McKinsey Global Institute




July 2013

Game changers: Five opportunities for US growth and renewal

The McKinsey Global Institute

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Game changers: Five opportunities for US growth and renewal

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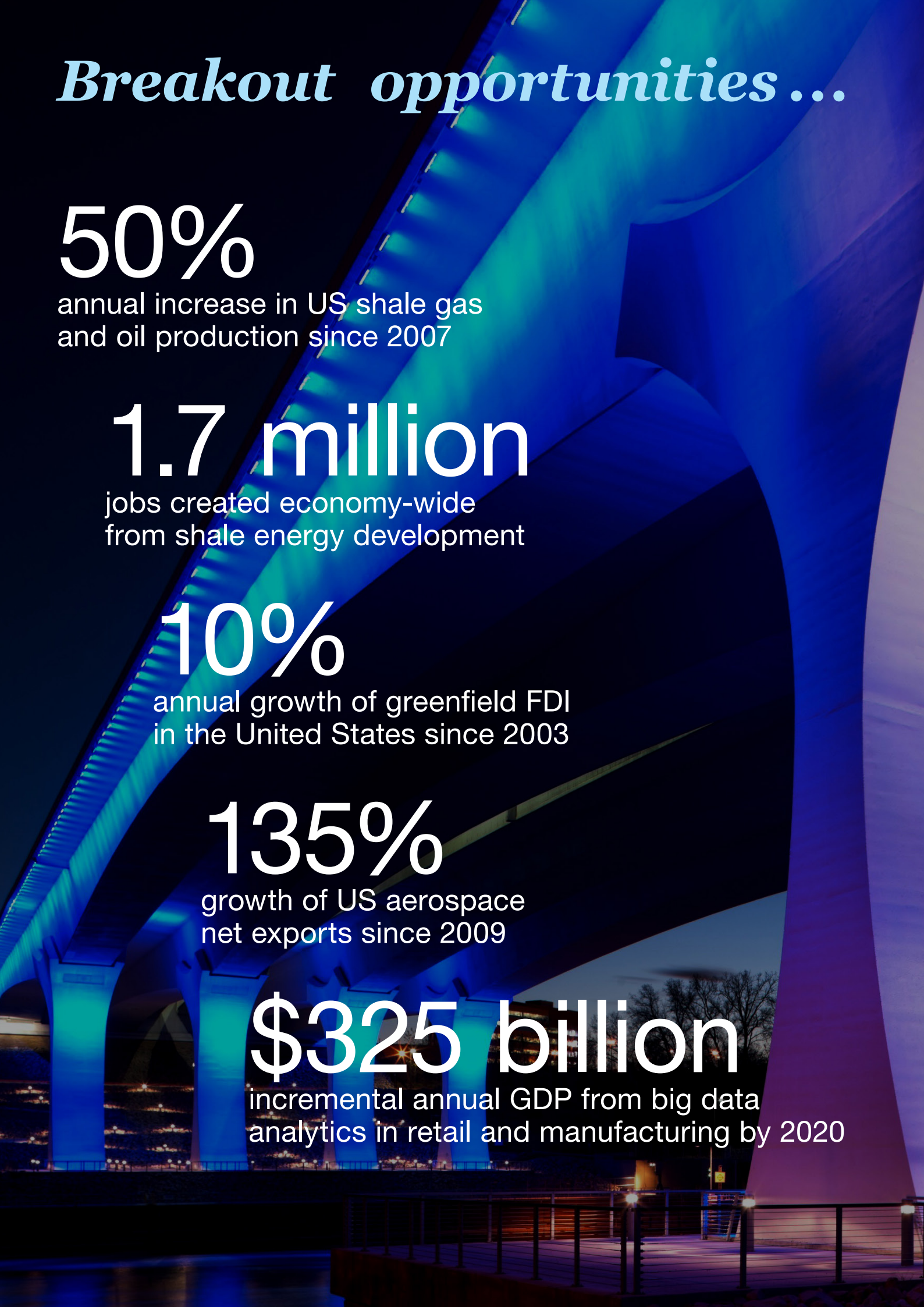
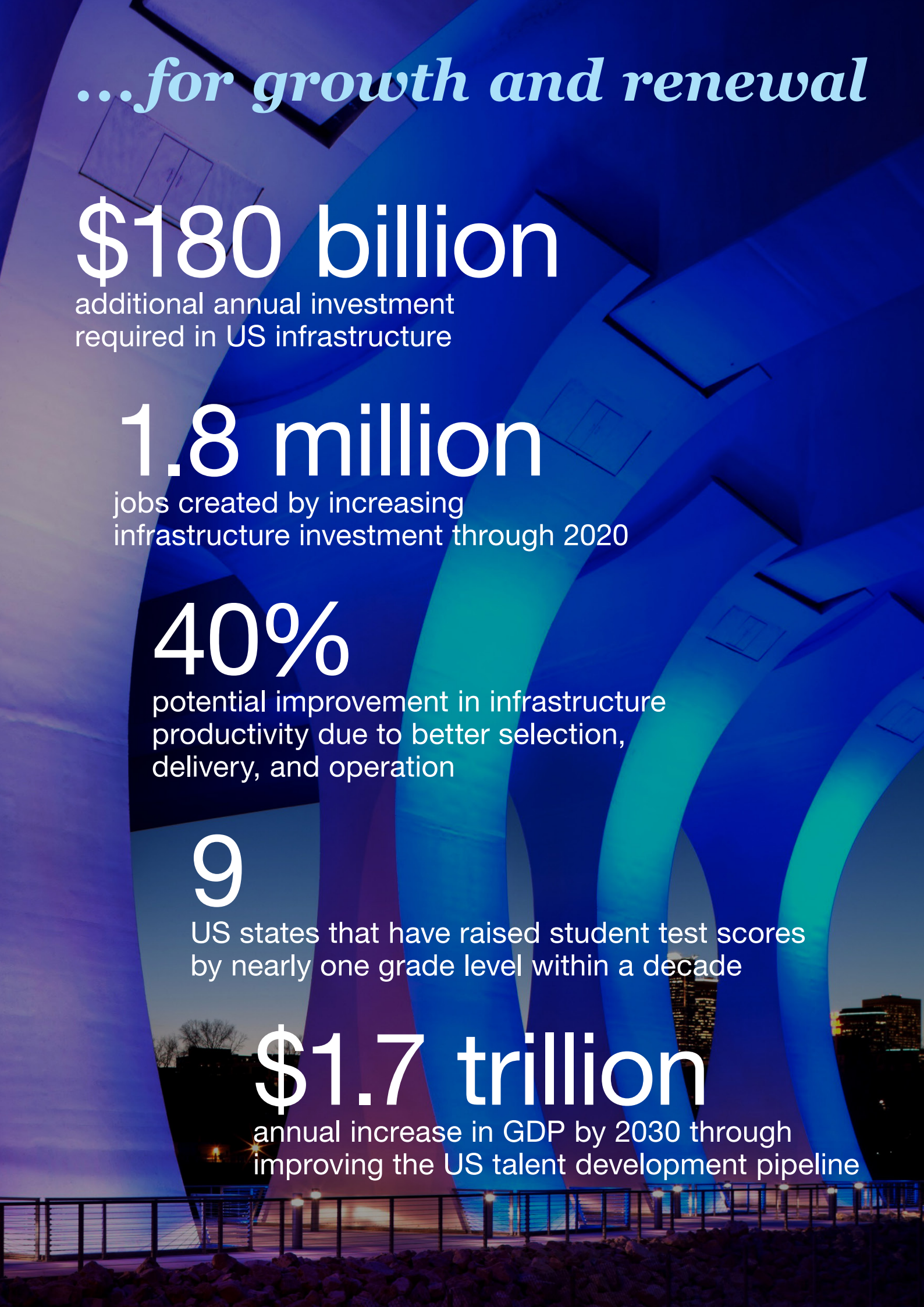

Breakout opportunities ...
50%
annual increase in US shale gas
and oil production since 2007
1.7 million
jobs created economy-wide
from shale energy development
10%
annual growth of greenfield FDI
in the United States since 2003
135%
growth of US aerospace
net exports since 2009
$325 billion
incremental annual GDP from big data
analytics in retail and manufacturing by 2020


...for growth and renewal
$180 billion
additional annual investment
required in US infrastructure
1.8 million
jobs created by increasing
infrastructure investment through 2020
40%
potential improvement in infrastructure
productivity due to better selection,
delivery, and operation
9
US states that have raised student test scores
by nearly one grade level within a decade
$1.7 trillion
annual increase in GDP by 2030 through
improving the US talent development pipeline

Executive summary

Five years after the start of the global financial crisis, the longest downturn in US postwar history has given way to a lackluster recovery. Deleveraging, a fragile housing market, restructuring in the financial system, and fiscal austerity have posed formidable headwinds to US growth. In late 2012, however, the Congressional Budget Office issued a report revising potential GDP downward for reasons that have received far less attention: weak investment in the underlying productive capacity of the economy, demographic shifts, and a slowdown in productivity growth.[1]

There is more at work here than simply the business cycle, and this decline in future potential should be a call to action. Structural problems have been brewing in the US economy for decades. Today the national unemployment rate has ticked down to 7.6 percent, but improvement in this number masks the fact that labor force participation has dropped from 67.3 percent in 2000 to 63.4 percent in May 2013, touching a 34-year low. Despite the recovery, the US economy still has two million fewer jobs than when the recession began.

If young Americans are to enjoy the same increase in living standards over their lifetime as previous generations, the United States must expand employment, make its workforce more competitive, and sharply accelerate productivity growth that is driven by innovation and higher-value goods and services. The latter will be a challenge, not least because a large share of the economy is now composed of sectors with historically stagnant or below-average productivity growth, including health care, government, education, and construction.

But the United States does not have to resign itself to sluggish growth. While fiscal and monetary issues have dominated recent public debate, we believe it is time to shift the conversation toward growth-oriented policies that can mobilize investment and job creation in the private sector. We set out to find “game changers”—catalysts that could spur productivity gains, boost GDP, and generate significant numbers of jobs by 2020. By narrowing down a larger universe of ideas, identifying a set of critical and mutually reinforcing opportunities, and then sizing their potential impact, we hope to spark a discussion across government, the private sector, and civil society about national economic priorities and a path forward.

This report identifies game changers in energy, trade, big data, infrastructure, and talent. Within each of these areas, we explore the most promising opportunities for growth, including the continued expansion of shale gas and oil production; increased US trade competitiveness in knowledge-intensive goods; the potential of big data analytics to raise productivity within sectors; increased investment in infrastructure, with a new emphasis on its productivity; and new approaches

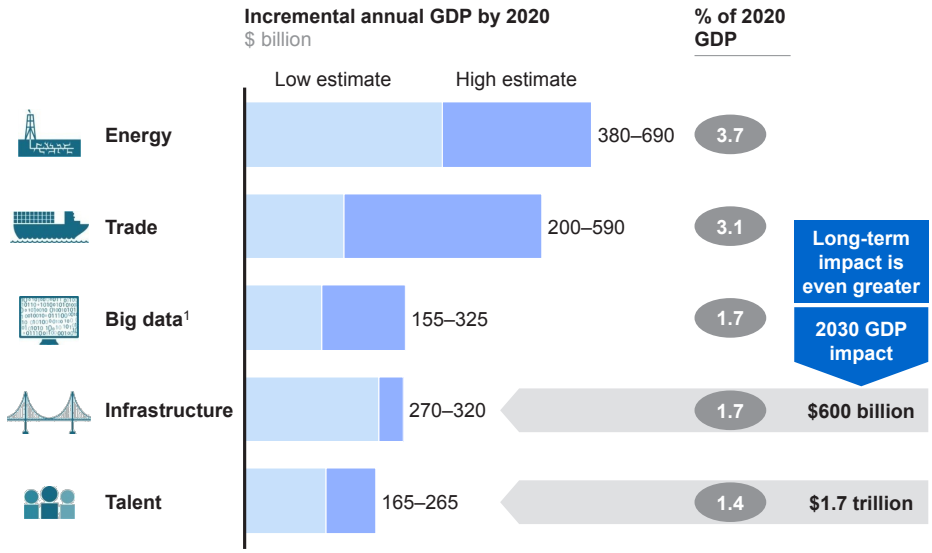
1 *What accounts for the slow growth of the economy after the recession?* Publication 4346, Congressional Budget Office, November 2012.

to both K–12 and post-secondary education.[2] This list includes specific sectors in which momentum is already unfolding, such as shale gas and oil, as well as fundamental enablers that will underpin competitiveness across the broader economy, such as talent development. Several can immediately boost demand to accelerate the recovery, and all of them provide a foundation for long-term growth.

We calculate that each one of the game changers could boost annual GDP by hundreds of billions of dollars by 2020 and create millions of jobs—with infrastructure and talent delivering even more dramatic gains by 2030 (Exhibit E1). There are solid reasons to believe that conditions are right for the United States to capture these opportunities by moving now.

Exhibit E1

Each of the game changers could substantially raise US GDP by 2020



1 Figures reflect additional GDP in retail and manufacturing sectors only. Big data could also produce cost savings in government services and health care ($135 billion–$285 billion), but these do not directly translate into additional GDP.
NOTE: These figures are based on a partial-equilibrium analysis that estimates only first-order effects and therefore cannot be summed to calculate the full economic impact.
SOURCE: Economist Intelligence Unit; IHS Global Insight; McKinsey Global Institute analysis

Although they will require substantial up-front investment, these game changers can ultimately ease the challenge of reducing fiscal deficits and debt by raising GDP growth. Federal funding and policy changes could speed results, but gridlock does not have to pose a barrier to undertaking these goals. Despite the stalemate in Washington, a great deal of policy experimentation and initiative is happening at the state and local levels. The US economy remains one of the most innovative and flexible in the world, and the private sector can drive much of the investment and realize much of the opportunity. Taking action now could mark a turning point for the US economy and ensure prosperity for this generation and the next.

2 A recent MGI report, *Disruptive technologies: Advances that will transform life, business, and the global economy*, describes a dozen breakthroughs, including advanced oil and gas exploration and several big data–related technologies. While *Disruptive technologies* is global in scope, this report takes a complementary look at how these and other opportunities may unfold in the US economy, sizing their impacts on GDP, productivity, and jobs.

WHAT CONSTITUTES A GAME CHANGER?

Over the past five years, the McKinsey Global Institute has studied the performance of the US economy from multiple angles, including the jobless recovery and labor market mismatches, large multinational companies and eroding competitiveness, the productivity challenge, savings and the demographic transition, and deleveraging from the financial crisis.[3] Drawing on this body of work, we set out to look for game changers—that is, catalysts that can reignite growth and reestablish a higher potential trajectory for the US economy. We find large opportunities waiting to be seized.

These five game changers were chosen from a longer list of ideas we considered, and they are drawn from broad categories that are foundational to the US economy. (See Box E1, "Selecting the five game changers," for more detail on our selection criteria.) They are possible today because of technology breakthroughs; changing costs of capital, labor, and energy around the world; policy innovation at the state and local levels; or new evidence-based understanding of how to address long-standing problems.

Some may disrupt entire industries—and all have the potential to impact multiple sectors (Exhibit E2). Moreover, the five game changers presented here are mutually reinforcing. The shale boom, for example, is boosting trade competitiveness, particularly in energy-intensive manufacturing, as the shift in input costs caused by cheap natural gas has made the United States a more attractive place to base production. Big data can play a role in raising the productivity of knowledge-intensive manufacturing for export, maximizing infrastructure assets, and facilitating new personalized digital learning tools. Shoring up US infrastructure is necessary to capture the potential of the shale energy boom and facilitate greater trade. A talent revolution is needed to train tomorrow's energy engineers and big data analysts, as well as the skilled workforce needed for a 21st-century knowledge economy.

These opportunities can exert two types of economic impact: more immediate demand stimulus effects that can get the economy moving again in the short term, and longer-term enabling effects that build competitiveness and productivity well beyond 2020. The shale boom, for example, has already provided an immediate spark as it coaxes private capital off the sidelines and leads to new investment in both oil and gas production and energy-intensive manufacturing. Increased trade competitiveness can have a relatively rapid impact by leveraging global demand and building on US strengths in innovation. Big data, by contrast, is already being adopted by a range of US companies, but it will take time to reach critical mass and raise sector-wide productivity. Infrastructure investment can be a powerful short-term stimulus and boost to employment, but as with talent development, it also has important long-term enabling effects on the rest of the economy. The impact of these two game changers would grow in magnitude from 2020 to 2030 as the US stock of human capital and infrastructure deepens.

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3 See MGI reports *Debt and deleveraging: Uneven progress on the path to growth*, January 2012; *An economy that works: Job creation and America's future*, June 2011; *Growth and renewal in the United States: Retooling America's economic engine*, February 2011; *Growth and competitiveness in the United States: The role of its multinational companies*, June 2010; and *Talkin' 'bout my generation: The economic impact of aging US baby boomers*, June 2008.

Box E1. Selecting the five game changers

Many ideas have been offered for reviving economic growth. Startups, renewable energy, and the "reshoring" of manufacturing are commonly offered as solutions that can accelerate the current weak recovery. In this research, we have attempted to sort through the possibilities to identify the opportunities with the greatest potential for economic impact. While acknowledging that some options not discussed in this report also hold promise, we believe that we have identified a set of five priorities that could spur growth and renewal in the US economy by 2020.

To narrow down the possibilities, we set the following parameters: Each development had to be a catalyst with the ability to drive substantial growth in GDP, productivity, or jobs. It had to be poised to achieve scale now and capable of producing tangible impact by 2020. And it had to have the potential to accelerate growth across multiple sectors of the economy. We also looked for areas in which new technologies, discoveries, or other factors are creating a unique window for action.

We started with a broad set of potential candidates and narrowed the list.[1] Some topics were combined into one larger category. For example, K–12 education reform, workforce skills, and immigration were consolidated into one game changer on talent development. Other ideas were important, but the impact was not likely to be realized at scale within our time frame, such as the broad adoption of smart grid technologies that can boost energy efficiency. Difficulties in measurement caused us to exclude others, such as innovation. The link between innovation and economic growth is widely accepted, but proxy metrics that are typically used to measure innovation—R&D spending, patents, number of scientists and engineers—provide only a partial picture of innovative activity. Other metrics, such as the vitality index, have been proposed but are hard to quantify.[2]

Finally, we excluded other topics because they address mainly cyclical challenges rather than long-term opportunities. Reviving business startups is an example. The rate of new business creation collapsed in the Great Recession, falling nearly 25 percent from 2007 to 2010 and erasing the potential for 1.8 million jobs that would otherwise have existed today. Reviving the startup engine is an important priority, as new businesses that are less than one year old generate nearly all net new jobs. However, a longer historical perspective shows that, apart from the past few years, startup creation in the United States has remained remarkably stable as a share of the civilian labor force since 1990. Furthermore, a gradual recovery in the number of startups is already under way. Although their recovery is not complete, it appears that business creation is primarily a cyclical rather than a chronic issue.[3]

We also considered possibilities for raising the productivity and performance of specific large sectors of the economy—health care, the public sector, and manufacturing, in particular. Although transforming these sectors could have a major impact, we chose instead to focus on opportunities that can benefit multiple sectors and lay a new foundation for growth. However, we do analyze in detail the potential to raise productivity in health care and government services through big data analytics, and we discuss the impact of several of the game changers on manufacturing in Box E2, "The future of US manufacturing," later in this executive summary.

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1 Among the other ideas considered were foreign investment, reshoring, advanced robotics, advanced materials, 3D printing, broadband, genomics, nanotechnology, renewables, and resource efficiency.

2 Created by 3M, the vitality index has been adopted by many other companies to measure new product revenue as a percentage of total revenue. Measuring this economy-wide and over time would be challenging due to data limitations.

3 There are many different views on the state of US entrepreneurship. The Kauffman Index of Entrepreneurial Activity shows that business creation actually increased during the recession. Other studies attempt to distinguish between self-employed entrepreneurs and newly incorporated firms that are more likely to have employees. See Scott Shane, *The Great Recession's effect on entrepreneurship*, Federal Reserve Bank of Cleveland, March 2011; and Zoltan Acs, Brian Headd, and Hezekiah Agwara, *Non-employer start-up puzzle*, SBA Office of Advocacy working paper, December 2009.

Exhibit E2

The game changers will benefit multiple sectors of the economy

Sectors potentially affected by each game changer

● Primary
● Secondary

Sectors of the economy	GDP, 2012 $ billion	Jobs, 2012[1] Million	Game changers that strongly impact sector: Energy	Trade	Big data	Infrastructure	Talent
Resource extraction (e.g., oil and gas, mining, agriculture)	453.8	2.9	●			●	○
Knowledge-intensive manufacturing (e.g., autos, aerospace, chemicals)	894.3	4.8	○	●	●	●	●
Resource-intensive manufacturing (e.g., metals, pulp, refinery products)	427.8	3.1	●	○	○	●	○
Labor-intensive manufacturing (e.g., apparel, furniture)	544.6	4.1		○	○	●	○
Construction and utilities	863.0	6.3	●			●	
Retail	949.1	15.0		○	●	○	○
Wholesale, transport, and logistics	1,367.2	10.2	○	○	●	●	●
Information and media	690.6	2.7		○	●		●
Financial, legal, and technical services	2,730.2	15.9	○	●	●		●
Real estate	1,926.3	1.9			●	●	
Hospitality and other services[2]	1,466.1	27.5					○
Education and health care	1,344.7	20.5			●		●
Government	2,026.2	21.9			●		●

1 Jobs column shows seasonally adjusted employment statistics as of December 2012.
2 Includes administration and support services, accommodation and food services, arts and entertainment, repair and maintenance, and personal services. These sectors will benefit indirectly from higher employment and spending.

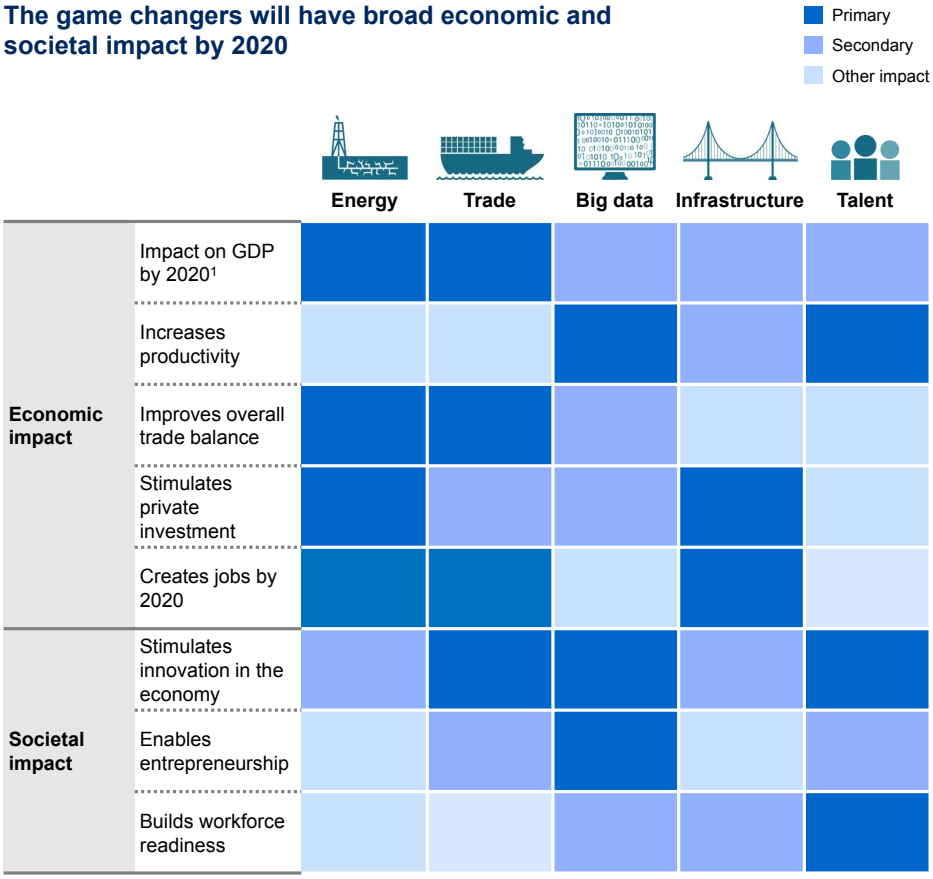
SOURCE: US Bureau of Economic Analysis; US Bureau of Labor Statistics; McKinsey Global Institute analysis

Each of the five game changers has the potential to boost annual GDP by at least $150 billion by 2020. In most cases, the potential is much greater—almost $700 billion by 2020 for shale energy, and up to $1.7 trillion by 2030 for talent. The impact on employment is also striking, with three of the game changers (energy, infrastructure, and trade) potentially creating more than 1.5 million new jobs each.

More subtly, concerted action to realize these opportunities can build general confidence that encourages investors, companies, and would-be entrepreneurs to focus their energies on the United States, creating a positive cycle. In addition, the game changers will have far-ranging economic, social, and policy implications (Exhibit E3). Although the benefits of pursuing these goals simultaneously would vary across different parts of the US economy, the resulting complementary effects would enhance the nation's overall competitiveness, productivity, innovation, and quality of life.

Exhibit E3

The game changers will have broad economic and societal impact by 2020



1 Talent and infrastructure have much larger GDP impact by 2030
SOURCE: McKinsey Global Institute analysis

The projections associated with each game changer are based on quantitative analysis as well as the insights of multiple industry and policy experts. While it is tempting to add these numbers together into a rosy forecast for trillions of dollars in additional GDP, we caution that these scenarios are not meant for simple addition.[4] Each one was calculated in isolation and did not consider the second-order effects on prices and exchange rates. Our calculations are also not predictions of how much of the opportunity will actually be realized. They are meant to demonstrate the size of the potential impact and explore the actions needed by both business leaders and policy makers to pursue these game changers.

4 Each one is a partial-equilibrium comparative static analysis that estimates only the first-order magnitude of impact. These calculations do not take into account second-order effects such as those due to changes in the value of the US dollar, interest rates, or inflation.

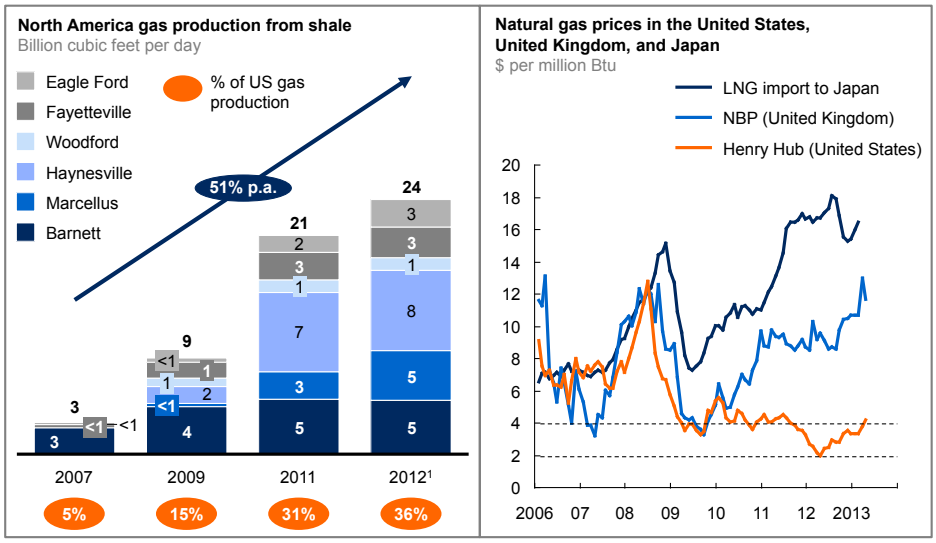
ENERGY: CAPTURING THE SHALE OPPORTUNITY

After its peak in the early 1970s, US oil production experienced three decades of decline, and energy grew to account for half of the nation's trade deficit in goods. As recently as five years ago, there was little evidence that this trend could be reversed.

Today the picture is changing rapidly, driven by technological advances in horizontal drilling and hydraulic fracturing. This process has unlocked large deposits of both natural gas and oil trapped in shale—resources once considered too difficult or costly to extract. From 2007 to 2012, North American shale gas production climbed by more than 50 percent annually (Exhibit E4). Today, production of so-called light tight oil is growing even faster.[5]

Exhibit E4

Shale gas production in North America has grown by 51 percent annually since 2007, lowering the price by two-thirds



1 Marketed production levels at wellhead. Includes Lower 48 onshore and Gulf of Mexico offshore volumes.
NOTE: Numbers may not sum due to rounding.
SOURCE: Energy Insights (a McKinsey Solution); Hydrocarbon Production Data; US Energy Information Administration; McKinsey Global Institute analysis

If the United States fully realizes the opportunity, shale energy could revitalize the oil and gas industry, have downstream benefits for energy-intensive manufacturing, and send ripple effects across the economy. We estimate that it could add 2 to 4 percent ($380 billion to $690 billion) to annual GDP and create up to 1.7 million permanent jobs by 2020. This could be an important source of high-wage employment for workers without college degrees, generating economic activity in parts of the country that have seen little investment in recent decades.

The impact is already being felt in the energy sector and beyond. We project that increased hydrocarbon production could boost annual GDP within the energy sector itself by $115 billion to $225 billion by 2020. It can also drive growth in manufacturing industries that rely heavily on natural gas as a fuel or feedstock. These include petrochemicals, fertilizer, and synthetic resins; iron and steel; and

5 This oil is called "light" because it is less dense than heavy oil, and "tight" because it is found in very low-permeability reservoirs and cannot be tapped without advanced drilling and completion processes.

glass, paper and pulp, and plastics packaging. Annual GDP in manufacturing could rise by $55 billion to $85 billion. And the ripple effects may extend even wider, as increased production will require support from other industries, including professional services, construction, transport, and trade, driving an additional $210 billion to $380 billion incremental increase in annual GDP.

Building the required infrastructure for the shale boom is providing short-term stimulus to the recovery. We estimate it would take up to $1.4 trillion in investment to complete the necessary pipelines, rail networks, and drilling and gathering infrastructure. This could generate 1.6 million temporary jobs during the build-out, mainly in the construction sector. And this investment boom is being financed mainly by private capital from the United States and abroad; it does not hinge on public funding.

Beyond the increase in output and jobs, the implications are significant. The surge in shale gas production has driven down the price of US natural gas from nearly $13 per MMBtu in 2008 to approximately $4 per MMBtu in spring 2013—sharply lower than prices elsewhere around the world and a level at which some wells are being capped as producers cannot recoup their investment. In response, the United States is considering exporting liquefied natural gas (LNG), a shift that would require converting underutilized import terminals to export terminals. The US Department of Energy has approved two applications for such projects to date, and 20 more are under review. Combining potential LNG exports with reduced demand for imports of crude oil, the United States now has the potential to reduce net energy imports effectively to zero in the next decade and beyond.[6]

Finding solutions for the environmental risks associated with horizontal drilling and hydraulic fracturing—including groundwater contamination, fugitive methane emissions, and potential seismic effects—will be essential. The full extent of these risks is debated, and the long-term cost of damage in a worst-case scenario, should it occur, could be quite high.[7] It is in the interest of energy producers themselves to create transparency on these risks, build public confidence, and adopt rigorous operational standards (with special focus on the soundness of well casings and best practices for the disposal of wastewater). If they fail to do so, local and state governments may prohibit hydraulic fracturing, as some states have done, or a single disaster could turn public opinion sharply negative. While policy makers will have to set clear standards on drilling, well maintenance, and emissions, the industry would be well served by proactively addressing these issues.

There are additional challenges as well, including land-use impacts on local communities and the intensity of water use for drilling in drought-prone regions. But if the United States can successfully manage these issues, the shale boom could generate economic growth, high-wage jobs, and a secure supply of affordable energy that enhances US competitiveness.

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6 *World energy outlook 2012*, International Energy Agency, November 2012.

7 See *Shale gas extraction in the UK: A review of hydraulic fracturing*, Royal Society and the Royal Academy of Engineering, Final report, June 2012; R. D. Vidic et al., "Impact of shale gas development on regional water quality," *Science*, volume 340, number 6134, May 2013; and *The inventory of US greenhouse gas emissions and sinks: 1990–2011*, US Environmental Protection Agency, April 2013.

TRADE: INCREASING US COMPETITIVENESS IN KNOWLEDGE-INTENSIVE INDUSTRIES

"Competitiveness" has become shorthand for a broad range of success factors: the ability to win share in export markets, attract global investment, create dynamic new companies, and draw a steady stream of talented students and workers from around the world. Historically one of the best places to do business, the United States continues to be a magnet for foreign direct investment (FDI) and the headquarters of many of the world's most successful companies. Since 2008, the United States has attracted more inward FDI relative to the size of its economy than Germany, France, and many other advanced economies.

But by some measures, the United States may be losing its edge and falling behind its international peers. Many US business executives, for example, say that permitting, regulation, and taxes are increasingly impediments to investing in the United States, and some of the fundamentals of the economy, including talent and infrastructure, are eroding.[8]

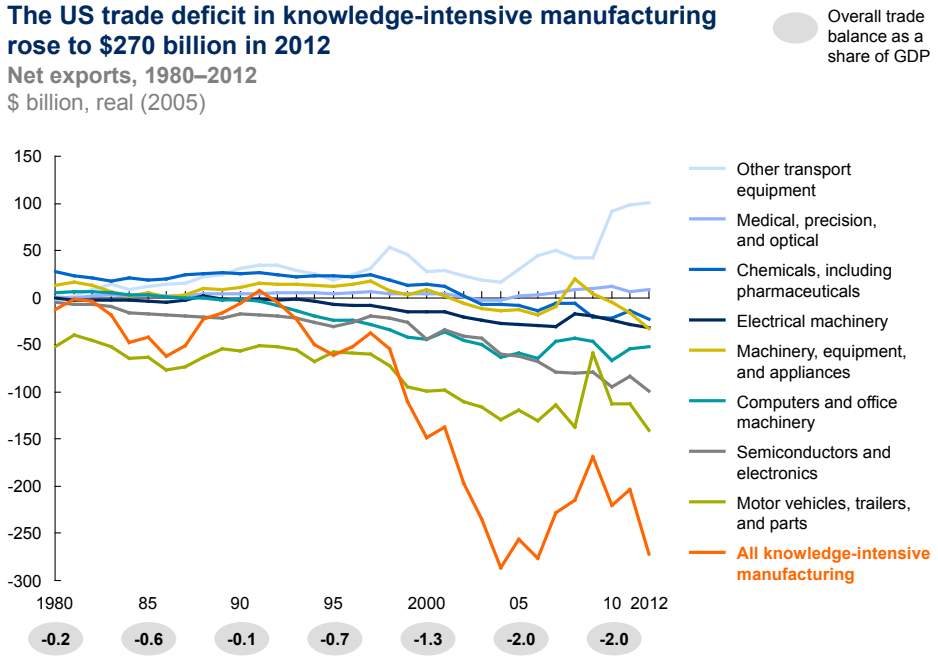
And surprisingly, given its track record for scientific research and technological innovation, the United States is one of the only advanced economies in the world that runs a trade deficit in knowledge-intensive manufactured goods. This category includes automobiles, aerospace, semiconductors and electronics, medical and precision equipment, and chemicals and pharmaceuticals. These industries are R&D-intensive and match up well with traditional US strengths, and they account for 50 percent of US manufacturing value added and 40 percent of employment. Yet the US trade deficit in these categories has gone from $6 billion in the early 1990s to $270 billion in 2012 (in 2005 dollars; Exhibit E5).

Exhibit E5

The US trade deficit in knowledge-intensive manufacturing rose to $270 billion in 2012

Net exports, 1980–2012

$ billion, real (2005)



SOURCE: IHS Global Insight May 2013; McKinsey Global Institute analysis

8 *Growth and competitiveness in the United States: The role of its multinational companies*, McKinsey Global Institute, June 2010.

The trade balance of any nation reflects a range of factors, including the value of its currency; its saving and investment rates; tax, regulatory, and trade policies; and the productivity and competitiveness of companies. This study does not consider macroeconomic policies that can address the first two of these issues; instead we focus on other measures that policy makers and the private sector can take to improve this trade deficit in knowledge-intensive goods by enhancing US competitiveness.

Our own analysis, as well as interviews with a broad range of industry executives and experts, reveals that there may be opportunities to increase US domestic production in specific categories of knowledge-intensive manufacturing in the years ahead, thereby increasing exports and/or reducing imports, either of which would improve the trade balance.

We project, for instance, that US petrochemical production will increase significantly in the years ahead due to cheap natural gas unlocked by the shale boom. This would transform the current $25 billion trade deficit in chemicals into a substantial surplus even if other parts of the chemicals sector, such as pharmaceuticals, remain unchanged. In aerospace, US exports of aircraft have nearly doubled in real terms since 2009, driven by demand growth in Asia and the Middle East. Industry analysts project that global aircraft fleets will double in size by 2031, and the United States is well positioned to capture a large share of this growth. In automotive, which makes up nearly half the total trade deficit in knowledge-intensive manufacturing, foreign auto producers are investing in the southeastern United States. Some foreign manufacturers, such as BMW, even export vehicles from the United States. Japanese automakers were at the forefront of establishing US production in the 1990s and eventually began sourcing parts in the United States; European, South Korean, and other foreign carmakers may follow that path as well, reducing US imports of parts and components. In addition, US automakers can consolidate a competitive edge in next-generation vehicles, including hybrid and electric models, exporting to global markets from the United States. And there is existing growth momentum that can be maximized in other categories, such as medical devices.

Five broad strategies can reduce the trade deficit in knowledge-intensive industries: building world-class infrastructure and talent as a foundation for business; sustaining a commitment to R&D, innovation, and staying at the forefront of emerging new technologies; improving the US business environment through tax and regulatory reform; aggressively pursuing new export markets as the consuming class grows in developing countries; and attracting more production from both foreign and domestic companies to the United States. These will in turn strengthen the already considerable success the United States enjoys as an exporter of knowledge-intensive services, where its trade surplus has shown consistent 9 percent annual growth, reaching $200 billion in 2012 (in nominal terms).

US businesses will need to move quickly to take advantage of growth in emerging economies, new technologies, and changing factor costs. Policy makers must also work toward creating an environment that will attract investment and production. Offering a "one-stop shop" for foreign companies that want to set up operations in the United States is one idea; the US Commerce Department has made this initial step with the establishment of SelectUSA, which could be taken to greater scale. The United States could also bring its corporate tax rate into line with other OECD countries through a revenue-neutral approach that broadens the base while simplifying the complexities of the tax code. Continued bilateral, regional, and global trade negotiations can expand market opportunities.

If the United States were to enhance its business environment and if the private-sector companies in knowledge-intensive industries can rise to the challenge, the impact on US GDP and jobs would be substantial. We examine a conservative scenario in which the trade deficit in knowledge-intensive manufactured goods is reduced from 2 percent of GDP (its level in 2012) to 1.3 percent of GDP (its level in 2000); this could raise US GDP by $200 billion annually by 2020 while creating 600,000 new jobs. If the United States makes a more concerted push to roughly close the trade deficit in knowledge-intensive industries, reverting to the same level as in the early 1990s, it could increase annual GDP by $590 billion annually by 2020 and create 1.8 million new jobs.

BIG DATA: HARNESSING DIGITAL INFORMATION TO RAISE PRODUCTIVITY

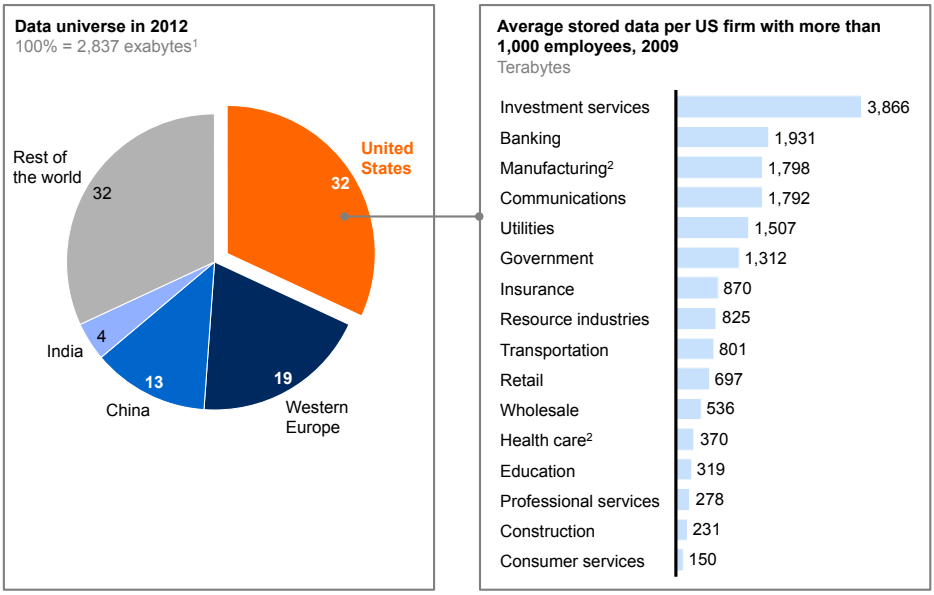
Given its aging population and the resulting fall in labor force participation, the United States will need to accelerate productivity growth by more than 30 percent, achieving a rate not seen since the 1960s, to maintain historic growth rates in per capita GDP.[9] A convergence of breakthrough technologies in big data and advanced analytics may provide one critical solution to help meet the economy-wide productivity challenge.

Sectors across the economy can find new efficiencies by harnessing the deluge of data being generated by transactions, medical and legal records, videos, and social technologies—not to mention the ubiquitous network of sensors, cameras, bar codes, and transmitters embedded in the world around us. Thanks to advances in cloud computing and the development of software that can extract useful information, this sea of data can now be transformed into insights that create both efficiencies and innovative services. The potentially transformative impact of these technologies is only just beginning to be understood. But the United States owns a disproportionate share of the world's data assets (Exhibit E6), and its companies, entrepreneurs, and universities are leading the development of this technology.

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

Exhibit E6

The United States has one-third of the world's data



1 One exabyte = 1,024 terabytes, nearly 2.5 times as large as US Library of Congress web archive (as of May 2013).
2 The large number of firms in the manufacturing and health-care sectors reduces the available storage per company.
SOURCE: IDC; US Bureau of Labor Statistics; US Library of Congress; McKinsey Global Institute analysis

We have analyzed big data's potential to raise productivity in four large and markedly different sectors of the US economy: retail, manufacturing, health care, and government services. In these sample sectors alone, we estimate that the widespread use of big data analytics could increase annual GDP in retail and manufacturing by up to $325 billion by 2020 and produce up to $285 billion in productivity gains in health care and government services.

In the retail sector, for example, real-time data on inventory can be combined with demand forecasting to reduce excess ordering and stockouts. Analytics can make more accurate predictions of store traffic and associated staffing needs to optimize labor scheduling. We estimate that big data tools could generate up to $55 billion in annual productivity gains in retail. As more retailers adopt the new technologies, productivity will increase throughout the sector, translating into higher national GDP in the process.

Manufacturers can deploy big data analytics across the production process. In product design, engineers can combine computer-aided design with data generated from production systems to minimize production costs and raw material use. In the production stage, sensors embedded in equipment can minimize disruptions by monitoring wear and signaling for preventive maintenance. Companies can also use advanced simulation techniques to create 3D models of new processes, factory floors, and even entire plants before physically building them. All told, the adoption of big data could generate up to $270 billion in productivity gains in manufacturing. As in the retail sector, these gains contribute directly to GDP, and the investment comes from the private sector.

Controlling health-care costs is imperative for long-term public finances and for the business environment in the United States. Big data tools have the potential to support innovation in health-care delivery, significantly reducing costs while improving outcomes. Comparative effectiveness research, for example, uses powerful algorithms to analyze millions of records to identify the relative efficacy and cost of various treatments for specific patient profiles. The shift to electronic medical records, now under way, will be critical in enabling these gains. Clinical decision support systems can check physicians' orders against updated medical guidelines and generate warnings against adverse drug reactions. In medical R&D, big data analytics can streamline clinical trials, allow scientists to test molecules using simulations, and analyze genomic sequencing to move personalized medicine closer to reality. Cost savings in health care could total as much as $190 billion by 2020—in addition to the far broader benefits of improving the well-being of Americans.[10]

Big data has myriad applications to boost the efficiency of government services while reducing their cost, achieving up to $95 billion in productivity gains. In addition, big data analytics can reduce expenses, for instance by using algorithms to weed out erroneous payments in entitlement or social insurance programs and lowering procurement costs.[11] It can also increase government revenue by reducing tax fraud and improving tax collection.

Realizing the full potential of this game changer hinges on creating the right incentives and training the highly specialized talent needed to manage and analyze big data. Previous MGI research has estimated that by 2018, the United States will face a shortage of up to 190,000 data scientists with advanced training in statistics and machine learning as well as 1.5 million managers and analysts with enough proficiency in statistics to use big data effectively.[12]

Privacy and intellectual property laws must be reevaluated and updated to address the uses of big data; at present there are many gray areas. In some cases, privacy laws hamper the free flow or use of data for potentially beneficial uses; in other areas, the lack of explicit regulation affords consumers little or no protection. In addition, cybersecurity is an ongoing challenge that requires a continuously evolving response on the part of the public sector and private companies alike.

10 An MGI report on big data from May 2011 calculated its value in US health care as $333 billion, including $226 billion in reduced national health-care expenditures. The approach used here is consistent, but the estimate of impact is smaller because we have reclassified items such as pricing and accounting changes as shifts in market share or consumer surplus. Furthermore, this research does not estimate the impact of big data beyond cost savings.

11 Although the potential cost efficiencies in government services and health care are large, they do not directly raise US GDP because of the way value added is measured in these sectors.

12 *Big data: The next frontier for innovation, competition, and productivity*, McKinsey Global Institute, May 2011.

Box E2. The future of US manufacturing

Both the employment and share of GDP driven by US manufacturing have declined over the past two decades, but the sector remains an important driver of prosperity. It produces 12 percent of US GDP but accounts for 70 percent of private R&D spending, 60 percent of US exports, and 30 percent of productivity growth.[1] Employment in the sector declined from 17.3 million in 2000 to 11.9 million as of May 2013, indicating that manufacturing will not be a solution to the nation's employment crisis. But the jobs that remain in the sector are valuable, as they pay higher compensation than those in service sectors while spurring ancillary jobs and market opportunities, whether in design, distribution, or after-sales service.

Half a million net new jobs have been created in US manufacturing since 2010, but this rebound does not necessarily add up to a broad-based "reshoring" trend. Nearly 80 percent of the jobs created are concentrated in just four industries that together make up one-third of US manufacturing employment. Two of these—motor vehicles, and machinery and equipment—respond primarily to growth in final demand from consumers and businesses, and usually locate their assembly facilities close to demand. The two other industries—primary and fabricated metals—provide intermediate commodity products mainly for domestic consumption, and nearly 60 percent of their output goes into motor vehicles and machinery. If we include other locally based industries such as food processing, nearly 90 percent of the manufacturing recovery can be attributed to a rebound in US demand during the recovery.

The research presented in this report does give some cause for optimism about a continued expansion in very specific parts of manufacturing in the United States. We find that the two-thirds decline in the price of natural gas due to shale production is leading to soaring new investments in petrochemicals, steel, and other energy-intensive industrial activities. This shift in relative costs will favor more domestic production, in part for export. Our chapter on the trade competitiveness of knowledge-intensive manufacturing reveals the potential to expand US production and improve the trade balance in some specific goods, including aerospace, automobiles, and medical devices. This report also describes how big data analytics tools can significantly raise productivity across the manufacturing process and value chain (reducing product development time by 20 to 50 percent, for example). Productivity is strongly correlated with sector competitiveness in the global economy, and this boost may enable increased production in a range of exports and import-competing products. And finally, the modernization of US infrastructure, discussed later in this report, will enable growth in US manufacturing, as it will improve the sector's ability to manage supply-chain logistics and shipping.

If the United States pursues these opportunities, its manufacturing output will continue to grow and more new jobs will be created. While it is only part of what is needed to boost broader US growth, it is possible to reinforce the important contributions that manufacturing makes to US productivity, trade, and innovation.

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1 *Manufacturing the future: The next era of global growth and innovation*, McKinsey Global Institute and McKinsey Operations Practice, November 2012.

INFRASTRUCTURE: BUILDING A FOUNDATION FOR LONG-TERM GROWTH

Years of chronic underinvestment in infrastructure are now catching up with the United States. With economic activity returning to more normal levels after the Great Recession, capacity constraints are once again looming. The backlog of necessary maintenance and upgrades is reaching critical levels—and the need is particularly acute for roads, highways, and transit as well as water systems.

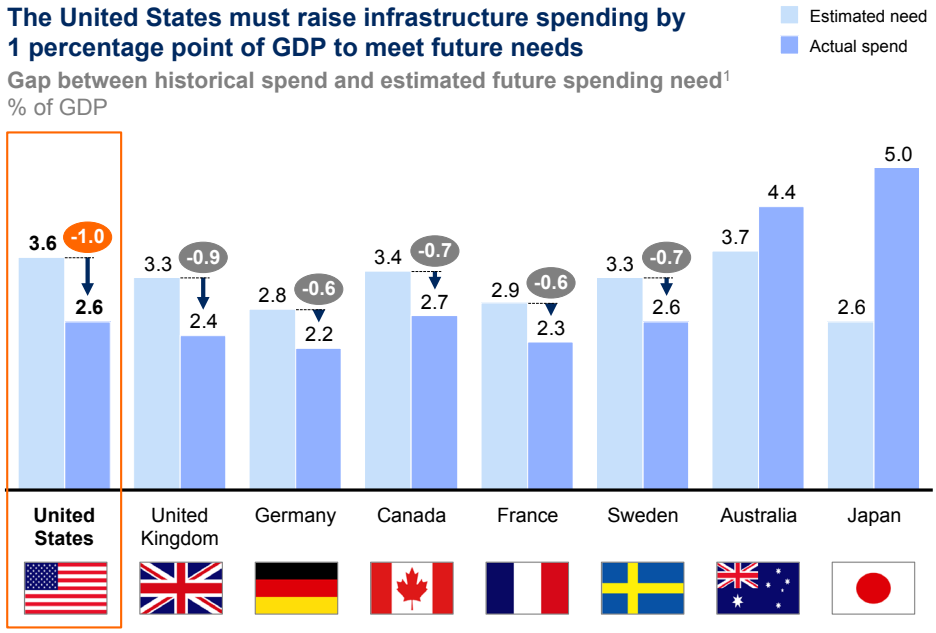
The United States cannot defer hard decisions indefinitely while backbone systems deteriorate. The combination of high unemployment in the construction sector and the large economic multiplier effects associated with these projects makes a compelling case for investing now to accelerate recovery and avoid a legacy of deferred maintenance for the next generation. Currently low borrowing rates present a unique window of opportunity—but that window will not remain open indefinitely. In addition, the right infrastructure must be in place to enable the other game changers described in this report, from domestic shale gas and oil production to increased trade competitiveness.

Our analysis shows that the United States will need to increase infrastructure spending by 1 percentage point of GDP on a sustained annual basis to compensate for past underinvestment and set the stage for future growth (Exhibit E7). This equates to additional investment of $150 billion to $180 billion annually for the next 15 to 20 years.

Exhibit E7

The United States must raise infrastructure spending by 1 percentage point of GDP to meet future needs

Gap between historical spend and estimated future spending need[1]
% of GDP



1 Actual spend calculated as weighted average annual expenditure over years of available data, 1992–2011. Estimated need based on projected growth, 2013–30.

SOURCE: McKinsey Global Institute analysis

This would have a powerful short-term stimulus effect, adding 1.4 to 1.7 percent (or $270 billion to $320 billion) to annual GDP between now and 2020 and creating up to 1.8 million jobs. Sustaining this level of investment will eventually bring the nation's infrastructure stock up to the level of peer countries such as Germany by 2030.

In addition to investing more, the United States can substantially raise the productivity of infrastructure investments. In an era of funding constraints, the United States cannot afford to have major projects run over budget and behind schedule, as is too often the case. If strategic infrastructure investments are made with a new and more efficient approach to project selection, delivery, and operation, we estimate that annual GDP would rise by an additional $600 billion by 2030 through the combined effect of a higher and more productive national infrastructure stock.

One of the most effective ways to make infrastructure investment more productive is to choose the right mix of projects from the outset, using a systematic portfolio approach that incorporates rigorous economic analysis. Greater accountability and tighter management of the delivery and execution stages can protect the public interest and produce large efficiencies; based on 40 capital productivity studies, previous MGI research has found that typical delivery costs in infrastructure projects can be reduced by approximately one-quarter.[13] Speeding the approval and land acquisition processes, which can drag on for years in the United States due to fragmented decision making and process redundancy, could make a considerable difference.

Another strategy for increasing infrastructure productivity involves maximizing the life span and capacity of existing assets. In many cases, directing more resources to renewing existing infrastructure may be more cost-effective than new build-outs. There is a need to focus more attention on maintenance, refurbishment, and renewal. In addition, big data is enabling several innovations—including intelligent transportation systems and dynamic congestion pricing—that can avoid the need for costly investments in new capacity.

Given their current fiscal constraints, governments are increasingly turning to more creative funding mechanisms, including approaches that bring in private expertise and capital by offering investors long-term operating arrangements. Public-private partnerships, or PPPs, are commonly used for infrastructure projects across Canada, Europe, South America, and Asia, and they are now gaining traction in the United States. When successful, they can introduce incentives to manage costs by increasing efficiency in the design, construction, and operating stages of an infrastructure project. PPPs are not without their pitfalls, however, and governments and private investors alike must approach these deals with appropriate caution.

TALENT: INVESTING IN AMERICA'S HUMAN CAPITAL

One source of America's historic economic prosperity has been the high skill and education of its workforce. But this edge is now eroding as other nations surpass the United States. US student achievement measures have fallen near the bottom half in international rankings, and the nation's rate of tertiary education attainment for younger workers lags dramatically behind that of other countries (Exhibit E8). Moreover, even those who receive post-secondary education may not be acquiring the skills they need: a recent McKinsey survey found that more than 60 percent of US employers are skeptical of recent graduates' potential to succeed in their company.[14]

13 *Infrastructure productivity: How to save $1 trillion a year*, McKinsey Global Institute, January 2013.

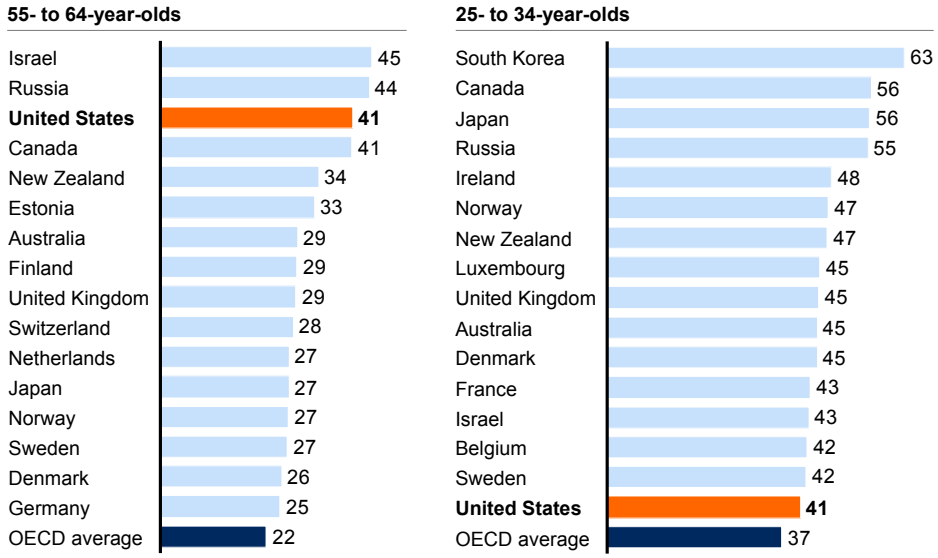
14 *Education to employment: Designing a system that works*, McKinsey Center for Government, December 2012.

Exhibit E8

The United States no longer leads the world in tertiary education attainment

Share of population with tertiary degrees, older versus younger cohort, 2009

%



SOURCE: Organisation for Economic Co-operation and Development (OECD), *Education at a glance 2011* statistical annex; McKinsey Global Institute analysis

Today the United States has an opportunity to fundamentally redesign its system of human capital development, which will increase its global competitiveness. This will also set the stage for capturing the other game changers outlined in this report, from big data analytics to shale energy to trade in knowledge-intensive industries. The talent game changer entails revamping post-secondary education and training as well as raising the quality of K–12 education.

Four initiatives can produce more career-ready workers with good job prospects. The first is expanding the number of apprenticeships and non-degree training programs that give workers marketable skills and credentials. This is particularly important for the millions of Americans currently looking for work, and especially the long-term unemployed. Second is a concerted focus on improving learning and labor market outcomes for graduates of two- and four-year post-secondary institutions. This includes providing better and more transparent information about career pathways and outcomes so that students can choose the most appropriate and effective programs. Boosting college completion rates is critical; fewer than one-third of students who start a two-year degree program at a community college, for example, complete it within three years.[15] Third, the United States needs more graduates with science, technology, engineering, and math (STEM) degrees to build a workforce capable of doing the calculations needed for modern manufacturing processes or interpreting the data that drive the economy. Finally, the United States must rethink its immigration policy to focus on attracting and retaining talent from around the world. Increasing the number of H-1B visas and offering a greater share of permanent residency permits to applicants with higher educational attainment would expand the pool of skilled workers and future entrepreneurs.

15 National Center for Education Statistics/IPEDS Graduation Survey.

Taking a longer view, the United States cannot remain competitive in the decades ahead without raising the quality of K–12 education for all students. Achievement in primary and secondary school lays the groundwork for future productivity and innovation and is closely linked to GDP growth—and US students are falling behind their international peers. But with the right reforms, it is possible to significantly raise student achievement within a decade, as countries such as Germany and Poland have done in a similar time frame. Individual states, including Massachusetts, New Jersey, and Texas, have also made impressive gains.

School reforms enacted by state and local governments and social entrepreneurs across the United States are producing successful models that can be replicated at scale. Three strategies in particular will be crucial: improving the quality of classroom instruction, turning around 2,000 high schools with the nation's highest dropout rates, and introducing new technology into the classroom. Forty-five states have now adopted Common Core State Standards, providing a consistent foundation for implementing reforms on a wider scale and supporting them with innovation and investment.

We estimate that a dual focus on improving US K–12 education and post-secondary education could raise GDP by as much as $265 billion by 2020. The impact would grow larger over the following decade, as more students achieve better outcomes, graduate, and join the labor force, and as the skill profile of the labor force shifts. We estimate these reforms could add as much as $1.7 trillion (almost 7 percent) to GDP by 2030.

In a world powered by increasingly sophisticated technology, human capital is crucial to competitiveness, and the United States will be unable to capitalize on new developments in technology and trade without the right talent in place. It is within reach to build a more cohesive education-to-employment pipeline that gives current and future generations the skill sets needed for success in a 21st-century economy.

CAPTURING THE OPPORTUNITIES

Over the past few years of slow recovery, both US public policy and private investment have sometimes been tentative, but it will take a new mindset to accelerate growth. Unique windows of opportunity are opening for the United States to build a competitive advantage in energy, trade, technology, infrastructure, and education. Business leaders and policy makers alike will have to think long term and act decisively.

The United States has the resources to successfully realize these game changers, and much of the leadership—and the initial investment—will come from the private sector (Exhibit E9). Even in areas such as infrastructure and talent development, which have traditionally relied on government funding, there is an opportunity to inject greater private-sector capital and innovation. Policy makers at all levels will have an important role to play as well, by addressing a range of regulatory and legal issues raised by the game changers and spearheading some necessary policy shifts.

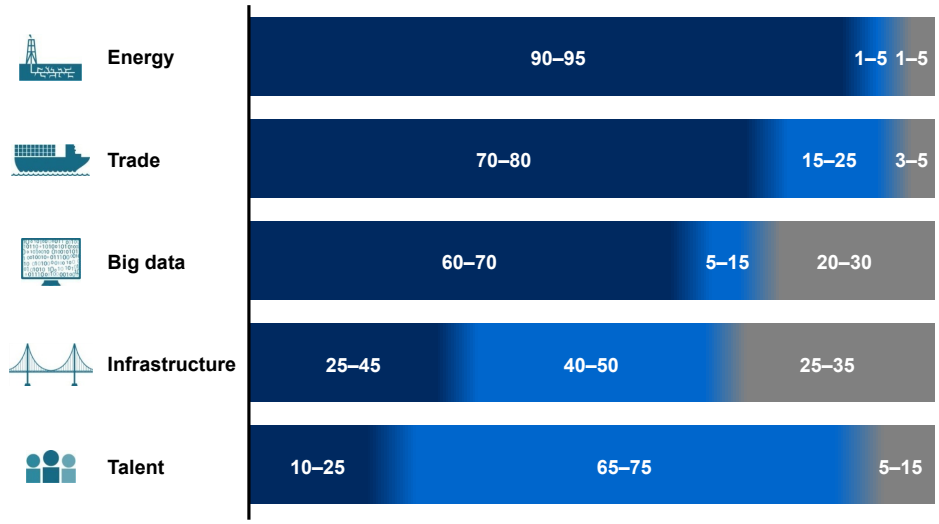
Each of the five game changers identified in this report can have a powerful impact that reverberates throughout the US economy on its own, but pursuing these mutually reinforcing goals simultaneously would result in additional spillover

effects. It could produce a virtuous cycle of growth that puts the nation back on the path to prosperity, increases employment opportunities, and improves its fiscal outlook.

Exhibit E9

The private sector and state/local governments will provide the majority of investment needed to achieve the game changers

Likely sources of investment needed to realize each game changer
%



SOURCE: McKinsey Global Institute analysis

Private-sector investment and innovation are the key ingredients

Much of the outcome ultimately rests with the private sector. Many companies have the resources to increase investment where they see opportunity and are considering where to deploy their capital in an uncertain global environment.

The five game changers discussed in this report present sustainable medium- and long-term opportunities for investment and new business models in the United States—and the businesses that recognize them quickly will edge out their competitors. This is a pivotal moment for gaining a foothold in new markets and riding the next wave of disruptive technologies. The private sector is taking the lead in shale energy development and its supporting infrastructure, as well as energy-intensive manufacturing. Private companies are entering creative infrastructure partnerships, using big data to transform their operations, and exporting goods and services to fast-growing emerging economies. In talent development, the newly adopted Common Core State Standards are opening the door for educators, social entrepreneurs, publishers, tech firms, and open-source projects to develop new curriculum tools in public schools. Foreign companies are increasing their investment in the United States, and it is time for more domestic companies to follow.

Beyond the immediate opportunities, businesses have a role to play in addressing longer-term issues. In shale energy, oil and gas producers can take the lead in managing environmental risks by continuing to invest in equipment that incorporates new and cleaner technology as well as ensuring that all producers—both large and small—maintain best safety practices. There is a great deal at stake here: mitigating these risks is crucial to protecting the air and groundwater

as well as allowing the industry and the US economy as a whole to fully realize the benefits. In addition, the private sector can become more actively engaged in developing infrastructure and shaping a first-class system for education and training, since US businesses cannot thrive without these crucial enablers.

Business engagement can drive considerable change without waiting for legislation or policy. Employers who see a skills gap, for example, are reaching out to local educators to build degree programs and short-term training programs that create their own talent pipeline while also giving workers the credentials and skills they need. Business executives across the country are actively partnering with state and local officials, universities, and industry associations to drive an economic renaissance in their communities and regions.

National policy makers can create the right environment for growth

In an age of globalization, when companies can and do move their operations anywhere in the world, it is more important than ever for the United States to maintain an attractive business environment. This will involve leveling the playing field on corporate taxes as well as addressing cumbersome regulations and slow permitting processes that add red tape and delay to many new projects. It is crucial to underline that these goals can be achieved in a balanced manner that does not reduce revenue or harm the public interest that regulation is meant to protect; it is a matter of simplifying, streamlining, and considering how US requirements measure up against best practices from around the world.

Governing by temporary measures or taking years to approve projects also creates policy uncertainty that discourages businesses from investing and slows economic momentum. There is tremendous scope to make the process of applying for business permits and environmental approvals more efficient, transparent, and coordinated without loosening oversight and public protections. This will be crucial to encouraging private-sector investment in energy infrastructure and new manufacturing plants. In addition, a new policy framework will be necessary to capture the maximum benefits of big data in health care and the public sector; establishing rules on privacy protections and clarity on data ownership is needed to govern its usage in the private sector.

National policy makers can also create structures that attract private capital to fund public infrastructure and education; this could open the door to greater accountability, innovation, and efficiency in public works projects. Similarly, policy makers can launch incentives and programs that encourage state and local experimentation and private-sector participation in education and workforce training. The Race to the Top, for example, accelerated school reform efforts across the country. A public-private partnership between the Skills for America's Future initiative and the National Association of Manufacturers created an industry-specific curriculum, allowing 500,000 community college students to earn credentials that will be a stepping-stone to jobs in the manufacturing sector. There is a great willingness on the part of business leaders to engage with these issues, and policy innovations can provide a framework for doing so.

Cities can build on these game changers to drive regional economic growth

Under the best of circumstances, the wheels of federal regulation and legislation turn slowly; in the current political stalemate, they often fail to budge at all.

Although the federal government could be a powerful catalyst, none of the five game changers presented here is fully contingent on action from Washington. Mayors, governors, and regional partnerships can also lead. Some of the most innovative policies, financing models, and approaches are emanating from the state and local levels, such as the Chicago Infrastructure Trust or New York's launch of Cornell NYC Tech, which will offer graduate degrees in science and cutting-edge technology. Cities and states are seizing the initiative on promoting export industries, attracting foreign direct investment, developing infrastructure, and creating vocational training.

Indeed, the economic vitality of its cities sets the United States apart from other nations. US cities are expected to generate more than 10 percent of global GDP growth between 2010 and 2025—more than the cities of all other advanced economies combined.[16] "Middleweight" cities with populations between 150,000 and ten million, including innovation hubs such as Boston, San Jose, and Austin, account for more than 70 percent of US GDP. The industry-specific clusters that have developed around many cities across the country are the hidden strength of the US economy. Silicon Valley and North Carolina's Research Triangle are well-known examples, but dozens of other economic clusters foster continuous innovation, from cybersecurity in San Antonio to medical devices in Minneapolis and aerospace in Wichita. These clusters, which often feature industry-academic-government research collaborations, become ecosystems that foster higher productivity and support advanced manufacturing.

Other countries are beginning to replicate this model of city and regional economic development, but the United States remains at the forefront. Realizing the game changers at the local level will be crucial to the success of the national economy.

□ □ □

Sluggish growth may not appear to be a problem that can galvanize decisive action, but it is quite damaging over time. An economy that performs below its capacity is a slow-motion crisis that erodes living standards. The United States can disrupt this status quo by mobilizing a new wave of investment that rebuilds the productive capacity of the economy. After considering a variety of growth policies, we have identified a set of five game changers with the potential to create a step change in US economic performance. By sizing these opportunities, we hope to focus national attention on renewing long-term growth and prosperity.

16 *Urban America: US cities in the global economy*, McKinsey Global Institute, April 2012.

Related McKinsey Global Institute research

An economy that works: Job creation and America's future (June 2011)

The US economy will need to create 21 million jobs by 2020 to regain full employment. To understand how this could be achieved, MGI undertook extensive sector analysis, interviews with human resource executives, and a proprietary survey of 2,000 business leaders.

Growth and renewal in the United States: Retooling America's economic engine (February 2011)

As baby boomers retire and the female labor participation rate plateaus, increases in the workforce will no longer lift US growth as they once did. To continue to raise living standards, the United States needs to accelerate labor productivity growth by 34 percent—achieving a rate not seen since the 1960s.

Growth and competitiveness in the United States: The role of its multinational companies (June 2010)

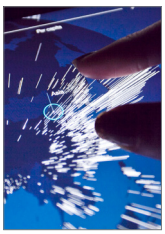
Although US multinationals include many of the biggest companies in the world, the full extent of their economic impact is less well known. MGI provides a fuller picture by assessing the contributions of multinational companies across the key metrics of economic performance, and explores the implications of global competition for multinational activity.

Infrastructure productivity: How to save $1 trillion a year (January 2013)

This report focuses on rethinking how to select, design, deliver, and manage infrastructure projects, and make more out of the infrastructure assets already in place. It draws on McKinsey & Company's work with governments and private-sector infrastructure players around the world to show that large gains in productivity are possible.

Big data: The next frontier for innovation, competition, and productivity (May 2011)

The amount of data in our world has been exploding, and the ability to analyze large data sets and glean new insights will become a key basis of competition, underpinning new waves of productivity growth, innovation, and consumer surplus—as long as the right policies and enablers are in place.



Urban world tablet app for iPad and Android (May 2013)

An unprecedented wave of urbanization is driving the most significant economic transformation in history, as the center of economic gravity shifts decisively east. MGI's new app offers an intuitive sense of this new urban world, showcasing GDP, population, and income levels for more than 2,600 cities worldwide in 2010 and 2025. The app is available for iPad, iPhone, and Android, from all major app stores.

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