help, from accounting to marketing assistance for a product launch.

DIGITIZATION IS TRANSFORMING INDUSTRY STRUCTURES, PROFITABILITY, AND COMPETITION IN A RANGE OF COMMERCIAL DOMAINS

The firm-level changes described above eventually create spillover effects across entire industries (Exhibit 14). In many cases, we are seeing fierce price competition, shifting profits, and increased competitive churn.

Below we examine some of the new dynamics that are reshaping commercial ecosystems. Many industries are experiencing more than one of these shifts, and even those that have been unaffected so far have to brace themselves. Disruption could hit anywhere as new technologies, business models, and competitors appear with incredible speed.

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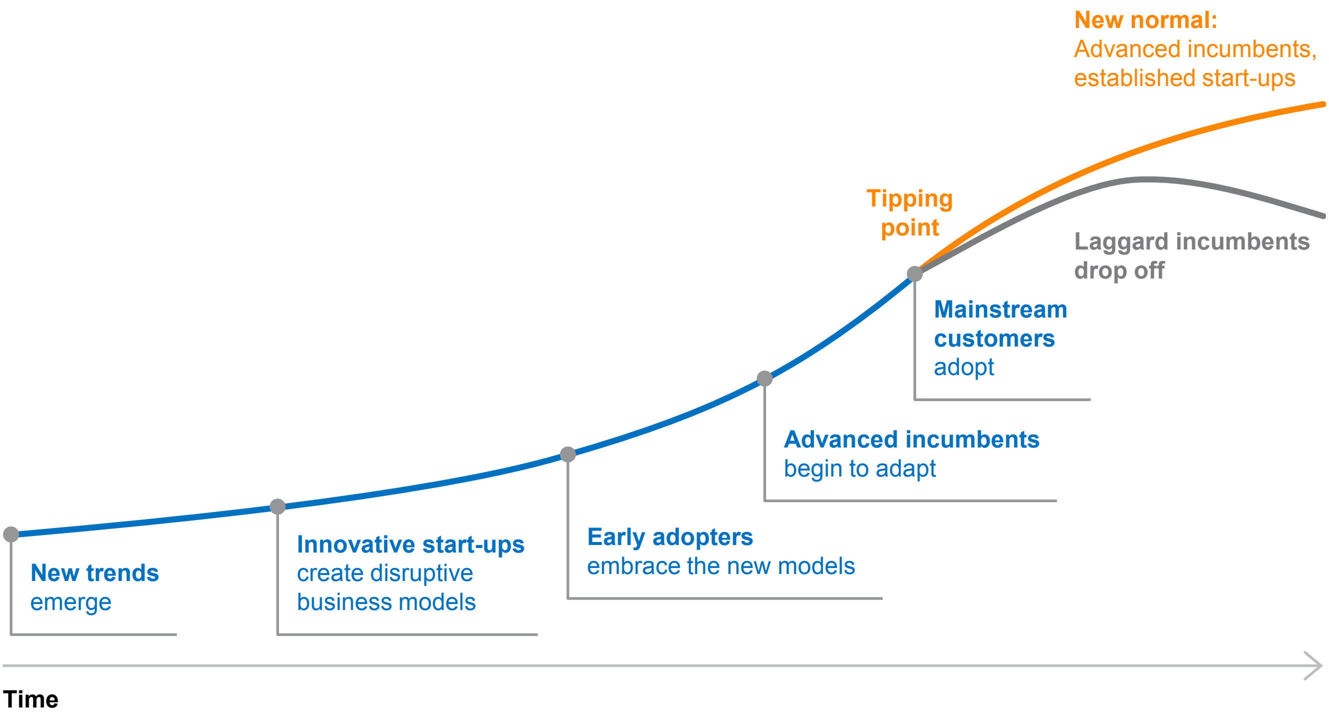
[57] Susan Lund, James Manyika, and Sree Ramaswamy, “Preparing for a new era of work,” *McKinsey Quarterly*, November 2012.

[58] *A labor market that works: Connecting talent with opportunity in the digital age*, McKinsey Global Institute, June 2015.

Exhibit 14

Digitization starts with pioneering firms, then spreads to entire industries



SOURCE: "Strategic principles for competing in the digital age," *McKinsey Quarterly*, May 2014

Digital assets are the new competitive advantage

Competitive dynamics are increasingly determined by who holds the right digital assets.[59] Sectors such as media are moving from physical to digital products, and companies in all types of industries are building massive data repositories and using analytics to generate revenue and efficiencies from all that information. IBM recently purchased the digital assets of the Weather Company, aiming to create even more value by combining this complex information stream with Watson, its artificial intelligence business.[60] Among the most prized assets are digital platforms, such those created by Facebook, iTunes, eBay, Amazon, LinkedIn, and Airbnb (see below for a fuller discussion of platform economics).

100M
lines of programming code in a connected car

Beyond these well-known examples, traditional sectors are beginning to focus on data, platforms, and connectivity as the key to interactions, transactions, and innovation. In the automobile industry, consumers now save tremendous amounts of time and money by searching and comparing online before making a vehicle purchase—and their online activity leaves a data trail that dealers can use to identify selling opportunities. Technology is also embedded within the physical product. Today's "connected car" has the computing power of 20 PCs, features about 100 million lines of programming code, and processes up to 25 gigabytes of data an hour.[61] Google's Android Auto and Apple's CarPlay are competing driving platforms that integrate into manufacturers' pre-existing technology, allowing hands-free smartphone functionality powered by voice-recognition commands. Both companies have entered partnership agreements with multiple car manufacturers.

59 Jacques Bughin and James Manyika, "Measuring the full impact of digital capital," *McKinsey Quarterly*, July 2013; David Bollier, *Managing digital assets: The challenge of creating and sustaining intangible value in a data-driven economy*, The Aspen Institute, 2015.

60 Quentin Hardy, "IBM to acquire The Weather Company," *The New York Times*, October 28, 2015.

61 "What's driving the connected car," *McKinsey.com Insights & Publications,* September 2014.

Tesla, one of the newest manufacturers, has pioneered some of the most sophisticated connected cars to date. Its cars are capable of integrating wireless software downloads to add new features and fixes. In October 2015, the company made headlines by delivering a software update to its existing vehicles that gave them autonomous driving capabilities for moves such as changing lanes and parallel parking.[62]

A similar shift to digital products is under way in many other industries. The media sector derives an increasing share of revenue from e-books and digital news and entertainment. Many venerable incumbents—including the *Encyclopædia Britannica* as well as countless newspapers, magazines, book publishing imprints, and music labels—could not cope with the disruption. But some long-established names are adapting. *The New York Times* is attempting to offset declining print circulation with growth in digital subscriptions and advertising. It has also incorporated more interactive digital features and video, as well as establishing a more interactive experience by allowing comments on articles and blogs.

Information becomes widely available, disrupting traditional intermediaries

As an ecosystem becomes more digitized, information becomes more widely available. In consumer-facing businesses, this translates into lower search and transaction costs, better matching of products to preferences, and greater transparency that can drive down prices. A user can compare prices, features, service, and product satisfaction with a few clicks of a mouse.

In addition to creating pricing pressures, this has consequences for middlemen, as digital platforms can replace localized, physical intermediaries. The ability to find an apartment on Craigslist, for instance, allows renters and landlords to bypass real estate brokers. Harvard Law School recently embarked on an initiative to create a comprehensive, searchable database of American case law by literally slicing the spines off most of the books in its library and scanning some 40 million pages. The information will be made available online at no charge. The school is undertaking this project to open its considerable resources to the public and improve equal access to justice—but the move immediately disrupts the businesses that once retrieved vital records for a fee.[63]

In the hospitality sector, Expedia, Priceline, and other online travel sites allow users to search, compare, and assemble airfares, hotel options, and other components of a trip. They spur price competition by making all of the traveler's options more transparent, and they have disrupted the fragmented network of travel agents that once brokered many transactions. From 2000 to 2014, online hotel booking revenue increased more than tenfold, from $14 billion to over $150 billion, but the number of US travel agents fell by 48 percent, from 124,000 to 65,000 (Exhibit 15).

More broadly, as digital platforms displace traditional intermediaries, they can create entirely new large-scale marketplaces. By allowing individual property owners to list their spare rooms or rental properties, platforms such as Airbnb, VRBO, Flipkey, and HomeAway monetize assets that might otherwise sit empty. Thus far, the hotel industry has not been seriously dented by this development, but this trend is still playing out. The US hospitality industry owns $340 billion in fixed commercial assets such as hotels, but platforms such as Airbnb can create digital trade in more than $17 trillion of residential assets currently in the hands of private owners.[64]

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[62] Aaron M. Kessler, "Tesla adds high-speed autonomous driving to its bag of tricks," *The New York Times*, October 15, 2015.

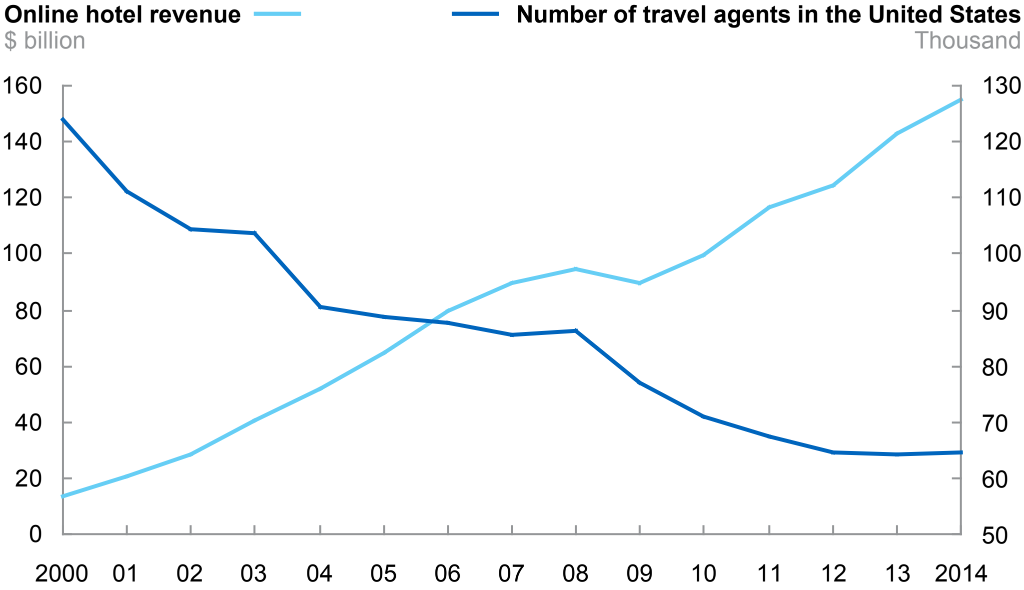
[63] Erik Eckholm, "Harvard Law library readies trove of decisions for digital age," *The New York Times*, October 28, 2015.

[64] *Playing to win: The new global competition for corporate profits*, McKinsey Global Institute, September 2015.

Exhibit 15

Since 2000, online hotel bookings have grown significantly and the number of human travel agents has decreased by half

US hotel booking revenue and number of live travel agents, 2000–14



SOURCE: Phocuswright; BLS; McKinsey Global Institute analysis

The hotel industry is thriving, with occupancy levels, room rates, revenues, and profits hitting new highs in 2014. But many chains are nevertheless responding to the new industry dynamics by building their own digital presence and booking capabilities to avoid the margin pressures created by third-party platforms. Interestingly, they are also moving to a more asset-light model of franchising rather than direct ownership of many properties (a trend that began with the post-9/11 downturn but has accelerated since then). In other words, some hotel chains now want to own fewer hotels.

Value chains are breaking apart, creating openings for specialization and new competitors

Digital tools allow individual firms to split jobs into smaller and more specialized tasks to become more efficient. Something similar happens as broader industries digitize: producers are better able to create specialized offerings for small markets within the ecosystem. More companies are focusing on their core competencies and outsourcing particular functions. Some firms focus on design and outsource manufacturing; others focus on manufacturing and outsource logistics. An insurer, for example, may rely on outside contractors to handle authorization or claims adjusting. Digital platforms and connectivity make it more feasible to manage the kind of close coordination needed for this model to work.

In health care, for example, digitization has broken up the traditional activity of seeing a physician into components such as setting up an appointment, conducting the visit, filing an insurance claim, and refilling a prescription. Companies can go after a specific segment, as ZocDoc has done with scheduling.

In financial services, the investment advisory business has become disaggregated, and small registered personal advisers, many of whom use “plug-and-play” systems, are the fastest-growing segment of this space. Large retail banks similarly face a growing array of small, tech-enabled challengers in specific markets, from credit (NerdWallet, Credit Karma) and loans (Avant, Upstart) to personal financial management (Mint.com, BillGuard).

Low marginal costs and network effects create hyperscale advantages

In traditional economic theory, firms may be able to achieve economies of scale as they grow. But at some point, marginal costs begin rising again as underlying materials become scarce or large bureaucracies take root. Digital goods and services, however, can be provided at essentially zero marginal cost no matter how many units are produced. Delivering an additional song through iTunes or welcoming a new user to a social network results in effectively no costs for Apple and Facebook, respectively, whether it's the tenth unit or the ten billionth. This effect gives digital companies a distinct advantage.

Up to
80%
gross profit margins enjoyed by software companies

The most successful high-tech firms have harnessed this phenomenon to achieve a scale and reach that has heretofore been impossible—and they've done so in record time (Exhibit 16). Facebook averaged more than 1.5 billion monthly active users as of September 2015, Twitter handles half a billion tweets per day, and Google processes some 3.5 billion searches a day. The unprecedented size of these tech giants is predicated on building and operating a platform or network. The power of platform economics is reflected in the gross margins enjoyed by software companies, which can run as high as 80 percent, the highest of any industry.

Exhibit 16

The largest US digital platforms rival the size of nations

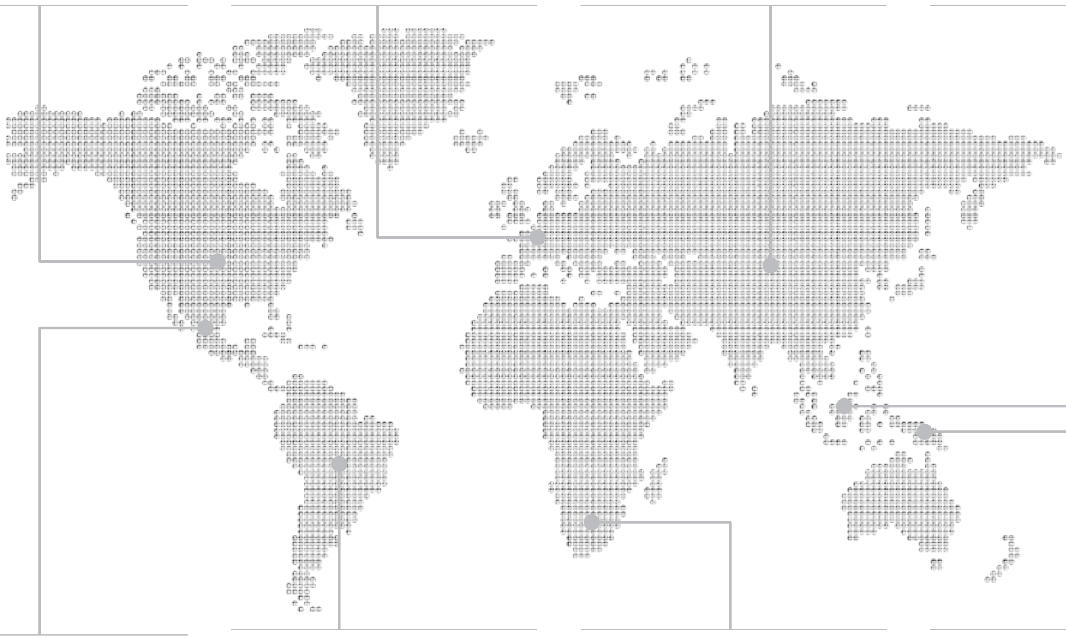
2014 or latest data

United States
Population = 320 million
Dropbox
Number of users = >400 million

France, Germany, United Kingdom, Spain
Population = 258 million
Amazon.com
Customer base = 244 million

China
Population = 1.37 billion
Facebook
Monthly active users = 1.49 billion

Indonesia
Population = 255 million
Google
Android phones shipped in Q2 2015 = >270 million



Mexico
Population = 123 million
Microsoft
Windows 10 downloads = 110 million

Brazil, Colombia, Peru, Argentina
Population = 320 million
Twitter
Monthly active users = 320 million

South Africa
Population = 53 million
Netflix
Number of subscribers in 2014 = >50 million

Papua New Guinea and New Zealand
Population = 12 million
Apple
Number of iPhone 6S shipments within first 3 days of release = >13 million

SOURCE: *Forbes*; Fortune 500; World Bank; company websites; annual reports; analyst reports; McKinsey Corporate Performance Analysis Tool; McKinsey Global Institute analysis

The combination of zero-cost economics and platform architecture is formidable. Consider Apple's iOS ecosystem. There are now 1.5 million apps available through iOS, made by nearly 300,000 developers. The average iOS user downloads 119 apps, and payments to iOS developers have totaled $30 billion, which encourages yet more app development.[65] To achieve parity, any new competitor to iOS would have to replicate the full ecosystem of apps, a community of developers with common standards, and users' ingrained comfort level with a particular interface. This type of advantage translates into a remarkable market position. In 2015, Apple reported a record-setting quarterly profit of $11.1 billion.[66]

Controlling a general-use platform gives companies such as Microsoft, Facebook, or Google a privileged position in users' lives. They become the primary digital touch point for millions of people, with access to an extensive amount of data on lives, tastes, and habits. It also encourages companies to add more capabilities to their platforms—which increases switching costs and gives companies yet more knowledge of their users.

Industry boundaries become blurred

Many traditional industry boundaries that have been in place for decades are blurring as digitization allows companies to add new business lines with greater ease (Exhibit 17).

Having already disrupted the traditional taxi industry, Uber has launched a food delivery service, UberEats, in several cities across the country. Companies such as Apple and Chase are competing in the mobile payments market. And Salesforce.com has teamed up with Philips to introduce a cloud-based health platform that can monitor patients remotely. It aims to improve the way health-care providers manage complex chronic diseases.[67]

Companies may move into adjacent businesses; Facebook's acquisition of WhatsApp, for example, immediately gave the company capabilities and scale in the messaging market. In other cases, digital players venture far beyond their origins. Amazon, which began as a bookseller, soon expanded into virtually every retail category—and then created its own self-publishing platform and started to offer cloud-based business services. Once the company had developed the platform, customer relationships, and logistics to sell books efficiently, it was able to scale this infrastructure to accommodate continuous expansion.

Google has added so many wide-ranging ventures over the years that it recently split its core Internet search operations from its other ventures. It formed the Alphabet holding company to better manage these widely divergent businesses, which include longevity and biotech research, smart home products, venture capital investing, and high-speed Internet fiber services.

In the automotive industry, the development of self-driving cars is demanding new expertise and attracting new types of competitors. Not only are leading carmakers teaming up with software companies, but tech firms themselves, including Google, are experimenting with their own self-driving vehicles. Some of the industry's value may shift from traditional manufacturers to new digital players.

In addition, some digital natives are born out of the tech industry with the express intent of shaking up traditional sectors. The rapidly growing "fintech" industry is a new entrepreneurial force in financial services, using digital capabilities to introduce an array of new microlending, crowdfunding, and payment models.

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[65] Install base from Strategy Analytics; developer estimates from AppFigures; all other stats from Apple WWDC 2015.

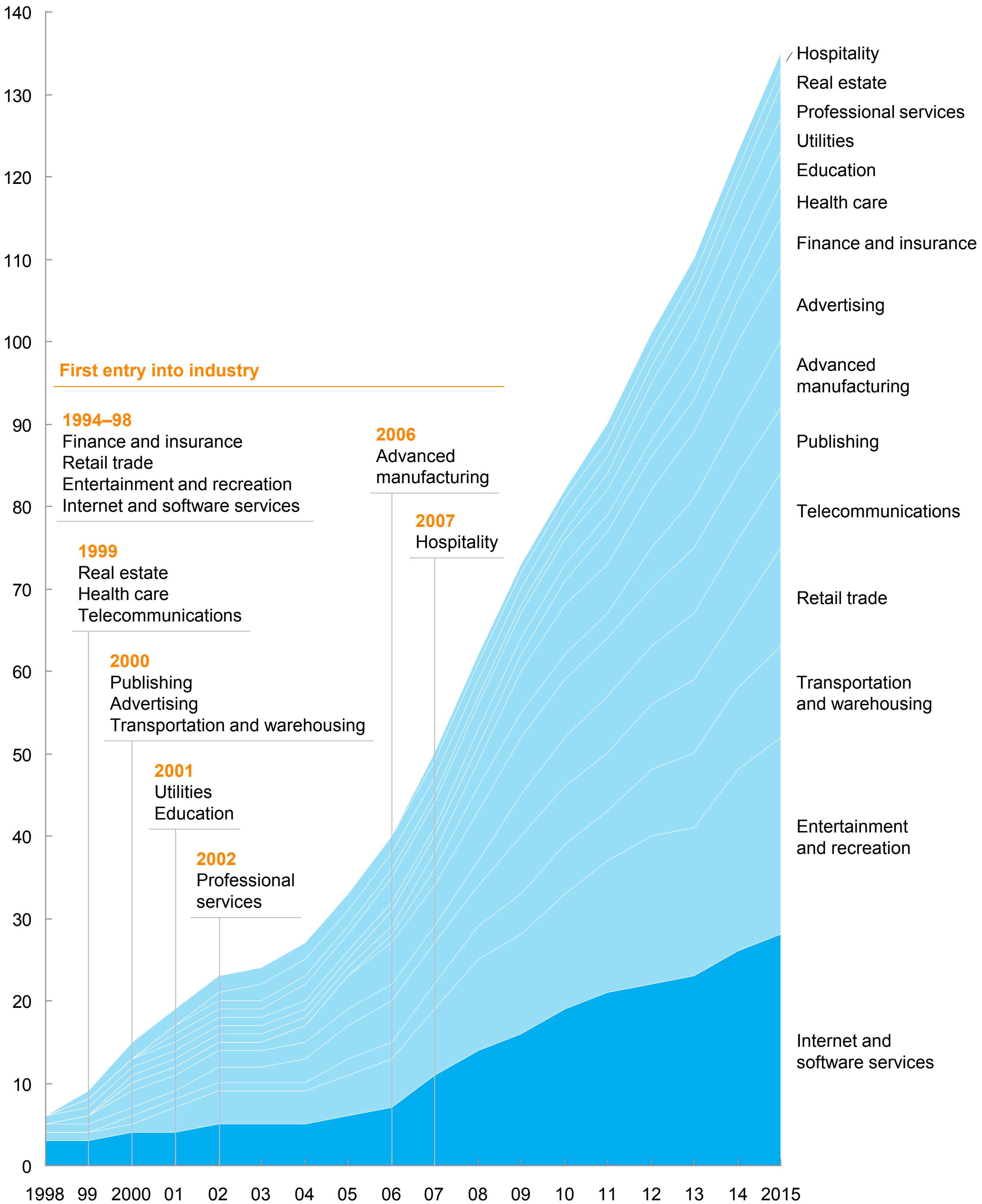
[66] Apple press release.

[67] Steve Lohr, "Salesforce takes its cloud model to health care," *The New York Times*, June 26, 2014.

Exhibit 17

Industry boundaries are blurring

Product launches across sectors by major digital platform providers[1]
Cumulative, 1998–2015



1 Includes acquisitions and new product launches by Amazon, Apple, Facebook, Google, and Microsoft.

SOURCE: Capital IQ; company websites and press releases; McKinsey Global Institute analysis

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Digital technologies are changing fundamental aspects of the ways that companies do business—and no organization can afford to sit on the sidelines while industries transform around it. Companies need to be willing to disrupt themselves before a more digitally fluent competitor does it to them. As more businesses go digital and begin to capture new efficiencies, the effects will be felt at the macroeconomic level. Chapter 3 considers what the next phase of digitization could mean for productivity, growth, and employment.

3. THE US ECONOMY IN TRANSITION

The cumulative effect of the firm- and industry-level changes described in Chapter 2 is clearly visible all around us, but ironically, it is obscured in the macroeconomic data. Digital technologies underpin a huge share of economic activity in the United States, but their precise role in fueling growth is the subject of ongoing debate.

Digitization helped to fuel robust productivity gains from 1995 to 2005, but it remains a puzzle that the ensuing decade of dazzling technological progress has coincided with a slowdown in productivity growth. At least part of this disconnect could be explained by the fact that many recent technological advances have benefited consumers and society far beyond what is captured in GDP measurements. Another issue could be that relatively recent digital adopters in sectors such as transport, government, and manufacturing have invested in digital assets but have yet to complete the organizational and process changes necessary to fully realize the benefits of technology. This would imply that the economy is experiencing a pause before the resulting productivity gains become apparent.

Over the past ten years, companies have steadily amassed more digital assets and begun to use digital tools in an ever-wider variety of ways, but the most rapid change has been the digitization of the US workforce. While there are other factors at work, this shift has exacerbated some of the long-term issues that have been brewing in the labor market for decades: the automation of routine transaction and production tasks, the hollowing out of middle-skill jobs, a growing disconnect between wage growth and productivity growth, wage polarization, and increasingly jobless recoveries from recessions.

We begin this chapter by examining the effects of digitization to date on consumers, workers, and overall productivity and GDP growth. The second part of the chapter then considers how these shifts may further impact the economy in the years ahead. The United States could be poised for sharply accelerating productivity growth. We examine how digitization could affect the economy in three key areas and find that it could boost annual GDP by up to $2.2 trillion by 2025. These gains could be driven by making physical assets more efficient as well as improving labor productivity—and they represent only a small part of the growth opportunities.

But as technology develops new capabilities for automating the work performed by humans, companies across the economy will undertake a large-scale redefinition of roles and business processes in businesses—a shift that will affect occupations at every skill level. Historical rates of job displacement could sharply accelerate over the next decade. As the strains that have already appeared in the US labor market intensify, companies, policy makers, and institutions will have to prepare for a period of greater churn and uncertainty.

DIGITIZATION HAS FUELED ECONOMIC GROWTH AND PRODUCTIVITY, BUT CONSUMERS HAVE FARED MUCH BETTER THAN WORKERS

As digitization has become more pervasive in recent decades, its macroeconomic impact has not always been easy to disentangle from other forces. Consumers have clearly captured a huge range of benefits, both tangible and intangible. But the productivity effect requires a more nuanced view, and there are negative implications for employment and wages.

The digital revolution has favored the consumer

Consumers are among the biggest winners in a more digital economy. This starts with the computing power they have at their disposal. Sixty percent of US consumers now have smartphones that put an entire universe of news, information, and applications in their hands. Since 1980, while overall consumer inflation has risen by 130 percent, prices for digital technologies have fallen by 60 percent, making progressively more powerful devices affordable to more of the population.

But this is only a small slice of the gains. As recently as the 1980s, US consumers paid each time they dialed 411 to get a phone number. Today they have a powerful tool that can sort through the store of human knowledge instantly for free. Social media, which creates a constant stream of communication and entertainment, is also free, as are detailed maps of any point on the globe and instant translation of text in any language.

$37B
value shifted to consumers by Skype in 2013 alone

The benefits to consumers are enormous, particularly for the savviest and most proficient users (see Box 3, "The consumer at the digital frontier"). Digital platforms can aggregate the products and services offered by multiple providers, creating a single portal where consumers can search, compare, and purchase all manner of goods and services. This has transformed the way Americans book travel and transportation, choose financial products, and shop for consumer goods. More efficient and transparent digital marketplaces have sparked fierce price competition, and consumers now find it easier than ever to hold out for bargains. Many sites make user reviews publicly visible, which has increased the pressure of businesses to provide quality offerings and better customer service. In addition, some tech firms have made aggressive moves into new markets by providing free or low-cost products or services where traditional businesses have charged fees for years. Skype, for instance, shifted some $37 billion in value to consumers in 2013 alone.[68]

Attempts to estimate the annual consumer surplus generated by Internet use vary from $5 billion per year to more than $100 billion, in part because such efforts use different approaches. Varian (2011) measures consumer surplus based on time saved using Google Search. Greenstein and McDevitt (2009) measure the economic value of upgrading to broadband connections. Kopecky and Greenwood (2011) estimate the welfare gain from the rapid price decline in personal computers. Goolsbee and Klenow (2006) and Brynjolfsson and Oh (2012) estimate the value of leisure time spent by consumers online or on free sites such as Google Search and social media. Finally, Bughin and Manyika (2014) use conjoint-based market surveys to determine how much consumers would be willing to pay for services that are currently free, supported by digital advertising, or both.

Summarizing across these and related studies, estimates based on time use tend to converge around $100 billion per year; monetary estimates converge around $5 billion per year; and estimates on willingness to pay are in the middle of this range. However, most studies do not account for newer forms of consumer surplus, from GPS navigation and traffic avoidance to personal financial tools.

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68 *Playing to win: The new global competition for corporate profits,* McKinsey Global Institute, September 2015.

Beyond the consumer gains, the United States has also benefited at a broader societal level. Areas ranging from public spending and infrastructure to health care and education are being rapidly transformed, although much more can be achieved in all of these domains.

Citizens have easier and more direct access to government information and services—and new platforms for activism. Technology is enabling breakthroughs in medical research, putting extensive educational resources online, and delivering critical public safety information during crises. Public health authorities can use real-time data from emergency rooms, Google searches, and even sensors in devices such as asthma inhalers to activate faster responses to disease outbreaks and health threats.[69]

Opening government data has been a huge source of innovation; California and Texas, for example, have identified millions of dollars a year in savings by releasing budgetary information and enabling citizens to spot potential opportunities to cut costs. Cities such as Boston and New York have made significant amounts of information public, from restaurant health inspection scores to school performance ratings, and have created systems to help citizens navigate traffic, parking, and public transport.[70]

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[69] Basel Kayyali, David Knott, and Steve Van Kuiken, "The big data revolution in US health care: Accelerating value and innovation," *McKinsey.com Insights & Publications*, April 2013.

[70] *Open data: Unlocking innovation and performance with liquid information*, McKinsey Global Institute, October 2013.

Box 3. The consumer at the digital frontier

The leading-edge digital consumers use better information and greater connectivity to save time and money. Armed with an arsenal of apps, they are able to streamline their lives in a variety of ways, as a day in the life of one hypothetical, hyper-wired consumer illustrates.

A typical morning might start with reading a personally curated mix of news stories on Flipboard and catching up with what his friends have posted on social media. The day's workout uses a personal trainer app and a wearable device that measures steps taken, calories burned, and heart rate, with the information fed into a health dashboard. Our consumer's phone alerts him when it's time to leave for the doctor's appointment he scheduled with ZocDoc. He was going to walk, but after a weather app alerts him that rain is coming, he summons an Uber instead. After the doctor discusses test results with him, he snaps a photo of them with an app that scans the document into searchable text and then sets up his phone with alarms to remind him when to take his new prescription.

At lunchtime, Siri recommends a nearby restaurant based on his preferences. He uses a mobile payment app, receiving a discount and loyalty points that he typically redeems for yet more discounts. He heads home, using Spotify to stream his favorite artist's new album on the way, and then summons Washio to pick up his laundry.

Now he's thinking about a vacation, so he logs onto his laptop to check his finances. He uses automated services to diversify and tax-optimize his investment portfolio, slashing the time he used to spend researching stocks. All of his investment, banking, and credit card accounts port into a finance and budgeting tool that shows he has savings available for travel. He uses an app that gives him a consolidated view of his travel points, then uses them to book his airfare on Kayak.com, where he sees that he can save 30 percent by taking a flight in off-peak hours. TripCase recognizes the flight confirmation email and automatically adds the itinerary to his calendar. He finds affordable accommodations on Airbnb and purchases new clothes for the trip, searching first to find a discount code at his favorite store. The airline pings him to check in 24 hours prior to his flight. Google Now alerts him, based on current traffic patterns, when he needs to leave to make his flight. At the airport, he uses a mobile boarding pass on his phone to skip check-in lines.

Finally, he remembers to call his mother to tell her he landed safely, using Skype for a free face-to-face chat.

Digitization has contributed to rapid GDP and productivity growth in the past, but recent gains may be blurred

In the late 1980s, companies in many sectors began to emulate the first movers in adopting digital tools to streamline workflows, coordinate supply chains, and engage with customers. The productivity gains from these investments were not visible immediately, in part because it takes time for companies to redesign processes, revamp organizations, and change mindsets to truly realize the benefits of going digital.[71] Total productivity growth among US businesses averaged only about 0.7 percent per year between 1975 and 1995. But over the next decade, it rose to an annual average of 1.6 percent, increasing nearly 2.5 times as fast as in the preceding 20 years.[72] These gains can be attributed at least in part to increased business investment in ICT tools, as the most digitized sectors (including the ICT sector itself) posted some of the largest productivity gains.[73] This productivity surge was reflected in GDP growth, which averaged nearly 4 percent per year in real terms during this period, compared with 3.3 percent per year in the previous decade.

But since 2005, these effects have vanished from the measured statistics. Total productivity growth has fallen by two-thirds since 2005, while real GDP growth has averaged about 2 percent per year—all during a period in which the digital economy has continued to grow. This new "Solow's paradox" phenomenon has led some to posit that the revolutionary nature of digital technologies has been overhyped.[74]

Moreover, the nature of productivity growth has also changed in the past decade. By definition, productivity growth stems either from improving efficiency (that is, reducing the inputs needed to produce a given output) or from increasing the volume and value of outputs relative to any given input. The productivity surge of the late 1990s reflected both of these factors. Firms in large sectors such as retail, wholesale, and financial services made ICT investments while simultaneously making innovative changes to business processes, organization, and management.[75] They not only became more efficient but were able to capitalize on strong GDP and demand growth as a result. In contrast, sectors that posted the greatest productivity growth in the 2000s substantially reduced employment.[76] Some of these sectors, such as ICT and media, have highly digitized workforces.

Multiple factors may explain why measured productivity during the past decade has been less than stellar despite the digital innovations all around us. First, economic statistics do not reflect the full benefits of those innovations in the lives of consumers. Many tech firms provide valuable services to consumers for free from day one, and the benefits grow over

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[71] See, for example, Ann Bartel, Casey Ichniowski, and Kathryn Shaw, "How does information technology affect productivity? Plant-level comparisons of product innovation, process improvement, and worker skills," *Quarterly Journal of Economics*, volume 122, number 4, November 2007; Erik Brynjolfsson and Lorin M. Hitt, "Computing productivity: Firm-level evidence," *Review of Economics and Statistics*, volume 85, number 4, November 2003; and Erik Brynjolfsson and Lorin M. Hitt, "Beyond computation: Information technology, organizational transformation, and business performance," *Journal of Economic Perspectives*, volume 14, issue 4, fall 2000.

[72] This refers to multifactor productivity growth in the non-farm business sector. Annual labor productivity growth shows similar but more muted trends; it grew at 1.8 percent between 1975 and 1995 and surged to 3 percent between 1995 and 2005.

[73] For more on the effects of information technology on productivity growth during this period, see, for example, Dale W. Jorgenson, Mun S. Ho, and Kevin J. Stiroh, "A retrospective look at the US productivity growth resurgence," *Journal of Economic Perspectives*, volume 22, number 1, winter 2008; and Stephen D. Oliner, Daniel E. Sichel, and Kevin J. Stiroh, *Explaining a productive decade*, Brookings Papers on Economic Activity, spring 2007.

[74] See, for example, Robert J. Gordon, "US productivity growth: The slowdown has returned after a temporary revival," *International Productivity Monitor*, number 25, spring 2013; Robert J. Gordon, "Is US economic growth over? Faltering innovation confronts the six headwinds," NBER working paper number 18315, August 2012; and Tyler Cowen, *The great stagnation: How America ate all the low-hanging fruit of modern history, got sick, and will eventually feel better*, Dutton, 2011.

[75] *US productivity growth: 1995–2000*, McKinsey Global Institute, October 2001.

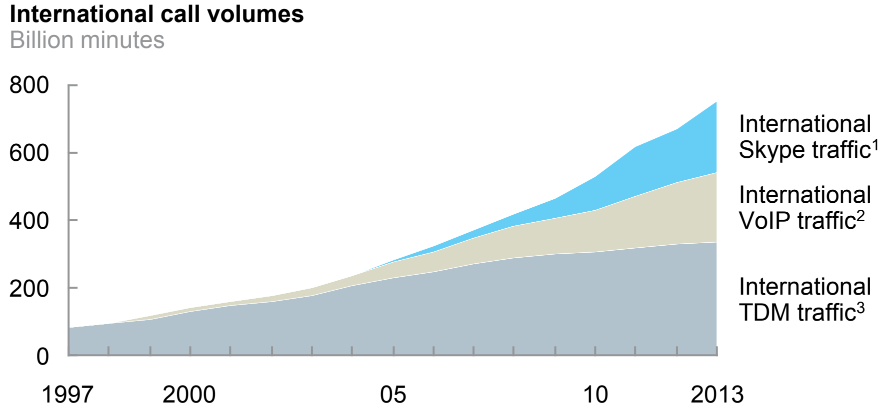
[76] *Growth and renewal in the United States: Retooling America's economic engine*, McKinsey Global Institute, February 2011.

time with rapid adoption—not from consumer price declines that are more easily measured. Statistics are not capturing an important and innovative part of the economy because the productivity advance flows to unmeasured consumer surplus. While it has been present for many years, it has grown dramatically in scope over the past decade (Exhibits 18 and 19). As we discussed earlier in this chapter, researchers' attempt to measure consumer surplus have resulted in widely varying estimates that range from $5 billion to more than $100 billion per year; at the upper end, this would account for roughly 0.7 percentage points of annual GDP growth.

Second, historical methods for estimating the real prices of ICT products may not adequately account for their expanding capabilities. Recent research argues that it is difficult for data to capture quality improvements and innovation in digital content and new capabilities in subsequent generations of advanced software.[77] This is a crucial point, since ICT and ICT-intensive industries contributed two-thirds to three-quarters of productivity growth between 1995 and 2005 and posted some of the steepest productivity declines over the past decade.[78]

Exhibit 18

Digital players such as Skype disrupt traditional business models and shift huge value from incumbents to consumers



TDM compound annual growth rate[4]
%

1997–2005	2005–08	2008–13
13.5	**6.3**	**3.0**

1 International Skype-to-Skype calls, including video calls.
2 International VoIP-transported calls, including Skype-to-phone calls, excluding PC-to-PC and Skype-to-Skype calls.
3 International TDM-carried calls (time division multiplex, traditional means for international calls transfer).
4 Assuming average 2013 price of $0.17 per minute for an international phone call.

SOURCE: TeleGeography; McKinsey Global Institute analysis

[77] A recent research note from Goldman Sachs argues that it is particularly difficult for data to capture quality improvements and innovation in digital content and the rapid additions of new capabilities as subsequent generations of advanced software are released. It notes that while the price consumers pay for a broadband connection can be measured in GDP and has stayed roughly flat, that measurement does not capture faster connection speeds, the explosion of available content, or the availability of free Wi-Fi in public spaces. See Jan Hatzius and Kris Dawsey, "Doing the sums on productivity paradox v2.0," Goldman Sachs, US Economics Research, issue number 15/30, July 2015. See also David Byrne, Stephen Oliner, and Daniel Sichel, *How fast are semiconductor prices falling?* NBER working paper number 21074, April 2015.

[78] John Fernald and Bing Wang, "The recent rise and fall of rapid productivity growth," Federal Reserve Bank of San Francisco, *FRBSF Economic Letter,* February 2015. Also see Bart van Ark et al., *Prioritizing productivity to drive growth, competitiveness, and profitability,* The Conference Board, 2015.

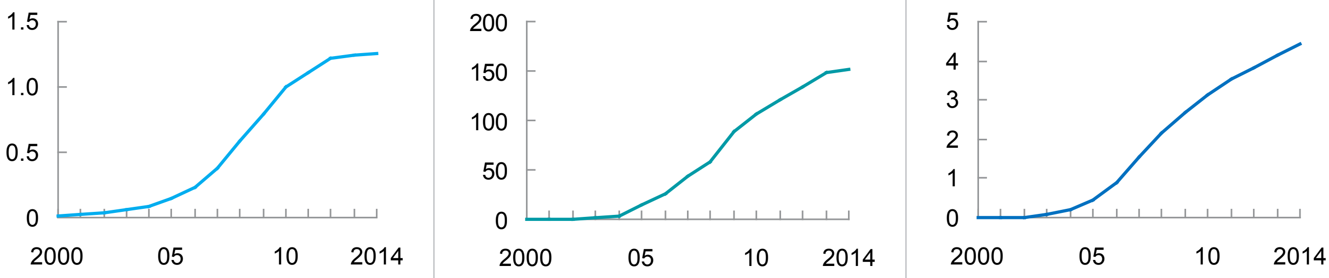
Exhibit 19

Consumer surplus through free Internet search and social networking applications has accumulated mainly within the past decade

Annual Google searches[1]
Trillion

Social media usage[2]
US adults using a social networking site (million)

Wikipedia article count
English-language articles on Wikipedia (million)



178 million
unique monthly US visitors (2014)

74%
of online US adults are on social media (2014)

100 million
unique monthly US visitors (2014)

1 2013 and 2014 extrapolated using constant growth rate from 2012 to 2014 derived from December search volume.
2 2003 and 2004 estimated using user growth numbers from early social networking sites, including Friendster, Myspace, and Facebook, and assumptions for user growth on other niche sites.

SOURCE: Pew Research Center; Google; Internet Live Stats; Wikipedia; ComScore; McKinsey Global Institute analysis

Finally, as digital technologies have made big leaps in capabilities in recent years, many companies have expanded their digital assets and usage. But it can take several years for large firms (and whole sectors) to make the many organizational and operational changes necessary to capture the full benefits of ongoing digital investments.[79] Today, for instance, some firms are already realizing the benefits of investing in the Internet of Things, but many others are grappling with issues such as interoperability, the difficulty of retrofitting legacy assets, cybersecurity, and data privacy issues. As with previous rounds of ICT-enabled productivity, it may take years for these types of issues to be resolved across entire sectors. Eventually, as large companies and broader value chains make the associated improvements in processes, organizational structures, supply chains, and business models, the effects could become substantial enough to register as sector-level and finally economy-wide productivity gains.[80]

Digitization contributes to labor market polarization and wage pressure

It is difficult to separate digitization from other trends that influence aggregate job creation, but its effect is much more evident in other aspects of the labor market. Previous MGI research found that digitization has contributed to increasingly jobless recoveries from recessions. Following most post-war recessions, it took the United States roughly six months, or two quarters, to restore lost jobs after GDP had recovered. But it took 15 months to restore lost jobs after the 1991 recession, 39 months after 2001, and 43 months after 2008. Large companies in particular now respond to recessions with a push to improve productivity, often through automation—and those changes tend to become permanent.[81]

79 Erik Brynjolfsson and Lorin M. Hitt, "Computing productivity: The firm-level evidence," *Review of Economics and Statistics*, November 2003.

80 Martin N. Baily and James Manyika, "Reassessing the Internet of Things," Project Syndicate, August 2015; also see Michael Spence, "Automation, productivity, and growth," Project Syndicate, August 2015.

81 *An economy that works: Job creation and America's future*, McKinsey Global Institute, June 2011. As part of this research, MGI conducted a business survey of 2,000 respondents from a variety of industries, 90 percent of whom were responsible for hiring in their companies. Roughly two-thirds of respondents said they had restructured their operations in recent years to reduce headcount and increase output per worker; this response was more common to large companies than to small firms. Forty-four percent of companies reported automating some tasks.

As a result, slowdowns now tend to hit employment hard even as productivity is unaffected, deviating from historical patterns.

Digitization has also affected the occupational and skill mix of the US workforce. Since the 1980s, employment in both low-skill and high-skill jobs has increased, while middle-skill jobs have declined; this phenomenon is often referred to as "skill-biased technical change."[82] As many routine production and assembly tasks have become automated, most of the growth at the low-skill end of the spectrum has been in occupations such as restaurant workers, home health care aides, security guards, maintenance, and other roles that provide in-person services that are less susceptible to automation.[83] At the same time, idea-intensive sectors have been capturing a larger share of the overall corporate profit pool.[84] There is now a premium on creative and cognitive tasks that improves overall productivity of highly skilled workers. The result is a two-tiered labor market with a hollowing out of the middle—a phenomenon that has been observed in a number of other developed economies.[85]

Our own analysis of the labor market since the 2000s confirms this ongoing trend. We use a framework that classifies occupations into four categories: production, transaction, high-skill interaction, and low-skill interaction jobs.[86] Some eight million net new full-time-equivalent positions were created in the United States between 2000 and 2014. Two-thirds of these were in low-skill interaction work, and the remaining one-third were in high-skill interaction work. Meanwhile, roughly 2.5 million net production and transaction positions were lost during this period, as many of the repetitive tasks that make up these jobs were automated (Exhibit 20). Humans on assembly lines have been supplanted by machines, and a great deal of the work once performed by bookkeepers, secretaries, and file clerks is now handled by software.

The historical link between rising productivity and wage growth has been broken. Real growth in labor compensation moved in tandem with productivity growth until the early 1980s, but since then, labor productivity has grown 2.5 times as fast as wages. But this development has hit workers at the lower-skilled end of the spectrum much harder. The trend lines have been diverging for the majority of workers and for a smaller group at the top, and digitization may have accelerated this trend.[87] Some highly educated or specialized workers, especially those in knowledge-intensive industries with strong profit growth such as finance and ICT, have enjoyed rapid wage increases (Exhibit 21). But these sectors also display sharp wage dispersion; in other words, even *within* the most digital sectors, wage gains are going to a select group of workers. Additionally, these industries make up only about 19 percent of total US employment, as digitized companies are able to generate more output and capture more profit with fewer workers. Overall, labor's share of US national

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82 Lawrence F. Katz and Robert A. Margo, "Technical change and the relative demand for skilled labor: The United States in historical perspective," in *Human capital in history*, Leah Platt Boustan, Carola Frydman, and Robert A. Margo, eds., University of Chicago Press and NBER, 2014.

83 David Autor and David Dorn, "The growth of low-skill service jobs and the polarization of the US labor market," *American Economic Review*, volume 103, number 5, 2013.

84 *Playing to win: The new global competition for corporate profits,* McKinsey Global Institute, September 2015.

85 Maarten Goos, Alan Manning, and Anna Salomons, "Job polarization in Europe," *American Economic Review*, volume 99, number 2, May 2009.

86 Production work refers to occupations that transform one resource into another, such as assembly work in the manufacturing sector. Transaction work refers to routine, mostly clerical tasks that follow well-defined rules, such as those performed by bank tellers. Interaction work refers to occupations that involve customer engagement, team discussions, and creative thinking. Occupations performing this kind of work fall into two categories: high-skill (such as doctors and scientists) and low-skill (such as retail salespersons and restaurant servers). See *Help wanted: The future of work in advanced economies*, McKinsey Global Institute, March 2012.

87 Daron Acemoglu and David Autor, "Skills, tasks and technologies: Implications for employment and earnings," in *Handbook of Labor Economics*, volume 4, part B, Orley Ashenfelter and David Card, eds, Elsevier, 2011; David Autor, *Polanyi's paradox and the shape of employment growth*, NBER working paper number 20485, September 2014.

income has fallen from 70 percent to 64 percent since 1980. As technology makes rapid advances in innovation, the prospects of the average worker have dimmed.

Exhibit 20

Since 2000, the United States has posted net job creation only in interactions work

Change in number of full-time-equivalent (FTE) workers
Million

	Change in FTEs, 2000–14	Total FTEs, 2000	Change in FTEs 2000–04	Change in FTEs 2005–09	Change in FTEs 2010–14
High-skill interactions work[1]	3.4	21.6	0.4	1.9	1.0
Low-skill interactions work	6.8	31.4	2.6	1.8	2.4
Production work	2.2	20.9	-1.3	-1.2	0.2
Transactional work	0.2	53.4	0.0	-1.0	0.8
Total	7.9	127.3	1.8	1.6	4.5

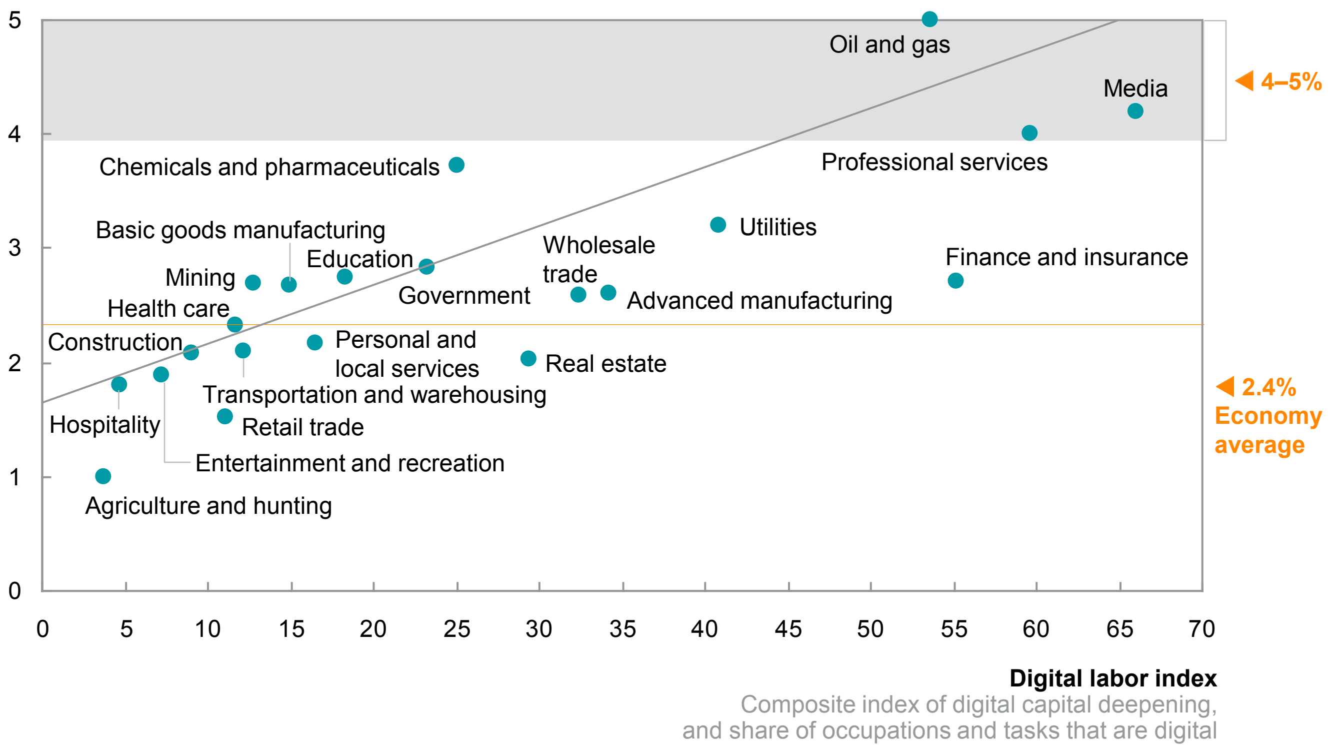
1 Bachelor's degree or higher required; all production work and most (~95%) of transactional work is low skill.
NOTE: Numbers may not sum due to rounding.

SOURCE: BLS; McKinsey Global Institute analysis

Exhibit 21

Wage growth is 70 to 100 percent higher than the national average in industries with higher penetration of digital tools and technologies

Wage growth, 1997–2014
Compound annual growth rate of mean nominal wage, %



SOURCE: BLS; McKinsey Global Institute analysis

Digital technologies have some beneficial implications for the labor market, however. Online talent platforms have empowered individual workers to a degree. Users can create public profiles that highlight their skills and experience, and they can network in new ways. Search capabilities allow users to find a much wider array of job openings and greater insight into how to shape a career path. By aggregating data across larger regions, talent platforms address some geographic mismatches, giving people insight into the opportunities they could realize by moving even a few hundred miles away. Some offer users visibility into what it would be like to work for a given company and the salary they can expect; this increases the likelihood that they will choose a job and a work environment they will enjoy. Additionally, freelance platforms are helping individuals market their skills more widely and find new clients. Uber, Lyft, Taskrabbit, Care.com, and other on-demand service platforms have created a flexible employment model that allows individuals to shape their own work schedules.[88]

Over the longer term, there may be ways to use data on the skills that are in demand to design a more effective system of education and training. The growing economic potential of online talent platforms is discussed in greater detail in the section that follows.

BY 2025, THREE EFFECTS OF DIGITIZATION ALONE COULD BOOST GDP BY UP TO $2.2 TRILLION—BUT THE POSSIBILITIES ARE EVEN WIDER

Over the next decade, digitization will continue to play out in a multitude of ways across various sectors of the US economy, and the full magnitude of these changes cannot be predicted today. In this section, we examine three specific applications of digital technology that are already emerging today. These examples are meant to illustrate the types of growth opportunities that could be realized over the next decade. But the overall potential is much larger, particularly if new technology innovations appear or if adoption unfolds rapidly in large sectors.

We consider the impact on future economic growth by focusing on three areas: the labor market, capital efficiency, and multifactor productivity. Much of this stems from innovations that are already percolating through the economy and could soon return large dividends.

$500B
potential boost to annual GDP from online talent platforms

First, online talent platforms can have a positive impact on labor supply and productivity. As these platforms grow in scope and capability, so do their network effects. LinkedIn alone had 122 million registered users in the United States in 2015, representing a substantial share of the total working-age population. This type of critical mass coupled with the ability to accelerate job searches could lower the equilibrium unemployment rate.

For many years, workers and companies alike have had to rely on crude, incomplete, and geographically restricted signals about the skills that actually are in demand. As a result, companies experience difficulties in hiring, and workers lack the information they need to map out an effective education, training, and career path. But online talent platforms address these issues by aggregating data on candidates and job openings in a broader geographic area, thereby illuminating for workers which positions are open today, as well as the actions they can take to gain more fulfilling work. In other parts of the economy, we see that digital platforms make markets more transparent and efficient, and they may be able to do the same for the US labor market.

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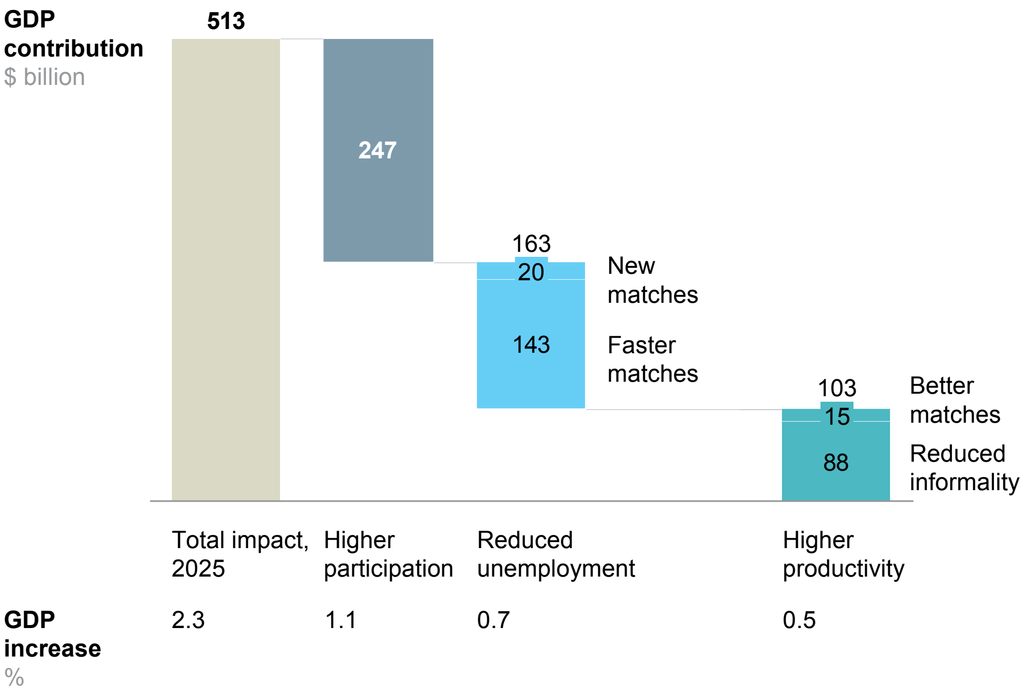
[88] *A labor market that works: Connecting talent with opportunity in the digital age*, McKinsey Global Institute, June 2015.

As individuals find better job matches, these platforms can even boost productivity. But their biggest impact may come from boosting the US labor force participation rate, which has been in long-term decline. On-demand service platforms are creating flexible opportunities that could draw some of the 60 million who are unemployed or inactive back into the workforce, or allow millions of part-time workers to increase their hours. Prior MGI research has estimated that online talent platforms could add roughly $500 billion to annual GDP by 2025 (Exhibit 22).[89]

Exhibit 22

By 2025, online talent platforms could add roughly $500 billion to US GDP by making the labor market more efficient

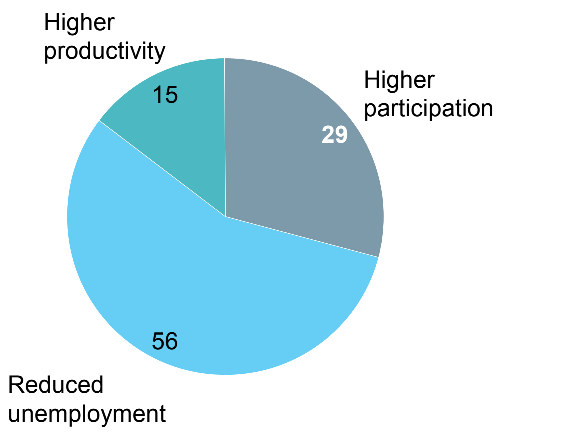
Impact on the US economy, 2025



Individuals who could benefit
%

41 million
people

18.5%
of working-age population



NOTE: Numbers may not sum due to rounding.

SOURCE: MGI Online Talent Platforms Model; McKinsey Global Institute analysis

[89] *A labor market that works: Connecting talent with opportunity in the digital age*, McKinsey Global Institute, June 2015.

Second, the Internet of Things has great potential to help companies get the most out of their fixed assets, from better energy efficiency in office buildings to improved workflows in assembly plants. Industries are beginning to install IoT systems, but many companies are not fully exploiting all of the data they collect today—if they use it at all. A great deal of additional value is waiting to be captured.

Most automation systems on factory floors, for instance, are used only for real-time control or detecting anomalies, but more sophisticated IoT applications can use performance data for predictive maintenance, reducing equipment outages and downtime, thereby increasing utilization by as much as 20 percent per year by 2025. In the oil and gas industry, less than 1 percent of the data being generated by the 30,000 sensors on an offshore oil rig is currently used to make decisions. But as companies gain proficiency with these systems, the IoT could boost recovery. In mining, self-driving vehicles, including mine cars and ore trucks, can streamline operations and reduce costs.[90] Improved asset productivity in the most asset-heavy sectors (oil and gas, mining, and manufacturing) could add $120 billion to $170 billion to annual GDP by 2025.

Third, companies that are investing in data analytics and the IoT are still learning how to get the most of out of these tools in for operational efficiency. This may involve managing the movement of costly supplies, machinery, and labor around complex worksites, or improving supply chain logistics. Mobile systems can track employees in the field, while intelligent systems in office buildings can reduce energy use. As these types of capabilities improve, the economy could benefit from a boost to multifactor productivity.

Organizations are collecting more accurate and detailed information in digital form, and the leading companies are using this data collection and analysis as the basis of better management decisions. Big data makes it possible to understand and target ever-narrower customer segments more precisely and even to develop the next generation of products and services. Retailers, for example, can combine real-time data on inventory with demand forecasting to reduce excess ordering and stockouts. Knowledge of customer behavior can make advertising campaigns, pricing strategies, and loyalty programs more effective. In manufacturing, engineers can combine computer-aided product design with data generated from production systems, designing next-generation products with a leaner approach to costs and raw material use.[91] Companies can monitor every point in the production process and make real-time adjustments to prevent bottlenecks and defects. Automakers, for example, can use sensors to monitor for humidity that can affect the painting stage and cause rework.

Up to

$2.2T

potential increase in annual GDP from three applications of digital technologies alone

These impacts on labor, capital, and multifactor productivity could generate a combined annual impact of $1.6 trillion to $2.2 trillion by 2025 (Exhibit 23). This would lift GDP 6 to 8 percent above baseline projections for that year.

Additionally, digitization supports growth by deepening US ties to the rest of the global economy. New, purely digital goods and services can be more easily traded, and e-commerce marketplaces are facilitating an explosion of e-commerce that is increasingly global, with new opportunities for small companies and entrepreneurs to participate. In a more connected world, countries enjoy faster growth when they have large cross-border exchanges of trade, finance, people, and data with a wider set of partner countries. In a global comparison, the United States ranked first in the world on the extent of its cross-

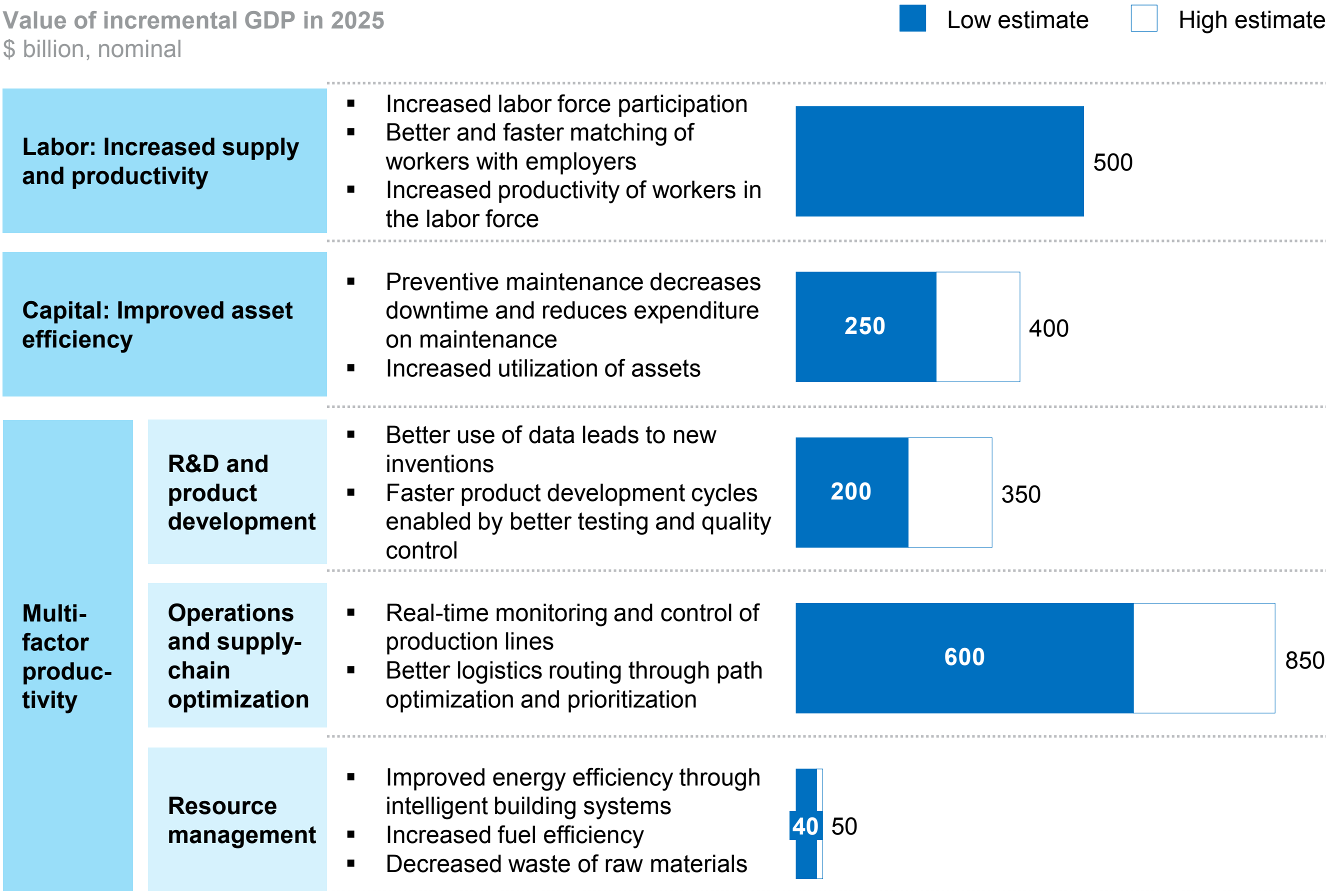
90 For more on IoT technologies, their applications in various settings, and their economic potential, see *The Internet of Things: Mapping the value beyond the hype*, McKinsey Global Institute, June 2015.

91 Previous MGI research has covered big data analytics, its applications, and its economic potential. See *Big data: The next frontier for innovation, competition, and productivity*, June 2011, and *Game changers: Five opportunities for US growth and renewal*, July 2013.

border data connections—and there is room to continue building on this advantage.[92] We estimate that global flows caused by digitization will add nearly $150 billion to US GDP by 2025. Because some of this may include overlap with the effects analyzed above, we excluded this number from the total impact.

Exhibit 23

By 2025, three effects of digitization alone could boost annual US GDP by up to $2.2 trillion



These opportunities alone could add $1.6 trillion to $2.2 trillion to annual GDP by 2025. However, this sizing is not comprehensive and only reflects the applications we have analyzed in this report. The potential for technology-fueled growth is much wider.

NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

AUTOMATION COULD REDEFINE MANY OCCUPATIONS AND ACCELERATE HISTORICAL RATES OF MIDDLE-SKILL JOB DISPLACEMENT

Historically, technological advances have usually created net jobs, but some academics have argued that this time things are different.[93] Automation long ago moved beyond the assembly line and began to affect administrative workers as well. Today technology is beginning to encroach on human skills—from navigating in the physical world to producing language—in ways that were once the stuff of science fiction.

92 *Global flows in a digital age: How trade, finance, data, and people connect the world economy*, McKinsey Global Institute, April 2014.

93 Erik Brynjolfsson and Andrew McAfee, *Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy*, Digital Frontier Press, 2011.

As these technologies advance, there is growing anxiety about the jobs that could be lost. But relatively few jobs can be entirely automated across all of their tasks, making it difficult to draw a neat line between automation and job losses. In addition, technology creates the need for new roles and skills even as it renders others redundant. Two decades ago, occupations such as app developer, social media manager, SEO specialist, cloud services specialist, and big data analyst were not on the radar. In the years ahead, some jobs will evolve, some will be eliminated, and still others may be created—including, perhaps, entirely new occupations that we cannot predict today. Because these dynamics occur simultaneously and many factors are in play, we do not attempt to quantify the impact of digitization on net job creation across the economy.

Automation is ultimately about handling tasks and activities rather than eliminating specific jobs and occupations, and we consider its potential impact on the labor market through this lens. As companies in many industries integrate these technologies, jobs and business processes will be redefined on a large scale. Some 60 percent of occupations could have 30 percent or more of their activities automated. This will affect skill requirements and the day-to-day nature of work for a large share of the labor force. Even highly skilled workers such as physicians and CEOs will not be immune.[94]

2x
increase in historical job displacement rate over the next decade

To illustrate what could unfold over the next decade, we take a closer look at the potential impact on clerical, sales, production, and operational roles—the middle-skill segment of the workforce that has already experienced increasing job displacement over the past two decades. After analyzing a detailed list of tasks performed by these workers, we consider which ones could be automated by currently demonstrated technologies. We then map these tasks to jobs to estimate the share of employment that would be affected, applying historical adoption rates of comparable technologies. This approach considers only what is possible from a technological perspective, not whether this shift will be economically viable. Based on different adoption curves, we find that automation could displace anywhere from 10 to 15 percent of these jobs in the decade ahead. The median point of our scenario is 13 percent, which would represent a sharp acceleration of historical displacement rates (Exhibit 24).[95] This does not necessarily mean there will be 13 percent fewer middle-skill jobs overall, as technology will simultaneously create new tasks and jobs at a rate we cannot predict.

Any reduction of labor is likely to occur without a loss of output, since automation is designed to increase production and efficiency. Historical trends in the US economy suggest that any trade-off between productivity growth and job growth is a short-term phenomenon. Viewed over a ten-year period, stretches of productivity growth have gone hand in hand with job growth.[96] Over the medium to long term, if displaced workers acquire the capabilities and training they need for new jobs, the overall productivity of the US labor force could increase. In the short term, however, this could be a wrenching shift for many workers.

Companies will have to consider carefully what this technological capability means for redefining roles and business processes—including the impact on intangible aspects of their business such as creativity and the value of providing a human touch in customer interactions. These decisions are not always simple trade-offs between machines and

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[94] For more on this issue and the underlying analysis, see Michael Chui, James Manyika, and Mehdi Miremadi, "Four fundamentals of workplace automation," *McKinsey Quarterly*, November 2015. This analysis suggests that 45 percent of work tasks can be automated with currently demonstrated technologies.

[95] These historical displacement rates are based on Daron Acemoglu and David Autor, "Skills, tasks and technologies: Implications for employment and earnings," in *Handbook of Labor Economics*, volume 4, part B, Orley Ashenfelter and David Card, eds, Elsevier, 2011.

[96] *US growth and renewal: Retooling America's economic engine*, McKinsey Global Institute, February 2011.

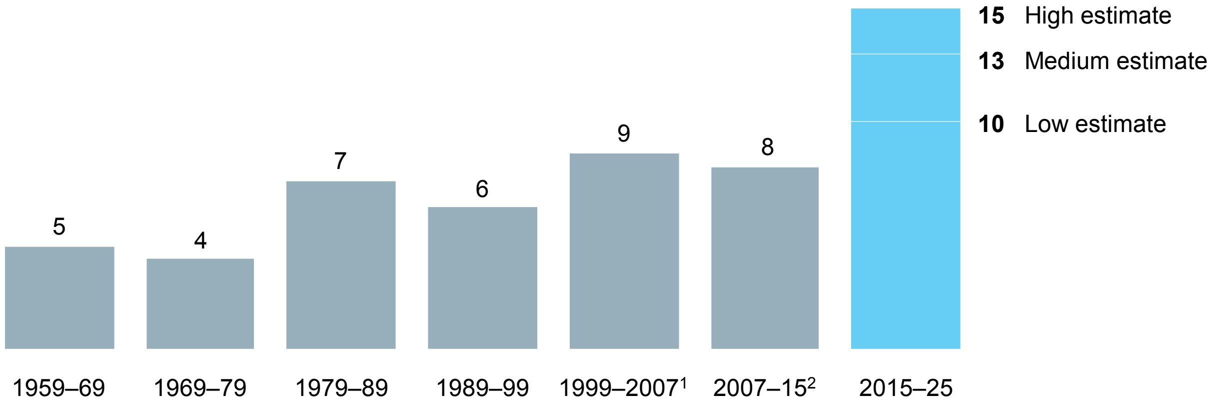
humans. There are many avenues for using automation to augment what workers can do and shift their focus to high-value-adding activities rather than simply replacing them.

As these types of organizational changes play out across companies and industries, the broader labor market is likely to experience a period of increased churn. The resulting policy and societal questions loom large. As digital technologies reshape the demands of the workplace, the job market will value individuals who can reinvent themselves and continue to acquire new skills. Creating a more comprehensive and responsive system of skills development will be critical to helping affected workers navigate this new and fast-changing world.

Exhibit 24

Automation could accelerate the displacement of middle-skill jobs to nearly twice the rate of recent decades

Share of middle-skill jobs displaced in the US economy
%



Millions of jobs displaced	2	3	5	5	6	6	8–12

1 Normalized to 10 years and adjusted for the 2008 recession.
2 Extrapolated 2015 total and middle-skill employment based on trends through 2014.

SOURCE: BLS; O*NET; Katz and Margo, 2013; Acemoglu and Autor, 2010; Brancheau and Wetherbe, 1990; McKinsey Global Institute analysis

THE FRONTIER WILL CONTINUE TO EXPAND IN NEW DIRECTIONS

Because they focus on specific uses for currently existing technologies, the economic projections described in this chapter represent a highly conservative estimate of how much growth digitization could produce over the next decade. But the expansion of the digital frontier shows no sign of slowing, and we have barely scratched the surface of the many markets that could be transformed.

It is impossible to predict the exact direction that disruption will take, but the possibilities are immense. Mobile payments and microlending could take off, or entirely new types of "fintech" could disrupt traditional financial services. Digital marketplaces could reduce search and transaction costs for new types of goods and services, and the "sharing economy" model could spread to new areas. Consumers could begin printing custom-ordered 3D products as a matter of course. Robots, already fixtures on assembly lines, are being introduced into health-care settings and could appear in our homes. Self-driving cars could become the dominant form of transportation, freeing up hours of time each day for millions of people and reducing traffic fatalities. The Internet of Things could reduce gridlock in cities, make infrastructure systems more efficient, and personalize homes, cars, offices, and products.

So far we have seen only a fraction of what digitization can do to improve the delivery of government services (an issue that is discussed in greater detail in Chapter 4). The possibilities are even more exciting in areas such as education and health care, where there is still a great deal of room for further digitization. There is a wave of technology innovation in both of these areas, but it is taking longer for change to penetrate the many fragmented layers of institutions and stakeholders in both of these systems.

In health care, for instance, there is enormous potential to combine big data analytics with synthetic biology to usher in the era of personalized medicine. The Internet of Things can allow providers to monitor patient data remotely, transforming the way we treat the chronic diseases that account for a large share of US health-care expenditure. For all of the promise on the frontier, however, large parts of the US health-care system still need to do a vast amount of work to build fundamental systems and interoperability. A recent report found that almost a quarter of the nation's hospitals and more than 40 percent of its office-based physicians had not yet adopted electronic health record systems as of 2014.[97] Many still rely on paper records. Even those that do have electronic health record systems may not be sharing information seamlessly with the patient and with other providers; tests are repeated needlessly and patients recount their histories over and over because these systems are not interoperable. Much of the workforce will need enhanced digital skills in order to transform the health-care system. But if the United States can break through the institutional barriers, digitization could help to eliminate many duplicative processes and unnecessary procedures, improving the patient experience and yielding cost savings. Most important, it could improve the quality of care with technologies such as clinical diagnosis support systems.

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After a new technology is introduced, there is a time lag before it becomes widely adopted and the resulting boost to productivity becomes evident. The US economy could be passing through such a moment right now as it awaits the payoff from recent investments in big data analytics and the Internet of Things, two technological advances with the most significant implications for business productivity we have seen in many years. Our future scenario indicates that a decade of economic restructuring lies ahead. The United States could be on the brink of significant productivity gains—as well as a period of unsettling shifts in the job market. Chapter 4 examines what this period of rapid transition could mean for companies, policy makers, and individuals.

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[97] *Update on the adoption of health information technology and related efforts to facilitate the electronic use and exchange of health information*, Report to Congress, Office of the National Coordinator for Health Information Technology, US Department of Health and Human Services, October 2014. See also *Health information technology in the United States, 2015: Transition to a post-HITECH world*, University of Michigan School of Information, Harvard School of Public Health, Mathematica Policy Research, and the Robert Wood Johnson Foundation, September 2015; and "Going digital: Why more physicians will adopt electronic medical records," Brookings Institution TechTank blog, October 15, 2015.

4. IMPLICATIONS FOR COMPANIES, POLICY MAKERS, AND INDIVIDUALS

As technology races ahead, we are entering a hypercompetitive, warp-speed world. Digitization is reshaping the way companies operate, outpacing the ability of many institutions to adapt, and putting the onus on individuals to navigate their way through a more uncertain labor market.

Many traditional companies are struggling to develop new capabilities and respond to challenges from digital players that may not be burdened with heavy capital costs or legacy systems. Incumbents can take a page from their competitors' playbook by viewing their digital transformation as an opportunity to rebuild a more agile and customer-focused business model. The most formidable tech firms are continuously inventing, experimenting, and taking risks—and incumbents will have to do the same.

Policy makers are wrestling with the need to create the right enabling environment for technology to fuel growth while at the same time easing the stresses and dislocations that it may unleash. Additionally, governments at all levels could be on the cusp of transforming their own operations. Integrating more sophisticated digital tools could allow them to deliver public services in more transparent, cost-effective, and creative ways.

As individuals, many of us are both enamored of technology and overwhelmed by it. Most of us are still struggling to find the right balance in a world of constant connectivity and digital distractions. The pervasiveness of digital technology is opening up new professional, personal, and entrepreneurial opportunities that were largely unimagined just a few short years ago. But it also raises questions and challenges that will have to be resolved through trial and error for the foreseeable future.

ADAPTING TO WIN: THE DIGITAL IMPERATIVE FOR COMPANIES

The ongoing digital transformation of the US economy places companies under immense and constant pressure to evolve. Today the race is on to capture value from data analytics and the Internet of Things, but there is no finish line.

Digitizing can be a daunting challenge for larger incumbents that operate in more traditional, physical industries. Meeting it starts with the recognition that digital strategy and business strategy are now one and the same. Wide-ranging organizational change is never easy, and a successful digital transformation demands a high level of coordination and a whole new set of capabilities. Silos that have been in place for many years may need to be dismantled in order to capture the full benefits of streamlining processes.

On the other side of the spectrum, the shift to a more digital economy is an empowering moment for entrepreneurs. The barriers to entry have never been lower, as new businesses of all stripes can piggyback onto larger platforms and immediately tap into a substantial customer base. They can instantly recruit specialized help on a project basis, access computing power via the cloud, and connect with a wide range of suppliers.

As described in Chapter 2, digitization is changing cost structures, disrupting value chains, opening up new markets, and intensifying competition. Large and small organizations alike will need ingenuity and a faster metabolism to adapt to these changes. Most are still in the early stages of this process, and it is far too early to say that a definitive set of best practices has emerged. But the list below outlines some of the most pressing considerations for companies in the areas of competition, customer engagement, and operations.

Prepare for a tougher world of 360-degree competition

Digitization has contributed to tougher, faster competition—and, increasingly, to a winner-take-all corporate environment. Since 2000, the average variance in returns on capital for North American firms has been more than 60 percent higher than the levels that prevailed from 1965 to 1980. Not only are profits rising, but in some of the most digitized industries, the leading firms are winning bigger than ever.[98] One of the largest competitive shifts has been the rise of dominant digital platforms, whether they are e-commerce marketplaces, operating systems, or social media networks.

Geographic and sector boundaries mean very little in a more digital world. New competitors that look nothing like traditional industry leaders can become market leaders practically overnight. Incumbents need better radar and constant vigilance to spot the new technologies, startups, and disruptions brewing on the horizon. Tomorrow's biggest challenger may be a much smaller company that can operate without the legacy costs and constraints that bog down many industry incumbents. In particular, the pooling of thousands of small players in the largest marketplaces and ecosystems represents a new competitive force. Many of these small enterprises have the advantage of being "born digital." Unburdened by legacy systems and constraints, they can embed digital technologies into their business models and strategies from the outset rather than retrofitting them onto existing processes.

Against this backdrop, a growing number of organizations outside the tech industry have added chief digital officers to their executive teams. Increasingly, the person in this role is charged with coordinating and managing comprehensive organizational change to integrate digital into all aspects of the business. This is an ongoing process, and the chief digital officer has to ensure that the momentum behind it does not flag. Chief digital officers also act as the company's radar to stay abreast of new technologies, startups, and other disruptive developments that could undermine established business models.[99]

Build new assets and revenue streams

Some digital disruptors are draining substantial value out of industries and giving it away to consumers. This trend may continue and even spread to additional industries. Companies have to figure out how to capture some of that surplus and create more sustainable business models. Businesses need to go into this fight with a strong digital balance sheet, considering all of the assets at their disposal (such as behavioral data or customer relationships) and whether they could be monetized.

Portfolio strategies can be a valuable hedge in such a fast-moving environment; businesses that rely too heavily on a single revenue stream or on playing an intermediary role in a given market are particularly vulnerable. The best digital strategies start fresh and are built on a vision of where value is likely to shift over the next three to five years, taking the most likely market disruptions into account. They prioritize a handful of initiatives to exploit the biggest opportunities—and they consider whether it is time to move out of markets where value is declining.[100] Profits are rapidly shifting to idea-intensive sectors, and the most profitable firms are those with strong designs, unique intellectual property, and unique user experiences.

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[98] *Playing to win: The new global competition for corporate profits*, McKinsey Global Institute, September 2015.

[99] Tuck Richards, Kate Smaje, and Vik Sohoni, "'Transformer-in-chief': The new chief digital officer," *McKinsey.com Insights & Publications*, September 2015.

[100] Driek Desmet, Ewan Duncan, Jay Scanlan, and Marc Singer, "Six building blocks for creating a high-performing digital enterprise," *McKinsey.com Insights & Publications*, September 2015.

Build—or buy—the capabilities of the future

In this competitive landscape, companies cannot afford to fall behind in critical capabilities. Some can be cultivated by establishing the right talent pipeline or building new business lines using existing resources. But sometimes companies need speed, and finding an outside partner with complementary strengths may make sense.

A massive wave of mergers and acquisitions activity has taken place in the most highly digitized industries. M&A is increasingly becoming a "land grab" as companies seek to add new capabilities, talent, or a built-in user base. Some recent deals would not pass the traditional valuation filter, but the need to execute a rapid strategy, acquire high-value intellectual property, and stay on the cutting edge may call for different metrics.

Companies are increasingly heading off their future competitors by buying them. The tech sector, in particular, has seen a wave of M&A activity as larger players use acquisitions to expand their portfolios and stay on the cutting edge. When Facebook acquired Instagram in 2012, for instance, it paid $1 billion—or $30 for each of the service's 33 million users. Just two years later, the company acquired WhatsApp for $19 billion. While the valuation caught many by surprise, it came to $42 for each of the messaging app's 450 million users, many of whom were located in markets where Facebook hoped to expand. The acquisition immediately made the company a major player in the messaging market.[101]

Seize the opportunity to redefine the customer decision journey

The move toward digital is an opportunity to redefine the customer decision journey. In addition to e-commerce sales, one study has estimated that 42 percent of in-store US retail sales will be influenced by the Web by 2020.[102]

Data analytics can deliver a streamlined yet personalized user experience that is seamless across multiple channels. Companies can harness all the data they generate to fine-tune their marketing efforts and customer interactions, increasing conversion, customer satisfaction, and retention. Most are still experimenting with new avenues for engaging with customers online, from social media campaigns to product reviews. Many companies are figuring out what to do with the sheer volume of unstructured data at their disposal. A sophisticated analytics engine that consolidates all of a company's touch points with customers can turn a series of discrete snapshots into a more holistic view of their behavior and motivation.[103]

Companies in a variety of industries are also realizing that design needs to play a greater role in business strategy. Design is no longer merely about packaging the end product; it is increasingly embedded in product development and branding. Design and storytelling can be critical to making one company's product more compelling in a noisy digital world where the customer can be sidetracked by a multitude of options and distractions.

As the largest platforms continue to solidify their positions as central gateways to customers, many companies are forced to sell their products or services on someone else's platform. That calls for a careful strategy around pricing and value retention. Companies also have to ensure that their brand maintains its integrity and stands out from the crowd in an ecosystem not of their own design.

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101 *Playing to win: The new global competition for corporate profits*, McKinsey Global Institute, September 2015.
102 Susan Wu, *Forrester Research Web-influenced retail sales forecast, 2015 to 2020 (US)*, September 2015.
103 Edwin van Bommel, David Edelman, and Kelly Ungerman, "Digitizing the consumer decision journey," *McKinsey.com Insights & Publications*, June 2014.

Take advantage of new innovation models

Digital is changing the nature of innovation. Companies are replacing closed and tightly managed R&D operations with more fluid, open processes involving teamwork across the organization and collaboration with customers and suppliers. New kinds of partnerships may make sense so that companies with different strengths can combine technologies in new ways. Auto manufacturers, for example, are teaming up with software companies in the race to develop connected and eventually autonomous cars.

Capturing the full value of new technologies may require cooperation with competitors and industry groups to set common standards for interoperability. In general, digital systems depend on the creation of widely accepted interface standards to provide a common language or the use of translation or aggregation systems as a bridge between an operating system and applications. While traditional Internet protocols have been widely adopted, the development and adoption of standards for the Internet of Things is still in its early stages. Deploying the IoT in complex settings such as urban environments, the health-care system, and broader manufacturing value chains will require integration across multiple systems and vendors, sometimes across different industries, to ensure that all systems interact smoothly.[104]

Emphasize agility and learning over forecasting and planning

Given the speed with which new innovations, new markets, and new disruptions appear, creating a five- or ten-year plan is becoming an exercise in futility. Long-term forecasting exercises are less relevant and reliable, while agility is more critical than ever. Large incumbents cannot afford to maintain cumbersome decision-making processes and slow-moving corporate cultures. Borrowing a page from winning tech firms, they need a new mindset that focuses on learning, experimenting, and iterating. Even the most successful tech giants never stop innovating, pivoting, and adjusting their platforms.

Incumbents facing the need to modernize with outdated legacy IT systems could take a two-speed approach, undertaking quick iterations of customer-facing applications while simply maintaining systems for back-end transactions and record-keeping.[105] This strategy can buy some time, but companies will eventually need to capture the cost savings associated with upgrading and streamlining back-office operations.

Think differently about your workforce

Today the most profitable industries are those that revolve around ideas, innovation, research, and expertise—and all that depends on having the most skilled and creative talent. Even outside those industries, most organizations need their employees to have a greater degree of digital fluency. But finding the right talent is becoming more difficult. More than a third of global employers surveyed by Manpower reported that they could not find the talent they needed in 2014, and more than half of affected firms said that this had a tangible impact on their ability to meet customer needs.[106] Previous MGI research has projected a global shortage of 38 million to 40 million workers with college or postgraduate degrees by 2020.[107]

The war for talent is taking on a whole new dimension now that digital platforms have assumed a more central role in the US labor market. One of their clearest early effects has been to give highly skilled workers more options, more mobility, more insider knowledge about any company's working culture, and a better sense of the wages they can command

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104 *The Internet of Things: Mapping the value beyond the hype*, McKinsey Global Institute, June 2015.

105 Juan Garcia Avedillo, Duarte Begonja, and Andrea Peyracchia, "Two ways to modernize IT systems for the digital era," *McKinsey.com Insights & Publications*, August 2015.

106 *The talent shortage continues: How the ever-changing role of HR can bridge the gap*, Manpower Group, 2014.

107 *The world at work: Jobs, pay, and skills for 3.5 billion people*, McKinsey Global Institute, June 2012.

on the open market. Business leaders need to recognize that they are now operating in a world in which employees are more empowered and competitors have new tools for poaching their best people. It has never been more important for companies to focus on finding the best people and creating compelling reasons for them to stay.

Even as companies have heavily digitized many of their operations, from supply chains to customer engagement, most have not invested heavily in digital human resource systems. Companies will need to add more analytic talent to their human resources teams, just as they have added it to marketing and product development. Perhaps the best-known example of a company applying technology to talent management is Google, whose "People Analytics" department aims to use rigorous testing and statistical analysis to augment human judgment regarding workforce decisions.[108] Companies can capture tangible financial benefits from adopting online talent platforms for hiring, onboarding, planning, employee engagement, and better productivity (Exhibit 25).

Exhibit 25

Companies can increase output and reduce costs by adopting online talent platforms for hiring, onboarding, planning, and management

Model company	Revenues $ billion	Employees	Incremental impact of online talent platforms: Output increase[1] %	Cost reduction[2] %	Profit impact Basis points
Professional services	2.5	5,000	9	7	540
Technology	11.1	10,000	7	4	390
Hospital	0.5	2,000	4	6	230
Retail	2.8	15,000	3	5	110
Manufacturing	2.4	10,000	3	4	120
Bank	31.7	100,000	2	6	255
			5	5	275

1 Includes productivity gains in front- and middle-office workers, which can translate into revenue or other increased output opportunities.
2 Includes productivity effect in middle- and back-office workers, and savings in recruiting, interviewing time, training, onboarding, and attrition costs.
Note: Numbers may not sum due to rounding.

SOURCE: BLS; company annual reports; McKinsey Global Institute analysis

The rapid-fire pace of technology innovation means that companies are constantly in need of the latest skills. This dynamic could lead to turnover and perpetual recruiting unless businesses take a new approach to skills development. Rather than engaging in a constant search for new talent with the latest skills, companies can benefit from investing in continuous learning programs that allow valued current employees to grow and keep their skills current.

108 Laszlo Bock, *Work rules! Insights from inside Google that will transform how you live and lead*, Twelve, 2015.

IN ADDITION TO ADDRESSING POLICY ISSUES, GOVERNMENT FACES THE TASK OF DIGITIZING ITS OWN OPERATIONS

Government has a dual role in the US digital economy. It establishes the policy framework and shapes the environment for innovation. These are critical for national competitiveness in an interconnected—and increasingly digital—global economy. But governments are also operating entities, and like any private-sector enterprise, they can use digital tools to manage complexity. Below we explore the challenges that lie ahead on both of these fronts.

Encourage participation

This report has focused on the growing gap between the average technology user and the digital leaders—a gap that has become central to competition for companies and individuals alike. But at the same time, there are still "have-nots" who are not participating in the digital economy at all. The digital divide is receding, but it has not gone away.

Some 84 percent of US adults use the Internet, but the flip side of that number is that nearly 40 million remain offline.[109] These digital have-nots are doubly affected by their lack of access. As workers, their prospects are narrowing, and as consumers, they miss out on significant savings and convenience. Encouraging them to participate in the digital economy starts with providing access and infrastructure, but it is also about enhancing digital literacy, increasing awareness of digital tools, and encouraging their adoption by consumers and workers.

97%
of US adults with household incomes >$75K are online

The US digital divide reflects urban/rural differences, sprawling geographies with lower population density, educational gaps, and income inequality. US households in the West and the Northeast are more connected than those in the South.[110] Urban Americans are three times as likely as rural Americans to have access to high-speed broadband, and just over 40 percent of rural schools cannot establish high-speed connections.[111] Some of the digital gaps are highly localized. Within the city of New York, for example, 80 percent of Manhattan residents have residential broadband access, but only 65 percent in the Bronx do.[112] Our analysis shows that there is much smaller variation in households' access to the Internet in Amsterdam than in New York. In fact, even the poorer neighborhoods of Amsterdam are more likely to have Internet access than Manhattan, despite the fact that per-capita incomes are lower.

74%
of US adults with household incomes <$30K are online

The digital divide is larger in the United States than in most other advanced economies (see Box 4, "Measuring the US digital economy against global peers"). It has stubbornly persisted despite years of attempts to bridge it, and its persistence mirrors the stickiness of related issues such as long-term unemployment, wage inequality, and declining mobility. A recent study found that 97 percent of adults in households with incomes exceeding $75,000 a year are Internet users, while only 74 percent of those in households with incomes below $30,000 a year are online. Ninety-five percent of US college graduates use the Internet, but only 66 percent of adults who did not complete high school are online.[113]

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[109] Brian Fung, "37 million Americans don't use the Web. Here's why you should care," *The Washington Post,* The Switch blog, July 29, 2015.

[110] Thom File and Camille Ryan, *Computer and Internet use in the United States, 2013*, American Community Survey Reports, US Census Bureau, November 2014. See also "Mapping the digital divide," Council of Economic Advisers issue brief, July 2015.

[111] FCC chairman Tom Wheeler, "Closing the digital divide in rural America," official FCC blog, November 20, 2014.

[112] *Internet inequality: Broadband access in NYC,* Office of the New York City Comptroller, December 2014.

[113] Andrew Perrin and Maeve Duggan, *Americans' Internet access: 2000–2015*, Pew Research Center, June 2015.

A 2013 survey of the offline US population found that 19 percent cited the cost of Internet access and devices as a barrier.[114] The United States posts some of the highest costs for high-speed broadband service, and it ranks in the middle of the pack among OECD member states for both household penetration and average speed of fixed broadband. In one global study of urban broadband speeds, Seoul, Hong Kong, and Tokyo were deemed the "speed leaders." Four US cities—Chattanooga (TN), Kansas City (KS), Kansas City (MO), and Lafayette (LA)—matched them, but did so at far higher prices. San Francisco tied for 20th in this ranking with Mexico City.[115]

Building a more inclusive digital economy could represent a step forward in addressing inequality. A great deal of progress has been made in recent years toward the goal of creating universal access to the Internet. Some 45 million Americans have adopted broadband since 2009, and federal investment has supported the deployment or upgrading of more than 100,000 miles of network infrastructure.[116] Today some 98 percent of Americans have access to high-speed wireless networks.[117] But many lower-income users are limited to using their phones to go online in public spaces.[118] As of 2013, more than a quarter of US households lacked a high-speed Internet connection, which is increasingly important for accessing information, educational resources, and job opportunities.[119] Federal initiatives and partnerships such as the ConnectED and ConnectHome programs have been launched to address the gaps, but there is more work to do.

100K

miles of network infrastructure built with federal investment since 2009

Beyond developing the infrastructure and skills to encourage individual participation, policy makers can create awareness among small business owners of the growth opportunities in digitally facilitated global trade. Today the vast majority of US small businesses do not export, and those that do tend to sell their products in only one country.[120] But digital platforms are creating new global flows of communication, capital, goods, and services; they are also removing many of the difficulties once associated with exporting. Small firms and startups have unprecedented opportunities to connect with global customers. Expanding the information, mentoring, and financing available to them can help these firms take advantage of this new shift in cross-border commerce. [121]

In terms of government ICT usage, the United States ranks 13th out of 34 countries in our analysis, which evaluates government efficiency and the importance of ICT to the government's vision of the future. The United States has been a global leader in opening up government data sets for private-sector innovation, but its own e-government services for citizens are not as well developed as those in the leading countries. In this area, as in the broader digital economy, the United States is a leader in innovation, but consumer and citizen access is not as strong.

114 *Who's not online and why*, Pew Research Center, September 2013.
115 Danielle Kehl et al., *The cost of connectivity 2014*, The Open Technology Institute at New America, October 2014.
116 "Mapping the digital divide," Council of Economic Advisers Issue Brief, July 2015.
117 "98 percent of Americans are connected to high-speed wireless Internet," White House blog, March 24, 2015.
118 *US smartphone use in 2015*, Pew Internet Research, April 2015.
119 "Computer and Internet use in the United States: 2013," American Community Survey Reports, US Census Bureau, November 2014.
120 *The United States of trade: 50 stories in 50 states that show the impact of trade across the US*, US Department of Commerce and Office of the US Trade Representative, April 2015.
121 See *Global flows in a digital age: How trade, finance, people, and data connect the world economy,* McKinsey Global Institute, April 2014, as well as upcoming MGI research into digitization and globalization.

Box 4. Measuring the US digital economy against global peers

There is a contradiction at the heart of the US digital economy. The United States is home to pioneering high-tech firms, and it remains at the center of a global web of cross-border collaboration for ICT-related patents and scientific publications. But while US companies and universities are recognized as digital leaders, many households and individuals are not as wired. This gap becomes apparent when the United States is viewed against peer economies.

Our Country Digitization Index aggregates a variety of indicators from various sources measuring ICT supply and innovation, business use, consumer use, and government use. Japan, Sweden, and the United Kingdom outperform the United States across all of these categories. The overall results place the United States only 11th among 34 OECD member states (Exhibit 26). Its performance is stronger on indicators that measure innovation and business use (such as B2B digital transactions and online advertising) than on indicators focusing on consumer or government use.

The United States ranks 12th out of 34 countries for consumer use, reflecting the extent of its digital divide. The United States is among the lowest-ranking OECD countries for both household penetration and average speed of fixed broadband. It also posts some of the highest costs for high-speed broadband service.

The Americans who *are* online lead highly digital lives. But US households and individuals, on average, are less wired than those in northern Europe, Japan, South Korea, New Zealand, and Israel. Nearly 80 percent of UK residents have ordered goods and services online; the share in the United States is less than 60 percent. More than 95 percent of 65-to-74-year-olds in Scandinavia use the Internet versus less than 80 percent of US seniors.

Exhibit 26

The United States is among the top countries for ICT innovation and business use but lags behind in government and consumer use

% rank, relative to best-performing country in each category, OECD countries[1]

Total[2]		ICT supply and innovation[3]		Business use[4]		Consumer use[5]		Government use[5]	
Sweden	1.00	United Kingdom	1.00	Norway	1.00	United Kingdom	1.00	South Korea	1.00
United Kingdom	0.98	Sweden	0.97	Iceland	0.96	Sweden	0.98	Estonia	0.96
Finland	0.95	Switzerland	0.96	United Kingdom	0.91	Norway	0.97	Luxembourg	0.88
Norway	0.92	Japan	0.92	Sweden	0.91	Denmark	0.95	Sweden	0.86
Netherlands	0.92	Finland	0.92	Japan	0.87	Finland	0.93	New Zealand	0.84
Japan	0.88	Netherlands	0.90	Switzerland	0.87	Netherlands	0.92	Finland	0.83
South Korea	0.85	United States	0.83	Luxembourg	0.85	South Korea	0.82	Norway	0.82
Luxembourg	0.85	Estonia	0.81	Finland	0.83	Luxembourg	0.81	Japan	0.82
Switzerland	0.85	South Korea	0.78	United States	0.81	Iceland	0.81	Portugal	0.79
Estonia	0.81	Luxembourg	0.73	Netherlands	0.75	Switzerland	0.80	Netherlands	0.78
United States	0.80	Ireland	0.73	Denmark	0.72	Japan	0.76	Israel	0.71
Denmark	0.79	Israel	0.71	New Zealand	0.71	United States	0.74	United Kingdom	0.69
Iceland	0.75	France	0.71	Austria	0.67	Germany	0.70	United States	0.64
Germany	0.68	Norway	0.69	Australia	0.65	Australia	0.70	Canada	0.58
Israel	0.68	Iceland	0.65	Israel	0.62	Estonia	0.69	Germany	0.58
Australia	0.66	Canada	0.63	Germany	0.61	Austria	0.66	Austria	0.55
Austria	0.65	Belgium	0.61	Estonia	0.59	New Zealand	0.63	Ireland	0.55
New Zealand	0.64	Germany	0.61	Canada	0.59	Israel	0.56	France	0.54
Canada	0.62	Czech Republic	0.59	Belgium	0.51	Belgium	0.56	Australia	0.54
France	0.61	Italy	0.59	Ireland	0.48	France	0.56	Chile	0.52
Ireland	0.61	Denmark	0.59	South Korea	0.44	Canada	0.55	Switzerland	0.52
Belgium	0.57	Turkey	0.55	France	0.44	Ireland	0.52	Denmark	0.52
Czech Republic	0.46	Austria	0.55	Czech Republic	0.42	Czech Republic	0.49	Iceland	0.47
Portugal	0.46	Australia	0.54	Portugal	0.40	Poland	0.38	Spain	0.42
Spain	0.42	Spain	0.53	Slovakia	0.30	Slovakia	0.38	Belgium	0.38
Italy	0.38	Slovenia	0.52	Hungary	0.27	Italy	0.35	Turkey	0.32
Slovakia	0.37	Poland	0.51	Spain	0.27	Spain	0.34	Mexico	0.28
Poland	0.35	Slovakia	0.50	Turkey	0.23	Slovenia	0.31	Hungary	0.20
Slovenia	0.34	Greece	0.48	Chile	0.21	Portugal	0.31	Slovenia	0.19
Chile	0.31	Mexico	0.47	Slovenia	0.19	Chile	0.31	Italy	0.17
Hungary	0.31	Portugal	0.39	Italy	0.17	Hungary	0.28	Greece	0.11
Turkey	0.30	Hungary	0.38	Poland	0.13	Greece	0.25	Czech Republic	0.11
Greece	0.28	New Zealand	0.31	Greece	0.13	Turkey	0.11	Slovakia	0.11
Mexico	0.22	Chile	0.11	Mexico	0.10	Mexico	0.05	Poland	0.10

1 All metrics are ranked based on percent ranks (excluding 0 and 1); bucket rankings are made by taking an average where all metrics have the same weight.
2 All available metrics per country weighted equally.
3 Based on the following metrics: ICT sector as share of the economy, broadband cost (the lower the cost, the better the ranking), mobile network coverage, international Internet bandwidth, secure Internet servers, ICT patents, share of top 250 ICT firm revenue.
4 Based on the following metrics: B2B Internet usage, online advertising spend per capita, firm-level technology absorption.
5 Based on the following metrics: B2C Internet use, share of population that purchases online, Internet retail as a share of total retail spend, households with a computer, Internet users, fixed and mobile broadband subscriptions, mobile cellular subscriptions, smartphone penetration, use of virtual social networks.
6 Based on the following metrics: ICT use and government efficiency, importance of ICT to government vision of the future, government online services index, government success in ICT promotion.

SOURCE: *Network readiness index 2015*, World Economic Forum; OECD; Magna Global; Forrester; Euromonitor; Strategy Analytics; McKinsey Global Institute analysis

Take a new approach to setting the rules of the game

Building a more comprehensive policy framework will require attention to ongoing issues such as consumer privacy, data sharing, and industry concentration. But more broadly, it requires a new mindset.

Regulatory bodies tend to operate with a presumption that the rules they set will provide stability and clarity over the long term. But the digital revolution is taking us into uncharted territory. New digital business models can spread rapidly, sometimes within gray areas. Uber and Airbnb, for example, built substantial user bases before regulators and local governments could fully respond to some of the ripple effects and community concerns related to their growth. And some innovations pose wide-ranging questions, such as the insurance and liability issues that will have to be worked out before autonomous cars can become a major presence on the roadways.

The rapid pace of innovation demands a more experimental, adaptive, test-and-learn approach to policy and regulation. The fact that state and local governments are regulating in different ways can actually be a source of strength. This patchwork approach has created real-world pilot programs and trials that will allow for comparison and make some of the outcomes and unintended consequences more apparent over time.

Facilitating the development of common standards is another important priority for unleashing industry innovation and capturing more of the economic potential of digital technologies. Governments can achieve this through regulation in some cases, but they can also move the process forward by convening stakeholders and wielding their own purchasing power. In electronic medical records, for instance, the federal government created incentives for adoption. But there has been only a partial payoff; providers adopted disparate systems that do not always communicate seamlessly, so that patients do not yet enjoy portability.

Data privacy and security are thorny issues in almost every area of digital use. They are central to the development of the Internet of Things, which is predicated on capturing a torrent of data about what companies and individuals are doing at any given moment and exchanging that data among systems. Governments can help to make choices about data collection, access, usage, and consent, especially for data generated in public spaces. The dangers that hackers could create in physical settings have to be carefully considered and guarded against; policy makers can help to address security issues by creating frameworks for liability.[122]

Help citizens navigate the transition

This period of sweeping technological change will not be painless. Wage pressures are building, and some occupations could lose relevance. Policy makers cannot fend off all of these forces, but they can provide some support and protections for the people who are most seriously affected.

The first major area for action is skills development. A 2013 survey found that approximately one-third of the offline US population felt daunted by the Internet or lacked the fundamental digital skills to go online.[123] Many adults who are already in the workforce will need to reinvent themselves quickly as more jobs become automated. Short, concentrated training programs for acquiring new skills need to be made widely available.

More broadly, however, there is an enormous opportunity to use the data now at our disposal to design a more effective and responsive system for education and training. We now have access to more comprehensive and detailed data about educational outcomes,

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122 *The Internet of Things: Mapping the value beyond the hype*, McKinsey Global Institute, June 2015.
123 *Who's not online and why*, Pew Research Center, September 2013.

skills, and career paths; it is already possible to track where the graduates of a given institution wind up in the labor market. Putting this data to work could empower individuals with better information about the payoff and prospects associated with educational investment. Educators and vocational training providers can make use of this data to shape their offerings—and they could be held to a new standard of accountability as the outcomes associated with specific institutions and degree programs become more publicly transparent. Over the longer term, the overall mix of skills in the workforce could adapt to meet the needs of the economy more dynamically.

Another major focus area is worker protections. As technology reshapes the world of work, some existing policy structures that have evolved over decades no longer fit the new realities. Digital platforms for freelancers and on-demand service workers, for example, are raising questions about how project-based workers are treated under the law—questions that are currently the subject of litigation. There are multiple approaches to resolving these issues. One option could be creating new categories of workers; Germany, Sweden, and Canada, for example, have a "dependent contractor" designation that grants some additional protections to workers who fall somewhere between employees and independent contractors and are dependent on a single employer.[124]

In addition to clarifying the status of these workers, there is growing urgency to address the lack of benefits and safety net protections for most on-demand service workers, freelancers, and part-timers. The United States designed a system many years ago in which employers are the mechanism for delivering a wide range of insurance and retirement benefits (even if employees share the costs with them). As new modes of digitally enabled project-based work continue to gain traction, that system may need to be modernized, with benefits becoming more portable. Digital platforms brought this problem into sharper focus—and they could provide the basis of new business models for solving it.

Use digital to transform the delivery of government services

In terms of government usage, the United States is among the global leaders but not at the top of the pack. One of its most notable achievements has been opening up government data sets on everything from weather to energy use to the earnings recorded by the graduates of various educational institutions. Tens of thousands of data sets are available through data.gov, providing the basis for outside research and private-sector innovation.

The United States is also steadily rolling out expanded e-government services for citizens, but these are not as extensive or well developed as government interfaces in the leading countries. In this area, as in the broader digital economy, the United States is a leader in innovation, but consumer and citizen access is not as strong.

The UN's most recent E-Government Development Index saw the United States slip from fifth to seventh in the global rankings, behind South Korea, Australia, Singapore, France, the Netherlands, and Japan. The trailblazers are building more seamless interfaces and using digital to drive innovation and fundamentally change the way they interact with citizens. South Korea, for example, has been rolling out more mobile and multichannel services.[125]

Governments around the world are beginning to realize tremendous cost savings; the United Kingdom, for instance, estimated that gov.uk saved £42 million ($63 million) in public spending within a year of its launch.[126] Streamlining cumbersome back-office functions can free federal, state, and local employees to provide better customer service to citizens,

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[124] Judy Fudge, Shae McCrystal, and Kamala Sankaran, eds., *Challenging the legal boundaries of work regulation,* Hart Publishing, 2012. See also Lauren Weber, "What if there were a new type of worker? Dependent contractor," *The Wall Street Journal*, January 28, 2015.

[125] UN e-government survey, United Nations, 2014.

[126] *£10bn saved in 2012/13: Efficiency and reform 2012/13 summary report*, UK Cabinet Office, 2013.

reducing wait times and lowering costs. Previous MGI research examined the potential for big data analytics alone to transform US government services by 2020. In addition to productivity gains of up to $95 billion annually, it found $280 billion to $460 billion in potential savings though minimizing erroneous government payments, improving procurement, and making tax collection more effective.[127]

Up to
$460B
potential savings in government programs by using big data analytics

The concept of e-government has moved beyond simply digitizing paper-based systems and establishing websites. Going digital is not only about making government operations more efficient; it also presents a remarkable opportunity to reinvent government services with an eye toward transparency, accountability, participation, and responsiveness.

This shift is under way in the United States, but progress is uneven. The federal government has taken steps toward opening data, consolidating hundreds of disparate data centers, and working to digitize paper-based systems such as the millions of medical records at the US Department of Veterans Affairs. But a great deal of potential is still unrealized, particularly at the local level, where technical capabilities vary dramatically. The Internet of Things has exciting potential to improve the way cities manage complex systems such as traffic, transit, water, energy use, and emergency response. The largest US cities are beginning to move in this direction but have only scratched the surface of what is possible.[128]

Fully digitizing government services and integrating next-generation technologies into government departments is easier said than done. A joint study by McKinsey and Oxford University found that public-sector IT projects requiring significant organizational change were six times more likely to experience cost overruns and 20 percent more likely to miss deadlines than similar projects in the private sector.[129] Lack of compatibility between IT systems and fragmented data ownership that spans various departments pose major challenges. Additionally, IT skills are in high demand, and public-sector entities need to create career opportunities that can lure the necessary talent away from higher-paying private-sector jobs. Deploying and managing Internet of Things applications requires highly sophisticated technical capacity that most public-sector entities—and particularly smaller city and county governments—currently do not have.

Establishing government-wide coordination of IT investments can help to overcome some of these challenges. Denmark, for example, created a digital council to serve as a central IT steering group. In addition to creating specific methodologies and guidelines for IT investments, it shares best practices and manages the project pipeline to ensure that the government is capturing all the possible synergies. The Netherlands established an implementation agenda that prioritized user-centered design; it also created a government-wide project dashboard and convened public-sector IT managers to disseminate key lessons.[130]

INDIVIDUALS WILL HAVE TO BALANCE THE BENEFITS WITH THE DEMANDS

Our ever-present smartphones are changing everything, from the way we interact with our families to how our brains are wired. This transition poses a host of implications for individuals in their various roles as workers, consumers, citizens, and entrepreneurs.

[127] *Game changers: Five opportunities for US growth and renewal*, McKinsey Global Institute, July 2013.
[128] For more on this topic, see *How to make a city great*, McKinsey Cities Special Initiative, 2013.
[129] For these and other findings, see "Delivering large-scale IT projects on time, on budget, and on value," *McKinsey.com Insights & Publications*, October 2012.
[130] "Public-sector digitization: The trillion-dollar challenge," *McKinsey.com Insights & Publications*, December 2014.

Prepare for a brave new world of work

As online talent platforms become the norm for hiring, individuals will need to put time and care into building a personal online presence and avoid online indiscretions that can affect their professional reputation. Individuals are gaining new insight into the opportunities that are out there, but they have to act on that information and plot a long-term career path. They may face more uncertainty and more frequent transitions, but that can bring greater access to opportunity than ever before for individuals who successfully adapt. Yet the new world of digital hiring has the potential to exacerbate the economic disparities that have been growing wider in recent decades. While people with distinctive digital skills are attracting job offers, employers may regard lower-skilled workers as more replaceable, compressing their wages even further.

Smartphones are a valuable workplace tool that can untether workers from being physically present in the office. But this flexibility comes at a growing price: "always on" working conditions, reduced productivity from multitasking, and distractions that impinge on personal relationships. In a hypercompetitive world, workers feel increasingly pressured to be accessible via their smartphones round the clock. Since the Internet knows no boundaries, individuals will have to decide where to draw them in their own lives to preserve their health and family life.[131]

Take advantage of a marketplace that puts the consumer in the driver's seat

In some regards, the Internet is a vast bazaar where consumers have access to an infinite variety of products, with extensive information about pricing, product features, and user satisfaction at their fingertips. Service-oriented businesses in particular are being forced to raise their game in terms of customer service; bad reviews from disgruntled customers on Yelp, Angie's List, TripAdvisor, or similar platforms can sink a small business.[132]

The digital economy has created an astounding array of consumer surplus, yet most users have barely scratched the surface of the time- and money-saving applications out there. Most have yet to take advantage of newly available tools in areas such as personal finance, health, and education.

However, participating in much of this activity entails sharing personal data—and many people remain unaware of just how pervasive this practice is. Consumers will need to weigh these trade-offs and take basic steps to prevent identify theft and guard their most sensitive information.

Exploit opportunities to become your own boss

The digital economy is evolving rapidly—and that creates new market niches for small businesses to fill. In 2014, Apple announced that there were nine million registered app developers within its ecosystem.[133]

The barriers to entry are falling, allowing anyone with a connection and a great idea to become an entrepreneur, even with limited capital. Digital technology has created "plug-and-play" solutions for startups such as enterprise software and cheap computing power on the cloud. Small firms that join the biggest e-commerce marketplaces can immediately connect with global suppliers and customers while taking advantage of well-established payment and logistics infrastructure. Entrepreneurs can turn to crowdfunding platforms

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131 A growing body of literature has begun to address these topics. See, for example, Sherry Turkle, *Alone together: Why we expect more from technology and less from each other*, Basic Books, 2011; Nicholas Carr, *The shallows: What the Internet is doing to our brains*, W.W. Norton, 2010; and Olga Khazan, "How smartphones hurt sleep," *The Atlantic*, February 24, 2015.

132 Michael Blanding, "The Yelp factor: Are consumer reviews good for business?" Harvard Business School Working Knowledge blog, October 24, 2011.

133 Sarah Perez, "iTunes app store now has 1.2 million apps, has seen 75 billion downloads to date," *TechCrunch*, June 2, 2014.

for financing and to digital marketplaces for project-based accounting, graphic design, or marketing help.

Even for those who simply want to work as independent contractors, it is also becoming easier to strike out on your own. New digital platforms for services help freelancers connect with clients and market their services more widely, and digital collaboration and file-sharing tools make large companies more willing to call in outside help on a project basis.[134]

Embrace tools that give citizens new ways to make their voices heard

The Internet is a democratizing force, and it has injected a new vibrancy into the political process. Citizens are empowered as never before to educate themselves on the issues and monitor what their representatives are doing. The public can now fact-check and question public officials, candidates, and traditional media outlets using simple searches and social media. Blogs and social media have proven to be effective tools for organizing campaigns and grassroots action, while digital payment platforms make it easier for individuals to donate to the candidates and causes they support.

Media coverage of politics and government has gone from a one-way conversation to a marketplace of ideas. Traditional news sources added comment boards and interactive features, and blogging has created a new brand of citizen journalism. Fresher and more diverse voices have emerged, and citizens are speaking out on a multitude of new platforms. But to some extent, these developments have also drawn audiences into echo chambers that reinforce their existing views. Many sources of information and opinion are vying against each other in a more digital public square; this places the onus on citizens to seek out information and apply a healthy degree of skepticism and critical thinking as they evaluate sources.

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The digital transformation has been a clear win for the US economy, and it is a testament to America's remarkable innovative capacity. But as technology-driven change accelerates, the race to keep up is growing tougher. Individuals have to commit to developing their skills on a more continuous basis and adjust to a faster-paced and more demanding job market. Governments will have to build new capabilities if they hope to deliver public services in more innovative ways and capture the potential cost savings. For companies, digitization is a boon to startups, disruptors, and small firms—and an existential challenge for established firms. But the organizations that embrace digital as an opportunity for reinvention can tap into markets and opportunities that were beyond their reach in the analog age.

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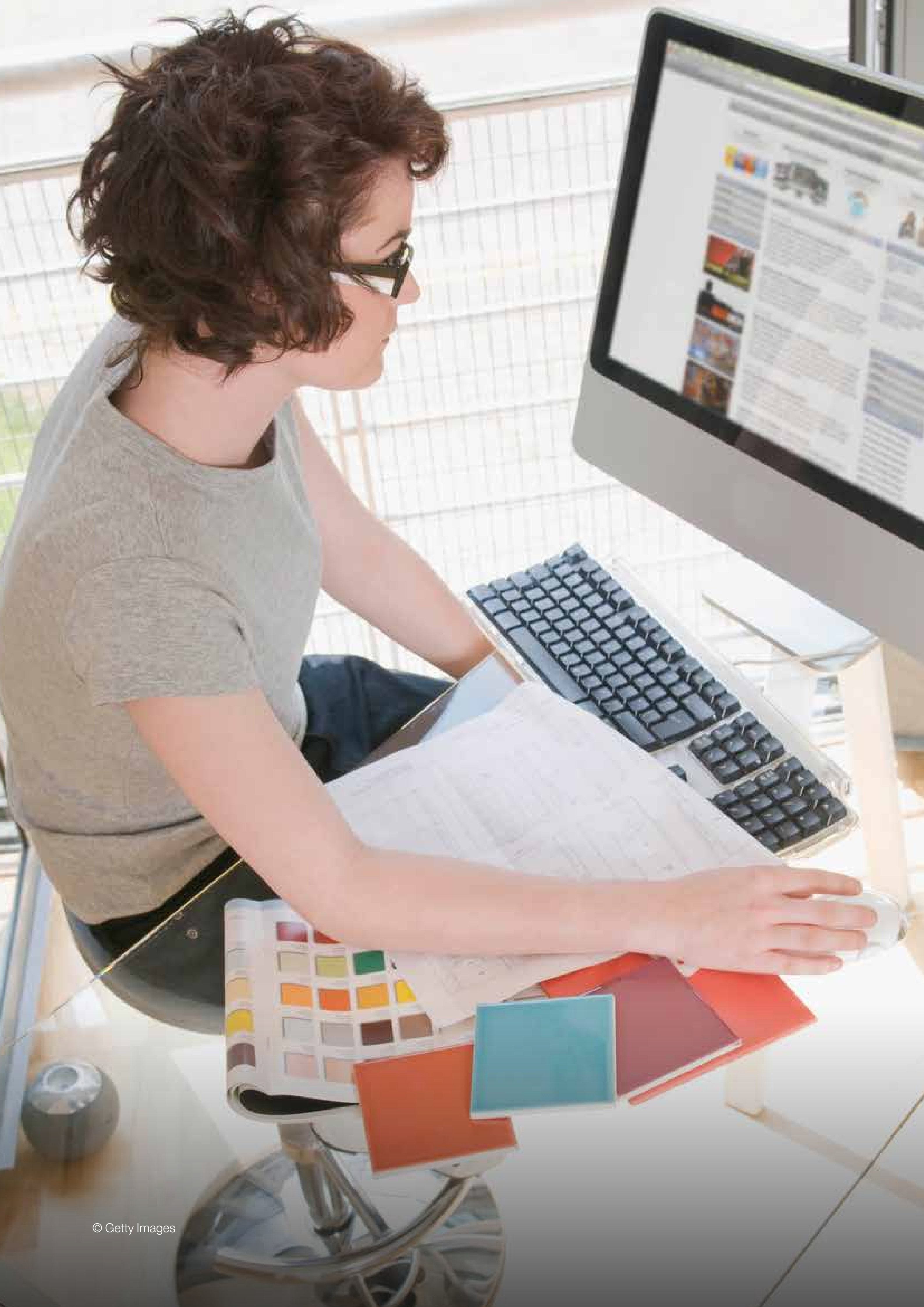
[134] Andrew Burke, "The entrepreneurship enabling role of freelancers: Theory with evidence from the construction industry," *International Review of Entrepreneurship*, volume 9, number 2, 2011.



TECHNICAL APPENDIX

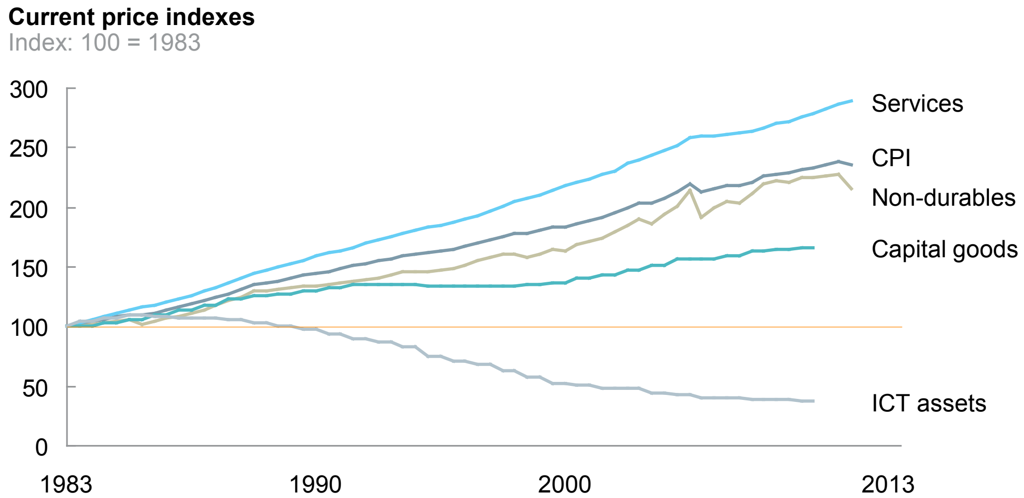
1. ICT SECTOR GDP CONTRIBUTION AND PRICE ADJUSTMENT

The ICT sector's share of the US economy is based on data from "The use of commodities by industries," published by the US Bureau of Economic Analysis (BEA) in 2013. This table includes value added by sector, and we total the value added in each industry classified as ICT (see "Industry categories" in the following section for full detail on industry categorizations). We divide that sum by the total value added across all sectors to arrive at 5 percent GDP contribution in 2013.

We also look at how this GDP contribution would change if we adjust for the fact that ICT goods and services have declined sharply in price even as they have dramatically improved in computing power and capabilities. In order to account for this price deflation, we analyze expenditures on ICT goods and services, taking the sum of spending by all industries on intermediate ICT goods and services (also sourced from the BEA's "The use of commodities by industries" table). We use a price deflator for ICT assets derived from BEA price indexes. We then adjust total gross output, multiplying the unadjusted gross output by the ratio of the 2010 price index over the 1983 price index (Exhibit A1).

Exhibit A1

ICT prices have declined more than 60 percent over the past 30 years as other prices have steadily risen



SOURCE: BEA; BLS; McKinsey Global Institute analysis

Next, we account for price elasticity of demand. If prices had not fallen since 1983, other sectors would have purchased fewer ICT goods and services. We use academic sources to obtain a range of price elasticity of demand factors for ICT goods and services.[135] Based on these estimates, we use a range of -0.5 to -0.8, which we multiply by the price-adjusted gross ICT output obtained from the BEA's Input-Output table. The table specifies the sale of commodities by each sector of the US economy to every other sector. The result reflects the elasticity-adjusted dollar value of purchases of ICT goods and services that would have resulted from higher prices.

To calculate the indirect value added by the ICT sector based on its elasticity-adjusted sales (gross output) to other sectors, we simply use the ratio of the ICT sector's direct value added to its gross output. We add this indirect value added to the measured value added of the ICT sector (5 percent) to arrive at a ratio of 10 percent of total GDP contributed by the ICT sector.

2. CONSTRUCTION OF MGI'S INDUSTRY DIGITIZATION INDEX

The Industry Digitization Index measures the extent of digitization in 22 sectors of the US economy. It combines 27 input metrics, splitting them into three categories: digital assets (eight metrics), digital usage (11 metrics), and digital labor (eight metrics). Within each of these categories, we highlight related metrics that offer different views of a particular activity or trend.

Using a principal component analysis, the input metrics are combined into an overall digitization score. The data for these metrics is primarily obtained from public sources such as the BEA and the Bureau of Labor Statistics (BLS) as well as the Occupational Information Network (O*NET). Furthermore, we use both public and proprietary McKinsey & Company data from previous MGI reports, proprietary databases, and client and consumer surveys (Exhibit A2).

List of sectors

We group industries into 22 sectors. We largely follow the North American Industry Classification System (NAICS) but make several adjustments in our industry categories as noted below.

We separate oil and gas from all other kinds of mining and resource extraction (e.g., coal or metal mining). We split manufacturing into advanced durable goods, chemicals and pharmaceuticals, and basic durable and non-durable goods. These categories allow us to combine manufacturing subsectors that exhibit similar features with regard to their levels of digitization.

Lastly, we isolate the ICT sector from the information sector and other sectors. Our "media" sector therefore includes only publishing, media, and broadcasting. Our definition of the ICT sector, on the other hand, includes software publishing, telecommunications, data processing, and web search portals. Furthermore, we consider computer and electrical manufacturing as well as computer systems design and related services part of the ICT sector.

In addition, we combine the professional, scientific, and technical services and management category with professional and business services. We further combine administrative and support and waste management and remediation services with other services (except public administration) to create the category called local and personal services.

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[135] Gilbert Cette and Jimmy Lopez, *ICT demand behaviour: An international comparison*, June 2009.

Exhibit A2

Metrics included in the MGI Industry Digitization Index

	Metric	Description
Assets		
Digital spending	**Hardware spending**	Share of total expenditures spent on ICT hardware (e.g., computers, servers)
	Software spending	Share of total expenditures spent on software (e.g., enterprise resource planning [ERP] software)
	Telecommunications spending	Share of total expenditures spent on telecommunications (e.g., broadband access, mobile data services)
	IT services spending	Share of total expenditures spent on IT services (e.g., IT consulting, IT architecture and implementation)
Digital asset stock	**Hardware assets**	Share of total assets made up of ICT hardware (e.g., computers, servers)
	Software assets	Share of total assets made up of software (e.g., purchased software licenses)
	Connected equipment	Share of equipment embedded with digital connections (e.g., oil rigs outfitted to transmit data on yield)
	Data storage	Data stored per firm, measured in terabytes, for firms with at least 1,000 employees
Usage		
Trans-actions	**Digital transactions**	Share of payments and transfers, both from consumers to businesses (C2B) and from businesses to other businesses (B2B) made through digital means (e.g., payments via ACH or wire)
Interactions between firms, customers, and suppliers	**Digital external communications**	Composite score based on share of firms reporting benefits from using social technologies to interface with customers and share of firms reporting benefits from using social technologies to work with partners
	Digital customer service	Composite score based on average number of customer service chats per month and share of total contact center calls routed by automated systems, i.e., integrated voice response (IVR) or automated speech recognition (ASR) technology
Business processes conducted internally	**Digitized back-office processes**	Composite score based on adoption of enterprise resource planning (ERP) software (e.g., SAP, Oracle) across the industry, and share of firms reporting that technology is very integrated into employees' daily activities
	Digitized front-office processes	Composite score based on adoption of customer relationship management (CRM) software (e.g., Salesforce.com) across the industry and digital marketing (e.g., email, banner, and search engine advertisements) expenditures, as an estimated share of total marketing expenditures
	Product development software intensity	Intensity of software usage in product development process (e.g., for computer-assisted design)
Market making	**Digitally enabled markets**	Extent to which digital platforms are being used to connect supply with demand, calibrated using the relative size of digital bid-ask or auction-based markets (in terms of users, transactions, and/or revenues)
Labor		
Digital spending	**Hardware spending on workers**	ICT hardware (e.g., computers, servers) expenditures per full-time-equivalent employee (FTE)
	Software spending per worker	Software (e.g., enterprise software licenses) expenditures per FTE
	Telecommunications spending per worker	Telecommunications (e.g., broadband access, mobile data services) expenditures per FTE
	IT services spending per worker	IT services (e.g., IT consulting, IT architecture and implementation) expenditures per FTE
Digital capital deepening	**Hardware assets per worker**	ICT hardware assets (e.g., servers, computers) per FTE
	Software assets per worker	Software assets (e.g., worker software licenses) per FTE
Digitization of work	**Share of tasks that are digital**	Time-weighted share of worker tasks involving digital tools or processes (e.g., tasks requiring workers to input information via tablet, conduct online research, or perform analyses with spreadsheet software). Based on a search for digital keywords (e.g., data, computer, software) in a publicly available database of worker tasks
	Share of jobs that are digital	Digital jobs (e.g., computer and information systems managers, hardware engineers, telecommunications equipment installers and repairers) as a share of total jobs

SOURCE: McKinsey Global Institute analysis

Further, we use simplified naming conventions that do not precisely match NAICS industry names (e.g., we simplify “health care and social assistance” to “health care”; Exhibit A3). Where different from the NAICS terminology, these sector names reflect the predominant nature of occupations in that sector.

Exhibit A3

List of sectors

MGI sector	Corresponding NAICS codes
ICT	334, 5112, 517, 5182, 51913, 5415
Agriculture and hunting	11
Oil and gas	211
Mining	212, 213
Utilities	22
Construction	23
Basic goods manufacturing	321, 327, 331, 332, 337, 311, 313, 315, 322, 323, 324, 326
Chemicals and pharmaceuticals	325
Advanced manufacturing	333, 335, 3361, 3364
Wholesale trade	42
Retail trade	44–45
Transportation and warehousing	48–49
Media	51 (excluding 5112, 517, 5182, 51913)
Finance and insurance	52
Real estate	53
Professional services	54 (excluding 5415), 55
Personal and local services	56, 81
Education	61
Health care	62
Entertainment and recreation	71
Hospitality	72
Government	G

SOURCE: McKinsey Global Institute analysis

Assets component of the index

The key categories within the assets component of the index are: spending on ICT (hardware, software, telecommunications, and IT services) as a share of total expenditure; share of digital assets (hardware, communications equipment, and software) as a share of total fixed assets (which includes total equipment, structures, and intellectual property assets); and data stored per firm for firms with at least 1,000 employees (Exhibit A4).

The ICT spending values reflect both capitalized and non-capitalized expenditures. Non-capitalized IT spending is obtained from the BEA’s “The use of commodities by industries” table published in 2013. The metric included in the index was obtained by taking the industry share of total commodity expenditure, corresponding to total intermediate output from the BEA’s table. Because software, telecommunications, and data processing/other information services are subsumed under broader commodity categories and were not broken out in the 2013 table, we use the more detailed 2007 table to estimate the share of software, telecommunications, and data processing/other information services in their respective category and apply it to the 2013 data to prevent overestimating IT spending.

Capitalized expenditure on IT goods and services is estimated using the current-cost depreciation reported by the BEA for 2013 on non-residential fixed assets.

Exhibit A4

The Industry Digitization Index: Assets detail

November 2015

SOURCE: BEA; BLS; US Census; IDC; Gartner; McKinsey social technology survey; McKinsey Payments Map; LiveChat customer satisfaction report; Appbrain; US contact center decision-makers guide; eMarketer; Bluewolf; Computer Economics; industry expert interviews; McKinsey Global Institute analysis

The second key category in the assets section of the index is the share of digital fixed assets. IT hardware and communications equipment are aggregated into one hardware category. The data was obtained using the net-stock, current-cost, non-residential detailed estimates for fixed assets provided by the BEA (2013 numbers used).

For government fixed assets, we used the current-cost net stock of fixed government assets (Table 7.1B), also provided by the BEA (2013 numbers used as well). Since equipment assets are not further detailed, we apply the share obtained from the IT spending analysis for government on hardware and telecommunications to the fixed assets data to obtain IT hardware and communications assets. Based on expert interviews and publications, we apply a 30 to 40 percent discount to government IT spending to make it comparable to private-sector IT spending.[136]

The final category within the assets part of the index is data stored per firm. We follow the 2011 MGI report *Big data: The next frontier for innovation, competition, and productivity,* which derives industry-level data storage per firm from the IDC. We assume the values from that analysis have remained stable on a relative basis. We convert the absolute data storage per firm (measured in terabytes) to a quintile scale, assigning each industry a score of 1 to 5 as an input to the index principal component analysis.

Usage component of the index

The usage component of the index is detailed in Exhibit A5. It combines 11 metrics to form a holistic picture of the extent of digital usage in transactions (one metric), interactions (four metrics), processes (five metrics), and market making (one metric).

Transactions

The shares of digital payments within various industries was determined by combining separate analyses for consumer and commercial payments based on data gathered from four major sources (three of which are proprietary McKinsey assets).

In order to determine the share of digital payment methods used by consumers, we drew on two proprietary McKinsey assets, the US Payments Map and the Consumer Financial Life Survey. The US Payments Map is an economic model built to measure and forecast the number and value of domestic payment transactions in the United States, as well as the aggregate revenues and costs for the US payments industry. Transactions can be segmented by payment instrument (e.g., cash, check, credit card, and automatic clearinghouse/ACH), counterparty (e.g., consumer to business, business to business), purpose (e.g., point-of-sale vs. bill payments), and channel (e.g., in-person vs. remote). The model is constructed by merging the best publicly available payments research (from the Federal Reserve Payments Study, FDIC call reports, Federal Reserve statistical releases, and company financial reports) with internal McKinsey research and analysis (e.g., the McKinsey Annual Payments Study, GCI's Operations Benchmark,[137] and the Consumer Financial Life Survey). Historical data dates back to 2000, while forecasts extend to 2020. Forecasts are largely regression-based, using Moody's Analytics macroeconomic scenario forecasts as key inputs.

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[136] Based on estimates of government ICT spending effectiveness from *Understanding the federal government's "IT insecurity" crisis*, International Association of Information Technology Asset Managers, February 2015, as well as interviews with McKinsey and external experts.

[137] GCI, or GCinsights, is a wholly owned subsidiary of McKinsey & Company that provides data-driven payments expertise to clients in commercial banking, retail banking, and banking operations and technology.

The Consumer Financial Life Survey (CFLS) is a continuously fielded McKinsey survey dating to 2009, in which participants are asked a multitude of questions pertaining to their payment/banking usage, behaviors, and attitudes. The survey is fielded three times a year with approximately 1,500 households surveyed for each iteration. McKinsey contracts a field agency to program and host the online survey, while respondents are recruited from a national online consumer survey panel. In order to counteract the biases inherent in an online-only survey, the CFLS team annually conducts a random-digit-dialing telephone survey for a subset of questions. Since its inception, CFLS has gathered data on approximately 30,000 households, creating millions of data points for analysis.

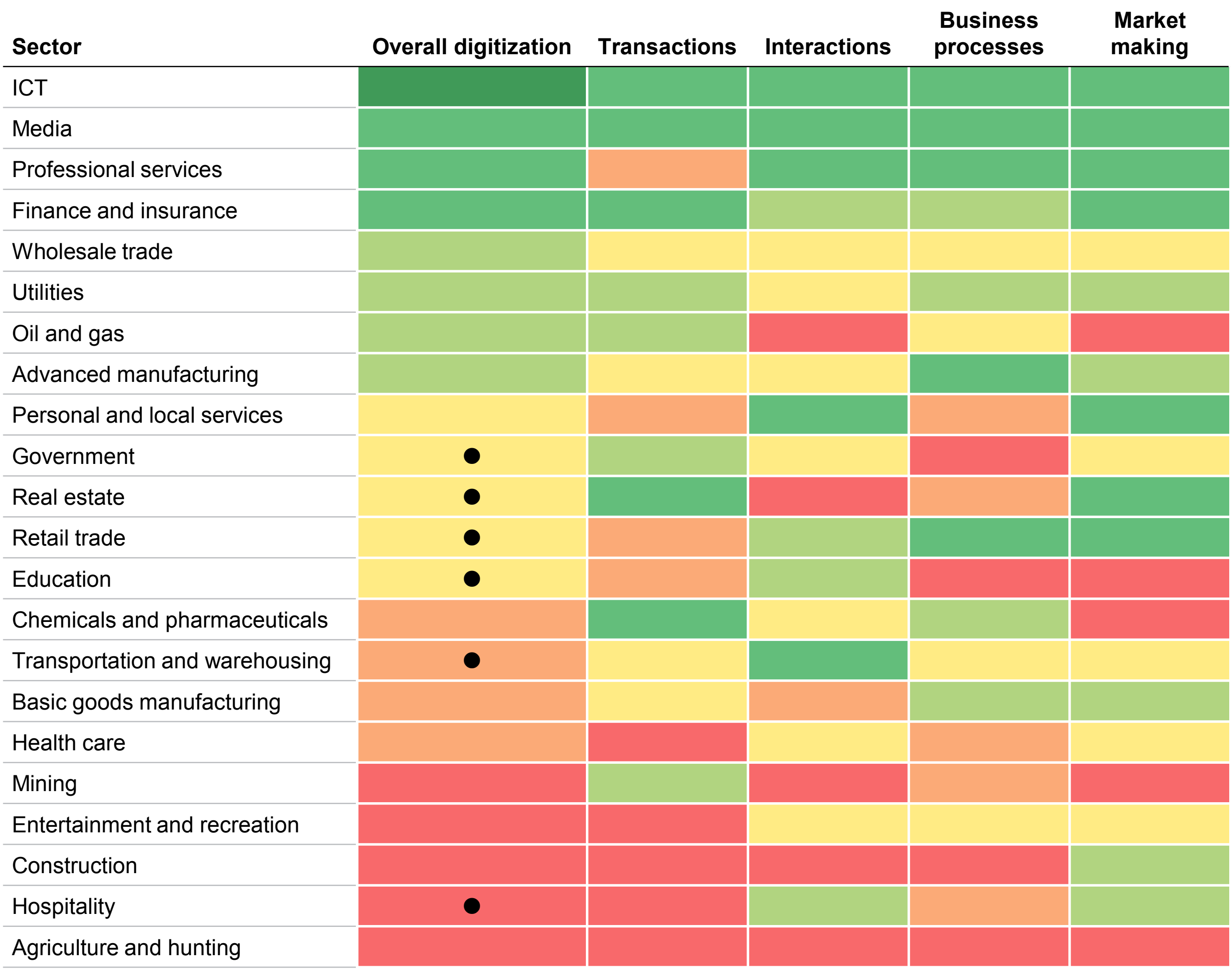
Exhibit A5

The Industry Digitization Index: Usage detail

November 2015

Relatively low digitization — Relatively high digitization

● Digital leaders within relatively un-digitized sectors



SOURCE: BEA; BLS; US Census; IDC; Gartner; McKinsey social technology survey; McKinsey Payments Map; LiveChat customer satisfaction report; Appbrain; US contact center decision-makers guide; eMarketer; Bluewolf; Computer Economics; industry expert interviews; McKinsey Global Institute analysis

For commercial payments, the team used data from the US Payments Map, GCI's Corporate Treasury Needs survey, and publicly available IRS data. While the US Payments Map provided a base for total commercial payments and instrument trends over time, payables and receivables dollar flows by payment instrument type were sourced from a McKinsey survey.[138] At its core, the CTN Study forecasts near-term market demand for cash management products. It is a survey of approximately 1,200 US treasury practitioners to assess their current and expected use of approximately 40 cash management offerings across receivables, payables, and liquidity management. The study, which was last conducted in 2010, covers US firms with annual sales between $1 million and $1.5 billion, using a quantitative telephone-based survey. The population was stratified by size (annual revenue) and industry (manufacturing, wholesale, retail, and services). Sample quotas were set in each industry/size substratum to ensure adequate representation. For sampling purposes, annual revenue and industry classifications were compiled from Dun & Bradstreet. Data are weighted to correct for over- and under-representation of the businesses surveyed. Publicly available business receipt data from the Internal Revenue Service were used to help size individual industries, given the CTN Study's exclusion of companies falling below $1 million and above $1.5 billion in annual sales.[139] This helped to properly weight the sample data by size of business. In instances where the CTN Study did not have data on a specific industry, the overall average for the study was used as a proxy.

To obtain the overall share of digital payments, we combine the data from consumer and commercial purchases by taking a weighted average (i.e., adding the digital payments from both consumer and commercial purchases and dividing by the total dollar amount of payments). Digital consumer payments include any payments made online, whereas the digital commercial payments are estimated by adding ACH and wire payments as purely digital payment instruments.

Interactions

The interactions category consists of four metrics: share of firms reporting one or more benefits from using social technology tools to interact with partners; share of firms reporting one or more benefits from using social technology tools to interact with customers; monthly number of online chats with customers as a share of revenue (i.e., customer chats per dollar of revenue); and share of calls routed by automated systems. The first two metrics come directly from McKinsey's 2015 Social Technology Survey, which will be published in early 2016. We use global survey results for these two metrics. The number of online chats per month comes from a report based on a sample of 600 LiveChat customers in various sectors.[140] We then normalize the monthly chat figures by dividing by revenue. We use revenue as a proxy for total customer volume, as there is no single data source to provide number of customers per firm by sector. The revenue figures are the gross industry output from "The use of commodities by industries" published by the BEA in 2013. The share of calls routed by automated systems gives an indication of how digitally intensive call centers are across industries. The data for this metric comes from a ContactBabel report measuring the share of calls routed by dual-tone multi-frequency, integrated voice response, and/or automated speech recognition technologies.[141]

In order to construct a score for this category, we convert all of the above metrics to a quartile-based, four-point scale, and take the sum across all metrics. We use that summed score as the input to the principal component analysis.

138 McKinsey Corporate Treasury Needs Survey, 2008.
139 IRS Statistics of Income (SOI) Tax Stats, Integrated Business Data, Tables 1, 5, and 14b.
140 "Live Chat Customer Happiness Report," LiveChat Inc., August 2012.
141 "The US Contact Center Decision-Makers' Guide 2014," ContactBabel.

Business processes

The business processes category consists of five metrics: enterprise resource planning (ERP) software adoption, software intensity in product development, spending on digital marketing as a share of total marketing spending, the share of firms reporting that technology is very integrated into employees' daily activities, and customer relationship management (CRM) software adoption.

ERP software adoption comes directly from a 2014 report published by Computer Economics that notes the adoption rate of ERP software by sector.[142] Software intensity in product development is rated on a relative, five-point scale based on proprietary McKinsey data sources as well as internal and external expert interviews. We derive spending on digital marketing from a report that breaks out direct marketing expenditures into 15 categories, including direct mail, magazine, newspaper, etc.[143] We classify six of the 15 categories as digital: commercial email; Internet–social networking; Internet display; Internet other; Internet search; and mobile. We divide the sum of marketing spending in those six categories by the total spending across all 15 categories to arrive at the digital share of total marketing spending. The next metric, the share of firms reporting that technology is very integrated into employees' daily activities, comes directly from McKinsey's 2015 Social Technology Survey, which will be published in early 2016. We use global survey results for this metric. CRM software adoption comes from a 2012 report published by Computer Economics reporting the adoption rate of CRM software by sector.[144]

We convert all of the above metrics to a quartile-based, four-point scale and take the sum across all metrics. We use that summed score for the overall category as the input to the principal component analysis.

Market making

Market making is used to indicate the prominence of digital platforms as a means of connecting buyers and sellers in a given market. Some sectors have major digital platforms (e.g., eBay in retail trade) that create markets, and some (such as chemicals and pharmaceuticals) have relatively few digital market makers. We rate digital market making on a relative, five-point scale using input from publicly available resources, proprietary McKinsey data sources, as well as internal and external expert interviews.

Labor component of the index

The labor component of the index (Exhibit A6) contains three main categories: digital spending per worker (ICT expenditures per full-time equivalent employee, or FTE), capital deepening (ICT asset stock per FTE), and digitization of the labor force (the share of worker tasks and industry jobs categorized as digital). The digital spending per worker and capital deepening categories contain the same ICT spending and digital assets variables described above in the assets index; however, the expenditures and assets are represented not as a share of total expenditures and total assets, but rather on a per-worker basis. The data for FTEs by industry category is obtained from the BEA.[145]

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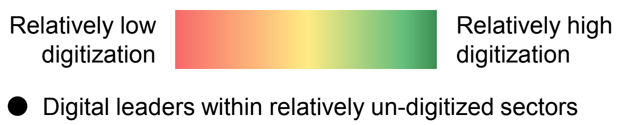
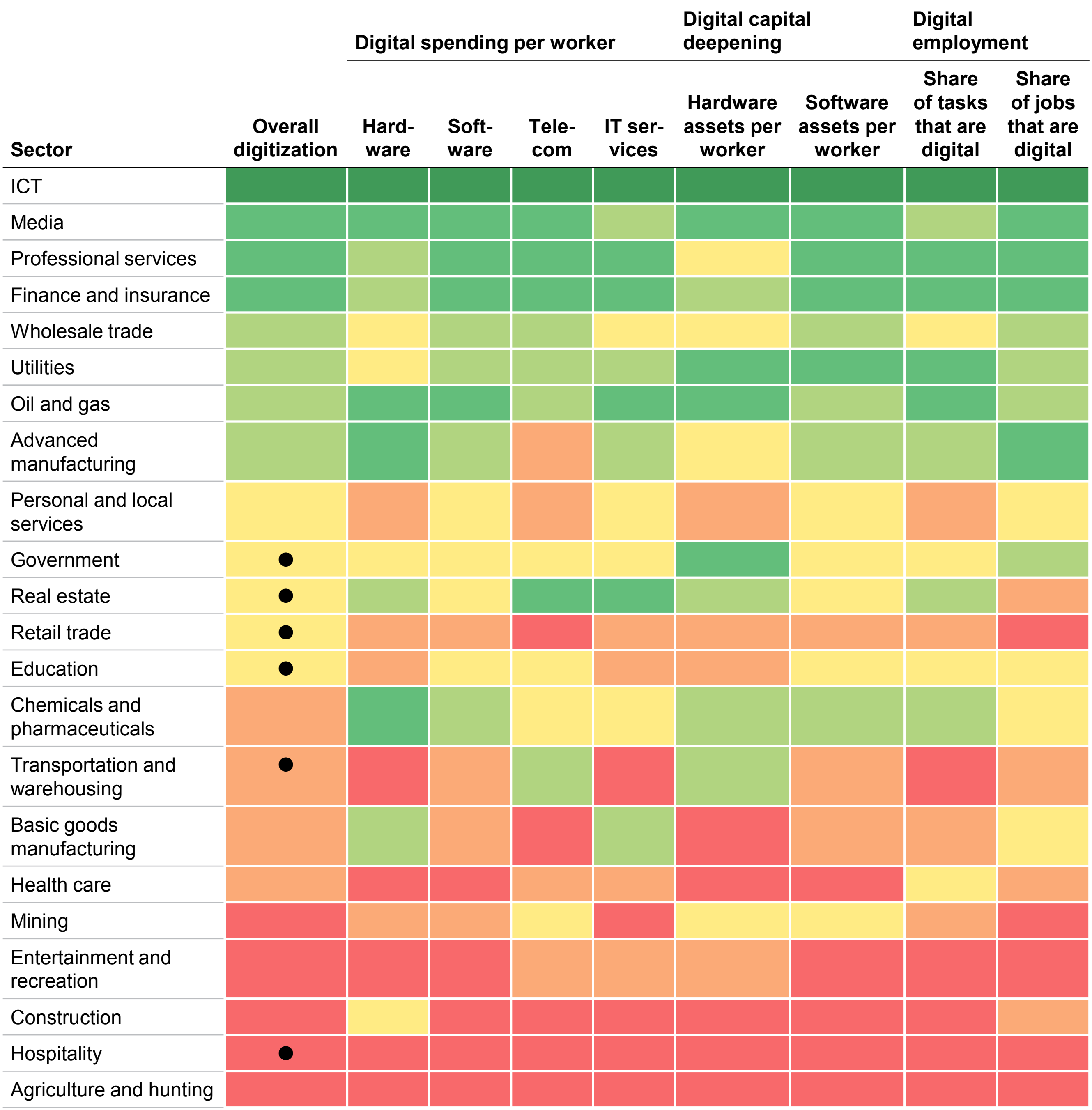
142 "ERP adoption trends and customer experience 2014," Computer Economics, May 2014.
143 Based on DMA's 2009–10 report, "The power of direct marketing." We use projected 2014 expenditures.
144 "Current trends in CRM adoption and customer experience," Computer Economics, July 2012.
145 US Bureau of Economic Analysis, Table 5.D, "Full-time-equivalent employees by industry."

Exhibit A6

The Industry Digitization Index: Labor detail

November 2015





SOURCE: BEA; BLS; US Census; IDC; Gartner; McKinsey social technology survey; McKinsey Payments Map; LiveChat customer satisfaction report; Appbrain; US contact center decision-makers guide; eMarketer; Bluewolf; Computer Economics; industry expert interviews; McKinsey Global Institute analysis

We use two metrics to estimate the digitization of the labor force: the percentage of core tasks that are digital by industry and the share of employees in newly created digital jobs. For the digital share of core tasks, we use O*NET data providing detailed task descriptions for each occupation. The database, developed by the National Center for O*NET Development for the US Bureau of Labor Statistics, includes 13,700 distinct core tasks. We distinguish between digital and non-digital tasks based on a keyword search (Exhibit A7).

Furthermore, the O*NET data assigns an importance score to each task. We use this importance score as a weight by adding the importance scores of all digital core tasks and dividing it by the total of the importance scores for all core tasks in that occupation, thus obtaining an aggregate digital score for each occupation. We then use the number of employees in each of the occupations with digital tasks as weights (i.e., we multiply the number of employees in each occupation by its digital score, aggregate this number to an industry level, and then divide it by the total number of employees in that industry) to obtain the overall percentage of digital tasks by industry. The employment numbers by industry and occupation level are obtained from the BLS.[146]

In order to estimate the share of employees in newly created digital jobs, 11 occupation groups are identified as newly created due to the introduction of new digital technologies over the past 20 years. Exhibit A8 provides the full list of these occupation groups and the corresponding Standard Occupational Classification (SOC) codes.[147]

Exhibit A7

Most common words in descriptions of worker tasks identified as digital

SOURCE: McKinsey Global Institute analysis

[146] US Bureau of Labor Statistics, Table 1.9, 2012–22, "Industry-occupation matrix data, by industry," using the 2012 numbers.

[147] Note that not all occupation groups have the same SOC code hierarchy level.

Exhibit A8

Analysis of digitization of labor force

Keywords, partial words, and abbreviations used to identify digital tasks		
Algorithm	Electronic	Radiograph
Allocate print space	Firewall	Review company records
Analyz	Global positioning system	Review reports
Automated	Hardware	Robot
Calculate	Http	Scanner
Communicate with dispatchers	Information system	Search engine
Communication equipment	Internet	Server
Compu	Local area network	Software
Connectivity	Mathematical model	Spreadsheet
Cost models	Medical records	Statistical model
Data	Network systems	Telecommunications
Digital	Photocop	Test conductors
Edit copy	Prepare budget	Type office memos
Electrical-testing instruments	Prepare legal briefs	Watt-hour meters
Electrocardiogram	Programming	Web

List of newly created digital jobs

SOC code	Name of occupation group
11-3021	Computer and information systems managers
15-1100	Computer occupations (e.g., software developers and programmers, computer scientists, computer support specialists)
17-2061	Computer hardware engineers
25-1021	Computer science teachers, postsecondary
43-9011	Computer operators
43-9020	Data entry and information processing workers
43-9031	Desktop publishers
49-2011	Computer, automated teller, and office machine repairers
49-2022	Telecommunications equipment installers and repairers, except line installers
49-9052	Telecommunications line installers and repairers
51-4010	Computer control programmers and operators

SOURCE: McKinsey Global Institute analysis

Index construction

From the initial set of 27 input metrics, we consolidate five into an overall business process digitization score and four into an overall digital interactions score. Thus, the index analysis takes a total of 20 inputs.

In order to reach the overall digitization score for an industry, we assign a weight to each variable. We use a principal component analysis (PCA) to determine the weights. The PCA is a mathematical transformation that converts a set of potentially correlated input variables into principal components, or new sets of values that explain the variance in the input variables. In this case, the resulting principal components aim to explain the variance across 20 input variables. A PCA yields multiple components, so we use the component that explains the most variance of the original 20 variables. Each component has corresponding variable loadings or weights, which we apply as the weights for each value in the index calculation. Since the 20 input variables are not in the same units, we divide each value by its standard deviation to standardize the value. The multiplication product of weight and standardized value over the sum of all 20 variable weights yields the standardized score for each industry. We then convert the standardized scores to an index with a theoretical maximum of 100. For the conversion, we divide the standardized scores by the inverse of a cumulative normal distribution function (with mean of 0, standard deviation of 1, and probability of 99.999 percent), then multiply by 100.

For each index and category, we repeat the same methodology with a subset of the 20 input metrics. For any category with one or two metrics, the principal component analysis results in even weights for each metric (e.g., in the digital employment category, each of the two metrics receives a weight of 0.97).

3. MEASURING HISTORICAL DIGITIZATION IN 1997, 2005, AND 2013

Asset and labor metrics

Our analysis of digitization over time (for 1997, 2005, and 2013) uses 18 metrics, six each from the three categories of digital assets, digital usage, and digital labor. We measure these on an industry level. The metrics are a subset of those used in the digitization index, and the selection was determined by the availability of historical data.

Within assets, we analyze software, hardware, telecom, and IT services spending as a share of total expenditures, as well as software and hardware asset stock as a share of total assets. Within labor, we measure software, hardware, telecom, and IT services spending per FTE, as well as software and hardware asset stock per FTE. All 12 of the asset and labor metrics are also used in the digitization index, and are from "The use of commodities by industries" published by the BEA. The number of FTEs used to calculate the labor metrics is also from the BEA. We adjust the values of all 12 metrics for semiconductor price declines. Price adjustment factors are derived from the FRED economic database of the St. Louis Federal Reserve. We compare the producer price indexes from the middle of each year: June 1, 1997; June 1, 2005; and June 1, 2013. We renormalize these indexes to 1997.

Usage metrics

The six metrics for the usage portion of this analysis measure the share of transactions processed digitally, digital marketing spending as a share of GDP contribution, ERP spending as a share of GDP contribution, share of firms reporting one or more benefits from using customer-facing social technologies, and share of firms reporting one or more benefits from using social technologies to interact with partners.

Transactions data is derived from the 2013 shares used to calculate the Industry Digitization Index and additional historical data from the US Payments Map and Consumer Financial Life Survey (CFLS).[148] The historical data is only available at an aggregate level going back to 2000, so we estimate the value of payments in 1997 by taking the compound annual growth rate from 2000 to 2005, and projecting values for previous years on the assumption that the rate was consistent with the rate in the 1997–2000 period. In order to estimate the industry breakdown, we assume that industries' relative shares of transactions made digitally are consistent with the 2013 industry breakdown. We therefore project historical shares of digital transactions using the overall growth in share of transactions made digitally from 1997 to 2013, and applying it at the industry level.

[148] GCinsights, "Consumer Financial Life Survey," April 2014.

Historical digital marketing spending is based on the same source and methodology used to calculate share of marketing spending in digital channels in the Industry Digitization Index. We apply the relative values across industries in 2004 to the aggregate expenditures in to arrive at an estimate of digital marketing spending by industry in 1997. We then normalize the spending for the size of the sector by dividing by each sector's GDP contribution. GDP contributions for 1997, 2005, and 2013 are derived from the value-added row of "The use of commodities by industries," published by the BEA.

ERP spending is sourced from a Gartner report that includes industry-level spending on ERP systems going back to 2000, as well as aggregate spending going back to 1998.[149] The report also includes the year-over-year growth rate from 1997 to 1998, which we use to calculate aggregate ERP spending in 1997. We assume relative spending across sectors is constant from 1997 to 2000, and project spending for 1997 by applying relative proportions of each sector to the aggregate spending figure. We normalize these values for the size of each industry by dividing ERP expenditures by each sector's GDP contribution.

Lastly, we include two metrics from McKinsey's annual Social Technology Survey. The survey asks respondents if they experience benefits from consumer-facing social technology tools and from partner-facing social technology tools. We calculate the proportion of respondents answering affirmatively to each of those two questions from each sector. The survey began in 2007, so we apply 2007 values in our calculations of digitization in 2005. We assume the 2005 and 2007 levels are roughly equivalent. We assume that in 1997, the share of firms that would report benefits from social technology tools is roughly zero. We make this assumption on the basis that blogs, podcasts, wikis, and similar social tools were in the very early stages of adoption at that time.

Digitization calculation

Based on the industry-level data for each of these metrics in 1997, 2005, and 2013, we calculate an overall digitization score as well as a digitization index for assets, usage, and labor in all three years. We calculate these values for the leading digital sectors as well as the rest of the US economy. We use variable weights derived from the principal component analysis used to calculate the Industry Digitization Index (described above). In the cases where usage metrics do not align precisely with those metrics used to calculate the index, we adjust the weights. For example, the principal component analysis yields a weight of 0.5 for digital interactions. Since this historical analysis includes two metrics in the customer interactions category, we split the weight evenly, assigning weights of 0.25 to both of the metrics derived from the McKinsey Social Technology Survey. In the same methodology used to calculate the index, we normalize weights, dividing each by the standard deviation of values across sectors.

We calculate a composite score for the most digitized sector by taking the maximum value in each metric for any sector at each of the three points in time. For example, in 1997, the composite score used the value from finance and insurance as the maximum value of share of transactions made digitally, and used the value from media as the maximum value of digital marketing spending over GDP. In doing so, we create a hypothetical "digital leader" sector that demonstrates the maximum digitization across all metrics. To calculate the digitization indices, we multiply these maximum values by their respective, adjusted weights. We then take the sum of those products to arrive at digitization indices for assets, usage, and labor. The overall score is simply a sum of those three indices.

In order to calculate these scores for the rest of the US economy (vs. the most digitized sector), we similarly calculate each index for every sector. We then weight the sectors' scores by fixed asset stock (for the assets index), GDP (for the usage index), and

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149 *ERP license revenue and preliminary forecast: Worldwide, 1998–2008,* Gartner.

employment (for the labor index). Asset stock data comes from the BEA's fixed asset stock tables, GDP comes from "The use of commodities by industries" published by the BEA, and employment comes from the BEA. The sum of these three weighted-average indices yields the overall digitization score for the total US economy. We then remove the contributions from the "digital leader" sector by subtracting the weighted sum of metrics that contribute toward the hypothetical "digital leader" industry. Thus, we arrive at a score for the rest of the US economy.

We normalize the scores so that the composite score of the most digitized sectors in 1997 is the baseline (=1x). We then show how digitization has increased over time relative to its 1997 values. We show digitization in the rest of the US economy as a percentage of the most digitized sectors' performance at each point in time (1997, 2005, and 2013).

4. ESTIMATING THE IMPACT OF DIGITIZATION ON US GDP IN 2025

Baseline GDP

All GDP impact estimates are in nominal figures, and we use an average of various estimates for our baseline 2025 GDP. The estimates are derived from the Economist Intelligence Unit, the World Market Monitor from IHS (Global Insight), and the US Congressional Budget Office.

Labor impact: Increased supply and productivity

This estimate is taken directly from the 2015 MGI report *A labor market that works: Connecting talent with opportunity in the digital age*. Full details on the methodology are outlined in the report's technical appendix.

Capital impact: Improved asset efficiency

Based on MGI's 2015 report *The Internet of Things: Mapping the value beyond the hype,* we estimated the capital savings that could be realized by 2025 as the Internet of Things enables predictive maintenance of equipment (which both increases its utilization and avoids expenditures on new assets). Given that the United States is already becoming an early leader in adoption of these technologies, we use the average of the pessimistic and optimistic estimates in this report as the lower bound of our own estimate and keep the upper bound as the optimistic estimate. The cost savings are assumed to be equal to an increase in GDP, as they would translate to a proportional increase in productivity. This equation would also assume full employment and that there is no slack in demand. The technical appendix of MGI's *Internet of Things* report includes a comprehensive discussion of its methodology and assumptions.

Multifactor productivity

Based on MGI's 2015 report *The Internet of Things: Mapping the value beyond the hype,* as well as our 2013 report *Game changers: Five opportunities for US growth and renewal,* we estimated the cost savings that could be realized in expenditures on R&D, operations, and resource consumption by utilizing both big data analytics and the Internet of Things to their full potential in these areas. Both of these MGI reports include technical appendixes with comprehensive details regarding methodology and assumptions.

We extend the timeline from the *Game changers* report to 2025; determine the savings that fall into the R&D, operations, and resource consumption categories; and take their lower and upper estimate.

Building on the *Internet of Things* report, we determine the savings that are related to R&D, operations, and resource consumption from that report's overall savings estimate (excluding the labor and capital impact as well as consumer surplus). We then take the average of that report's pessimistic and optimistic case be the lower bound of our estimate, and the optimistic case as the upper bound of our estimate. Similar to the methodology adopted for capital impact, we assume that cost savings equate to an increase in GDP.

5. DISPLACEMENT OF JOBS DUE TO AUTOMATION

Our analysis focuses on gross capital substitution of labor, and does not attempt to quantify the net impact of digitization on job creation.

Recent McKinsey research has estimated that nearly half of time-weighted tasks performed by the workforce today can be automated by currently existing technologies. It further suggests that at least 30 percent of the tasks performed by roughly 60 percent of today's occupations could be automated, which will cause a large-scale redefinition of job roles and business processes.[150]

This report applies that analysis to one segment of the US workforce to determine the potential rate of job displacement over the next decade. We undertake this analysis for illustrative purposes only; this is not meant to imply that this category of workers will be the only affected segment or even the most affected segment. We highlight the potential effects on clerical, sales, production, and operational roles—that is, the "middle-skills" segment of the workforce that has already experienced increasing job displacement over the past two decades. Historical data for skill-biased technical change among this group is available from academic research by Autor, Levy, and Murnane, who argue that their increased job displacement in recent decades was primarily due to improvements in information technology and the decreasing price of computer processing devices.[151]

After analyzing a detailed list of tasks performed by these workers (obtained from the O*NET database), we consider which ones could be automated by currently existing technologies, including those that are already commercialized as well as those in advanced R&D stages. We then map these tasks to jobs to estimate the share of employment that would be affected, applying historical adoption rates of comparable technologies.

We assume that the number of jobs that could be displaced is proportional to the number of tasks that can be automated. We model the uptake in automation technology by looking at a basket of eight adoption curves that include ATMs, spreadsheet software, and other past innovations. We extend the adoption curves by the average time it takes for a product to advance from the R&D stage to commercialization in the advanced industries sector.

We find that automation could displace anywhere from 10 to 15 percent of these jobs in the decade ahead, depending on the adoption curve that is used. The median point of our scenario is 13 percent, which would represent a sharp acceleration of historical displacement rates, which Autor, Levy, and Murnane estimate at 8 to 9 percent in the two most recent decades.

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150 For more on this issue and the underlying analysis, see Michael Chui, James Manyika, and Mehdi Miremadi, "Four fundamentals of workplace automation," *McKinsey Quarterly*, November 2015. This analysis suggests that 45 percent of work tasks can be automated with currently available technologies.

151 David H. Autor, Frank Levy, and Richard J. Murnane, "The skill content of recent technological change: An empirical exploration," *Quarterly Journal of Economics*, volume 116, number 4, 2003. We also consulted Lawrence F. Katz and Robert A. Margo, "Technical change and the relative demand for skilled labor: The United States in historical perspective," in *Human capital in history*, Leah Platt Boustan, Carola Frydman, and Robert A. Margo, eds., University of Chicago Press and NBER, 2014; and Daron Acemoglu and David Autor, "Skills, tasks and technologies: Implications for employment and earnings," in *Handbook of Labor Economics*, volume 4, part B, Orley Ashenfelter and David Card, eds., Elsevier, 2011.

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