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MAKING IT IN AMERICA: REVITALIZING US MANUFACTURING

NOVEMBER 2017



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MGI is led by three McKinsey & Company senior partners: Jacques Bughin, Jonathan Woetzel, and James Manyika, who also serves as the chairman of MGI. Michael Chui, Susan Lund, Anu Madgavkar, Sree Ramaswamy, and Jaana Remes are MGI partners, and Jan Mischke and Jeongmin Seong are MGI senior fellows.

Project teams are led by the MGI partners and a group of senior fellows, and include consultants from McKinsey offices around the world. These teams draw on McKinsey's global network of partners and industry and management experts. Advice and input to MGI research are provided by the MGI Council, members of which are also involved in MGI's research. MGI council members are drawn from around the world and from various sectors and include Andrés Cadena, Sandrine Devillard, Richard Dobbs, Tarek Elmasry, Katy George, Rajat Gupta, Eric Hazan, Eric Labaye, Acha Leke, Scott Nyquist, Gary Pinkus, Sven Smit, Oliver Tonby, and Eckart Windhagen. In addition, leading economists, including Nobel laureates, act as research advisers to MGI research.

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PREFACE

It's a tale of two manufacturing sectors. While a handful of outlier industries are posting robust growth in real GDP, many others are eroding. The biggest US manufacturing firms are generating stronger returns than their global peers. But many of the small and midsize suppliers that account for most of the establishments and employment in the US industrial base are struggling—and as a result, they are unable to invest in new equipment and technologies that would boost productivity.

The decline of manufacturing activity and employment has been the biggest contributor driving down labor's share of US GDP. It has also delivered a hit to the nation's optimism. The losses are not solely the result of automation and globalization—and it is not inevitable that they will continue.

The United States could take advantage of rising demand and new Industry 4.0 technologies to revitalize its entire manufacturing sector. Many individual firms, federal agencies, and local governments have launched some promising but fragmented initiatives. Now the sector's future depends on turning what works into a more coordinated and large-scale effort, backed by a wave of investment and a long-term vision for competing in the future. The key priorities will be raising productivity in the nation's supplier base, broadening participation in exports, ramping up a national apprenticeship program, and making the long-term investment needed to upgrade plants and equipment for digital readiness. After two decades of decline, US manufacturing can rewrite the narrative. None of this will be easy—but it's worth remembering that the United States still accounts for nearly 20 percent of the world's manufacturing activity, and it can draw on many advantages to chart a course forward.

This report builds on a multiyear body of MGI work exploring the future of global manufacturing, the US economy, productivity, digital technologies, and inclusive growth. The research was led by James Manyika, an MGI director based in San Francisco; Sree Ramaswamy, an MGI partner based in Washington, DC; Gary Pinkus, the managing partner for McKinsey & Company in North America; Katy George, a McKinsey senior partner based in New Jersey; Jonathan Law, a McKinsey partner based in New York; and Tony Gambell, a McKinsey partner based in Chicago. The project team, led by Andrea Serafino, included Luis Campos, Mike Child, Nikhil George, Christian Gonzales, Karthik Khajana, Elle Kang, and Ankit Mishra. Lisa Renaud served as senior editor. We acknowledge our colleagues Tim Beacom, Marisa Carder, Joana Carreiro, Deadra Henderson, Richard Johnson, Lauren Meling, Julie Philpot, Rebeca Robboy, Rachel Schaff, Margo Shimasaki, Vivien Singer, and Ana Laura Sobalbarro for their invaluable support.

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of Commerce; Jeff Connelly, former vice president of supply chain at GE Power; Jason Miller, CEO of the Greater Washington Partnership and former deputy director of the National Economic Council; Barry Bosworth, Nicholas Montalbano, and Mark Muro of the Brookings Institution; Jessica Nicholson of the US Department of Commerce; Harry Holzer of Georgetown University; Joseph Sandor and Tobias Schoenherr, both of Michigan State University; and Monika Herk, Gad Levanon, Joe Minarik, and Brian Schaitkin of the Conference Board.

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

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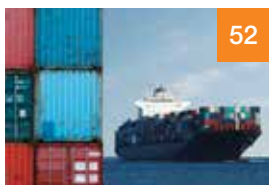
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IN BRIEF

MAKING IT IN AMERICA

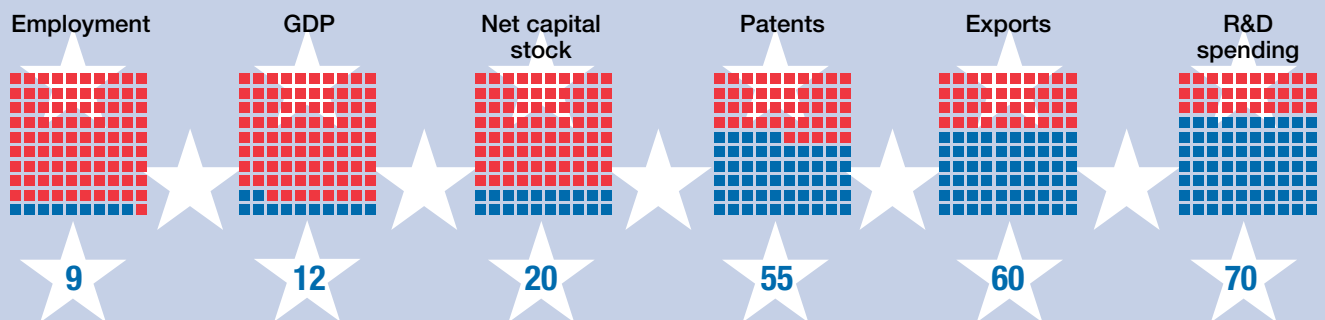
In the past two decades, output growth in US manufacturing has been concentrated in only a few industries, including pharmaceuticals, electronics, and aerospace. Most other manufacturing industries have experienced slower growth or real declines in value added. While small and midsize US manufacturers have borne the brunt of these trends, the largest firms have managed to thrive. However, the lack of a healthy domestic base of small firms exposes larger firms to global supply chain risk and limits their agility and innovation. More broadly, the decline of manufacturing has diminished prospects for the US middle class, contributing two-thirds of the fall in labor's share of US GDP.

- Despite the loss of global market share over two decades, manufacturing continues to punch above its weight, especially in the 500 counties where it is still the main economic activity. Manufacturing makes up 9 percent of employment and 12 percent of US GDP but drives 35 percent of productivity growth, 60 percent of exports, and 70 percent of private-sector R&D. The United States remains the world's second-largest manufacturing nation, and its industrial diversity is unmatched among advanced economies. The nation can build on long-standing advantages—including a lucrative domestic market, human capital, and robust technology and innovation capabilities—to regroup.
- MGI finds that the United States could build on its strengths to boost manufacturing value added by up to 20 percent over current trends by 2025. Global demand is rising, and value chains are evolving to US advantage, particularly for firms in advanced industries and their suppliers. **As value shifts from production to R&D, design, and services, new business models are becoming possible.** Favorable changes in relative labor and energy costs provide a tailwind. To capitalize, US manufacturers will be challenged to offer greater product variety and accelerate cycle times as markets grow more fragmented.
- As data, connectivity, and smart machines merge the digital and physical worlds, technology is creating avenues for US manufacturers to improve their productivity, agility, and competitiveness. **New design tools can improve speed to market, creating rapid prototypes and simulations to validate processes before build-out.** Internet of things sensors can combine with analytics and advanced robots to run flexible, autonomous factory operations. Digital threads can connect firms with suppliers and customers, improving coordination and turning data-driven insights into new revenue.
- Capturing these opportunities will not be easy. The manufacturing sector needs new capabilities and investment, and more firms need to participate in exports in order to bring the benefits of global trade to more US workers. Aging plants and equipment, especially in the supply chains of advanced industries, will have to be upgraded for digital readiness. The sector requires new digital and technical skills from its workforce, and US-based manufacturers need to be as attractive to high-caliber talent as their foreign competitors.
- Today, individual firms and local governments spend millions of dollars annually on isolated initiatives. Taxpayer incentives go toward attracting or retaining a single firm or production facility, effectively picking winners and losers while the pie shrinks. But revitalizing the entire sector will take coordinated action and long-term investment on a much bigger scale. A national apprenticeship program, for instance, could cost \$40 billion annually. Upgrading the capital base would take an additional \$115 billion annually over the next decade.

A successful revitalization will not restore 1960s-style mass employment on assembly lines. But it can raise manufacturing GDP by more than \$500 billion annually above the current trend, spurring income growth, new jobs, local investment, and ripple effects across other industries. The decline of US manufacturing is not solely the result of technology and globalization—and it is not inevitable. The United States can make policy and investment decisions to change the current trajectory. But this effort has to be focused on competing in the future rather than re-creating the past.

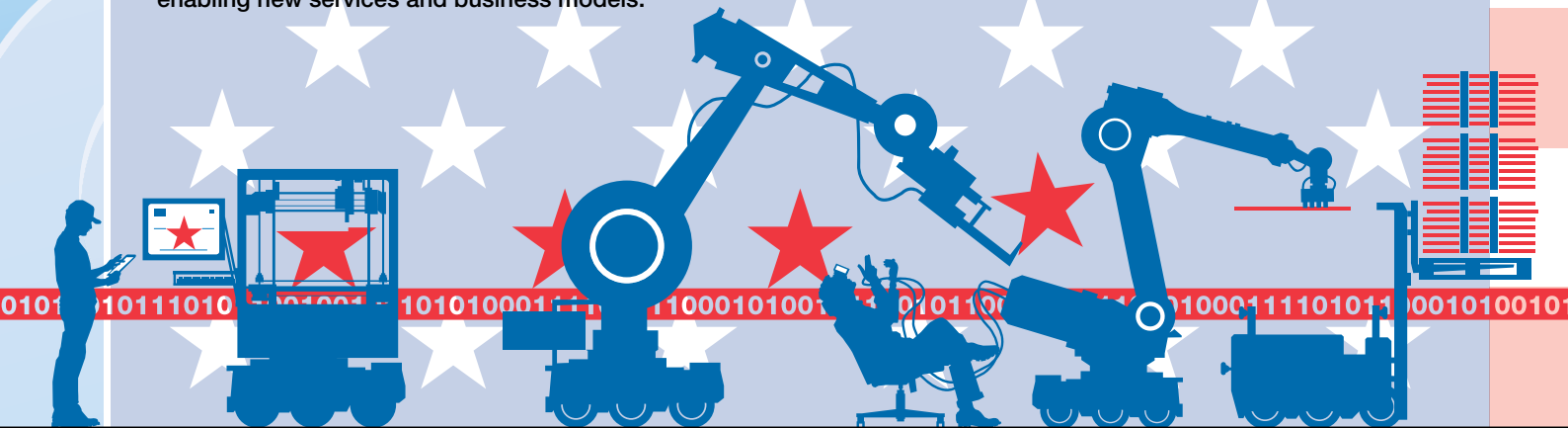
Revitalizing US manufacturing

Manufacturing plays an outsized role in national competitiveness Manufacturing as % of US total, 2016 or latest



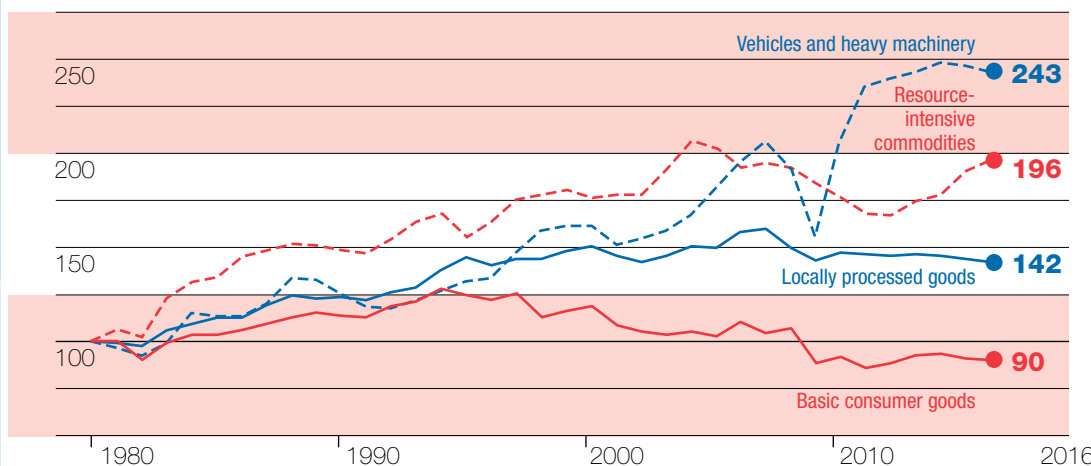
The future of production is digital

As global demand rises and fragments, manufacturers need agility—and technologies such as **analytics**, the **Internet of Things**, advanced **robotics**, and **3-D printing** can provide it. Optimized, autonomous factories will connect with supplier networks in a fully digitized and tightly integrated value chain. Real-time data will run from product design through customer usage, enabling new services and business models.



Real value added is at 10- to 20-year lows for a range of US manufacturing industries¹

Index: 100 = 1980



Compound annual growth rate

%

2.6	2.6	1.8
1.1	0.7	0.1
0.5	-0.4	-1.3
-0.9	-1.7	-1.6
1990–2016	2000–2016	2007–2016

¹ Chart does not include technology-driven products (e.g., pharma and computers), where value added has increased by 6.6x in nominal terms since 1980.

Key priorities to help US manufacturing regain its competitive edge

- Stimulate** long-term investment
- Revitalize** domestic supply base
- Increase** workforce training
- Encourage** more firms to export



EXECUTIVE SUMMARY

Many Americans long for a return to the glory days of the 1960s and '70s, when manufacturing jobs were the bedrock of the middle class and the United States led the world in industrial output. But evaluating the state of US manufacturing is a matter of perspective. Viewed another way, a sector that has suffered a decline over two decades still generated \$2.2 trillion in nominal value added in 2015—a figure larger than the entire GDP of Italy, Brazil, Canada, South Korea, or Russia.¹

US manufacturing is not what it was a generation ago. Its contraction has been felt by firms, suppliers, workers, and entire communities. Today the prevailing narrative says that nothing can be done to stop its ongoing decline at the hands of globalization and technology. But continued losses are not a foregone conclusion. The United States can make policy choices and investment decisions to change the current trajectory. This is not about protecting the status quo or restoring what has been lost. It is about how to compete in the future.

The decade ahead will reshape global manufacturing as demand grows, technology unlocks productivity gains, and companies find opportunities in new parts of the value chain. But manufacturers will have to navigate increasingly fragmented markets and accelerating product cycles. Industry 4.0 technologies promise new levels of efficiency on the factory floor as well as more seamless interactions with suppliers and customers, but implementing these systems will require plant upgrades and new ways of working alongside machines.

All of this gives the United States an opening to revitalize its manufacturing sector. After combining demand projections with an analysis of specific industry trends and historic performance, MGI finds that the United States could boost annual manufacturing value added by more than \$500 billion (20 percent) over current trends by 2025.

In some industries, US multinationals are capturing value by focusing on the technologies, designs, brands, and marketing strategies behind products but actually making them elsewhere. This, too, may seem to be an inevitable trend—and it is unlikely to be reversed in highly tradable and commoditized product categories. But it is worth fighting to retain a healthy production base, which is closely linked to the nation's ability to bring new innovations to market. The erosion of manufacturing has been a major factor driving down labor's share of national income and hollowing out local economies. No other sector fills manufacturing's traditional role in providing middle-income jobs across a wide swath of the country.

Turning things around will take more than isolated efforts. It calls for deeper industry cooperation and a new level of coordination and scale. Building a stronger ecosystem of innovative, digital-ready small and midsize manufacturers would give the entire sector a shot in the arm. Large firms have a stake in this, since access to a thriving domestic supplier

¹ The manufacturing sector refers to the broad part of the economy made up of establishments that turn raw materials into processed goods sold as intermediate or final products. We rely on the federal government's North American Industry Classification System (NAICS), which defines establishments based on their primary activity, focusing on industries in NAICS codes 31 to 33. Economic statistics regarding sector output, value added, employment, and establishments generally take companies' "upstream" activities (such as R&D, software, and product design) into account, although they do not include downstream activities such as transportation, sales, and distribution.

500

US counties
in which
manufacturing
is still the primary
sector

base can help them improve speed to market and product quality while mitigating risks associated with trade-, currency-, and supplier-related disruptions.

Although it has been gradually shrinking as a share of GDP and losing its role as a major engine of employment, manufacturing still matters. It drives 35 percent of the nation's productivity growth, 60 percent of its exports, and 70 percent of private-sector R&D spending. It is the primary sector in 500 counties from coast to coast and a magnet for foreign direct investment. Above all, manufacturing reflects US innovation, ingenuity, and technical prowess. The United States cannot afford to look backward when the sector needs to keep evolving.

US MANUFACTURING HAS EXPERIENCED TWO “LOST DECADES”

After a surge of growth in the late 1990s, the US manufacturing sector has experienced two decades of erosion in many industries—and the losses accelerated sharply when demand collapsed during the Great Recession. Some industries staged a modest demand-driven recovery between 2010 and 2015. But growth in overall US manufacturing output has been slowing for two decades, with little net increase during the most recent decade.

Manufacturing firms have responded to a tougher operating environment by cutting costs, whether that meant offshoring work, squeezing suppliers, reducing wages and benefits—or going out of business altogether. Today there are roughly 25 percent fewer US manufacturing firms and plants than there were in 1997, reflecting not only closures but also fewer manufacturing startups. Along the way, the sector has shed roughly one-third of its jobs. A recent study found that the wage premium traditionally associated with manufacturing has evaporated.²

The decline played out unevenly

The trends of the past two decades were not uniform across all parts of manufacturing, the broad swath of the economy that turns raw materials into processed goods, whether sold as intermediate or final products. The sector encompasses a remarkably diverse set of industries and the companies that operate within them—including not only their production activities, but most of their upstream activities such as R&D, design, and software as well. Their degree of resilience has been a mixed bag. It is helpful to examine these patterns across five distinct industry segments that vary widely in technological sophistication, labor intensity, R&D, inputs, costs, and markets (Exhibit E1).

Industries specializing in tech-driven innovative products have managed to buck the decline and post strong growth in value added since the 1990s, but most of this value derives from research, design, and intellectual property. Companies have found it profitable to retain functions such as R&D, product development, and marketing in the United States while offshoring actual production activities.

In other industries, the loss of production has been a symptom of deeper distress affecting entire companies and entire vertical industries. No one factor single-handedly explains the decline; firms were often buffeted by multiple forces. After losing market power to distributors and retailers, US makers of basic consumer goods were replaced in the supply chain by low-cost contract manufacturers in locations such as Mexico, China, Vietnam, and Bangladesh. Weak consumer demand, low public investment, and an unfavorable exchange rate slowed demand growth for US-made vehicles, heavy machinery, and locally processed goods, in turn affecting suppliers of fabricated metal, rubber, and plastic products. A commodity boom also drove input costs higher for these suppliers and resource-intensive manufacturers.

² Marc Levinson, *Job creation in the manufacturing revival*, Congressional Research Service, May 2017.

Exhibit E1

US manufacturing includes five varied industry groups, all of which have contracted in some way over the past two decades

- Share of US manufacturing value added, 2016 (%)
- Share of US manufacturing employment, 2016 (%)

Industry group	Change since peak %			Example industries	Relative importance of inputs ¹					
	Value added	Employment	Estab-lish-ments		R&D	Labor	Capital	Energy	Freight	Trade
Basic consumer goods 4 (Value added), 7 (Employment)	-29	-68	-45	Apparel, leather products	Low	High	Low	Low-Medium	Low-Medium	High
				Appliances, electrical equipment	Low	High	Low	Low-Medium	Low-Medium	High
Tech-driven innovative products 23 (Value added), 11 (Employment)	At peak	-37	-8	Pharmaceuticals, medical devices	High	Low	Low	Low	Low	Low
				Computers, electronics	High	Low	Low	Low	Low	High
Vehicles and heavy machinery 23 (Value added), 23 (Employment)	-2	-25	-15	Machinery, machine tools	Low-Medium	High	High	Low	Low	Low
				Motor vehicles and parts	Low-Medium	High	High	Low	Low	Low
				Aircraft and components	Low-Medium	High	High	Low	Low	Low
				Other transportation equipment	Low-Medium	High	High	Low	Low	Low
Locally processed goods 29 (Value added), 43 (Employment)	-11	-21	-14	Fabricated metal products	Low	High	Low	Low	Low	Low
				Rubber and plastic products	Low	High	Low	Low	Low	Low
				Specialty and household chemicals	Low	High	Low	Low	Low	Low
				Food and beverage products	Low	High	Low	Low	High	Low
Resource-intensive commodities 21 (Value added), 16 (Employment)	-5	-36	-15	Wood and paper products	Low	High	High	High	High	Low
				Petrochemicals, coke products	Low	High	High	High	High	Low
				Other non-metallic minerals	Low	High	High	High	High	Low
				Basic metals	Low	High	High	High	High	Low

1 The following metrics are used to calculate the intensity of each indicator relative to its value added: R&D spend for R&D intensity; payroll costs for labor intensity; capital expenditure for capital intensity; fuel and electricity costs for energy intensity; inverse of dollar value per pound of shipment for freight intensity; exports plus imports for trade intensity.

SOURCE: OECD; WTO; BEA; Moody's; BLS; US Census Bureau; McKinsey Global Institute analysis

After posting brisk gains in the 1990s, US manufacturing has experienced slower growth in value added over the past two decades. Today it is no higher than it was a decade ago in aggregate, with the slowdown affecting most manufacturing industries (Exhibit E2).

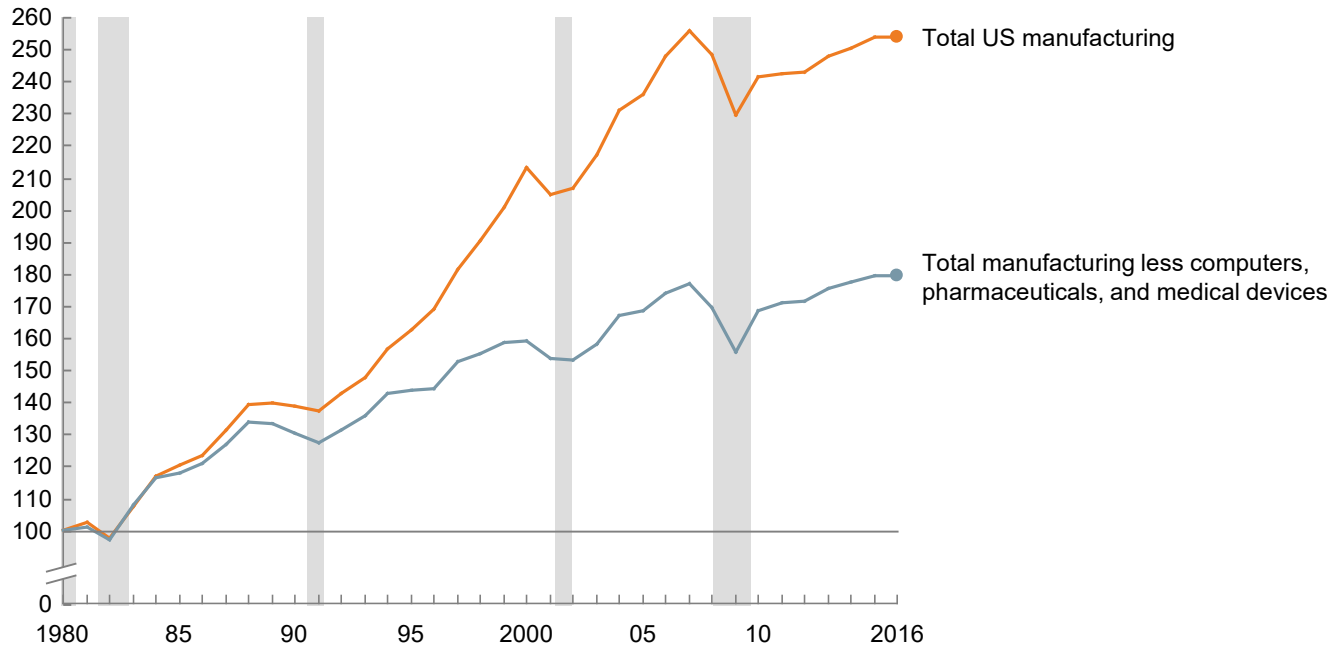
Exhibit E2

Real value added in US manufacturing is no higher today than it was a decade ago

■ Recession

The sector's real value added is sharply lower when tech products, pharmaceuticals, and medical devices are excluded

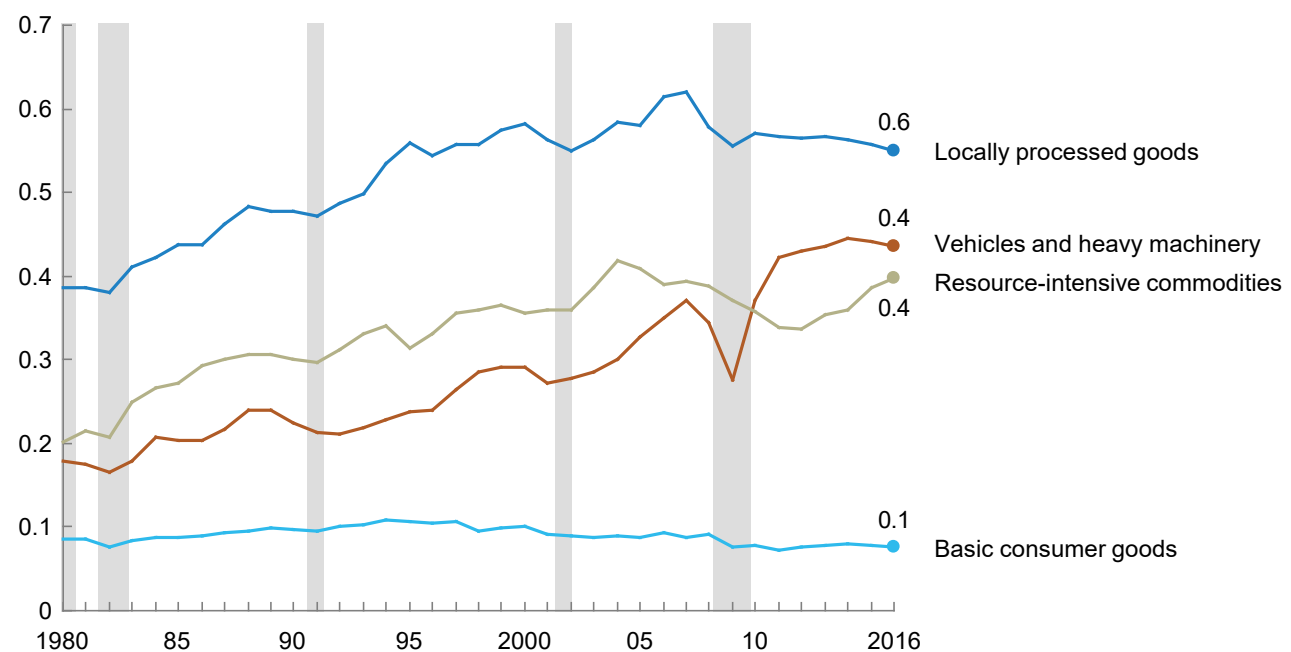
Index: 100 = 1980



Absolute values ¹ 2009 \$ trillion	1.6	1.8	1.8	1.9
	1.3	1.4	1.4	1.5

Some segments have posted real declines over 15–20 years

2009 \$ trillion



1 Absolute values prior to 2000 are not displayed due to distortions in the available data.

SOURCE: BEA; Moody's; McKinsey Global Institute analysis

MGI's analysis shows that only the largest US manufacturers have weathered the past two decades well. Since 1990, manufacturing firms with more than \$1 billion in assets have grown domestic revenues by more than 2 percent annually—twice as fast as the sector overall—while small and midsize firms have posted negative growth. Even as they have dominated revenue growth, the largest manufacturers have achieved 40 percent higher returns on capital than smaller firms, boosted by higher profit margins and capital turnover. The out-performance of the largest US firms, most of them multinationals, extends to their global operations as well. Among publicly listed global manufacturing firms, large US-based manufacturers enjoy returns on capital exceeding 20 percent, much higher than their European and Asian peers.

The strains facing larger firms, including global competition and shareholder expectations, are often transmitted through the supply chain in the form of pricing pressures and higher working capital costs. Many have increased their reliance on cheaper imported components. Among highly tradable segments such as technology-driven products and basic consumer goods, US domestic content has fallen by 13 to 15 percentage points since 2000. The locally processed goods segment relies more heavily on domestic suppliers than any other part of the sector, but even here, the share of domestic content in final goods declined by eight percentage points from 2000 to 2015.

Since most US-based manufacturing firms are small businesses with fewer than 100 employees, and supply chains account for most of the costs of finished goods, the struggles of small firms have a wide-ranging impact on the sector's health. Significant productivity gaps have opened up between large firms and small and midsize producers that are unable to invest in new equipment and technologies.

In recent decades, the sector has also developed a two-tiered workforce, with jobs in the bottom tier steadily deteriorating in quality. Since 1990, real wages for production workers have risen by only 0.1 percent annually for the sector as a whole. In some distressed industries, real wages have actually declined. One government report estimates that there are about 1.2 million temporary workers in manufacturing.³ Half of these temporary workers, and one-third of all manufacturing production workers, rely on food stamps or other federal assistance programs to make ends meet.⁴

Declining employment and wage stagnation in manufacturing have weakened the health of many local economies. Eighty percent of manufacturing counties have posted weaker income growth or higher unemployment than the national average, even during the recent manufacturing recovery. This is a striking reversal from previous decades, when manufacturing counties had a thriving middle class and lower levels of income inequality. The sector has contributed two-thirds of the recent overall decline in labor's share of national GDP (Exhibit E3).

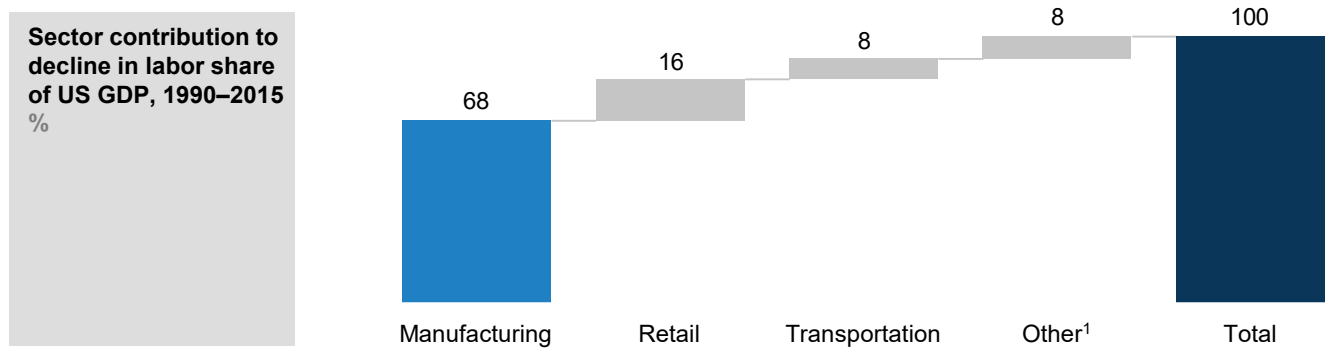
0.1%
real annual wage
growth for
manufacturing
production workers
since 1990

³ *Manufacturers' outsourcing to temporary help services: A research update*, US Bureau of Labor Statistics working paper 493, January 2017.

⁴ Ken Jacobs et al., *Producing poverty: The public cost of low-wage production jobs in manufacturing*, UC Berkeley Center for Labor Research and Education, May 2016.

Exhibit E3

Manufacturing has contributed approximately two-thirds of the decline in labor’s share of US GDP



Contribution of drivers in the decline in labor share of total value added (%)

Decline of labor share within sector's value added	45	81	67	11
Decline of sector's value added of total economy	55	19	33	89

¹ Primarily construction, utilities, agriculture, and mining.
NOTE: Numbers may not sum due to rounding. Not to scale.

SOURCE: OECD, McKinsey Global Institute analysis

This story began unfolding in other advanced economies before it hit the United States

The world experienced a great rebalancing of global manufacturing and supply chain activity as a huge amount of low-cost capacity came online—not only in China but also across South and Southeast Asia, Eastern Europe, and Latin America. Competition has intensified as emerging-market companies expand globally, using massive scale to reinforce an already-large cost advantage in some industries. Many of them prioritize rapid revenue growth over profit margin. In industries such as metals, building materials, and machinery, their presence has created overcapacity and commoditized production. Incumbents in advanced economies are being forced to consider whether they want to play in these markets where revenue and margin growth are declining. Some have not survived.

The United States is not alone in coming to grips with these trends. Manufacturing value added began to stagnate or erode in France, Germany, Italy, Japan, and the United Kingdom in the late 1980s and through the 1990s. In many industries, the loss of value added was a reflection of domestic economic conditions that constrained public investment and consumer demand.

In contrast to these countries, the United States posted a surge of manufacturing growth in the 1990s. But since the late 1990s, it has experienced a slowdown in output and value added (outside of computers, pharmaceuticals, and medical devices). Today manufacturing accounts for a significantly larger share of employment and GDP in Germany, Italy, and Japan than in the United States.

Among large, advanced economies, only Germany has managed to reverse the decline. German manufacturing value added has increased by 38 percent since 1999, and it resumed strong growth after the Great Recession. Labor reforms in the early 2000s to freeze wages, promote job-sharing, and expand worker training helped restrain costs while preserving talent. High-quality products and a competitive currency helped German firms of all sizes gain global market share, creating a large and growing trade surplus.

The US manufacturing sector's comeback from the recession was stronger than that of other advanced economies, with the notable exceptions of South Korea and Germany. However, even as large US firms expanded their output to meet a cyclical demand recovery in the domestic market, a weakening domestic supplier base and the strength of the US dollar led to a surge in imports. As a result, the United States has developed a large and rapidly growing trade deficit—even in the advanced industries where it should enjoy a natural competitive advantage. Only the United Kingdom has a similarly large trade deficit in these industries.

THE NEXT WAVE OF CHANGE PRESENTS MANUFACTURERS WITH NEW OPPORTUNITIES AND IMPERATIVES

The global manufacturing landscape is evolving rapidly, and the companies and countries that adapt to these changes quickly and effectively can realize major opportunities. Three key trends stand out: rising demand, the convergence of multiple new technologies, and shifting global value chains.

Demand is rising—and fragmenting

One fundamental advantage for US manufacturing remains unchanged: the United States remains one of the most lucrative markets in the world. While US consumer demand may be muted by lackluster income growth, access to the US market remains a powerful lure for domestic and foreign manufacturers alike. US demand for heavy machinery, equipment, and building materials could also increase if public investment revives from its 50-year lows.

But the US market is not the same familiar ground it was in the past. The uneven nature of regional income growth translates into wide market variations. US consumers are more ethnically and culturally diverse and more tech-savvy than in the past—and they have high expectations for quality, low prices, and variety. One global food manufacturer reports that the stock keeping unit (SKU) count of its North American business unit rose by 66 percent in just three years.

Beyond the domestic market, demand is soaring in emerging economies around the world, and it will continue to do so. Over the next decade, another one billion urban residents are expected to begin earning enough discretionary income to make significant purchases of goods and services. **By 2025, McKinsey has estimated that consumption in emerging markets will hit \$30 trillion, up from \$12 trillion in 2010.⁵**

⁵ *Winning the \$30 trillion decathlon: Going for gold in emerging markets*, McKinsey & Company, August 2012.

Tapping into demand growth in emerging economies requires knowing exactly where and how to compete. Markets such as China, India, Brazil, and Africa represent an enormous prize, but they have dizzying regional, ethnic, linguistic, and income diversity. There is no one-size-fits-all “China strategy,” for instance; it is more accurate to think of China as dozens of individual markets. Beyond the megacities, the most dramatic growth in the decades ahead is set to happen in more than 400 lesser-known midtier cities around the world.⁶

All of this means that manufacturers must navigate greater complexity than ever before. **They are being challenged to produce a wider range of product models with differing features, price points, and marketing approaches.** From fast fashion to new car models, products now have shorter life cycles, and customers are beginning to demand more choice and customization. Many firms are responding to fragmentation by focusing only on markets where they can realize scale efficiencies. This is opening up niche markets to smaller producers.

Industry 4.0 technologies are beginning to transform manufacturing

The US manufacturing sector needs an injection of productivity, and companies cannot capture the demand opportunities described above unless they step up their game. New technologies will play a large role in determining whether they can compete.

Today multiple technology advances are converging. This new wave, referred to as “Industry 4.0,” is driven by an explosion in the volume of available data, developments in analytics and machine learning, new forms of human-machine interaction (such as touch interfaces and augmented-reality systems), and the ability to transmit digital instructions to the physical world.⁷ Such complementary technologies can be transformative when applied in industrial settings. They can run smart, cost-efficient, and automated plants that produce large volumes. Conversely, they can also underpin customer-centric plants that turn out highly customized products—or even low-capex “factory-in-a-box” operations for rapid response to remote or niche markets.

These technologies touch on every aspect of manufacturing (Exhibit E4). New design and simulation tools can create “digital twins” of physical products and production processes, validating product designs and using virtual simulations to iron out the production process before it goes live. **One aircraft manufacturer that implemented a rapid simulation platform has reduced design time, cut design rework by 20 percent, and boosted engineering productivity.** Internet of things (IoT) sensors can feed real-time data into analytics systems, which can adjust machinery remotely to minimize defects, improve yield, and reduce downtime and waste.⁸ Collaborative robots can handle dangerous tasks and eliminate safety risks, while 3-D printing can now produce intricate, multimaterial components and final goods. Beyond the factory floor, new applications for coordinating distributed supplier networks improve the flow and tracking of raw materials and manufactured parts.

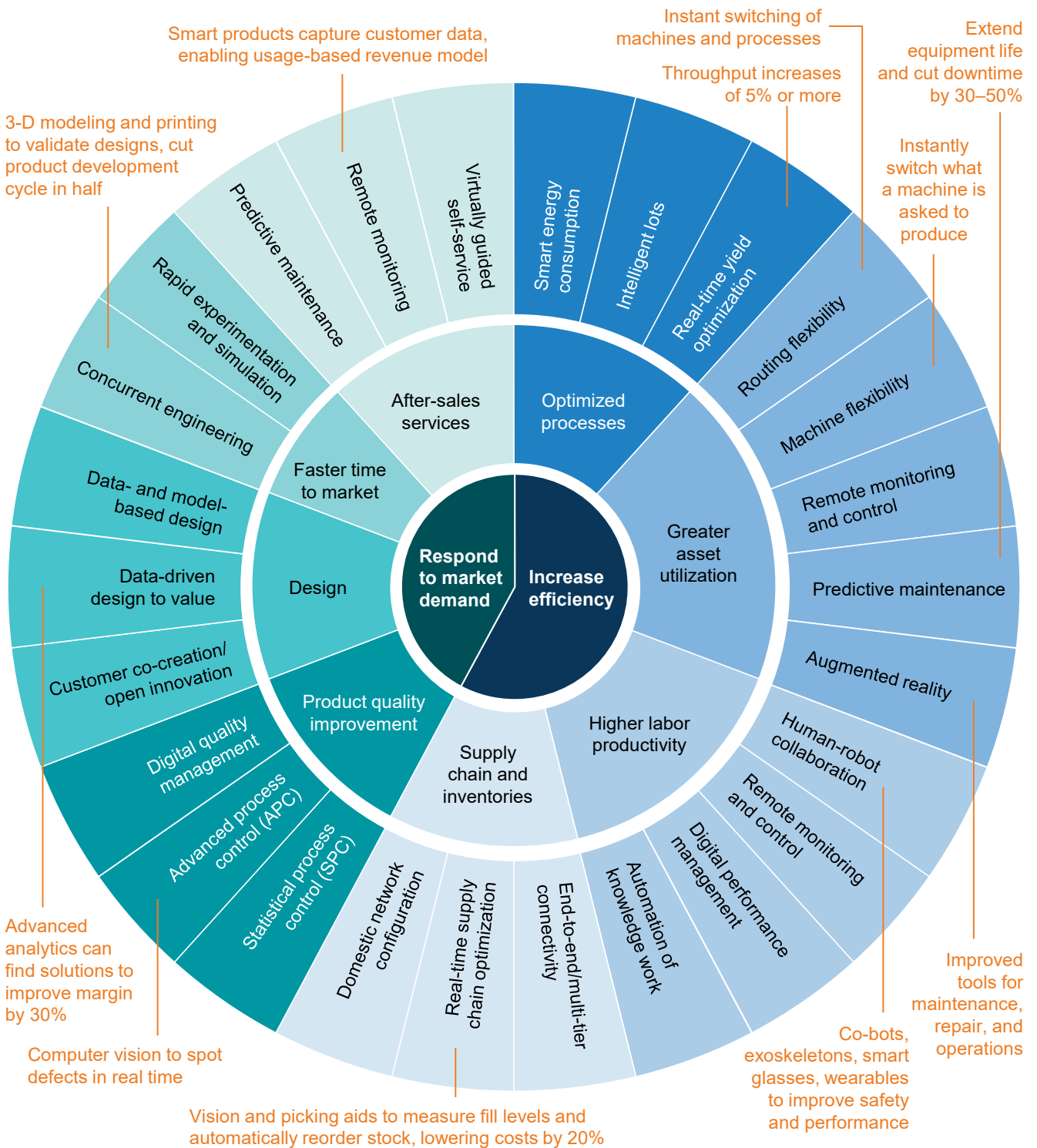
Manufacturing involves market research, demand forecasting, product development, distribution, and services—activities that may take place in multiple locations or involve outside providers. Companies will soon be able to connect their entire value chain, including customers, with a seamless flow of data. This “digital thread” may lead to new sources of productivity and revenue.

⁶ *Urban world: Cities and the rise of the consuming class*, McKinsey Global Institute, June 2012.

⁷ For more on this new era of technology, see *The great re-make: Manufacturing for modern times*, McKinsey & Company, June 2017.

⁸ See *The Internet of Things: Mapping the value beyond the hype*, McKinsey Global Institute, June 2015.

Manufacturers can use Industry 4.0 technologies to boost efficiency and respond to new market opportunities



SOURCE: Digital McKinsey; McKinsey Global Institute analysis

Value chains are evolving, creating opportunities for companies to rethink business models, footprint decisions, and sourcing

Manufacturers are finding ways to capture value beyond traditional production activities—whether upstream in design and product development or downstream in services. Aerospace firms, for instance, provide both pre- and post-sales services to their customers, including financing, risk sharing, training, and maintenance. Some now provide leased aviation services, including pilots, aerial refueling, and “power by the hour.” John Deere has added sensors to the farm machinery it sells. The data it captures enable the company to offer farmers new types of user-sourced, real-time information on planting, soil health, and other best practices. Nvidia, a maker of graphics processing units and chips, has established a developer platform, increasing the sales and reach of its core products.

Input costs are also changing. The gap between labor costs in the United States and overseas has narrowed, while the cost of industrial robots continues to fall. These trends have led some manufacturers to return production to the United States, albeit in more automated form. Finally, the dramatic increase in US shale energy production provides ongoing assurance of low natural gas costs for US-based plants, and it has made cost-effective raw inputs available to US producers of refined petroleum products, petrochemicals, and fertilizers. All of these factors make the business case for US firms to offshore production look less compelling and enhance the attractiveness of the United States as a destination for foreign direct investment (FDI).

Labor costs will continue to be paramount for low-margin and tradable products, but companies in many industries are reassessing the downsides of offshoring and lengthy supply chains. More companies are making footprint decisions using a “total factor performance” approach that considers logistics costs, lead time, productivity, risk, and proximity to suppliers, innovation partners, final demand, and other company operations. Even US firms that have already established operations in key emerging markets can consider sourcing more components from home-country suppliers.

Taking full advantage of these opportunities could boost real value added in manufacturing by more than \$500 billion annually

Translating the trends described above into opportunities, MGI has created three scenarios for 2025. They combine consumption forecasts with industry-by-industry analysis that considers the probability and potential impact of progressively higher technology adoption, export growth, and share of domestic content in finished goods.⁹ We focus on this last variable because finished goods derive much of their value from supplier inputs and because the deterioration of the US supplier base has been one of the major factors weakening the entire sector in recent decades.¹⁰ We also reconcile these industry-by-industry estimates with previous MGI analyses of the likely impact of the shale boom, big data, analytics, and the internet of things on the US manufacturing sector.

Real value added in US manufacturing stood at \$2.2 trillion in 2015.¹¹ In the “current trend” scenario, we assume that the share of domestically produced content continues its trajectory of decline across most industries. Even in this case, manufacturing GDP would increase over the next decade by \$350 billion in real terms. This can be attributed to rising demand that lifts output across all industries, plus new output from petrochemical, fertilizer, and energy processing plants coming online in the next decade.

⁹ In order to estimate domestic content of finished goods, we adopt a methodology developed by the US Department of Commerce. More details are provided in the technical appendix, available online.

¹⁰ We do not base our analysis on the global market share of US firms, since foreign-owned firms can and do conduct some of their production in the United States.

¹¹ All figures in this section are given in 2015 dollars.

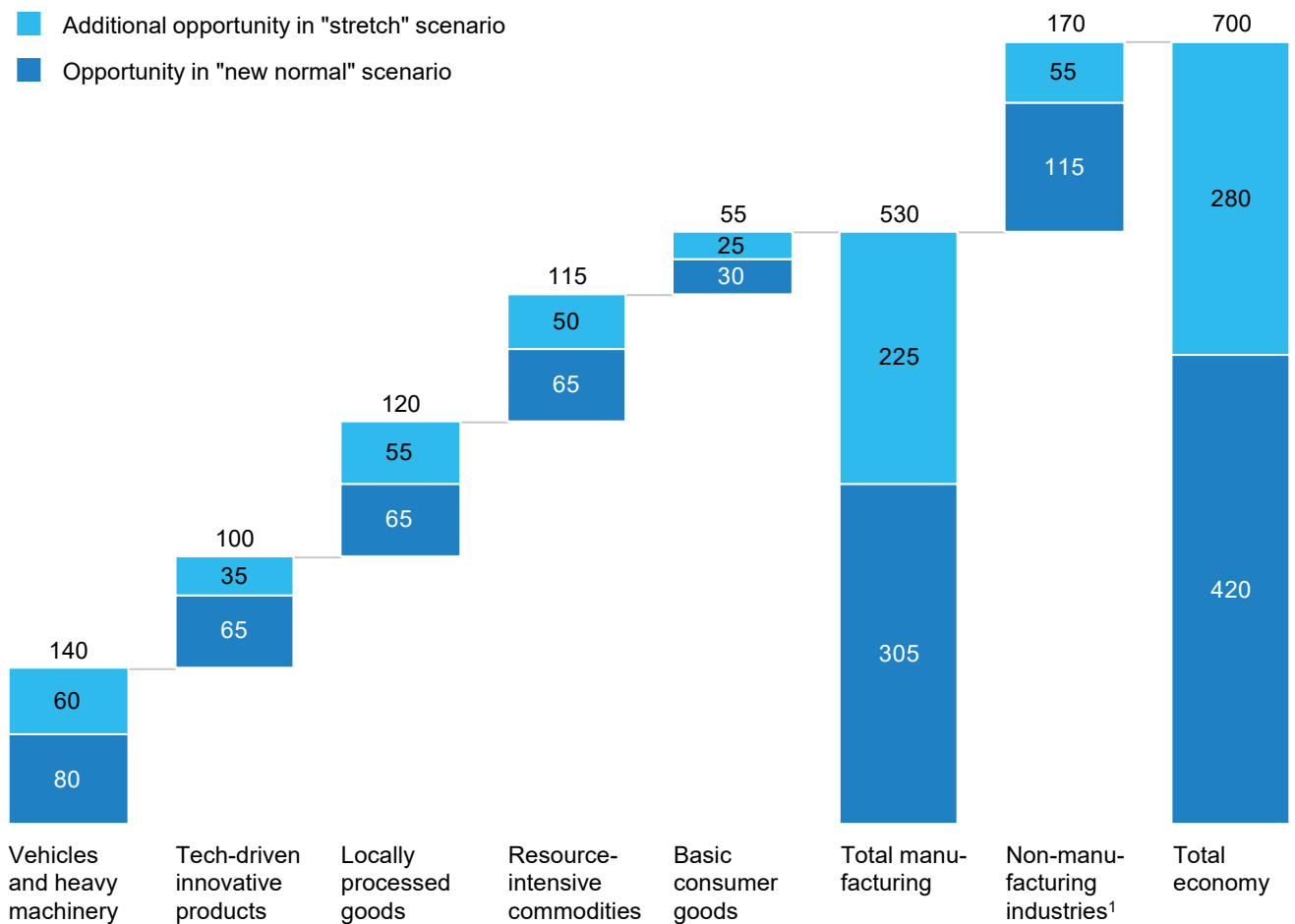
We also consider a “new normal” scenario in which the United States maintains the current level of domestic content in finished goods in most industries, arresting the decline. In this case, value added across the manufacturing sector would hit \$2.8 trillion by 2025, an increase of some \$300 billion over the current trend.

Finally, we consider a “stretch” scenario in which GDP in some industries returns to a recent peak (Exhibit E5). It is based on an analysis of global trends and each industry’s health in the United States; it also assumes greater technology diffusion and incorporates the higher-end projection for energy-intensive production output. By maximizing all of the opportunities, US manufacturing GDP would climb to \$3 trillion in 2025—a boost of \$530 billion, or 20 percent, above the current trend.

Exhibit E5

US manufacturing can boost value added by \$530 billion annually over baseline trends, potentially creating more than 2 million jobs

2025 value-added potential in US manufacturing and indirect effect on other sectors
 \$ billion (real, 2015) relative to baseline forecast



Potential increase in 2025 employment

Thousand jobs, relative to baseline forecast

390–665	130–200	490–880	160–260	200–365	1,370–2,370	675–960 ²	2,045–3,330
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1 Approximately 28% in professional and business services, 27% in mining and oil, 23% in wholesale, and the rest in other sectors.

2 Approximately 42% in professional and business services, 17% in wholesale, 15% in agriculture, 11% in transportation, and the rest in other sectors.

NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

The biggest upside potential is found in advanced manufacturing industries—areas in which the United States should have a competitive advantage but instead runs a large trade deficit. With Asian, European, and luxury carmakers gaining market share and domestic original equipment manufacturers (OEMs) sourcing more heavily from Mexico for SUVs and pickup trucks sold in the United States, imports have risen in recent years. But foreign carmakers are expanding some US production of both parts and finished cars—and since car production is already starting from a large base, an increase of even a small percentage adds significant value. Aerospace is another industry with significant potential. Its domestic production remains strong, global market growth is expected to be robust, and import competition remains relatively weak. Computer and electronics industries could also make a contribution, given that domestic content has stabilized recently and demand is expected to stay strong. By contrast, we find limited prospects for growth in industries such as basic consumer goods, where domestic production has already been hollowed out.

In addition to boosting its value added by \$530 billion, the manufacturing sector would add 2.4 million jobs on top of current trends by realizing the stretch scenario. Furthermore, the positive effects would ripple into services and other industries, potentially creating another \$170 billion of direct value added and almost one million jobs in industries that provide inputs to manufacturing. Adding together the manufacturing and upstream effects, the total potential benefit to the economy could be \$700 billion in additional annual value added and 3.3 million net new jobs.

US MANUFACTURING NEEDS TO SCALE UP EFFORTS ON MULTIPLE FRONTS TO COMPETE IN THE FUTURE

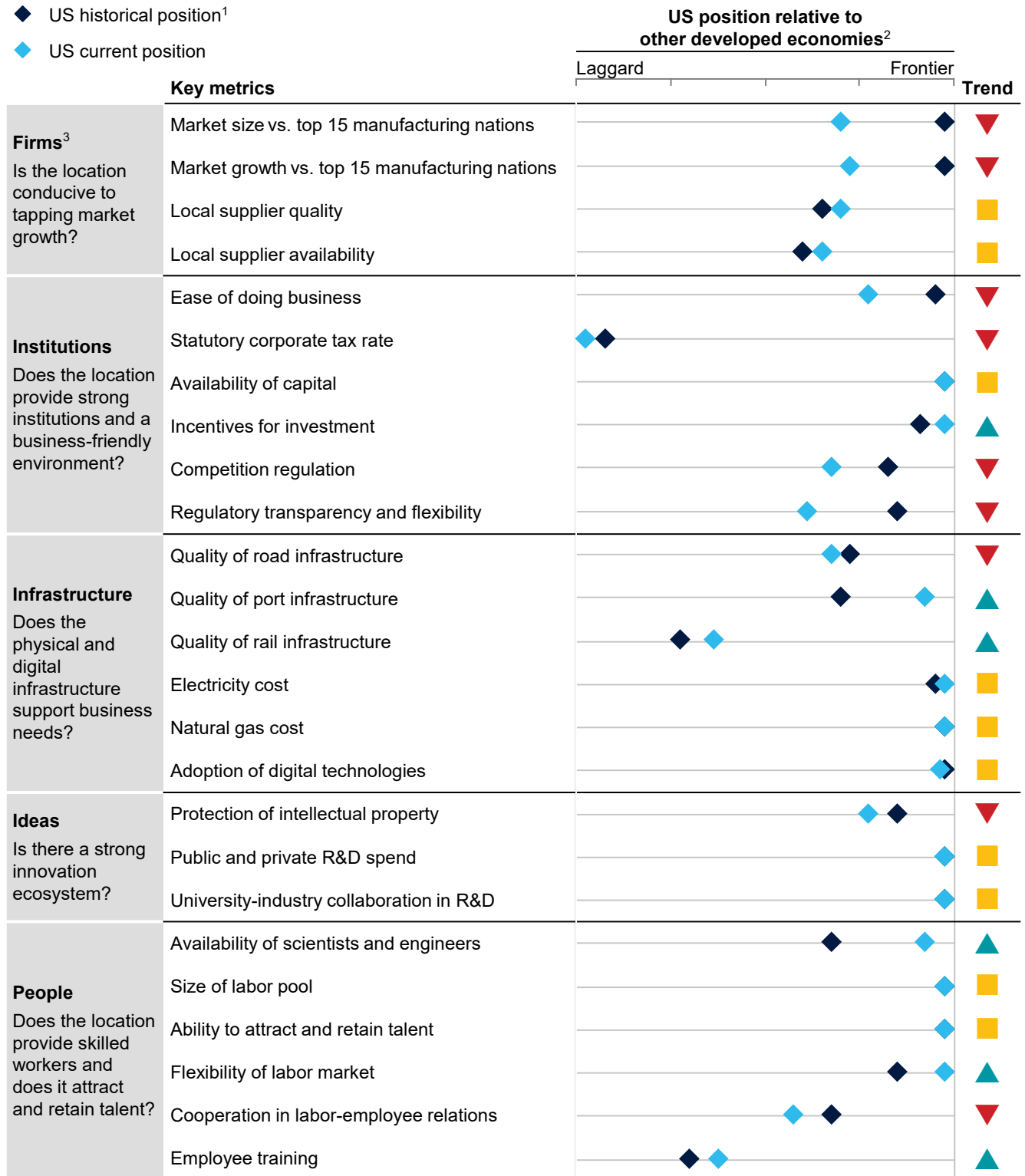
The opportunities outlined above are real and substantial, but the United States will have to make up lost ground. In many industries and counties, manufacturing plants and equipment are outdated, the workforce is aging, and firms are staying alive only by cutting costs and putting off investment. No one should underestimate the effort it will take to turn things around.

There are multiple issues to tackle. Business surveys over time reveal a growing perception that the United States has lost its edge against peer economies in some of the metrics that influence firms' location decisions (Exhibit E6). This is not always because US performance has deteriorated; in some cases it is because other countries have taken steps to improve. There are differences in the ability of firms to manage these factors. The effective corporate income tax rate for midsize US manufacturers, for instance, is 22 percent, while the rate for the largest firms is 17 percent. Although monetary and fiscal policy is beyond the scope of our research, a persistently overvalued US dollar and the higher statutory and effective tax rate appear to have made it more difficult for some US firms to compete—particularly those in the domestic supply base. This makes it all the more urgent to address other areas where private- and public-sector action could make a difference.

Exhibit E6

Business surveys and economic data identify opportunities to improve US competitiveness as a manufacturing location

- ◆ US historical position¹
- ◆ US current position



1 Historical position is 20 years ago for most metrics, with the exception of ease of doing business, statutory tax rate, supplier quality and availability, and infrastructure metrics, which refer to ten years ago.
 2 Other developed economies include those in the top 15 manufacturing nations: Canada, France, Germany, Italy, Japan, South Korea, and the United Kingdom.
 3 Comparison set is top 15 manufacturing countries by value added, which, in addition to the United States, include Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Korea, Taiwan, and the United Kingdom.

SOURCE: WEF; OECD; IMD; POLES data; EIA; IHS; McKinsey Global Institute analysis

Strengthen the US supplier base

An “everyone for themselves” ethos can cause strains in a sector that combines inputs from multiple firms. In contrast to the institutional support enjoyed by Germany’s *Mittelstand* (medium-size firms), small and midsize US manufacturers typically lack financial, technical, and business development help. The German approach may not translate into the US context, but there are ideas to extract from it about the value of greater coordination. The weakening of the domestic supplier base has left large US manufacturers more exposed to global supply-chain risk, especially to changes in trade terms or exchange rates.

Keeping suppliers at arm’s length affects the bottom line of large manufacturers. One McKinsey study found that inefficiencies in OEM-supplier interactions add up to roughly 5 percent of development, tooling, and product costs in the auto industry. These costs are significantly higher for US carmakers than for their Asian counterparts, and may accumulate with each tier of the supply chain.¹² Similar inefficiencies affect other industries as well, and they are likely to multiply as manufacturers seek to expand product portfolios and reduce turnaround times. Firms that work closely with their tier-one suppliers may have little visibility into their tier-two and -three suppliers, especially if they are overseas.

Over time, seeking out ever-lower bids from suppliers produces diminishing returns. Procurement can be a source of value rather than simply a place to cut costs, but this mindset requires large firms to change incentive structures among their own purchasing teams. Large firms can benefit from identifying which of their suppliers provide critical, high-value components; these may not be the largest suppliers. Instead of just monitoring them, large firms could solicit their ideas, invest in their capabilities, and build trust to create a preferred relationship. They could even design contracts with incentives for finding efficiencies or partner with suppliers to go after new opportunities, sharing both risk and reward. Beyond their current suppliers, large companies also need to be engaged in strengthening the entire base of smaller manufacturers. Having an ecosystem of reliable, top-quality suppliers close at hand provides agility when new market opportunities arise and resilience to macroeconomic risks such as trade or exchange-rate adjustments.¹³

Policy can play a role in modernizing smaller manufacturers through financing programs, business accelerators, or tax incentives. Singapore, for instance, has established a tax credit program for productivity and innovation that rewards firms for demonstrating efficiency gains from their investment. Canada funds “technology access centers” at colleges and universities so that firms have access to applied research and innovation, specialized technical assistance, and even worker training. The US federal government has established a Manufacturing Extension Partnership for small and medium-size firms, but it does not have the scale for maximum impact. Smaller firms need expanded access to advanced technology, whether at federal labs, universities, or public-private hubs.

Pursue growth through deeper global engagement

Emerging markets present crucial opportunities to win brand loyalty from huge new customer bases. But less than 1 percent of US companies sell abroad, a far lower share than in other large advanced economies. To capitalize, manufacturers first have to do their homework to learn what growth opportunities are out there, what these new customers want, and what local competitors are doing. Competing in these markets also involves managing more complex production footprints; finding the right distributors and retailers; and adapting to different regulatory regimes. Bringing domestic suppliers along to capture these export opportunities can help to mitigate some of the challenges and risks.

<1%
share of US firms
that export

¹² *Managing the OEM-supplier interface: Challenges and opportunities for the passenger car industry*, McKinsey & Company, 2007.

¹³ See Susan Helper, *Supply chains and equitable growth*, Washington Center for Equitable Growth, October 2016.

On the policy side, it will be critical to help more US companies of all sizes develop export capabilities. This can be part of a broader strategy to boost net exports and promote them abroad. Small and midsize US manufacturers need more mentorship and strategic guidance to understand the market opportunities at stake, and they lack the networking opportunities that their counterparts enjoy in many other advanced economies. They also need access to capital in order to handle the additional costs associated with exporting. But trade finance remains a major barrier for them; in fact, access to capital has generally been tighter for small and medium-size enterprises (SMEs) in the United States than in other OECD countries since the Great Recession.¹⁴

The United States cannot afford to pass up the growth opportunities associated with global trade, but it also needs to address the dislocations caused by trade shocks more effectively. Although Trade Adjustment Assistance was designed specifically to address trade-related displacement, it has had mixed success; investment in this program represents only a small fraction of the economic value created by trade deals.¹⁵

Foreign direct investment supported 2.4 million US manufacturing jobs in 2015, or 20 percent of the sector's total employment.¹⁶ But the United States can attract even more FDI, particularly from China and India, whose outbound investment cumulatively accounts for less than 1 percent of US inbound FDI in the past decade. Some individual state and local governments are already making a substantial push for more overseas investment; Tennessee is a notable success story. The federal government can play a bigger role in facilitating these matches and directing investment where it is most needed, as investment promotion agencies do in other countries around the world. Helping small firms participate in these initiatives could expand their access to capital for upgrades.

Improve digital adoption to boost productivity

The US manufacturing sector's relatively slow pace of digital adoption has been a drag on its productivity performance. Industry 4.0 can help companies up their game, and the stakes are higher than ever as the global marketplace grows more fragmented and fast-paced. The falling cost of robotics, analytics software, and other Industry 4.0 technologies is lowering barriers to their adoption, and early movers are already seeing results in terms of better demand forecasting, product design, inventory management, quality, and efficiency.

Nevertheless, a recent McKinsey survey of 400 manufacturers found that roughly half had no digital road map. Some may be hesitating because technology continues to evolve rapidly, but waiting to get started in the hopes of leapfrogging later on is a risky strategy. The intensity of industrial robot usage remains lower in the United States than in countries such as Germany, Japan, and South Korea. While US plants turning out vehicles and electronics are generally highly automated, robots have relatively little penetration in large US industries such as metals and food processing. Many other barriers hinder digital adoption, including technology readiness among lower-tier suppliers; interoperability issues across legacy plants, equipment, and firms in the supply chain; and concerns around data privacy, ownership, and security.

¹⁴ See *Bridging trade finance gaps: State-led innovations to bolster exporting by small and medium-sized firms*, Brookings Institution, January 2015; and *Entrepreneurship: Improving SME financing for stronger growth and job creation*, United States policy brief, OECD, April 2015 and April 2017.

¹⁵ See the US Government Accountability Office reports on trade adjustment assistance in 2001 (number GAO-01-998) and 2006 (number GAO-06-43). Also see Kara M. Reynolds and John S. Palatucci, "Does trade adjustment assistance make a difference?" *Contemporary Economic Policy*, volume 30, issue 1, January 2012.

¹⁶ *FDI in manufacturing: Advancing US competitiveness in a global economy*, SelectUSA, US Department of Commerce, 2017 release.

To capitalize on technology, companies have to start by capturing, integrating, and analyzing data flows from across their operations and ecosystems. Building the right structures for exchanging and safeguarding information is critical. Some machinery will have to be upgraded or replaced. More fundamentally, manufacturers will need to identify strategic use cases, link their digital initiatives to their broader business strategy, and consider how to begin working alongside machines in a more automated and data-driven environment. They will need to add technical talent and, equally important, “business translators” who combine digital fluency with deep manufacturing expertise.

Look for new ways to create value

Manufacturers need to revisit old assumptions about their business models. **More value is being generated today from design, data, solutions, and brands.** Changing factor costs, risks, and digitization make this an opportune moment for companies to reassess past location and sourcing decisions—and even their business models and balance sheets.

Capturing customer data enables manufacturers to add more types of after-sales services. Some companies are even shifting from selling machinery to offering use of their products as a service on a pay-by-usage or subscription model predicated on steady recurring services revenues rather than one-time sales. But this requires building new types of organizational capabilities and customer-facing teams. Even more ambitiously, other firms have found ways to secure “control points”—that is, platforms, strategic positions, or customer interfaces they can own to maximize advantages. Carmakers, for example, have a number of control points within vehicles themselves for capturing data about the customer experience—data that can form the basis of new revenue streams. Qualcomm has focused on driving standardization efforts for wireless technology—and since many of those standards are based on the company’s own products, it now derives a significant share of its business from licensing royalties. Another new type of business model would involve offering production capacity itself as a service. Xometry, a Maryland-based startup, has launched an “on-demand” digital marketplace with the intent of offering manufacturers a faster way to source custom parts.

Manufacturers may find that evaluating their current assets reveals untapped sources of potential value. Then they can look for ways to expand and secure customer relationships, taking advantage of any proprietary data they hold. They may find that there is value to be had outside of production activity itself. This is particularly true for manufacturers in advanced industries, whose B2B customers in infrastructure, transportation, health care, and other sectors are looking for ways to modernize their own business models and may be open to new types of arrangements.

Develop the manufacturing workforce of the future

Although debate surrounds the nature and drivers of the skills gap, many manufacturers, particularly in advanced industries, report difficulties filling open positions. The skills gap takes many forms. Some firms say they struggle to find entry-level candidates with basic math, reading, and soft skills. Others report challenges finding workers with the know-how to handle advanced machinery. Over the longer term, these issues seem likely to worsen. The manufacturing workforce is aging, and highly specialized skills will be lost to retirement. The median US worker in the aerospace supply chain, for instance, is 50 years old.

Tomorrow’s manufacturing jobs may have very different and more digital skill requirements. Education systems alone cannot be expected to solve all the potential mismatches beyond providing basic math and digital skills. Workforce apprenticeships will need to be a greater part of the solution. Apprenticeships that pay trainees while they learn on the job are widely available in countries such as Germany and Switzerland, and the model is finally gaining traction in the United States. Now these efforts need to happen on a much larger scale and with a system of established, transferable credentials that promote worker mobility across

\$40B

estimated annual cost of a national apprenticeship program

firms and industries. MGI estimates that ramping up a program to apprentice roughly one million workers might cost \$40 billion a year, but it would go a long way toward developing new workforce skills and creating new career paths.

Companies will also need to consider how to make manufacturing careers more attractive to the next generation. After decades of weak wage growth and underinvestment in skills, US manufacturers have a bigger challenge in attracting and retaining the best talent than their European and Asian competitors.

Think—and invest—for the long term

Faced with competitive headwinds, financial constraints, or shareholders driven by short-term expectations, US manufacturers have deferred investment and focused on cutting costs. Now many US plants have aging assets that need to be upgraded, particularly for digital readiness. The average US factory was 16 years old in 1980, but today it is 25 years old. Inside the plant, the average piece of equipment was seven years old in 1980 but is nine years old today. Production assets are even older in metals, machinery, and equipment manufacturing.

MGI estimates that upgrading the capital base would require \$115 billion in annual investment. There is urgency to get started. Many industries have long capex cycles; it can take years to build petrochemical processing plants or semiconductor factories. Companies that put off investing will not be positioned to capitalize when growth picks up. It will be critical for investors to give them enough breathing room to make big bets.

Multiple federal programs already exist, such as the Manufacturing Extension Partnership for small and medium-size firms and SelectUSA for attracting FDI. But these and other efforts generally have smaller budgets, less certainty of ongoing funding, and more constraints on their mandates than comparable programs in other countries. Policy makers should examine which existing initiatives are producing the most promising results, then scale up those efforts and commit to them for the long term.

Local policy makers, too, can fall into a short-term mindset. Announcing a brand-new manufacturing plant to their constituents is a political win, but it is too often accomplished by awarding poorly designed subsidies to individual companies without ensuring a sufficient return. The value of such subsidies is estimated to have tripled as a share of GDP since 1990.¹⁷ Yet we find little correlation among incentives, investment, and income growth. Most subsidies are geared to greenfield investment, but incentives for brownfield investment could help existing firms upgrade and stay productive. Overall, while subsidies are part of the tool kit, they are most effective when they are part of a solid and more holistic economic development plan targeting growth industries that complement a region's legacy strengths. Local regions have to sustain investment in workforce skills, infrastructure, institutions, and quality of life over the long haul.

...

It is not hard to find industry success stories and promising initiatives in US manufacturing, but isolated examples have not created broad momentum. Revitalizing the entire sector will require dramatically scaling up what works—and the task is too big for any single entity. Manufacturing needs supportive government programs and policies with long-term certainty and funding. It also needs regional coalitions with everyone at the table: large and small manufacturers, workers, technology experts, educators, public officials, and investors.

\$115B
estimated annual
investment needed
to upgrade the US
capital base

¹⁷ Timothy J. Bartik, "A new panel database on business incentives for economic development offered by state and local governments in the United States," prepared for the Pew Charitable Trusts, 2017.



1. US MANUFACTURING: WHY IT MATTERS AND WHERE IT STANDS

Many Americans view the manufacturing sector as a point of pride, a living symbol of the nation's blue-collar can-do spirit. But there is also a tendency to romanticize the sector's past rather than taking a clear-eyed view of where it stands today—and what it could be in the future as the nature of global manufacturing evolves.

20%

US share of global manufacturing activity

Although China claimed the mantle of the world's top manufacturing country in 2010, the United States still ranks second as measured by the dollar value of its annual output and by its global market share. In 2015, US value added in manufacturing reached \$2.2 trillion, more than 2.5 times higher than the total recorded by Japan and three times higher than that of Germany.¹⁸

At first glance, it appears that the sector's real value added has been climbing steadily. But a closer look reveals that this growth has been driven mostly by technology products and pharmaceuticals, masking a slowdown in other manufacturing industries (see Box 1, "Defining a sector that resists easy definition"). When these products are excluded, the growth rate in the rest of the sector over the past 20 years has slowed to half the pace of the 1990s—and growth has virtually dried up in the most recent decade. Some industries experienced actual declines.

There is no denying that US manufacturing has been through two rocky decades, absorbing losses that have taken a toll on workers, communities, and the nation's optimism. This is not just a story of textile manufacturing and electronics assembly migrating to low-wage countries. US companies have also lost market share to innovative firms from other advanced economies in more complex and tech-driven products such as machinery, automobiles, and electronics. On top of intensifying global competition, US manufacturers have faced muted consumer demand, weak public investment, a boom-then-bust commodity cycle, and the effects of a stronger US dollar.

Some pessimists view it as a foregone conclusion that US manufacturing will continue to shrink. While it may be true that the sector will not regain its former share of national GDP or employment in light of structural shifts, there is nothing inevitable about its absolute decline continuing. Some of these losses could be reversed with a different set of investment and policy choices—and manufacturing is too important for any nation to write off. The sector directly and indirectly generates new products, processes, materials, and business models. It sustains the middle class. It reflects a nation's technical prowess and its ability to execute on great ideas, taking them from the drawing board to the sales floor. It's worth remembering that the United States still has a highly diversified industrial base that accounts for nearly 20 percent of the world's manufacturing activity—and the nation can draw on many advantages to chart a course forward.

¹⁸ *US manufacturing in international perspective*, Congressional Research Service, January 2017.

Box 1. Defining a sector that resists easy definition

The US manufacturing sector encompasses such a wide range of industries that it resists being painted with a broad brush. The products, operations, and competitive dynamics of aircraft manufacturing, for instance, bear little resemblance to those of regional food processing.

The manufacturing sector is made up of establishments that turn raw materials into processed goods to be sold as intermediate or final products. We rely on the federal government's North American Industry Classification System (NAICS), which defines establishments based on their primary activity. Our discussions of the sector refer to industries in NAICS codes 31 to 33. These codes categorize establishments with others that have similar methods of production although their products may differ widely. Economic statistics regarding sector output, value added, share of GDP, and establishments generally take upstream activities such as R&D, software, and product design into account, although they do not include downstream activities such as transportation, sales, and distribution. (See the technical appendix, available online, for more on this.) However, employment statistics enable us to look more specifically at production workers.

Because of the sector's diversity, it is helpful to look at five broad industry groups that vary widely in technological sophistication, inputs, costs, and markets (Exhibit 1). The firms within each category take different factors into account when they decide where to base production. This has influenced the way manufacturing industries have contracted in the United States over the past two decades—and how they might view footprint decisions in the future (see Box 2 in Chapter 2 for a full discussion of decision-making dynamics).

Because they are highly traded and labor intensive, industries in the basic consumer good segment (such as textiles, apparel, and footwear) have suffered a steep decline in the United States. The decline of this category, plain to see in retail stores nationwide, feeds the narrative that America doesn't make things anymore. Outside of that category, however, manufacturing is more diversified in the United States than in some other advanced economies. This factor has helped the United States remain the world's second-leading manufacturing nation despite weathering two decades of adversity.

The diversity of US manufacturing is apparent at the company level as well. The sector includes the research, design, and production activities of large US multinationals such as Ford, GM, Boeing, Caterpillar, DowDupont, and Procter & Gamble. It also includes the US production operations of foreign multinationals such as BMW, Honda, Volkswagen, BASF, and Siemens. These companies in turn support a multitude of small and midsize suppliers. In fact, a large majority of the roughly quarter-million US-based manufacturing firms are small businesses with fewer than 100 employees.

Box 1. Defining a sector that resists easy definition (continued)

Exhibit 1

US manufacturing includes five varied industry groups, all of which have contracted in some way over the past two decades

- Share of US manufacturing value added, 2016 (%)
- Share of US manufacturing employment, 2016 (%)

Industry group	Change since peak %			Example industries	Relative importance of inputs ¹						
	Value added	Employment	Establishments		R&D	Labor	Capital	Energy	Freight	Trade	
Basic consumer goods	4	-29	-68	-45	Apparel, leather products	Low	High	Low	Low-Medium	Low-Medium	High
	7				Appliances, electrical equipment	Low	High	Low	Low-Medium	Low-Medium	High
Tech-driven innovative products	23	At peak	-37	-8	Pharmaceuticals, medical devices	High	Low	Low	Low	Low-Medium	Low
	11				Computers, electronics	High	Low	Low	Low	Low-Medium	High
Vehicles and heavy machinery	23	-2	-25	-15	Machinery, machine tools	Low-Medium	High	High	Low	Low	Low
	23				Motor vehicles and parts	Low-Medium	High	High	Low	Low	Low
					Aircraft and components	Low-Medium	High	High	Low	Low	Low
					Other transportation equipment	Low-Medium	High	High	Low	Low	Low
Locally processed goods	29	-11	-21	-14	Fabricated metal products	Low	High	Low	Low	Low	Low
	43				Rubber and plastic products	Low	High	Low	Low	Low	Low
					Specialty and household chemicals	Low	High	Low	Low	Low	Low
					Food and beverage products	Low	High	Low	Low	High	Low
Resource-intensive commodities	21	-5	-36	-15	Wood and paper products	Low	High	High	High	Low	Low
	16				Petrochemicals, coke products	Low	High	High	High	High	Low
					Other non-metallic minerals	Low	High	High	High	High	Low
					Basic metals	Low	High	High	High	High	Low

1 The following metrics are used to calculate the intensity of each indicator relative to its value added: R&D spend for R&D intensity; payroll costs for labor intensity; capital expenditure for capital intensity; fuel and electricity costs for energy intensity; inverse of dollar value per pound of shipment for freight intensity; exports plus imports for trade intensity.

SOURCE: OECD; WTO; BEA; Moody's; BLS; US Census Bureau; McKinsey Global Institute analysis

US MANUFACTURING HAS EXPERIENCED TWO DECADES OF STAGNATION

Although it once played a much bigger role in the US economy, manufacturing today accounts for only 11.7 percent of GDP. Service sectors now produce roughly 80 percent of GDP and employ more than 80 percent of private-sector US workers. To some extent, this is the natural order of economic development: manufacturing's value added and employment grow quickly as a nation industrializes, then tend to fall as economies grow wealthier and consume more services such as education, health care, and travel.

But the growth of service sectors provides only a partial explanation of what has occurred in the United States. Manufacturing has not only contracted in relative terms; it has also lost ground in absolute terms. The losses have been rapid and steep, with the sector shedding one-third of its jobs in the decade from 2000 to 2010. Faced with a tougher operating environment and intensifying global competition, firms responded by cutting costs. This took multiple forms: offshoring, automating, closing plants, squeezing suppliers, cutting wages and benefits—or even going out of business altogether. While the primary focus of this report is on the sector's future, it is important to examine where it stands today and how it got there.

Most US manufacturing industries have posted declines in real value added

Viewed one way, value added for the overall US manufacturing sector has been rising sharply. But a closer look reveals that most of the gains have been fueled by just one industry segment, and little of this value comes from productivity activity in the United States.

The standout segment, tech-driven innovative products, has posted rapid growth in value added since the 1990s. This group includes industries that make highly R&D-intensive goods such as computers, electronics, and pharmaceuticals—and most of their value is derived from research, patents, design, and branding rather than production of final goods. Some companies have found it profitable to retain functions such as R&D, product design, marketing, and sales in the United States while offshoring actual production.

The strong performance of this group masks a broader loss of competitiveness in most other manufacturing industries. The trend line for the overall sector looks dramatically different when pharmaceuticals, medical devices, and computers are excluded (Exhibit 2). When these types of tech-driven innovative products are removed from the picture, we see that the growth rate of real value added in the rest of the sector has fallen by half over the past 20 years when compared to the rate in the 1990s. In the most recent decade, growth collapsed during the Great Recession, then experienced a modest comeback that has recently run out of momentum, producing a decade of no net growth. Some segments have actually experienced declines. Real value added is now below its pre-recession peak in the locally processed goods, resource-intensive commodities, and basic consumer goods segments. In some cases, the decline in real value added signals distress in entire vertical industries and the companies within those verticals.

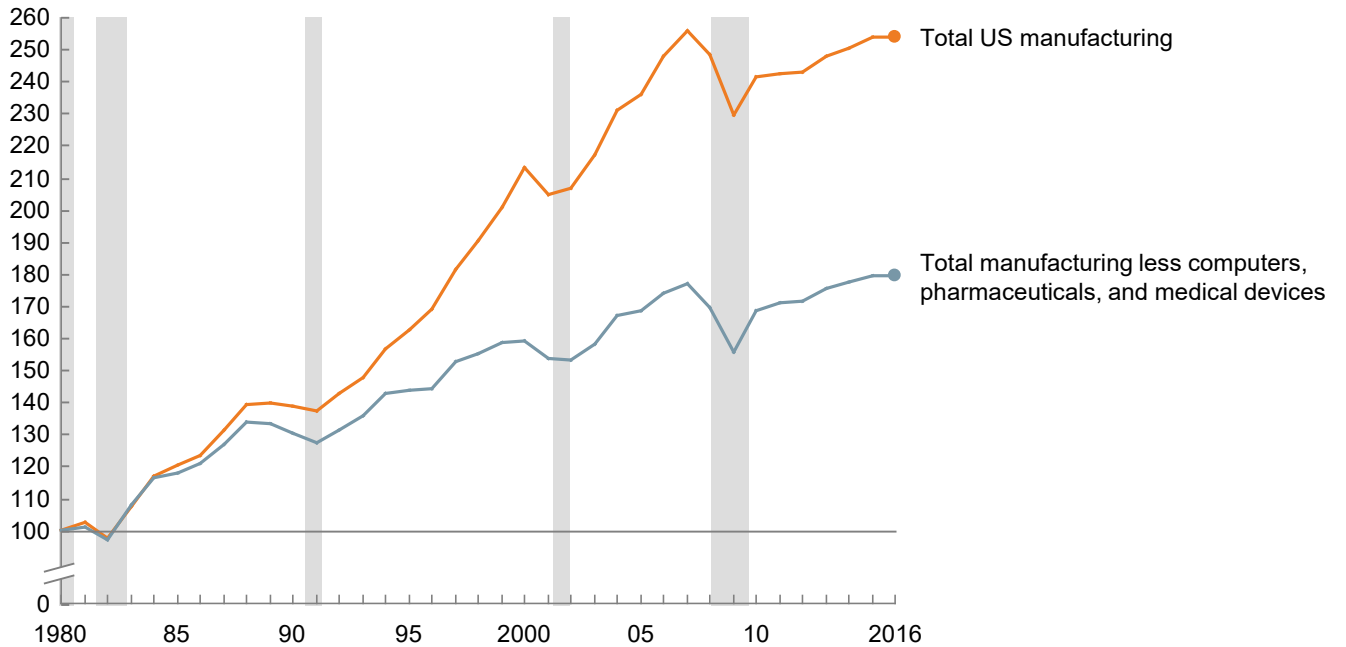
Exhibit 2

Real value added in US manufacturing is no higher today than it was a decade ago

■ Recession

The sector's real value added is sharply lower when tech products, pharmaceuticals, and medical devices are excluded

Index: 100 = 1980



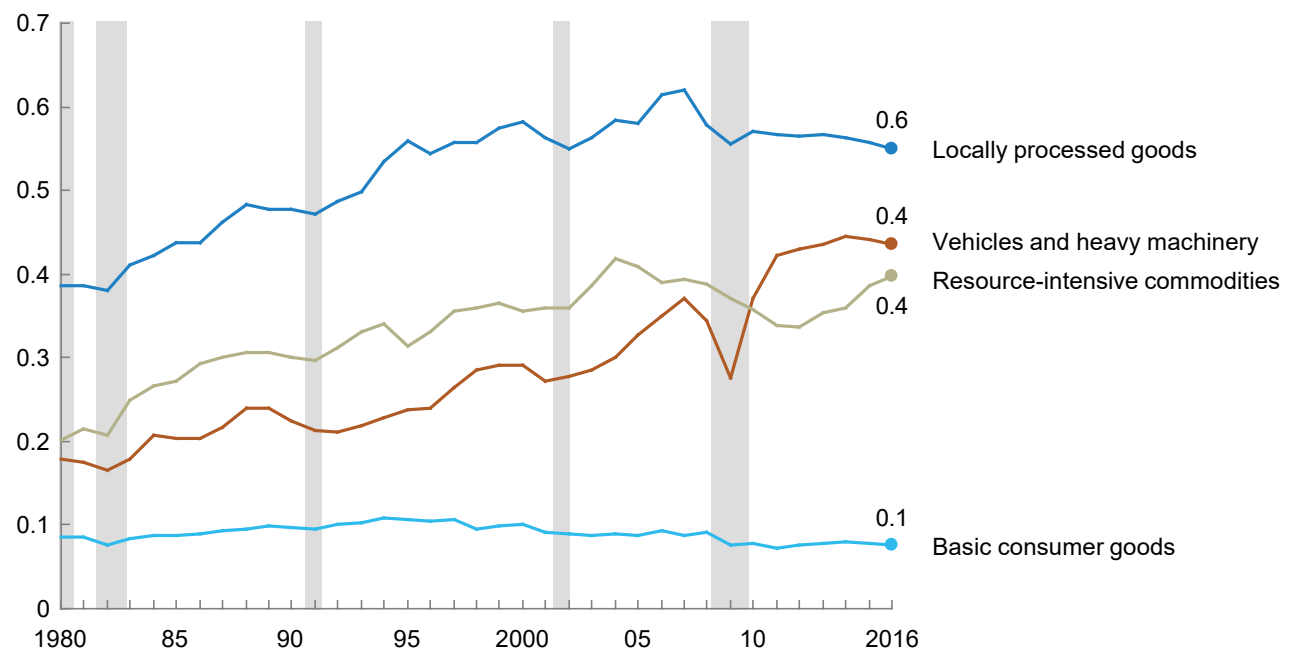
Absolute values¹

2009 \$ trillion

— (Orange)	1.6	1.8	1.8	1.9
— (Blue)	1.3	1.4	1.4	1.5

Some segments have posted real declines over 15–20 years

2009 \$ trillion



¹ Absolute values prior to 2000 are not displayed due to distortions in the available data.

SOURCE: BEA; Moody's; McKinsey Global Institute analysis

Several factors converged to form serious headwinds over the past two decades, although the story played out slightly differently in each segment (Exhibit 3). In basic consumer goods, for instance, rapid consolidation in the retail industry gave distributors and retailers stronger bargaining power over the supply chain. Facing bargain-conscious consumers and low margins of their own, many of them began sourcing from lower-wage countries. In automotive, the preferences of US consumers shifted to foreign-produced car models. As a result, the combined domestic market share of the five biggest US-based producers (a list that includes both US companies and foreign companies with significant US production) has fallen from 85 percent in 1990 to 67 percent.¹⁹ Weak public investment in infrastructure has dampened demand for heavy goods such as machinery and equipment. These headwinds in automotive and machinery in turn affected domestic suppliers of fabricated metal, rubber, and plastic products. A commodity boom also drove input costs higher for these suppliers and for resource-intensive manufacturers.

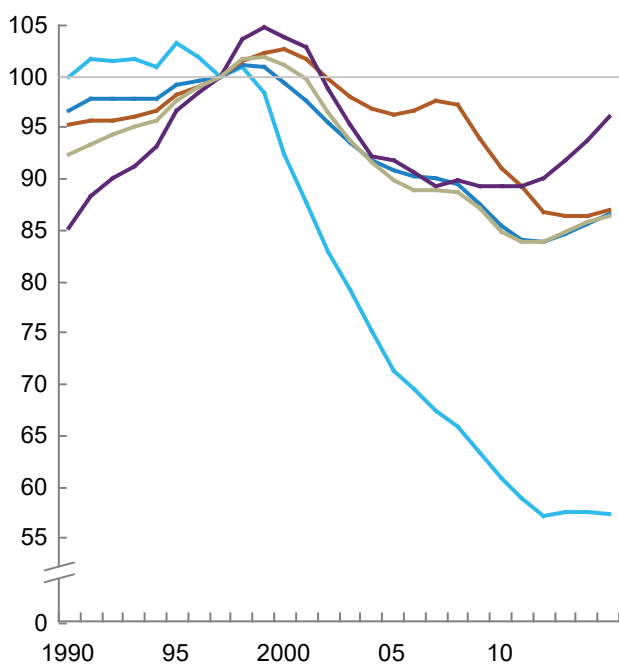
Exhibit 3

US manufacturing has lost both establishments and jobs over the past two decades, with the basic consumer goods segment taking the biggest hit

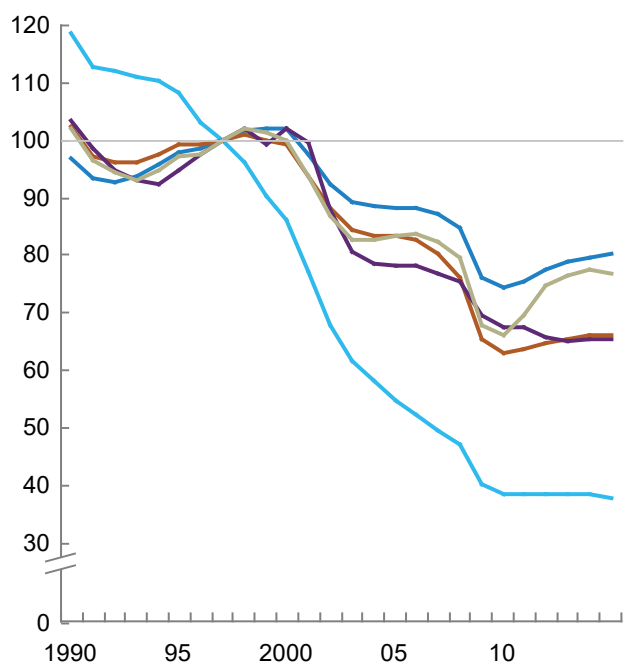
100 = 1997

- Basic consumer goods
- Resource-intensive commodities
- Vehicles and heavy machinery
- Tech-driven innovative products
- Locally processed goods

Establishments by manufacturing segments



Employment by manufacturing segments



SOURCE: BLS; McKinsey Global Institute analysis

¹⁹ WardsAuto data.

Some pressures have affected US manufacturers across the board. A strengthening dollar, for instance, made US exports less competitive and imports cheaper (see Chapter 3 for further discussion of currency exchange rates). Perhaps the most striking change is the growing number of global competitors vying for a share of both international markets and the US domestic market. There are twice as many multinational firms active today as in 1990, and most of that growth has occurred since 2000. In some industries, emerging-market firms are expanding globally and using their massive scale to reinforce an already-large cost advantage. These companies tend to prioritize rapid revenue growth over profit margin. They have created overcapacity and commoditized production in industries such as metals, building materials, and machinery. Incumbents in advanced economies have found it hard to continue operating in markets where revenue and margin growth are declining.²⁰

The largest US firms are still performing well, but small and midsize suppliers are struggling

Many industries across the US economy have developed a winner-take-most dynamic, with a handful of “superstar” firms generating outsized returns on capital.²¹ Recent research suggests that by contributing to industry concentration, the superstar effect is playing a significant role in labor’s declining share of national income.²² In such an environment, suppliers and workers have fewer alternatives.

The manufacturing sector has not been immune to this general pattern. Since 1997, the number of manufacturing firms and production plants has fallen by roughly 25 percent—and this drop is a reflection not only of closures but also of fewer manufacturing firms and factories opening.²³

As a group, the largest US firms have had the scale and resources to navigate the challenges of the past two decades successfully—and they have been posting healthier returns than their peers in other parts of the world. In fact, MGI analysis of financial data shows that large publicly traded US manufacturing firms, most of them multinationals with revenues greater than \$500 million, averaged returns on invested capital of 22 percent from 1997 to 2013. These returns were sustained by improvements in both profit margins and sales growth—and they were notably higher than those posted by large manufacturers headquartered in Western Europe (17 percent), South Korea (12 percent), Japan (7 percent), and China (6 percent). Similar trends are observed in individual manufacturing industries such as machinery and equipment.

The pain in the US manufacturing sector has been disproportionately borne by smaller firms, and there is a stark gap in financial performance between large US multinationals and the domestic base of small and midsize manufacturers. The largest firms have seen their domestic revenues grow more than twice as fast as the sector average, while smaller firms in the supply chain have experienced negative growth (Exhibit 4). Some tier-one suppliers to major OEMs are performing well, but tier-two and -three suppliers in many industries are struggling. The performance gap is also evident in the returns on capital from domestic operations for both public and privately held manufacturing firms. The largest manufacturers have higher profit margins, capital turnover, and returns on capital than smaller firms.

40%
productivity gap
between large
and small
manufacturing
firms

²⁰ For more on this topic, see *Playing to win: The new global competition for corporate profits*, McKinsey Global Institute, September 2015.

²¹ See *Benefits of competition and indicators of market power*, US Council of Economic Advisers issue brief, updated May 2016.

²² David Autor et al., “The fall of the labor share and the rise of superstar firms,” NBER working paper number 23396, May 2017; and David Autor et al., “Concentrating on the fall of the labor share,” NBER working paper number 23108, January 2017.

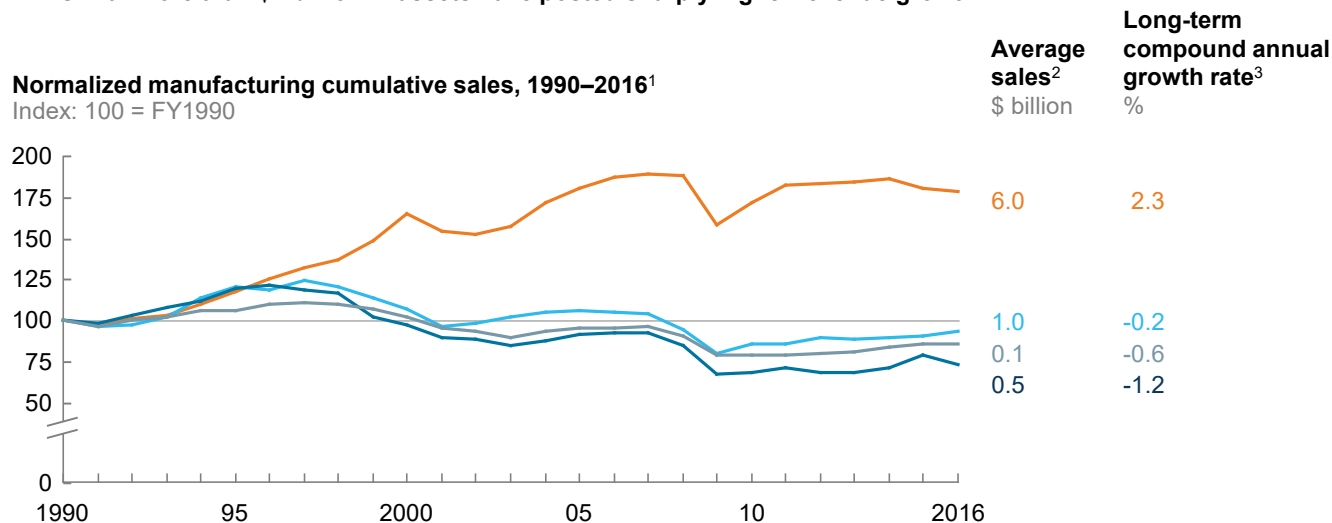
²³ US Census Bureau statistics.

Exhibit 4

Large manufacturing firms have performed much better than smaller players

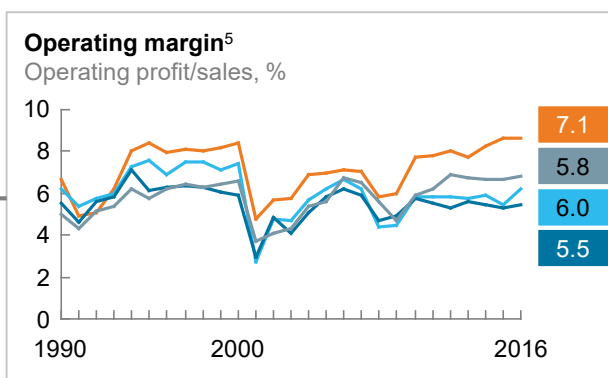
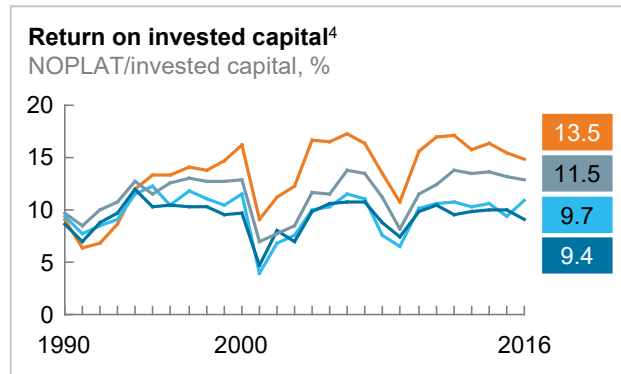
Assets ■ >\$1 billion ■ \$250 million–\$1 billion ■ \$100 million–\$250 million ■ <\$100 million

Firms with more than \$1 billion in assets have posted sharply higher revenue growth ...

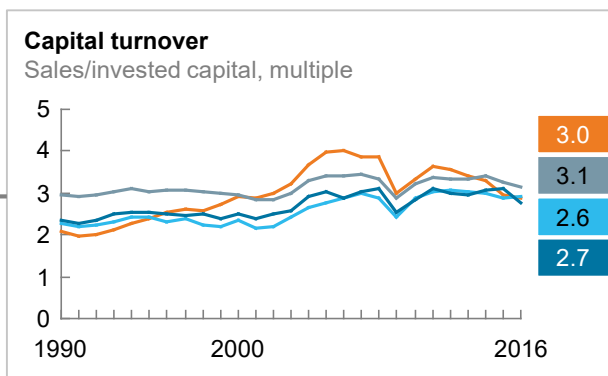


... and higher returns on invested capital

■ Long-term average



(1 – Tax rate)⁶



1 Sales deflated by Producer Price Index (FY1990 dollars) for manufacturing sector.

2 Average sales for FY2015–16 estimated based on number of active corporations in each tier.

3 Long-term compound annual growth rate percent over entire time frame of 1990–2016.

4 Calculated as net operating profit less adjusted taxes divided by invested capital for domestic operations of US manufacturing companies. Invested capital calculated as net operating working capital plus net PPE.

5 Based on reported operating income.

6 Marginal tax rate for United States.

NOTE: Years of sector classification changes: 1992, 2000, 2001. For FY2000 Q1 to Q3, data reported per SIC, while Q4 data reported per NAICS classification. To ensure consistency, Q4 FY2000 data approximated by taking average growth rate of Q4 over Q3 from 1997–99 and applying it to Q3 FY2000 base.

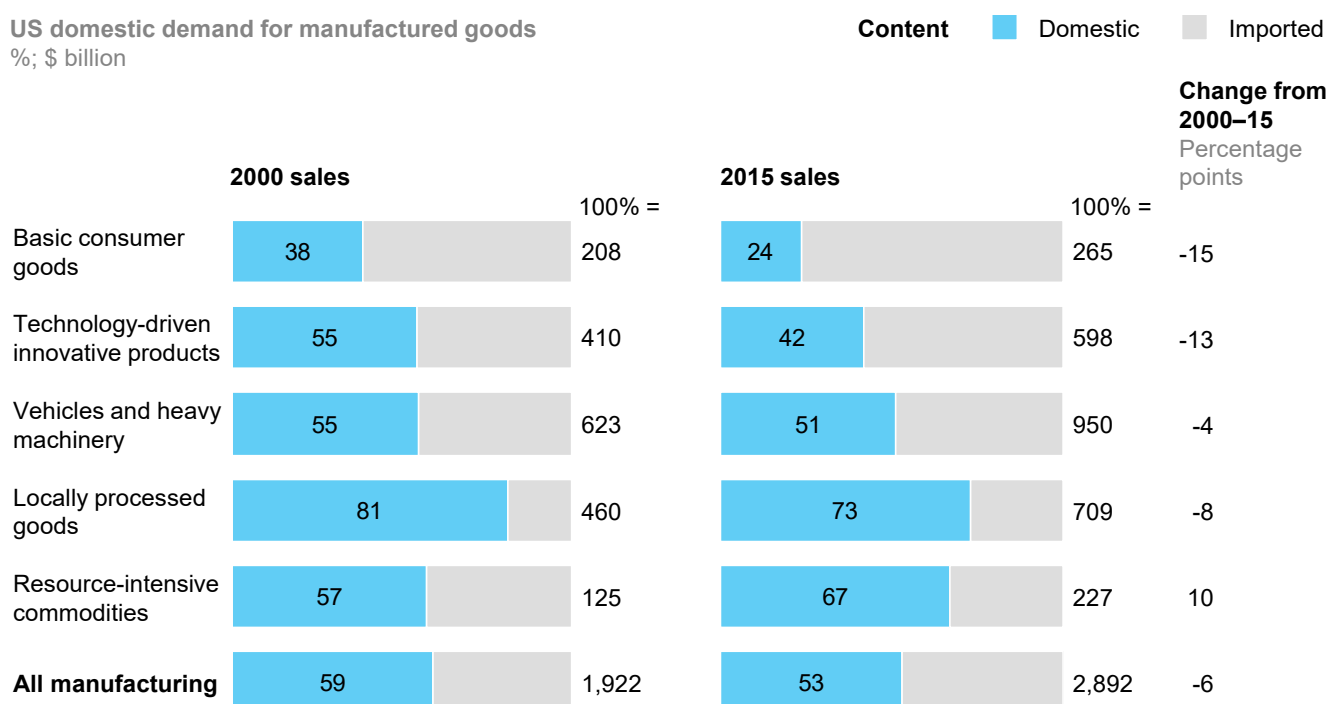
SOURCE: US Census Bureau; BEA; McKinsey Global Institute analysis

One cause of distress for smaller firms is the fact that US manufacturers in a range of industries now rely more heavily on cheaper imported content and components. In vehicles and heavy machinery, the domestic content of domestically sold manufactured goods dropped by four percentage points from 2000 to 2015 (Exhibit 5). An SUV may be assembled in Michigan but with a transmission that was produced in Mexico. The shift to imported content has been even stronger for basic consumer goods such as textiles, apparel, and leather products (15 percentage points). The locally processed goods segment relies more heavily on domestic suppliers than any other part of the sector, but even here, the share of domestic content in final goods declined by eight percentage points from 2000 to 2015. This dynamic has forced US suppliers into relentless price competition against foreign companies with a lower operating cost base.

Exhibit 5

Most manufacturing segments use less domestic and more imported content today than they did in 2000

US domestic demand for manufactured goods
%; \$ billion



NOTE: Numbers may not sum due to rounding.

SOURCE: US Department of Commerce; McKinsey Global Institute analysis

Small and midsize manufacturers tend to be 40 percent less productive than large firms, and this partly stems from their inability to invest in equipment and plant upgrades.²⁴ Large firms have tightened their cash management practices and become more productive with their working capital. But financing is an issue for smaller companies. Access to capital has generally been tighter for SMEs in the United States than in other OECD countries since the Great Recession.²⁵

The health of small and midsize firms has ramifications for the entire sector. Most US-based manufacturing firms are small businesses with fewer than 100 employees, and supply-chain inputs account for most of the costs of finished goods (70 to 80 percent of product

²⁴ *Supply chain innovation: Strengthening America's small manufacturers*, Executive Office of the President and the US Commerce Department, March 2015.

²⁵ *Entrepreneurship: Improving SME financing for stronger growth and job creation*, United States policy brief, OECD, April 2015 and April 2017.

value comes from the supply chain in consumer and automotive manufacturing industries, for instance). Major manufacturers report a hollowing out of the domestic supply base, jeopardizing their ability to scale up production at home to meet future demand growth or bring innovations to market.

VERSIONS OF THIS STORY ARE PLAYING OUT IN OTHER ADVANCED ECONOMIES

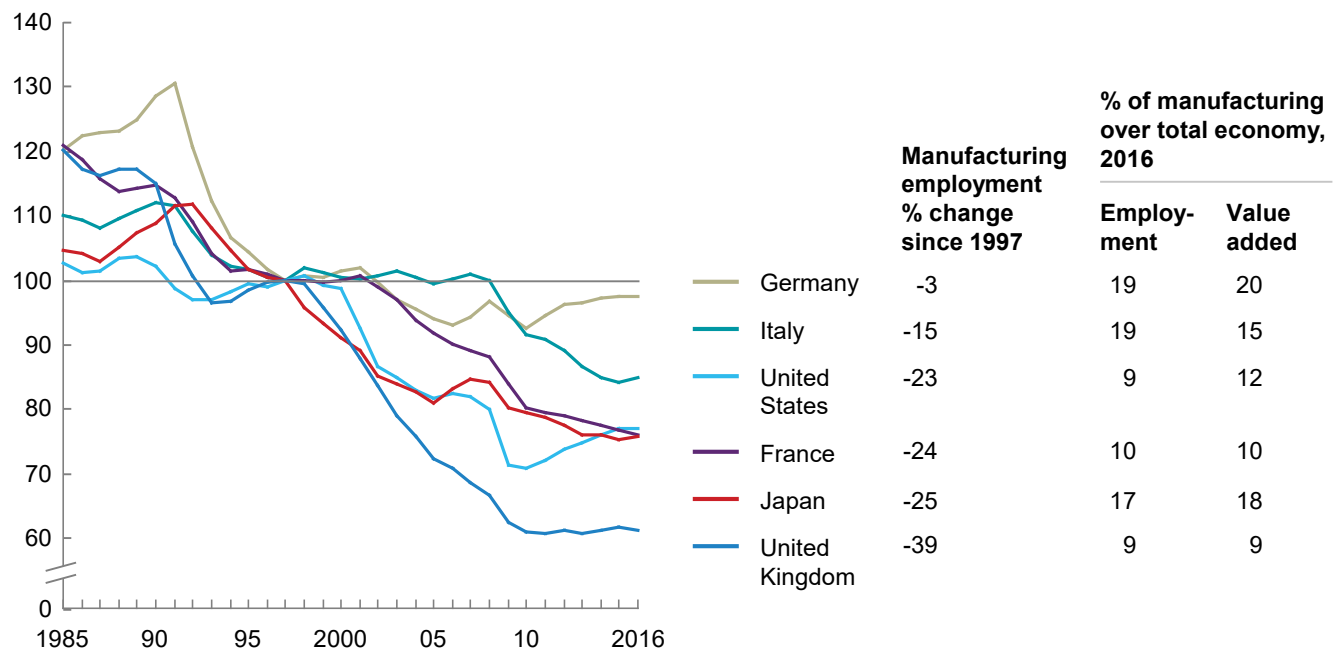
The world experienced a great rebalancing of global manufacturing and supply chains as a huge amount of low-cost capacity came online—not only in China but also across South and Southeast Asia, Eastern Europe, and Latin America. The loss of production activity is evident across most advanced economies (Exhibit 6). The United States is not alone in coming to grips with these trends, but it is still adjusting to more recent and more rapid losses.

Exhibit 6

Most advanced economies have lost manufacturing jobs since the 1990s

Manufacturing employment

Index: 100 = 1997



SOURCE: The Conference Board, OECD; International Labor Comparisons program, May 2017; McKinsey Global Institute analysis

Manufacturing value added and employment began to stagnate and then erode in France, Germany, Italy, Japan, and the United Kingdom in the 1990s, a period in which the United States continued to enjoy a surge of manufacturing growth. In many industries, this reflected domestic economic conditions that constrained public investment and consumer demand.

After 1997, US manufacturing employment began to fall, while job losses in the United Kingdom, Japan, and France grew even steeper. The Great Recession hit the manufacturing sector hard in all advanced economies; in the United States, it caused job losses to accelerate sharply. As of 2016, manufacturing still accounted for 19 percent of total employment in Germany and Italy and for 17 percent of employment in Japan. Meanwhile, its share of total employment has dropped to 9 percent in the United States.

Among large advanced economies, only Germany has managed to reverse the decline. German manufacturing value added has increased by 38 percent since 1999, and it resumed strong growth after the Great Recession. Labor reforms in the early 2000s to freeze wages, promote job-sharing, and expand worker training helped restrain costs while preserving talent. High-quality products and a competitive currency helped German firms of all sizes gain global market share, reflected in a large and growing trade surplus.

The US manufacturing sector posted a stronger comeback from the recession than most other advanced economies with the notable exceptions of Germany and South Korea. However, even as large US firms expanded their output to meet a cyclical demand recovery in the domestic market, a weakening domestic supplier base and the strength of the US dollar led to a surge in imports. As a result, the United States has developed a large and rapidly growing trade deficit—even in the advanced industries where it should enjoy a natural competitive advantage. Only the United Kingdom has a similarly large trade deficit in these industries.

MANUFACTURING STILL MATTERS TO THE BROADER US ECONOMY

Manufacturing remains a pillar of the US economy—as an important force that keeps the nation’s innovation machine humming and a foundation of the middle class. For decades, it was a key force for reducing income inequality and generating jobs and investment in counties across the entire nation.²⁶ Although the sector now accounts for a smaller share of US GDP and employment than it did in the past, it punches above its weight in other key indicators. It drives 35 percent of the nation’s productivity growth, 60 percent of its exports, and 70 percent of private-sector R&D spending. The sector also attracted 59 percent of foreign direct investment inflows into the United States from 2013 to 2016.²⁷

US leadership in science and technology is closely linked to the nation’s manufacturing base. The sector supports an R&D ecosystem that routinely turns out new and improved products, services, materials, and technologies. Its contribution to productivity growth has held down the price of durable goods in the United States, giving households more spending power. To give just one example, the retail price of a base model Toyota Camry was \$25,000 in 2000 (in 2015 dollars). The 2015 model had \$3,000 worth of additional components, yet its retail price was only \$23,000.²⁸

A strong manufacturing sector even offers the economy a measure of stability in the face of global disruptions. For largely service-based economies, it provides valuable diversification and resilience. It even contributes to national security. Having a weak industrial base leads to overreliance on imports, which can increase a nation’s vulnerability to exchange rate fluctuations and supply-chain disruptions.²⁹

Manufacturing is closely linked to the health of the US middle class

Manufacturing has historically offered opportunities for workers without college degrees to gain technical skills and climb the economic ladder. But its erosion has had profound effects on the US economy—and on the prospects of American workers in general. We find that

60%
manufacturing’s
share of US
exports;

59%
manufacturing’s
share of FDI inflows

²⁶ See, for instance, Albert Chevan and Randall Stokes, “Growth in family income inequality, 1970–1990: Industrial restructuring and demographic change,” *Demography*, volume 37, issue 3, August 2000; and Linda Lobao, Jamie Rulli, and Lawrence A. Brown, “Macrolevel theory and local-level inequality: Industrial structure, institutional arrangements, and the political economy of redistribution, 1970 and 1990,” *Annals of the Association of American Geographers*, volume 89, number 4, December 1999.

²⁷ “Foreign direct investment in the United States,” US Department of Commerce, Economics and Statistics Administration, October 2017.

²⁸ *Playing to win: The new global competition for corporate profits*, McKinsey Global Institute, September 2015.

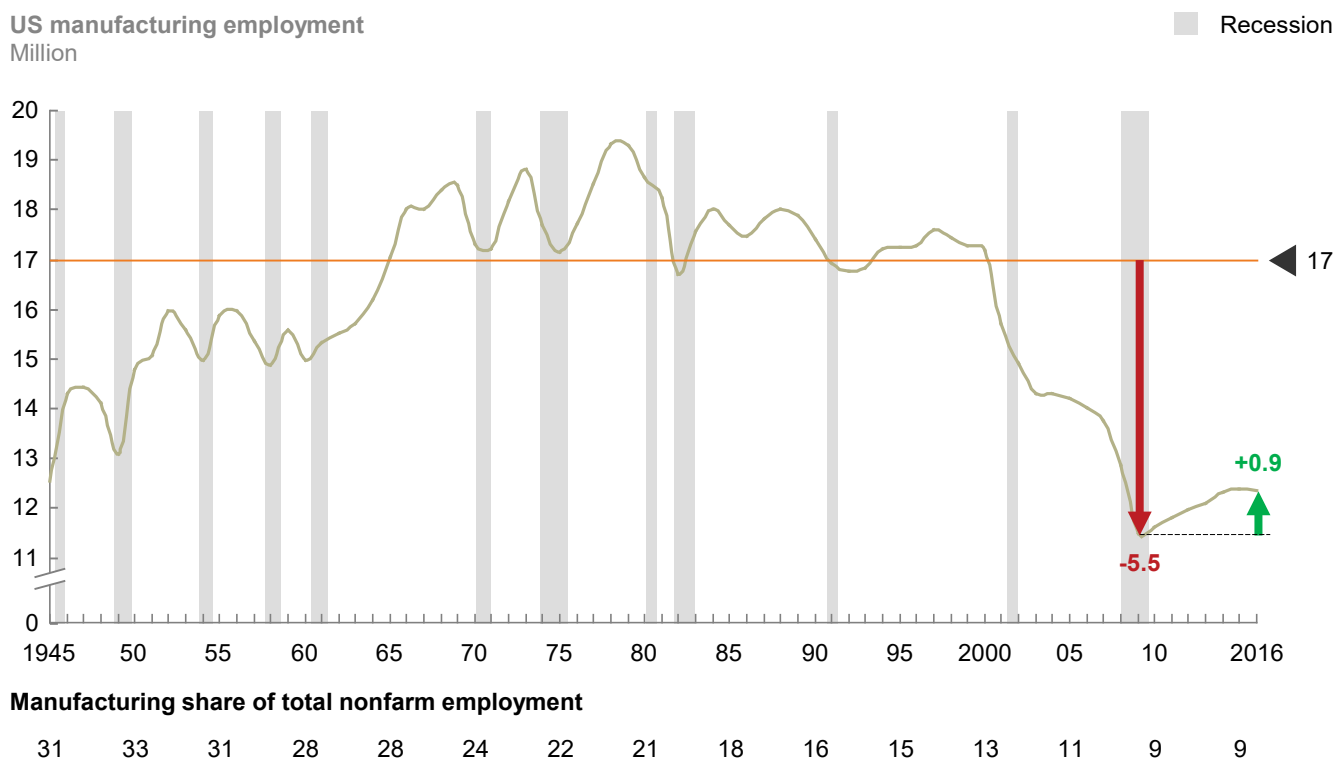
²⁹ Martin Neil Baily and Barry P. Bosworth, “US manufacturing: Understanding its past and its potential future,” *Journal of Economic Perspectives*, volume 28, number 1, winter 2014.

manufacturing accounts for more than two-thirds of the overall decline in labor's share of GDP since 1990.³⁰

One-third of manufacturing jobs were lost between 2000 and 2010 (Exhibit 7). Starting in 2010, a cyclical recovery in demand led to a modest rebound in manufacturing. Nearly one million jobs were restored, raising hopes that a wave of “reshoring” would fix the sector's problems. But now that recovery has largely played out, with no job growth in 2016.

Exhibit 7

After shedding one-third of its jobs, US manufacturing experienced a modest rebound



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

On top of job losses, manufacturing has produced lackluster wage growth (Exhibit 8). It has fallen behind the pace in leisure and hospitality, retail, and construction—sectors in which wage growth for production workers has also come under pressure. A recent study found that the wage premium traditionally associated with manufacturing has evaporated when the comparison considers the degree to which sectors employ teenagers, employ part-time workers, and require similar levels of worker education.³¹ Some US manufacturing firms have increased their reliance on temporary workers rather than employees. One government report estimates that there are about 1.2 million temporary workers in manufacturing, although they do not show up as direct employment in the sector.³² Half of these temporary workers, and one-third of all manufacturing production workers, rely on food stamps or other federal assistance programs to make ends meet.³³

³⁰ Manufacturing historically had a high share of GDP going to labor. We find that 55 percent of this drop stems from manufacturing's declining share of GDP, and the remainder stems from an actual decline in the share going to labor within the sector. Machinery and equipment, transportation equipment, and chemicals were the major industries driving these trends.

³¹ Marc Levinson, *Job creation in the manufacturing revival*, Congressional Research Service, May 2017.

³² *Manufacturers' outsourcing to temporary help services: A research update*, US Bureau of Labor Statistics, working paper 493, January 2017.

³³ Ken Jacobs et al., *Producing poverty: The public cost of low-wage production jobs in manufacturing*, UC Berkeley Labor Center, May 2016.

Exhibit 8

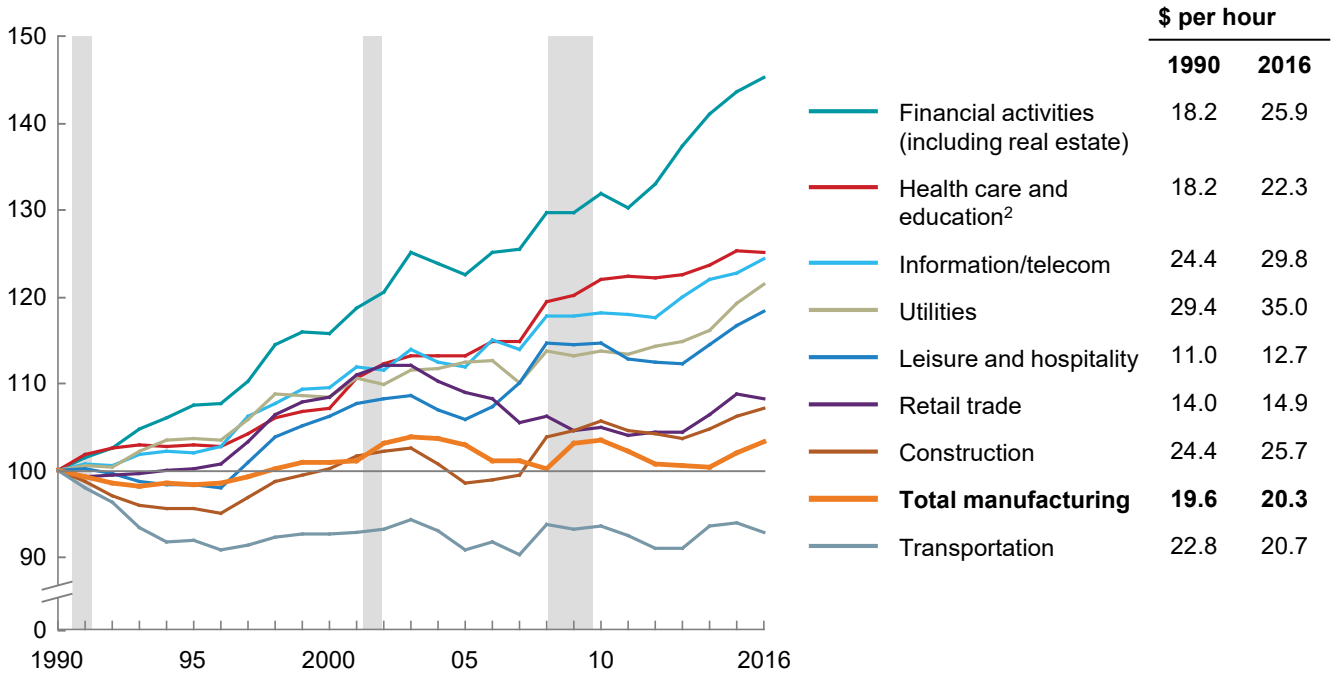
Manufacturing wages

■ Recession

Wage growth for production workers has been more muted in manufacturing than in many other sectors of the US economy

Average real hourly wages for production workers, by non-manufacturing industry, 1990–2016¹

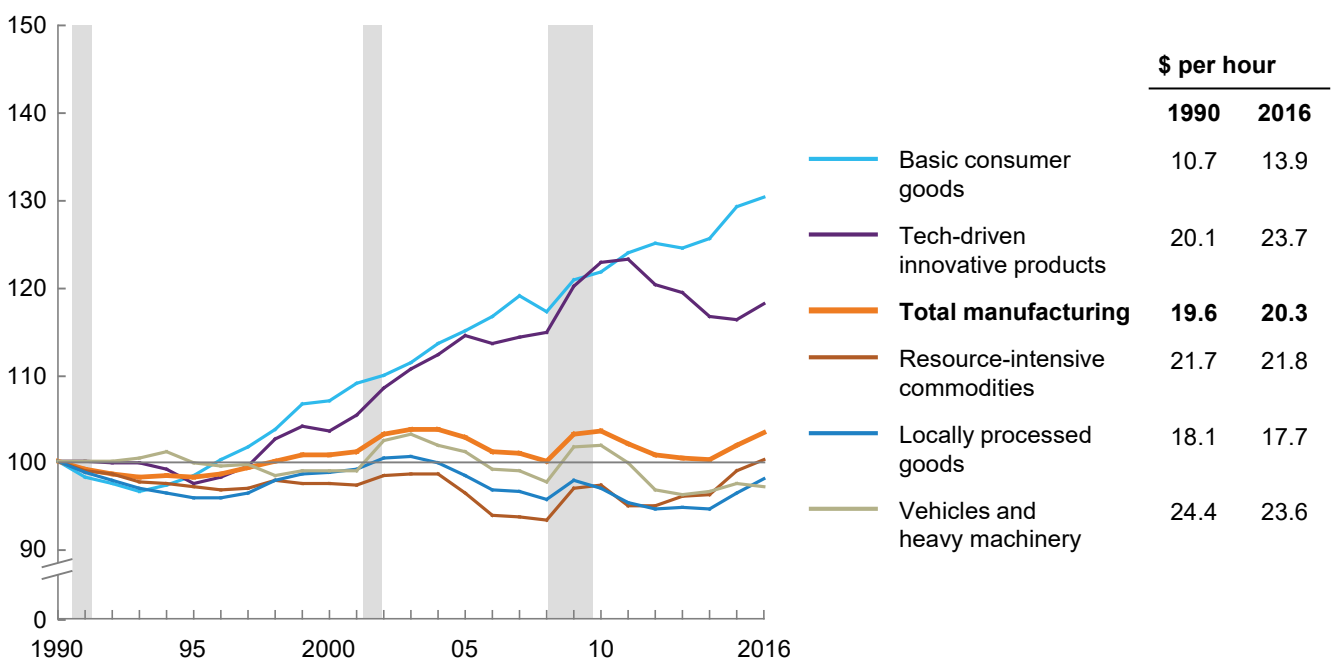
Index: 100 = 1990



Within manufacturing, wage growth has diverged by segment

Average real hourly wages for production workers, by manufacturing segment, 1990–2016¹

Index: 100 = 1990



1 Production (non-supervisory) workers constitute 70–88% of the total workforce. Examples include retail salespeople, construction laborers, and truck drivers.
 2 Refers to private-sector workers only.

SOURCE: BLS; McKinsey Global Institute analysis

It is critical to reverse this situation and return to growth in manufacturing. This would involve not only capturing more production but unleashing investment in new plants, equipment, technologies, and workforce skills development to boost productivity and mobility, which is the key to wage growth and better jobs. Chapter 3 will discuss productivity and workforce development in greater detail.

Manufacturing remains vital to hundreds of local economies across the country

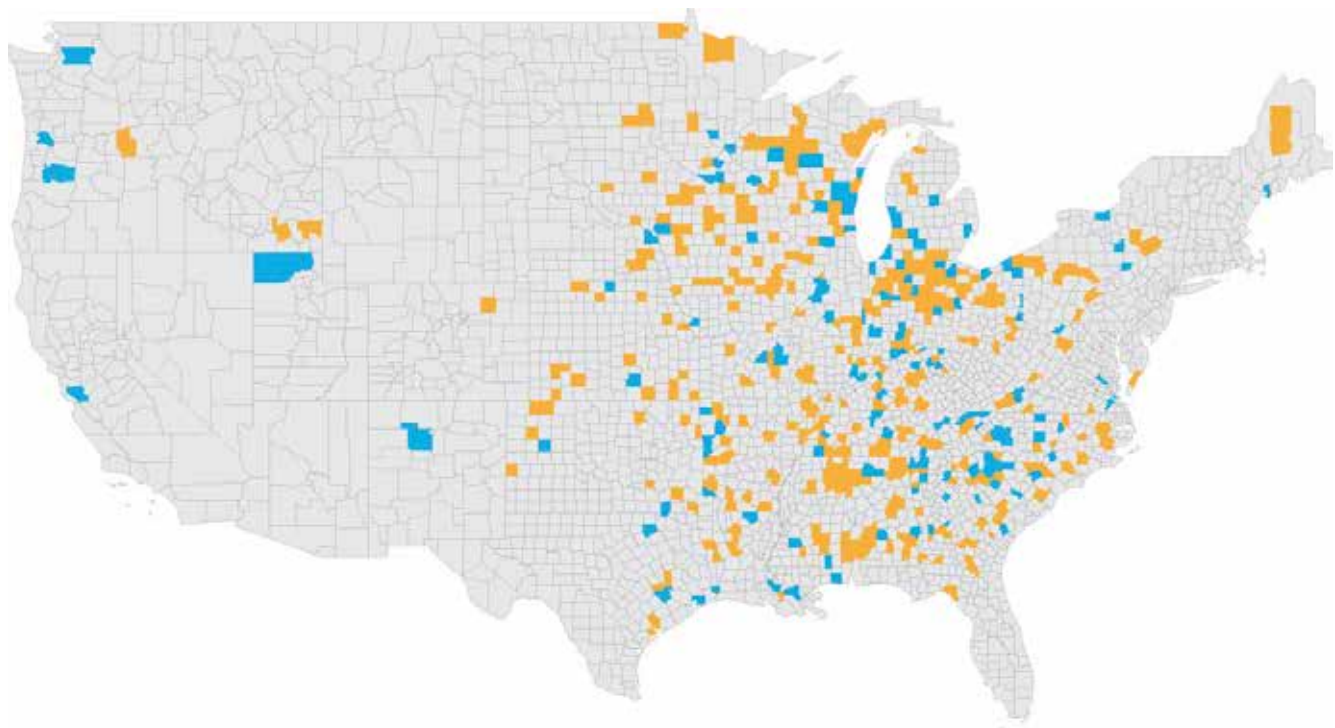
Today manufacturing is still the primary economic activity in more than 500 counties nationwide, including many rural and suburban parts of the Midwest and South (Exhibit 9). While job opportunities in many higher-skill service industries are disproportionately concentrated in coastal urban areas, manufacturing has a much broader geographic footprint.

Exhibit 9

Manufacturing remains the primary economic driver in more than 500 US counties

Manufacturing counties, 2015¹

■ Metro ■ Non-metro



¹ Defined as counties that derived 23% or more of their average annual labor and proprietors' income from manufacturing, or where 16% or more of jobs were in manufacturing.

SOURCE: 2015 ERS County Typology Codes, USDA; BLS; BEA; US Patent and Trademark Office; McKinsey Global Institute analysis

The United States has many specialized regional manufacturing clusters, often with large companies, research universities, and logistics infrastructure at their core. Think polymers in Ohio; automobiles in Michigan, South Carolina, and Tennessee; aerospace in Washington State and Alabama; food processing in Iowa; and chemicals in Louisiana and North Carolina.

Manufacturing creates strong spillover effects in local economies, stimulating demand in other sectors. The presence of manufacturing industries has encouraged dense supplier ecosystems and logistics networks to take root, creating new pathways for skill development and income growth in local economies. Previously published MGI research

found that US manufacturers support nearly 5 million US service-sector jobs through their purchasing.³⁴

Furthermore, the capabilities associated with making one type of product can translate to other products, making manufacturing operations uniquely adaptable.³⁵ **The cluster of designers, suppliers, distributors, and financiers that forms in an industrial ecosystem makes it easier to bring the next innovation to market quickly and at scale.**³⁶ In other words, the US communities that have lost manufacturing industries have the capacity for reinvention if they can attract the right investment and put the necessary enablers in place.

•••

The erosion of the sector over the past two decades has created a difficult starting point from which to imagine a comeback for US manufacturing. But the United States still has a formidable industrial base, and it is important to retain a healthy amount of production activity to ensure that the nation can continue to innovate into the future. No other sector has emerged to fill manufacturing's traditional role in providing middle-income jobs across much of the country. Today the global landscape is changing in ways that could favor the United States. Chapter 2 looks at these trends and highlights the opportunities they present.

³⁴ *Manufacturing the future: The next era of global growth and innovation*, McKinsey Global Institute, November 2012.

³⁵ César A. Hidalgo et al., "The product space conditions the development of nations," *Science*, volume 317, issue 5837, July 2007.

³⁶ Suzanne Berger, *Making it in America*, MIT Press, 2013.



2. OPPORTUNITIES FOR THE FUTURE

Revitalizing US manufacturing is a national priority. But this is not about re-creating the past or playing defense to preserve the status quo. It is about positioning the sector to compete in the future. The decade ahead will reshape global manufacturing as demand grows, technology unlocks productivity gains, and opportunities open up in new parts of the value chain. Companies and countries need to be ready.

Manufacturers will have to navigate increasingly fragmented markets and accelerating product cycles. The next era of manufacturing will challenge firms to respond quickly and cost-effectively to changes in demand, wherever new pockets of demand may be. The United States itself remains a huge and profitable market, but its consumers are more diverse and more demanding than in the past. Overseas, hundreds of millions of people are gaining purchasing power, but manufacturers have to operate in unfamiliar terrain and adapt their products for multiple markets to win a share of this business.

A wave of new Industry 4.0 technologies could give manufacturers the agility they need. Some early adopters are turning their factory floors into information networks, harnessing data to make instant, autonomous adjustments that maximize output and minimize downtime. At the cutting edge of this trend are new types of human-machine interactions, such as virtual reality, next-generation design tools, 3-D printing, and collaborative robots. As these complementary technologies begin to link multiple factories with designers, supply-chain partners, distributors, and customers, the sector can form more dynamic digital networks.³⁷

Manufacturers have an opening to expand their business models and find new sources of revenue as value shifts toward R&D, design, and services. With factor costs changing, this is also an opportune moment to revisit past location and sourcing decisions.

>\$500B
potential boost
to annual
manufacturing
GDP

The United States can harness these trends in demand, technology, and value chains to change the trajectory of its manufacturing sector. After combining demand projections with an analysis of specific industry trends and historic performance, MGI finds that the United States could boost manufacturing value added by \$530 billion (20 percent) annually over current trends. The biggest opportunities are in advanced manufacturing industries, where the United States should be able to capitalize on its strengths to capture more of the world's production, and in the possibility of shoring up the domestic supplier base.

GLOBAL DEMAND IS GROWING AND FRAGMENTING AT THE SAME TIME

The next decade will bring substantial demand growth, but manufacturers will have to navigate greater complexity than ever to capitalize on it. They are being challenged to produce a wider range of product models with differing features, price points, and marketing approaches. From fast fashion to new car models, products now have shorter, faster life cycles. Customers are beginning to demand more choice and customization. Many firms are responding to fragmentation by focusing only on markets where they can realize scale efficiencies—but this leaves many niche markets available for small and midsize manufacturers to serve directly.

³⁷ For more on these industry trends, see "Next-shoring: A CEO's guide," *McKinsey Quarterly*, January 2014.

The United States is a lucrative but increasingly complex market

For years it has been said that the US consumer is the engine that drives the global economy. Although demand has been muted by years of lackluster income growth, US consumers still accounted for more than a quarter of the world's household consumption in 2015.³⁸

Recent MGI research projects that the retiring and elderly in advanced economies will combine with North America's huge working-age population to generate almost 30 percent of global urban consumption growth in the years ahead.³⁹ As the baby boom generation ages, a massive cohort of seniors will be a key driver of consumption. Meeting their needs is a promising area for product innovation—and for exporting those solutions to aging economies around the world. Furthermore, US demand for equipment and building materials could also increase if public investment revives from its 50-year lows. The United States will remain one of the world's largest markets for goods such as tech-driven innovative products and heavy machinery over the next decade. It is forecast to continue accounting for approximately 20 percent of the global market for automobiles in the next decade, for example.

Foreign companies, like their US counterparts, want proximity to the lucrative US market. As a result, the United States is the world's leading destination for foreign direct investment. A recent report found that the total cumulative stock of manufacturing FDI reached \$1.2 trillion in 2015. That investment supported 2.4 million US manufacturing jobs, or 20 percent of the sector's workforce, and helped to boost US manufacturing output.⁴⁰ As more companies based in emerging markets reach significant scale and begin to expand globally, a growing number will want to establish a presence in the United States.

But the US market is not the same familiar ground as in the past. Its consumers are now more culturally diverse and tech-savvy. They have high expectations for quality, low prices, and a wider range of choices. Makers of consumer goods have been continually launching new products and adding line extensions in a bid to expand their shelf space and fill niche demand. One global food manufacturer reports that the SKU count of its North American business unit rose by 66 percent in just three years.⁴¹ This trend in manufacturing may intensify as new technologies enable mass personalization, such as clothing made to suit a customer's body type. Adidas, for example, brought some footwear manufacturing back to the United States with the 2017 opening of its Atlanta "Speedfactory," a facility specifically designed to turn out shoes in a huge assortment of colors, materials, and sizes, with an eye toward offering customization.⁴²

Demand is rapidly rising in emerging economies

Political debates over the state of US manufacturing tend to cast emerging economies purely as sources of low-cost labor. But they are also the world's fastest-growing sources of consumer demand. Over the past two decades, an unprecedented wave of urbanization and industrialization has lifted huge populations out of poverty in countries around the world. In the decade ahead, another one billion urban residents in emerging markets will enter the "consuming class," with enough discretionary income to begin making significant purchases of goods and services. By 2025, McKinsey has estimated that consumption in emerging markets will hit \$30 trillion, up from \$12 trillion in 2010.⁴³ By that point, these

³⁸ World Bank household final consumption expenditure data.

³⁹ *Urban world: The global consumers to watch*, McKinsey Global Institute, April 2016.

⁴⁰ *FDI in manufacturing: Advancing US competitiveness in a global economy*, SelectUSA, US Department of Commerce, 2017 release.

⁴¹ "Simpler is (sometimes) better," McKinsey.com, December 2016.

⁴² Adidas corporate press release, August 10, 2016, available at <http://news.adidas.com/us/Latest-News/adidas-will-open-atlanta-based-facility--to-make-shoes-in-america/s/4d105d93-794c-4282-9382-d50032585cc1>.

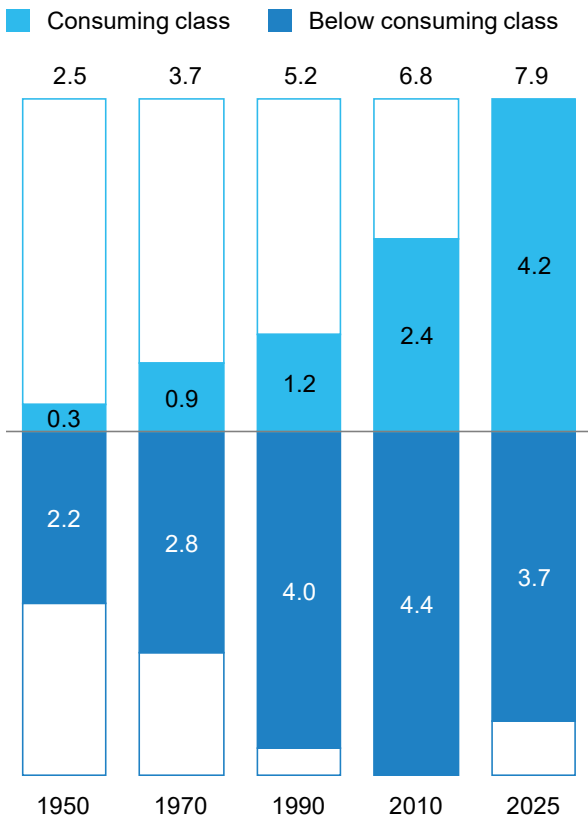
⁴³ *Winning the \$30 trillion decathlon: Going for gold in emerging markets*, McKinsey & Company, August 2012.

countries will account for more than 60 percent of the world's consumption of manufactured goods (Exhibit 10).

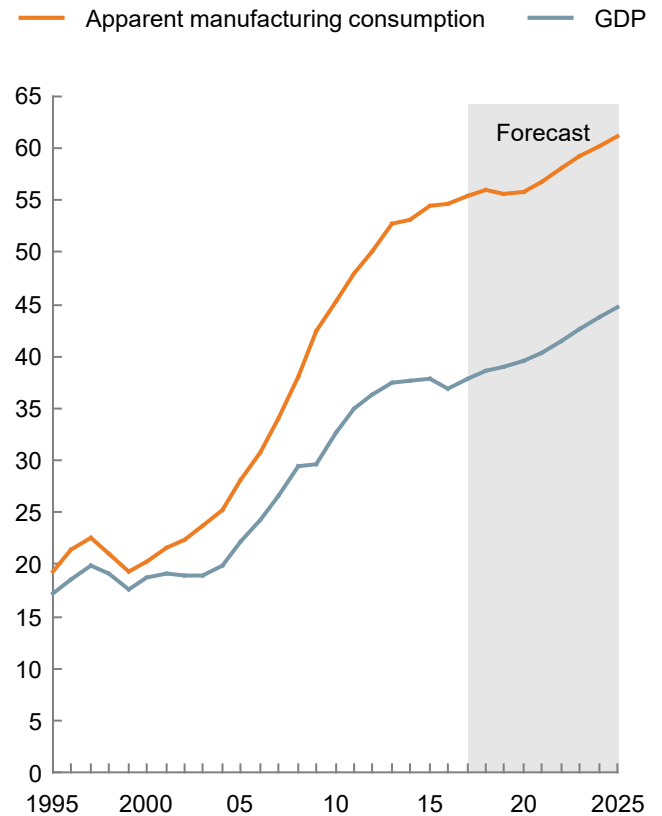
Exhibit 10

As their consuming class continues to grow, emerging markets account for a growing share of global demand for manufactured goods

World population and world consuming class (those with disposable income of more than \$10 per day)
Billion individuals



Emerging markets' share of global GDP and consumption of manufactured goods
%



NOTE: Numbers may not sum due to rounding.

SOURCE: IHS; McKinsey Global Institute analysis

China's working-age population will generate more consumption growth than any other demographic group across the globe, with per capita consumption expected to more than double by 2030. Furthermore, as more Chinese working-age households enter upper-middle-class and affluent income brackets, annual per-household spending on personal products is set to more than double, from around \$300 per household to about \$770.⁴⁴

Markets such as India, China, Brazil, and Africa represent an enormous prize. In fact, some of their urban and demographic markets are comparable in size to entire advanced nations. But these nations are distinguished by tremendous regional, ethnic, and income diversity. There is no one-size-fits-all "China strategy," for instance. It is more accurate to think of China as dozens of individual markets, since the country has 56 different ethnic groups, who speak nearly 300 distinct languages. India has about 20 official languages, hundreds of dialects, and four major religions. The residents of Africa's 54 countries speak an estimated 2,000 languages and dialects. Megacities such as Shanghai, São Paulo, and Mumbai are already on the radar of global companies, but the most dramatic growth is set to occur in

⁴⁴ *Urban world: The global consumers to watch*, McKinsey Global Institute, April 2016.

more than 400 lesser-known midtier cities around the world that will be home to hundreds of millions of new consumers.⁴⁵

Achieving global reach, whether in emerging markets or in other advanced economies, may require companies to expand their product portfolios, whether they introduce new varieties and brands or tweak their core products to suit local tastes. Swiss food giant Nestlé, for example, tapped into a huge vein of demand in Japan for its Kit Kat candy bars offered in hundreds of unique flavors such as wasabi, azuki bean, and green tea. These product variations have proven so popular that Nestlé has launched dedicated storefronts in Tokyo and is setting up a new Kit Kat factory—its first in more than a quarter-century—to serve regional demand in western Japan.⁴⁶ Frito-Lay captured a significant share of the enormous market for branded snacks in India by tailoring core products such as Lay's and Cheetos to local tastes as well as developing a new local brand called Kurkure, a cross between traditional Indian-style street food and Western-style potato chips.⁴⁷

There are limitless opportunities for US manufacturers to make similar forays into global markets. If they are adept at figuring out what resonates with consumers and handling greater complexity, they can bring a bigger product portfolio to market profitably. But poorly managed complexity can erode profit, increase inventory, and bog down operations.

The impact of demand fragmentation has implications for how companies should think about investment decisions. As demand fragments, the potential revenue per investment decreases and the cost often increases, making it harder for companies to hit traditional hurdle rates.

A prime example of these trends can be seen in the packaged foods industry, where companies are responding to changing consumer tastes and dietary concerns. The shrinking of the US middle class has created a more stratified consumer base, increasing demand for both high-end and value products. At the high end, the health and wellness segment of the market now supports organic, gluten-free, “free from,” “better for you,” and “naturally healthy” products that are more expensive but have a positive consumer perception. Since 2011, most of these segments of the food industry have been growing at 6 to 9 percent annually. They are expected to continue growing at about 8 percent through 2021, while the rest of the food industry is expected to remain flat or decline slightly.⁴⁸ In 2007, when the market was more uniform, a typical brand had an average revenue potential of some \$500 million, but as the market has fragmented, the average revenue potential per brand in the health and wellness segment today is roughly \$100 million.⁴⁹ The smaller revenue pool makes it harder for companies to fully leverage economies of scale in purchasing and production, potentially changing their investment decisions.

THE FUTURE OF PRODUCTION IS DIGITAL, WHICH PLAYS TO US STRENGTHS

Companies will need to step up their game to capitalize on the coming demand opportunities. Many have already gone as far as they can to wring efficiencies out of labor, suppliers, and existing processes with cost-cutting approaches. Now they need a different approach to boosting productivity. Industry 4.0 technologies can provide the agility they need in a more fragmented and fast-paced global marketplace (see Illustration).

⁴⁵ *Urban world: Cities and the rise of global consumption*, McKinsey Global Institute, June 2012.

⁴⁶ Naomi Schanen, “Demand for exotic Kit Kats is so high Nestle’s building a new plant,” *Bloomberg*, July 25, 2017.

⁴⁷ *Winning the \$30 trillion decathlon: Going for gold in emerging markets*, McKinsey & Company, August 2012.

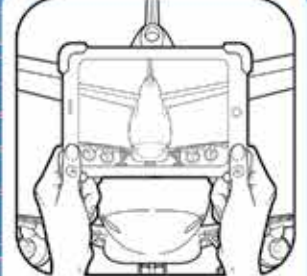
⁴⁸ Euromonitor data.

⁴⁹ *Ibid*, based on retail sales prices.

How Industry 4.0 technologies boost manufacturing and supply chain productivity



Better predictive maintenance



Product quality improvement



Optimized processes



More productive workers



Better inventory management



Designers connected to suppliers



Suppliers connected to customers



Faster time to market



A 2017 McKinsey survey found that most global executives are optimistic about the potential of digital manufacturing and see its relevance to their own businesses. But while a few companies are moving ahead quickly, the majority seem to be taking an incremental approach with isolated pilot programs. US firms have a window of opportunity to stake out a competitive position as technology transforms the sector worldwide.⁵⁰

What is Industry 4.0?

“Industry 4.0” refers to the convergence of multiple technologies that collectively create a more seamless cyber-physical environment, making industrial settings more efficient. The foundations have been falling into place for a number of years: dramatically improved computational power, ubiquitous connectivity, and an explosion in the volume of available data. These enablers paved the way for the web of connected devices and sensors known as the internet of things (or the industrial internet), which feeds real-time data from machinery, vehicles, and products into analytics systems. Thanks to advances in machine learning and artificial intelligence, these autonomous systems can transmit digital instructions to the physical world, remotely adjusting machinery and processes to optimize output, equipment utilization, energy consumption, and quality. Collaborative robots can handle many of the dangerous tasks that once posed safety risks to human workers. Once used primarily for prototypes and models, 3-D printing can now produce more intricate, multimaterial components and final goods.⁵¹

When applied in combination, these complementary technologies can run smart, cost-efficient, and automated plants that produce large volumes with minimal downtime and defects. One large automaker has connected tens of thousands of devices and robots to cloud analytics, enabling a single production line to adapt to build multiple models—maximizing 24 hours of production every day and producing a car body every 77 seconds. Conversely, Industry 4.0 technologies can also run customer-centric plants that turn out highly customized products—or even low-capex “factory-in-a-box” operations for rapid response to remote or niche markets.

It seems clear that Industry 4.0 will eventually set off fundamental change across the global sector. More remarkable advances are on the horizon in the form of nanotechnology, industrial biotechnology, advanced materials with novel properties, augmented reality, and “generative” software for the creation of self-adjusting industrial designs.⁵² Some observers have predicted that this wave of innovation will have the same impact as previous industrial revolutions.⁵³

The question today is how quickly this will happen and how it will alter the competitive landscape. The falling cost of these systems and the development of more intuitive, user-friendly interfaces are lowering barriers to adoption, but Industry 4.0 is still in the early stages. So far it has penetrated only a relatively small number of companies, most of them large multinationals, and these early adopters are demonstrating the kind of productivity improvements that are achievable.⁵⁴ But it can take several years for large firms (and whole sectors) to make the many organizational and operational changes necessary to capture the

⁵⁰ “How to achieve and sustain the impact of digital manufacturing at scale,” McKinsey.com, June 2017.

⁵¹ For more on this new era of technology, see *The great re-make: Manufacturing for modern times*, McKinsey & Company, June 2017; “Digitizing the value chain,” *McKinsey Quarterly*, March 2015; “Manufacturing’s next act,” McKinsey.com, June 2015; “Digital manufacturing: The revolution will be virtualized,” McKinsey.com, August 2015; and *The Internet of Things: Mapping the value beyond the hype*, McKinsey Global Institute, June 2015.

⁵² Alistair Nolan, “The next production revolution: Key issues and policy proposals,” in *The next production revolution: Implications for governments and business*, OECD, 2017.

⁵³ Klaus Schwab, *The fourth industrial revolution*, Crown Business, 2017.

⁵⁴ Vodafone’s *M2M Barometer 2015* report, for instance, found that industrial companies adopting the IoT reduced costs by an average of 18 percent.

full benefits of ongoing digital investment.⁵⁵ The degree to which individual companies and countries will emerge as leaders and benefit from these changes remains an open question.

These technologies can boost performance in every part of the manufacturing value chain

Many people think of Industry 4.0 as simply robots on assembly lines. But its impact is much broader than that, both on the factory floor and beyond. Manufacturing is more multifaceted than production, involving a complex value chain of market research, demand forecasting, product development, procurement, distribution, and after-sales services. These activities may take place in multiple locations or involve outside providers. Industry 4.0 technologies touch on every phase of the product life cycle, from concept through customer experience (Exhibit 11).

New digital tools and platforms open possibilities for collaborative design and accelerated product development. Companies can create “digital twins” of physical products and production processes, validating product designs and using virtual simulations to iron out the production process before it goes live. One aircraft manufacturer has implemented a rapid simulation platform to test and optimize physical product designs; it has reduced design time and cut design rework by 20 percent while boosting engineering productivity. Using analytics to forecast demand more precisely can create more certainty around new product launches.

Industry 4.0 technologies can transform the way manufacturers manage procurement and supplier relationships. It is now feasible for one device or control tower to coordinate an entire distributed network of suppliers stretching around the globe, synthesizing information from RFID tags, GPS tracking, and other sources. These capabilities can enable faster and more effective collaboration with suppliers, instantly sharing information about design specs, price, delivery, and quality. This is of significant value in advanced industries, where design modifications can have major ramifications for sourcing.

Having a clear view of the raw materials and manufactured parts flowing through the system enables managers to tighten inventory control, choreograph deliveries, and minimize downtime. Some analytics-based supply-chain monitoring systems can cut line stoppages by up to 60 percent. One pharmaceutical company installed a real-time supply-chain data system to manage inventory and monitor routes, saving \$80 million in the process. Appliance maker Bosch replaced its paper-based inventory tracking with an RFID system. All goods and transport containers are tracked with transponders, and whenever a unit is removed from the warehouse, the data is fed into a central system. When inventory reaches a minimum level, reorders are automatically triggered.⁵⁶

Applying technology to the production process itself can give manufacturers the flexibility they need to respond to demand fragmentation. Ford and General Motors, for example, have set up dynamically programmable robotics with interchangeable tooling that can switch between producing different models and variants with no loss of efficiency.⁵⁷ Intelligent systems can also elevate product quality. They can cut error rates almost to zero by monitoring every item coming off the line rather than relying on humans to pull samples from batches. After installing robotics and a sophisticated performance management system, one electronics manufacturer reduced manual rework by 90 percent.

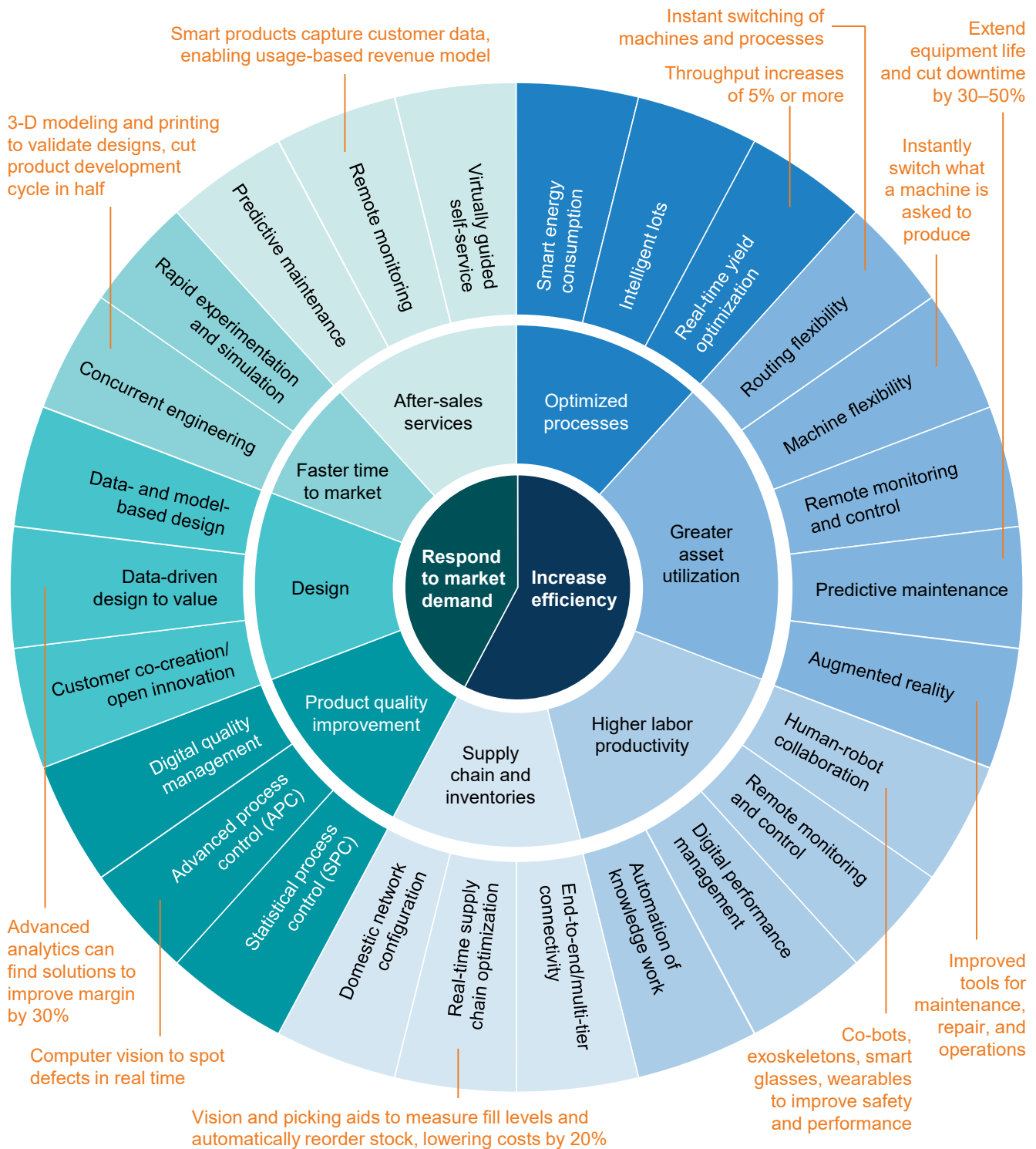
⁵⁵ Erik Brynjolfsson and Lorin M. Hitt, “Computing productivity: Firm-level evidence,” *Review of Economics and Statistics*, volume 85, number 4, November 2003.

⁵⁶ “Bosch is using Industry 4.0 to increase its competitiveness,” company press release, October 2016, available at <http://www.bosch-presse.de/pressportal/de/en/bosch-is-using-industry-4-0-to-increase-its-competitiveness-44805.html>.

⁵⁷ “How technology can drive the next wave of mass customization,” *McKinsey on Business Technology*, number 32, winter 2013.

Exhibit 11

Manufacturers can use Industry 4.0 technologies to boost efficiency and respond to new market opportunities



SOURCE: Digital McKinsey; McKinsey Global Institute analysis

Three types of analytics in particular stand out for delivering substantial productivity improvements. Predictive maintenance systems, for example, forecast when machines are likely to fail so they can be fixed before they go down and create bottlenecks. Yield-energy-throughput analytics ensure that machines run as efficiently as possible while reducing energy consumption. Profit-per-hour analytics can scrutinize thousands of data points from across a sprawling supply chain, examining which parameters affect profitability. These applications alone can deliver margin improvements of 4 to as much as 10 percent.⁵⁸

Industry 4.0 can eventually connect the entire manufacturing value chain—even customers—with a seamless flow of data. Continuous digital connectivity among designers, suppliers, managers, workers, consumers, and physical assets could unlock enormous value. Companies can use this digital thread to coordinate complex global networks more effectively and precisely. One of the biggest opportunities associated with Industry 4.0 technologies is creating ecosystems of reliable, innovative small and midsize firms. Chapter 3 contains further discussion of how large and small manufacturers would need to reinvent the supplier relationship and work together to gain more agility.

VALUE IS SHIFTING, LEADING COMPANIES TO RETHINK BUSINESS MODELS

Companies that take an expansive view of their whole value chain can find new sources of productivity, innovation, and revenue. They can also benefit from taking a fresh look at their location and sourcing decisions in light of new technologies and global trends.

Companies can look upstream and downstream for new sources of value

Manufacturers are finding new sources of revenue beyond traditional production activities—whether upstream in design and product development or downstream in services.

There is a large and growing market for after-sales services. Makers of capital goods such as vehicles, electronics, and medical devices must provide customer service as well as local parts and maintenance. In some manufacturing industries, the share of revenue and employment associated with services runs as high as 55 percent.⁵⁹ Aerospace firms, for instance, provide both pre- and post-sales services to their customers, including financing, risk sharing, training, and maintenance, and some offer leased aviation services, including pilots, aerial refueling, and “power by the hour.” In 2015, the global aerospace industry generated roughly a quarter of its revenue from maintenance, repair, and overhaul.⁶⁰

Digital connectivity and data expand those market opportunities. Intelligent products embedded with sensors can deliver data about their condition and performance from the customer site back to the manufacturer, signaling automatically when to offer the customer maintenance services. This type of connectivity can enable makers of industrial equipment to shift from selling capital goods to selling use of their products as a service. Sensor data can tell the manufacturer how much the machinery is used, enabling the manufacturer to charge by usage, perhaps bundling service and maintenance into the rate. This “product-as-a-service” approach can give the supplier a more intimate tie with customers that competitors would find difficult to disrupt. Rolls-Royce, for example, has moved from simply selling jet engine turbines in one-time transactions to renting them out in a new model that charges customers solely for operating time. The company assumes the risk of downtime but minimizes that risk by relying on big data capabilities that signal the need for preventive maintenance before any disruption can occur. This model has improved product safety and deepened customer relationships while lowering service costs.

⁵⁸ “Manufacturing: Analytics unleashes productivity and profitability,” McKinsey.com, August 2017.

⁵⁹ *Manufacturing the future: The new era of global growth and innovation*, McKinsey Global Institute, November 2012.

⁶⁰ Gernot Strube et al., “Trends in the commercial aerospace industry,” in *Supply chain integration challenges in commercial aerospace: A comprehensive perspective on the aviation value chain*, Springer International Publishing, 2016.

Maintenance and usage are not the only possibilities. John Deere, for example, has added a new service line based on data captured by sensors in the farm machinery it sells. The company uses that data to offer farmers new types of user-sourced, real-time information on planting, soil health, and other best practices. Manufacturers can look for ways to secure “control points”—that is, strategic positions or customer interfaces they can own to maximize advantages. Carmakers, for example, have a number of control points within vehicles themselves for capturing data about the customer experience—data that can form the basis of new revenue streams. Today tech firms, mobility firms, insurers, roadside assistance providers, and infrastructure operators are all eager to find ways to stake out a position in this landscape and monetize this data. OEMs will be challenged to retain their control points, and most are now exploring new types of cross-sector partnerships and business models as the future of the connected car arrives.⁶¹ Nvidia, a maker of graphics processing units and chips, has established a developer platform, which increases the sales and reach of its core products.

Another new type of business model would involve offering production capacity itself as a service. Just as digital platforms have created efficient e-commerce marketplaces, they could enable manufacturers to begin monetizing even small windows of capacity that would have previously been idle. Xometry, a Maryland-based startup, has launched this type of “on-demand” digital marketplace with the intent of offering manufacturers a faster way to source custom parts. The company has drawn investment from GE and BMW, among others.⁶²

Locations and sourcing decisions are growing more nuanced as factor costs and risks change

After two decades of rapid growth, global supply chains are no longer expanding as rapidly, and overall global trade in goods has begun to flatten.⁶³ One possible explanation is that manufacturing has simply taken international fragmentation as far as it can go and is now engaged in a process of regional consolidation.⁶⁴ Already, two-thirds of manufacturing value added occurs in proximity to final demand.⁶⁵ These indicators suggest that more production may be happening where final goods are consumed—and, as mentioned above, the United States is one of the world’s biggest and most lucrative markets.

Multiple factors go into any manufacturing firm’s decision about location (see Box 2, “Understanding how companies make location decisions”). Today, relative costs are changing for some key inputs. As a result, the business case for US firms to offshore production looks less compelling, and the United States may be able to attract even more investment.

⁶¹ For more on this, see *Connected car, automotive value chain unbound* (September 2014) and *Monetizing car data: New service business opportunities to create new customer benefits* (September 2016), both published by McKinsey & Company’s Advanced Industries Practice.

⁶² Andrew Soergel, “BMW, GE commit millions to digital manufacturing marketplace,” *US News & World Report*, June 28, 2017.

⁶³ *Digital globalization: The new era of global flows*, McKinsey Global Institute, March 2016.

⁶⁴ See, for example, *Cardiac arrest or dizzy spell: Why is world trade so weak and what can policy do about it?* OECD Economic Policy Paper number 18, September 2016; and Marcel P. Timmer et al., *An anatomy of the global trade slowdown based on the WIOD 2016 release*, University of Groningen, Groningen Growth and Development Centre, December 2016.

⁶⁵ “Next-shoring: A CEO’s guide,” *McKinsey Quarterly*, January 2014.

Box 2. Understanding how companies make location decisions

Deciding where to set up manufacturing operations is not a simple proposition. For local policy makers eager to attract new plants and the jobs they represent, it is useful to understand what drives location decisions. While any firm will consider land costs and corporate tax rates, companies in each segment of the manufacturing sector tend to weigh other factors differently.¹

Basic consumer goods. This is the most labor-intensive part of the manufacturing sector. Because consumer goods such as clothing and housewares are globally traded (typically through retail supply chains), they are exposed to fierce price competition. Margins tend to be razor-thin as a result. End products are easy to ship from low-cost production sites to customers around the globe, which makes market proximity relatively less important. Labor costs are often the deciding factor for the makers of basic consumer goods, along with the ability to ensure speed to market via access to reliable freight transportation corridors and export markets.

Locally processed goods. These products are primarily sold into the domestic market, whether directly to consumers or as intermediate inputs that go into other companies' final goods. Food and beverage makers are a prime example of the companies in this labor-intensive segment, which includes many small producers. Their just-in-time logistics can be complex, involving issues such as the freshness and safety of perishable foods. Many industries in this segment, such as fabricated metals, plastics, and food processing, function in supply chains that require easy access to raw materials and suppliers, such as agricultural producers, toolmakers, and manufacturers of packaging materials. Lead times to market are tight, making market proximity critical (and perhaps required by customers, as in the case of automotive OEMs that require key suppliers to co-locate). Companies in this segment need access to a cost-effective supply of raw materials and to freight transportation corridors.

Resource-intensive commodities. These companies include producers of goods such as fertilizers, refined petroleum products, petrochemicals, paper and wood products, and cement. They provide first-stage process of raw materials—that is, they typically sell to other industries rather than directly to consumers. Their products may be bulky and even hazardous, and they have low value density. This makes transportation costs

and market proximity critical, along with the cost and availability of raw materials and electricity. In some cases, specialized infrastructure might be required (such as networks of pipelines).

Vehicles and heavy machinery. This R&D-, labor-, and capital-intensive segment produces sophisticated goods with many components, which gives rise to long and multitiered supply chains. In automotive and aerospace, for instance, just-in-time and just-in-sequence production systems are tightly choreographed with suppliers. Companies in this segment require easy access to domestic and export markets; proximity to capable and reliable suppliers; and engineering talent. They also look at exchange rates. The growing integration of digital technologies into these products is increasing the need for technical skills in the manufacturing workforce. Because these products are heavy and bulky, companies often do final assembly near pockets of demand. As in other countries, local governments across the United States tend to take an active role in attracting and maintaining these industries for their ability to generate higher-paying jobs and contribute to innovation, productivity, and other positive spillover effects. Companies therefore tend to weigh the attractiveness of the government incentives offered by different locations as well as regulatory regimes for product safety.

Tech-driven innovative products. Competition in this segment is based on R&D and cutting-edge technology. Companies generate the lion's share of product value through research and design, while intermediate and final products are highly tradable. Shipping costs are low relative to product value. Some companies in this segment have offshored production but retain R&D and design functions in the United States. They benefit from locating in places with a high degree of innovative activity, access to capital, an abundance of specialized talent, and a regulatory environment that supports the ability to commercialize new innovations swiftly. When making location decisions about production, companies in this segment look for the availability of low-cost, relatively skilled labor; a large and reliable base of component suppliers; and the ability to scale capacity up and down quickly in response to shifting demand and frequent product redesigns. Many of them need specialized production facilities; those making tech products and pharmaceuticals, for example, need highly controlled "clean rooms" that are free of environmental pollutants.

¹ For a more extensive discussion of these segments, their attributes, and the drivers of their location decisions, see *Manufacturing the future: The next era of global growth and innovation*, McKinsey Global Institute, November 2012.

First, the gap between productivity-adjusted labor costs in the United States and overseas has narrowed as wages rise in many emerging economies around the world. Meanwhile, the cost of industrial robots continues to fall even as robots become more adaptable and easier to deploy, a trend that is leading some manufacturers to rethink the trade-off between labor and automation. The change in traditional labor cost equations comes as manufacturers report greater difficulty in the management of large and globally fragmented supply chains.

Finally, the dramatic increase in US shale gas production has ensured that industrial electricity costs remain low for US-based plants. While commodity prices have fallen worldwide in recent years, shale gas production provides US-based manufacturers with some certainty in the event of spiking energy prices in the future. It has also made cost-effective raw inputs available to US producers of refined petroleum products, petrochemicals, and fertilizers, paving the way for increases in output and exports.

All of these shifts are prompting some manufacturers to take a fresh look at their footprint decisions. After years of choosing production locations largely on the basis of low labor costs, more companies are using a “total factor performance” approach that takes many variables into account. These include logistics costs, lead time, productivity, reliability, consumer preferences, and proximity to suppliers, innovation partners, final demand, and other company operations. Many larger R&D-intensive companies with manufacturing operations at their core have substantial service units, since the complexity of their products demands close interaction with B2B customers in fields such as finance, health care, or transportation.⁶⁶

Labor costs will continue to be paramount for low-margin products, but companies in many manufacturing industries are reassessing the downsides of offshoring and maintaining lengthy supply chains. These include organizational, logistical, and regulatory complexity as well as greater risks of quality problems and supply disruptions. Their calculus also has to include consideration of taxes and currency exchange rates. The United States has a higher statutory tax rate than many peer economies, although the effective tax rate is comparable for firms in many industries. The exchange rate currently adds a structural cost, with the IMF pointing to a 10 to 20 percent overvaluation of the US dollar. The cost is borne both by US exporters in the global market and by US suppliers in the domestic market. (See Chapter 3 for further discussion.)

THESE OPPORTUNITIES COULD BOOST ANNUAL MANUFACTURING GDP BY MORE THAN \$500 BILLION OVER CURRENT TRENDS

Translating the trends described above into opportunities, MGI has created three scenarios that combine consumption forecasts with industry-by-industry analysis and different trajectories in the use of domestic content in finished goods. We focus on this variable because finished goods derive much of their value from supplier inputs and because the deterioration of the US supplier base has been one of the major factors weakening the entire sector in recent decades.⁶⁷ We also reconcile these industry-by-industry estimates with previous MGI analyses of the likely “supply side” impact of the shale boom, big data, analytics, and the internet of things on the US manufacturing sector.⁶⁸

All scenarios assume that the overall manufacturing sector achieves labor productivity growth of around 3 percent per year in real terms over the next decade, with higher growth

⁶⁶ Gregory Tasse, “Competing in advanced manufacturing: The need for improved growth models and policies,” *Journal of Economic Perspectives*, volume 28, number 1, winter 2014.

⁶⁷ We do not base our analysis on the global market share of US firms, since foreign-owned firms can and do conduct some of their production in the United States. For more details on methodology, see the technical appendix, available online.

⁶⁸ See the following previously published McKinsey Global Institute reports: *Game changers: Five opportunities for US growth and renewal*, July 2013; *Big data: The next frontier for innovation, competition, and productivity*, May 2011; and *The Internet of Things: Mapping the value beyond the hype*, June 2015.

rates in some industries such as motor vehicles, computers and electronics, and fabricated metal products. In these industries, large firms are investing in technology upgrades, and if they follow through with the necessary organizational changes, we expect these investments to translate to productivity gains. This is consistent with an expectation that greater adoption of Industry 4.0 technologies will boost real labor productivity growth above the 1.5 percent annual rate posted over the past decade. But it does not assume that the sector will achieve the rapid 6.1 percent annual gains seen during the productivity surge of 1995–2005, since this would require greater technology diffusion among small firms that are currently struggling to invest.

Real value added in US manufacturing stood at \$2.2 trillion in 2015.⁶⁹ In the current-trend scenario, we assume that the share of domestically produced content continues its trajectory of decline across most industries. Even in this case, manufacturing GDP would increase over the next decade by \$350 billion in real terms. This can be attributed to rising demand both at home and overseas that lifts output across all industries. In addition, cheaper natural gas has spurred investment in new capacity in some energy-intensive industries such as petrochemicals. A portion of the expected output of these new plants is folded into this baseline estimate, although it is offset by continued declines in domestic sourcing in industries such as automobiles and primary metals. Strengthening consumption over the past five years has not benefited the supplier base in these industries, as imports grew and the share of domestic content continued to decline during the rebound.

The second scenario assumes that the United States simply maintains the current level of domestic content in finished goods, arresting the decline. In this “new normal” scenario, value added across the manufacturing sector would hit \$2.8 trillion in 2025, an increase of around \$300 billion over the current trend.

The fabricated metals industry is one example in which the share of domestic content has stabilized in recent years, as a result of two counterbalancing factors. The industry’s imports of parts and components have risen as rapidly aging plants have struggled to compete with low-cost foreign imports. Reversing this would require an unprecedented output surge in the next decade. Given long capex cycles, this is unlikely without a wave of investment already under way—and one is not in evidence. On the other hand, commodity prices have eased, and production has increased to meet demand from the oil and gas, residential construction, and infrastructure sectors. Together these trends are likely to hold the share of domestic content steady. Domestic content is also likely to remain flat in the semiconductor industry. Several US producers have moved assembly and testing activities offshore to countries such as Malaysia but are now capturing more value domestically from design, product development, and services.

Finally, we consider a “stretch” scenario in which GDP in some industries returns to a recent peak. Its assumptions are based on analysis of each industry’s health in the United States, global trends, and opportunities to take advantage of technology and value chain shifts. It also incorporates the higher-end projection for energy-intensive production output. By maximizing all of the opportunities, US manufacturing GDP would climb to \$3 trillion in 2025—a boost of \$530 billion, or some 20 percent, above the current trend.

The biggest opportunities are in the advanced manufacturing industries in which the United States should have a competitive advantage but instead runs a large trade deficit (Exhibit 12). As mentioned, the auto industry has generally seen low investment in recent years. But foreign carmakers are expanding some US production of both parts and finished cars—and since car production is already starting from a large base of production, even a small percentage increase of domestic content adds significant value.

⁶⁹ All figures in this section are given in 2015 dollars.

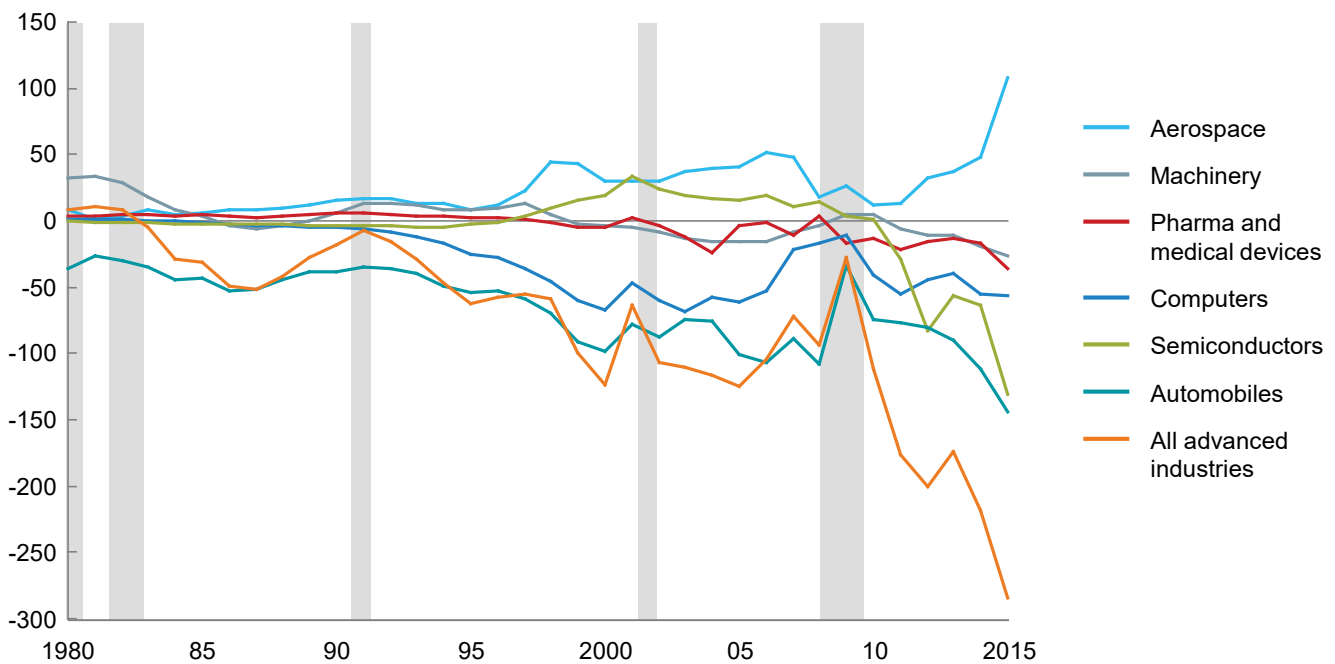
Exhibit 12

The US trade deficit in advanced industries has been widening

■ Recession

US trade balance in advanced industries

Real \$ billion (2005 \$)



Overall advanced industries trade balance as a share of GDP (%)

0.1 -0.5 -0.2 -0.7 -1.1 -1.0 -0.8 -1.9

SOURCE: IHS; McKinsey Global Institute analysis

Similarly, the computers and electronics industry has been thwarted by growing trade deficits over the past two decades, driven by shifts toward higher-value imports of semiconductors and the increasing commoditization of computers. But this sector has already turned its deficit around with the emergence of domestically produced “fables” semiconductors, and it has recently been increasing its use of domestic content.

Aerospace manufacturing is a key contributor to this potential. Its domestic production remains strong, global market growth is expected to be robust, and import competition remains relatively weak because of long production cycles and concerns around supplier certification, intellectual property protection, and national interest.

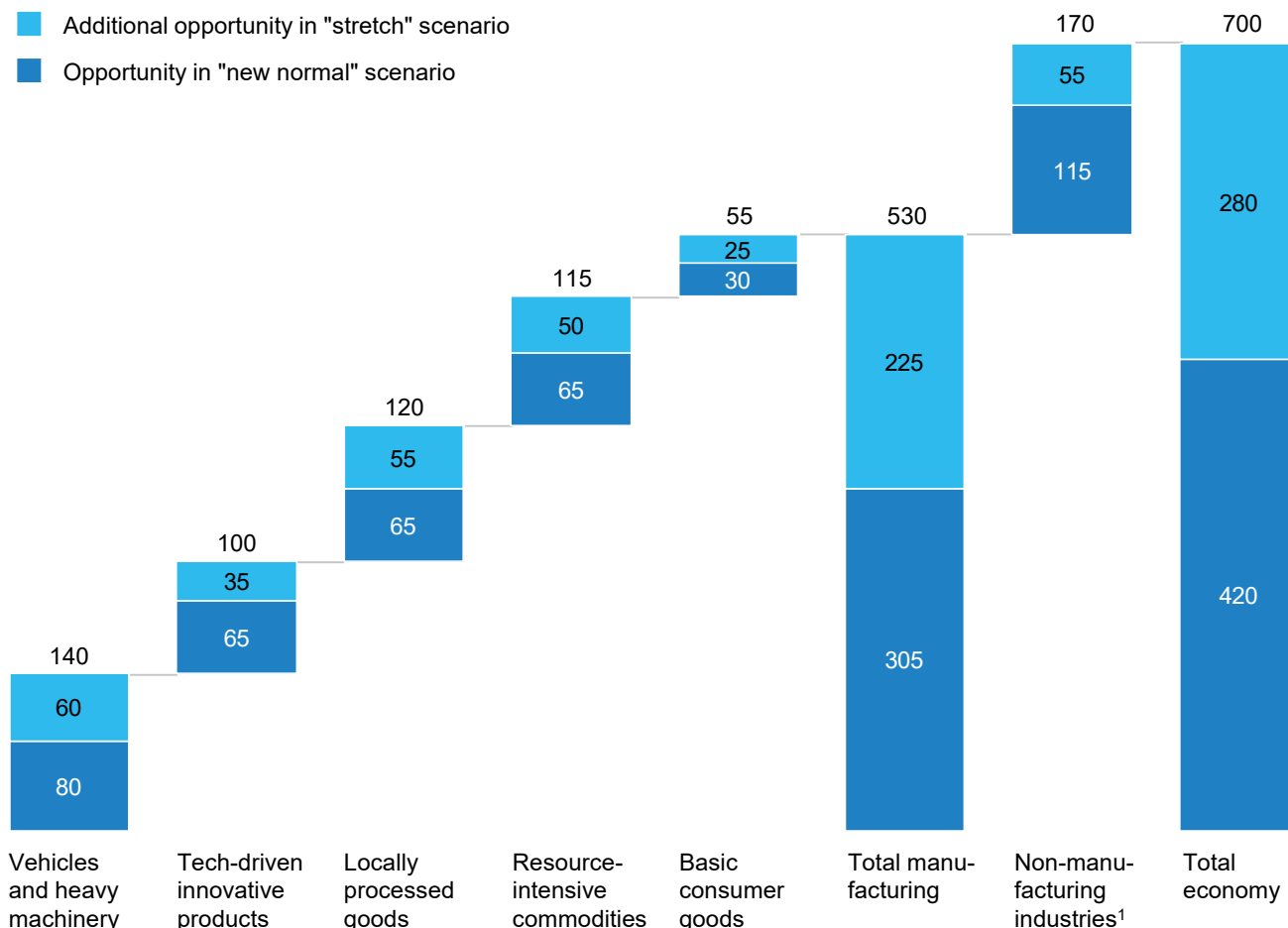
In addition to boosting its value added by \$530 billion, the manufacturing sector would add 2.4 million jobs on top of current trends by realizing the stretch scenario. Furthermore, the positive effects would ripple into services, resources, and other industries that provide upstream inputs to manufacturing establishments. We estimate the direct impact of these purchases at \$170 billion of direct value added and almost one million jobs. Adding together the manufacturing and upstream effects, the total potential benefit to the economy could be \$700 billion in additional annual value added and roughly 3.3 million net new jobs (Exhibit 13).

The manufacturing sector has a broad geographic footprint across the country—a factor that could amplify the economic benefits. Restoring some of this activity in rural or distressed parts of the country would create jobs in lower-income areas with a higher marginal propensity to spend. The revitalization of manufacturing could help to address the growing geographical disparities in income and opportunity.

Exhibit 13

US manufacturing can boost value added by \$530 billion annually over baseline trends, potentially creating more than 2 million jobs

2025 value-added potential in US manufacturing and indirect effect on other sectors
 \$ billion (real, 2015) relative to baseline forecast



Potential increase in 2025 employment

Thousand jobs, relative to baseline forecast

390–665	130–200	490–880	160–260	200–365	1,370–2,370	675–960 ²	2,045–3,330
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1 Approximately 28% in professional and business services, 27% in mining and oil, 23% in wholesale, and the rest in other sectors.

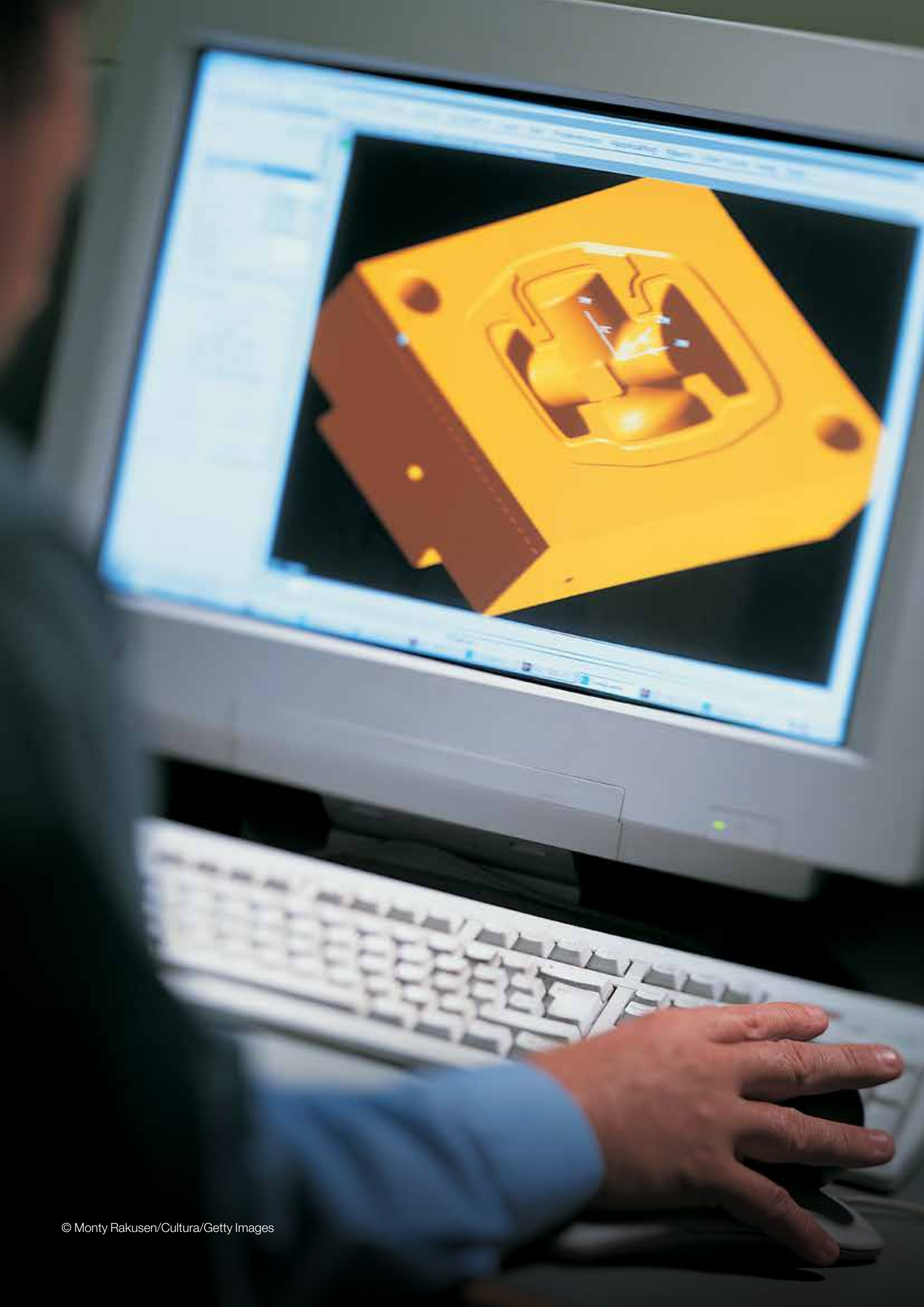
2 Approximately 42% in professional and business services, 17% in wholesale, 15% in agriculture, 11% in transportation, and the rest in other sectors.

NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis



The United States can take advantage of shifts in technology and global demand. There is a tangible and promising opportunity to boost output and narrow the trade deficit in the advanced manufacturing industries in which it should have a natural advantage—and it can shore up the domestic supplier base of small and medium-size firms in the process. But there are no guarantees. Now that global value chains are in flux, this is an important moment to address the long-standing problem of US competitiveness before any more erosion occurs. The payoff would be a manufacturing sector that can remain a pillar of the broader US economy for decades to come. Chapter 3 looks at the how the public and private sectors can work together to achieve this.



3. PRIORITIES FOR THE NEXT ERA OF MANUFACTURING

The economic imperative for revitalizing US manufacturing is clear. Its erosion has been a major driver of the decline in labor's share of US GDP and the consequent slowdown in inclusive growth. Manufacturing has an important regional dimension as well, supporting jobs and investment in parts of the country where they are sorely needed. Many counties that have lost their anchor manufacturing industries have been hurting economically ever since, and the United States cannot afford more of this dislocation. Production activity is also closely tied to innovation. If that engine slows, it becomes harder to incubate and grow new ideas and companies, harming the economy's dynamism.

After two decades in which the trend toward offshoring seemed to be unstoppable, many business leaders are also recognizing the importance of a healthy domestic supplier base—and what could be lost if its erosion continues unchecked. The quality of the supply chain is critical to large manufacturers, who can gain major advantages from being the preferred customer of their suppliers. Having an ecosystem of reliable, top-quality suppliers close at hand provides agility when new market opportunities arise and resilience to macroeconomic risks such as trade or exchange-rate adjustments.⁷⁰ Building a stronger ecosystem of small and midsize manufacturers would give the entire sector a shot in the arm.

Manufacturing is worth fighting for, but no one should underestimate the effort it will take to turn things around. In many industries and counties, manufacturing plants and equipment are outdated, the workforce is aging, and firms are forgoing investment to stay alive. Shifting the focus from protecting the status quo to boosting growth and productivity is the only way to return struggling companies to health and restore wage growth.

Industry 4.0 technologies can reinvent production processes and pave the way to new products and services, but it is unrealistic to expect a return to 1960s-style mass employment on assembly lines. The jobs at stake will be fewer in number but may be higher-paying positions that require higher skills. Some may be design, service, digital, or analytical roles—all of which means that workforce training will be crucial.

Revitalizing the broader manufacturing sector will take more than the efforts of individual firms or local governments. Today most regions tend to award one-off subsidies, essentially picking winners and losers based on whatever opportunity presents itself. But preparing US manufacturing to compete in the future will take a new level of coordination, scale, and investment. We estimate, for instance, that upgrading the sector's capital base would require some \$115 billion annually over the next decade, while it would take up to \$40 billion annually to establish a national apprenticeship program. This chapter will discuss some of the priority areas where the public and private sectors need to find solutions.

TO TURN THINGS AROUND, THE UNITED STATES NEEDS TO TAKE INVENTORY

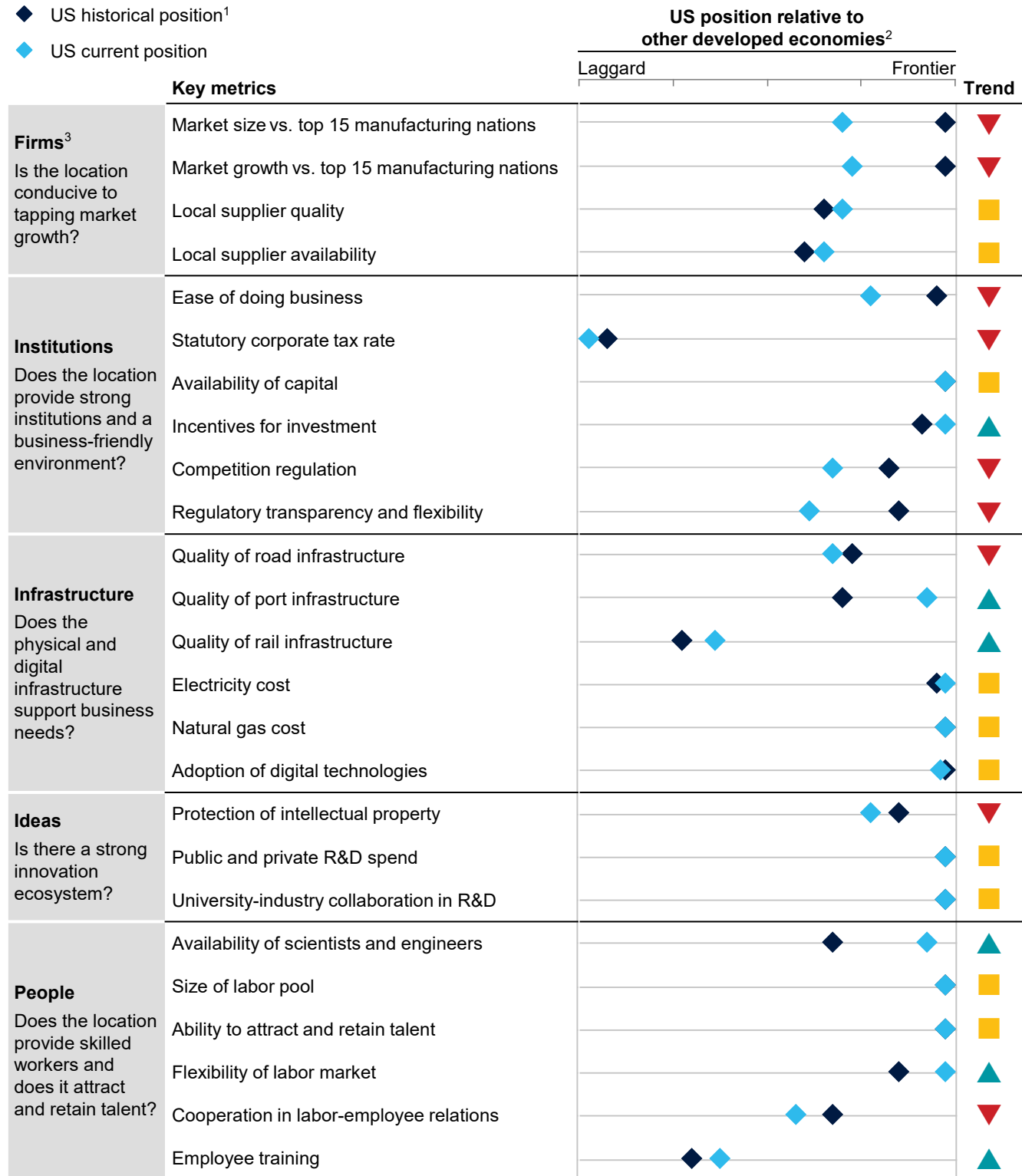
The United States has long-standing advantages in manufacturing, but when measured against other advanced economies, it has lost its edge in some of the metrics that influence where manufacturing firms choose to locate. Exhibit 14 summarizes these trends, comparing the US ranking relative to other major manufacturing nations over time. In some cases, slippage has occurred because of progress by peer economies rather than deterioration in US performance.

⁷⁰ For more discussion on this point, see Susan Helper, *Supply chains and equitable growth*, Washington Center for Equitable Growth, October 2016.

Exhibit 14

Business surveys and economic data identify opportunities to improve US competitiveness as a manufacturing location

- ◆ US historical position¹
- ◆ US current position



1 Historical position is 20 years ago for most metrics, with the exception of ease of doing business, statutory tax rate, supplier quality and availability, and infrastructure metrics, which refer to ten years ago.

2 Other developed economies include those in the top 15 manufacturing nations: Canada, France, Germany, Italy, Japan, South Korea, and the United Kingdom.

3 Comparison set is top 15 manufacturing countries by value added, which, in addition to the United States, include Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Korea, Taiwan, and the United Kingdom.

SOURCE: WEF; OECD; IMD; POLES data; EIA; IHS; McKinsey Global Institute analysis

Although monetary and fiscal policy is beyond the scope of our research, the strength of the US dollar and the relatively high statutory corporate tax rate appear to have made it harder for domestic producers to compete against foreign firms, both at home and in export markets.⁷¹ (See Box 3, “How the dollar affects the US manufacturing sector.”) But there are differences in the ability of firms to manage these factors. Most of the largest US manufacturing firms are multinationals, and they can remain competitive by organizing and locating their global activities to minimize these costs. But smaller firms, most of which operate exclusively in the domestic market, have less room to maneuver. The effective corporate income tax rate for midsize US manufacturers, for instance, is 22 percent, while the rate for the largest firms is 17 percent.

Manufacturing has also been affected by a perceived gradual weakening of regulatory transparency and of public institutions that enforce competition policy. As discussed in Chapter 1, economists have been warning about the growing concentration of corporate activity and the rise of superstar companies in nearly every sector.⁷² This environment limits the ability of suppliers to negotiate better pricing or working capital arrangements, seek alternate customers, or find new pathways to market. It may also contribute to a long-term decline in new business formation or inhibit new firms from scaling up quickly.

US public investment in infrastructure has declined for decades, but the problem is not uniform across all types of assets. For manufacturers, the deteriorating quality of the nation’s roads matters most, since they rely more heavily on trucking than any other form of transport. But the United States has made some improvements in ports, airports, and energy infrastructure, even as infrastructure systems are showing their age in other advanced economies, most notably Germany.

A final area of concern is around the availability and quality of worker training programs. The United States continues to lose ground to other countries on this issue as new technologies increase demand for specialized skills. (See below for more discussion of workforce training issues, including a national apprenticeship initiative.)

⁷¹ For further discussion, see *Growth and competitiveness in the United States: The role of its multinational companies*, McKinsey Global Institute, June 2010.

⁷² See, for example, *Benefits of competition and indicators of market power*, US Council of Economic Advisers, May 2016.

Box 3. How the dollar affects the US manufacturing sector

The relative competitiveness of many US-based manufacturers is affected by a major factor that is beyond their control: the real exchange rate between the US dollar and major international currencies.

A strong dollar helps US importers and consumers, since it buys more in relative terms against a foreign currency. It can also help US manufacturers that are looking to acquire assets and raw materials overseas. But an overvalued dollar can also take a toll on domestic manufacturers' market share and profit share at home and abroad, with spillover impacts on suppliers and workers. In addition, as companies are less likely to invest when facing growth pressures, there are long-term implications for technology upgrades, productivity growth, and competitiveness in the US manufacturing sector.

The United States (along with the United Kingdom) stands out among advanced economies for running a large and growing trade deficit in the knowledge-intensive industries in which it should have a comparative advantage. The trade deficit appears even larger in value-added terms (as of 2011, the latest year of data on trade in value added from the OECD).¹ US industries that produce vehicles, heavy machinery, and their parts and components are globally competitive. But even a small swing in relative exchange rates can have a big impact on both OEMs and suppliers—not only those in advanced industries but also domestic suppliers of metal, electronic, rubber, and plastic components.²

Between 1995 and 2002, the dollar strengthened by 40 percent against major industrialized currencies, reducing the profit share and global market share of US-based manufacturers.³ The US trade deficit in advanced industries nearly doubled in real terms as exports became less competitive and US producers lost ground to cheaper imports. Profit pressures and idle capacity meant that investment and upgrades were postponed across many of these industries and their supply chains, potentially harming long-term productivity and competitiveness.

The trade-weighted dollar began to depreciate after 2003, falling for a decade before rising again in 2014 (Exhibit 15). The decline was due primarily to the relative appreciation of the Chinese renminbi, Canadian dollar, and Mexican peso, and the rapid growth of US-China and US-NAFTA trade. But during this period the dollar remained strong against most other currencies, particularly those of other advanced economies with strong manufacturing sectors. An analysis of bilateral exchange rate movements shows that between 2003 and 2016, the US dollar remained 20 to 25 percent higher on average than its 1995 level in real terms vs. the currencies of Germany, South Korea, and Sweden. It also averaged 30 percent higher than its 1995 level against some Southeast Asian currencies, and 45 to 55 percent higher against the Taiwanese dollar and Japanese yen.⁴ These are all countries with trade surpluses vs. the United States that have persisted for nearly two decades.

¹ Recent research using firm-level supply-chain data indicates that the estimate of domestic value added in imports may be too low in some cases. For instance, US domestic value added in US automobile imports from Mexico, currently estimated at 17 percent, may actually be as high as 38 percent. Across all manufactured goods imports, US domestic value in US imports from Mexico, currently estimated at 18 percent, may actually be 27 percent. See Alonso de Gortari, *Disentangling global value chains*, Harvard University job market paper, updated October 2017.

² Zeresh Mall et al., "Exchange rate exposure on the automotive Industry: Evidence from USA and Japan," *Forman Journal of Economic Studies*, volume 7, January-December 2011; Simon Burru, Jessica Ghansiam, and Ceren Altincekic, *The effects of exchange rate fluctuations on Canada's automotive industry*, Automotive Policy Research Centre, March 2017.

³ Thomas I. Palley, "The overvalued dollar and the US slump," in *Dollar overvaluation and the world economy*, Peterson Institute for International Economics, 2003; also Martin Neil Baily and Robert Z. Lawrence, "Competitiveness and assessment of trade performance," in *C. Fred Bergsten and the world economy*, Peterson Institute for International Economics, 2006.

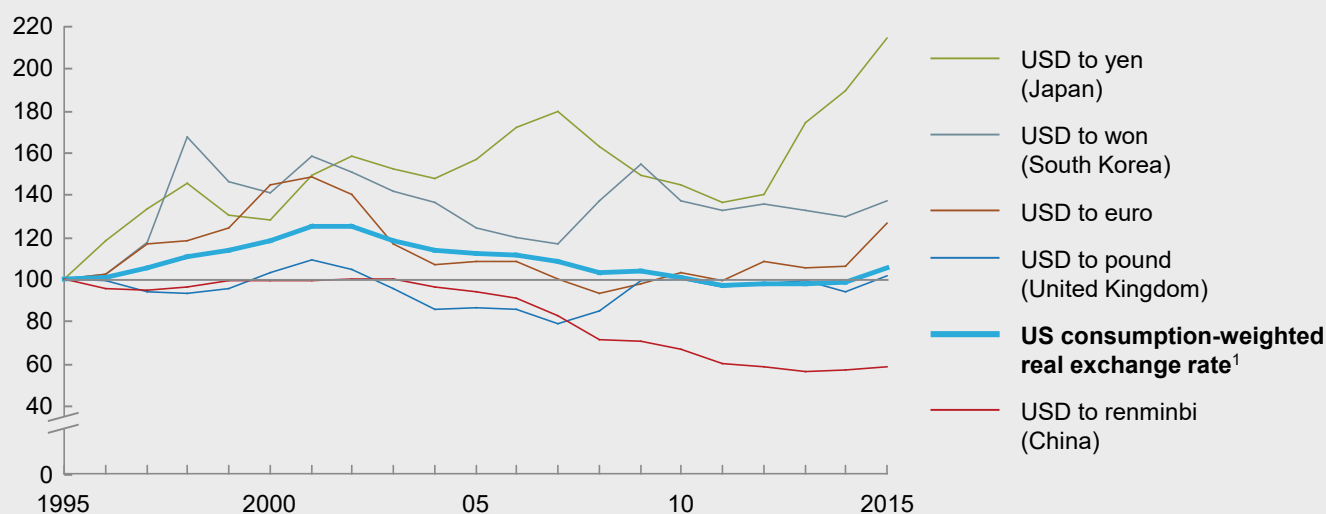
⁴ USDA ERS data on real exchange rate. Note that the euro itself is estimated to be 10 to 20 percent too low to reflect Germany's fundamentals; see, for example, the *2017 external sector report*, International Monetary Fund, July 2017.

Exhibit 15

The US real consumption-weighted exchange rate has declined against most currencies since 2000

Real exchange rate for US dollars normalized by country

Index: 100 = 1995



1 Countries considered in consumption-weighted real exchange rate are the top 15 countries by manufacturing value added (China, United States, Japan, Germany, South Korea, India, Brazil, United Kingdom, Italy, France, Mexico, Indonesia, Canada, Taiwan, Russia).

SOURCE: IHS; IMF; USDA; McKinsey Global Institute analysis

As the world's reserve currency, the US dollar is affected by actors both at home, such as US households, and overseas, such as foreign central banks. The full ramifications of the dollar's effects on the trade balance and current account are beyond the scope of this report. But in the near term, its strength reflects the US economic outlook and expectations for interest rates, fiscal stimuli, and other short-run policy changes. In the longer term, the exchange rate is influenced by saving and investment rates in the United States and other countries, and their impact on net lending and borrowing across national borders. While many analysts point to the low US savings rate and federal budget deficits as drivers of the US current account deficit, others focus on rising current account surpluses overseas, the result of foreign reserve accumulation and higher oil prices through much of the past decade.⁵ The net impact of these factors is that the US dollar is overvalued by 10 to 20 percent in the IMF's estimation.⁶

Near-term actions to address the trade deficit (by, for example, instituting tariffs) would not address these longer-term issues. They can also create unintended consequences, because higher import costs can affect individual firms and products to different degrees. In the highly competitive US midsize automobile market, for instance, the top four models (the Toyota Camry, Honda Accord, Ford Fusion, and Nissan Altima) have very different levels of imported components ranging from 20 to 75 percent. In the long run, addressing the overvaluation of the US dollar requires action on many fronts, from managing exchange rate expectations to promoting domestic savings and resolving global imbalances in consumption and saving. The US savings-investment balance would have to improve substantially to achieve a lower trade deficit.

⁵ "The global saving glut and the US current account deficit," remarks by Ben S. Bernanke at the Sandridge Lecture, Virginia Association of Economists, Richmond, Virginia, March 10, 2005.

⁶ 2017 Article IV consultation with the United States of America—concluding statement of the IMF mission, IMF, June 27, 2017.

THE AILING US SUPPLIER BASE NEEDS A DOSE OF INDUSTRY AND POLICY SUPPORT

Some tier-one suppliers to major OEMs are performing well, but tier-two and -three suppliers in many manufacturing industries are in a more precarious state. The broader US manufacturing sector cannot raise its overall productivity without the diffusion of know-how, lean principles, digital technologies, and new workforce skills throughout the supplier base.

Many small manufacturers find it increasingly difficult to obtain financing. In fact, access to capital has generally been tighter for SMEs in the United States than in other OECD countries since the Great Recession.⁷³ Higher-tier firms have tightened their cash management and become more productive with their working capital, which small firms have been unable to do (Exhibit 16). The inability of small firms to invest in equipment and plant upgrades contributes to a stark 40 percent productivity gap with large firms.⁷⁴

Large US manufacturers tend to keep suppliers at arm's length, but this approach can affect the bottom line. One McKinsey study found that inefficiencies in OEM-supplier interactions add up to roughly 5 percent of development, tooling, and product costs in the auto industry. These costs are significantly higher for US carmakers than for their Asian counterparts, and may accumulate with each tier of the supply chain.⁷⁵ Similar inefficiencies affect other industries as well, and they are likely to multiply as manufacturers seek to expand product portfolios and reduce turnaround times. Even firms that work closely with their tier-one suppliers may have little visibility into their tier-two and -three suppliers, especially if they are overseas.

Over time, seeking out ever-lower bids from suppliers produces diminishing returns. Procurement can be a source of value rather than simply a place to cut costs, but this mindset requires large firms to change incentive structures among their own purchasing teams. Rather than regarding their suppliers as a cost center, large firms can benefit from a thorough analysis of which suppliers are core to the business. While these can sometimes be suppliers accounting for the largest spend, OEM customers may find that they are surprisingly unfamiliar with “nexus” suppliers of critical components deep in the supply chain.⁷⁶ Instead of just monitoring key suppliers, large firms could solicit their ideas, invest in their capabilities, and build trust to create a preferred relationship. They could even design contracts with incentives for finding efficiencies or partner with suppliers to go after new opportunities, sharing both risk and reward.⁷⁷ McKinsey's procurement research shows that companies that collaborate effectively with their suppliers show distinct growth in margin relative to other firms in the same industry.

Beyond the way they interact with their own suppliers, large companies can play a role in strengthening the entire base of smaller manufacturers. Some are beginning to do this through regional organizations such as the Colorado Advanced Manufacturing Association, the Pennsylvania Governor's Manufacturing Advisory Council, and the Massachusetts Advanced Manufacturing Collaborative. These initiatives focus on issues such as technical assistance, ways to accelerate innovation, workforce development, access to capital, and policy roadblocks.

⁷³ *Entrepreneurship: Improving SME financing for stronger growth and job creation*, United States policy brief, OECD, April 2015 and April 2017.

⁷⁴ *Supply chain innovation: Strengthening America's small manufacturers*, Executive Office of the President and the US Commerce Department, March 2015.

⁷⁵ *Managing the OEM-supplier interface: Challenges and opportunities for the passenger car industry*, McKinsey & Company, 2007.

⁷⁶ Thomas Y. Choi, Benjamin B. M. Shao, and Zhan Michael Shi, “Hidden suppliers can make or break your operations,” *Harvard Business Review*, May 2015.

⁷⁷ For further discussion of varying international approaches to OEM-supplier relationships, see Susan Helper and Janet Kiehl, “Developing supplier capabilities: Market and non-market approaches,” *Industry and Innovation*, volume 11, numbers 1-2, March-June 2004.

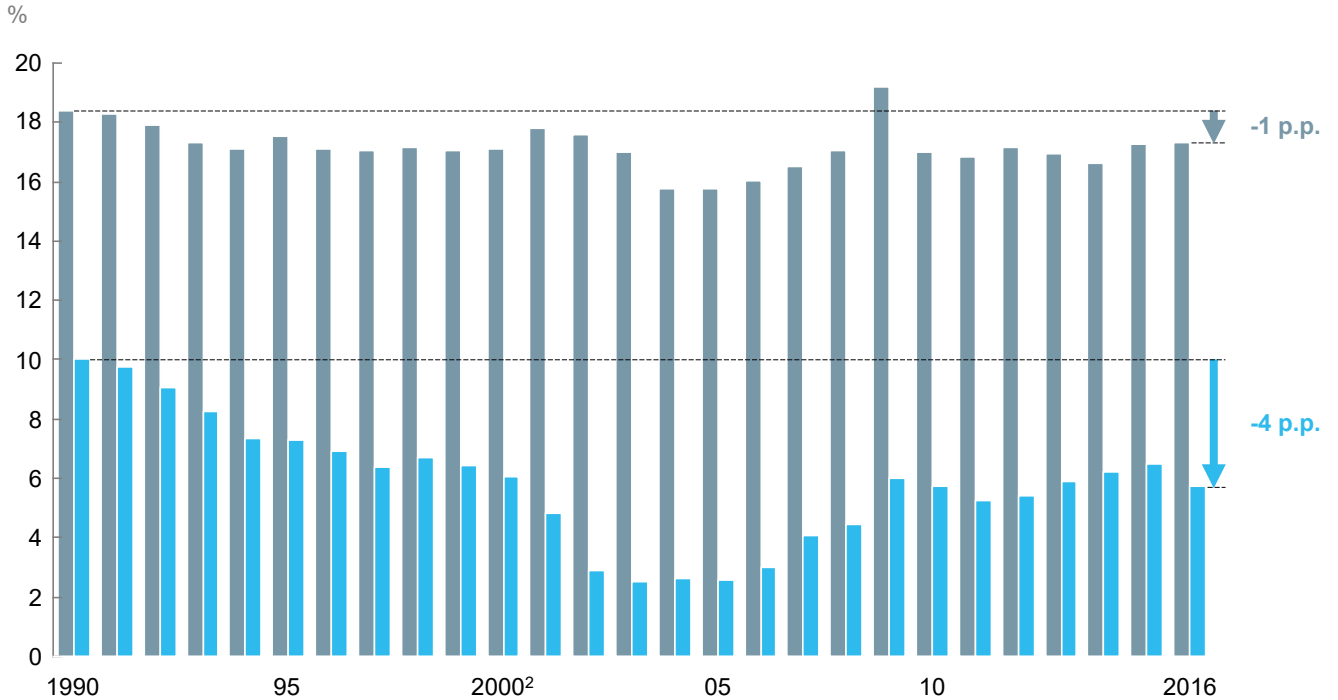
Exhibit 16

The largest US manufacturers are more productive with working capital than smaller firms and have reduced their receivables-payables gap

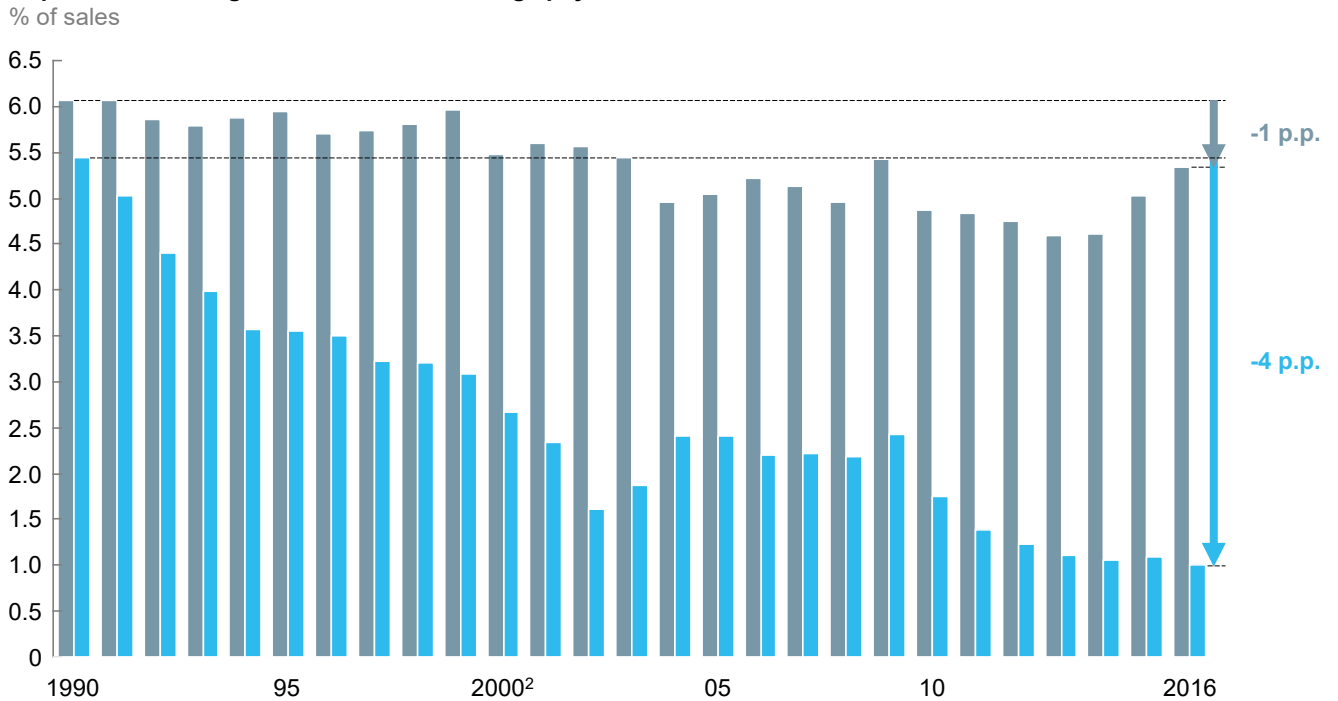
US manufacturing firms, 1990–2016

Firms with assets ... ■ <\$100 million ■ \$1 billion and over

Average ratio of net operating working capital to sales¹



Gap between average receivables and average payables



1 Calculated as current operating assets less current operating liabilities.

2 FY2000 Q1 to Q3 data reported per SIC, while Q4 data reported per NAICS classification. To ensure consistency, Q4 FY2000 data approximated by taking average percent of sales of Q4 over Q3 from 1997–99 and applying it to Q3 FY2000 approximated sales base.

NOTE: 1992, 2001 based on year-end rather than average figures due to sector classification changes.

SOURCE: US Census Bureau; McKinsey Global Institute analysis

Small and midsize US manufacturers need to seek out more of the networking and interaction that their counterparts in many other advanced economies enjoy to learn about growth opportunities and share best practices.⁷⁸ The prime example of this model is the institutional support enjoyed by Germany's *Mittelstand* (medium-size firms). While the German approach to cooperation and collaboration may not translate to the US context, it does offer some lessons about how coordination and scale can produce economic sustainability.

Policy can also help small and midsize manufacturers modernize through capital access programs, business accelerators, or tax incentives. Models from other countries could provide templates. Singapore's Productivity and Innovation Credit Scheme, for instance, provides 400 percent tax allowances for investment in automation, workforce development, or intellectual property—and additional benefits when firms demonstrate their use. Canada funds “technology access centers” at colleges and universities to ensure that small and midsize firms have access to publicly funded research and technology testbeds.

In the United States, the Department of Commerce is taking similar steps through its Manufacturing USA initiative, which is establishing public-private innovation institutes across the country, and the Manufacturing Extension Partnership for small and medium-size firms. Following the model of successful programs in Europe, Connecticut introduced an “innovation voucher” program that offers small and medium-size manufacturers relatively modest grants for purchasing specialized equipment or consulting with business and technical experts.⁷⁹ Like other US initiatives aimed at bolstering the sector, these programs would need to be scaled up for maximum impact.

GROWTH COMES FROM DEEPER GLOBAL ENGAGEMENT

One way to ensure that the benefits of globalization are distributed more evenly is to encourage more firms to participate in global trade. Workers in export-heavy industries earn wages that are 18 percent higher on average than those in other manufacturing industries.⁸⁰ But according to the International Trade Administration, less than 1 percent of US companies sell abroad, a far lower share than that in any other large advanced economy. The vast majority of US small businesses do not export, and those that do tend to sell their products in only one foreign country.⁸¹ There is significant room for US small and medium-size businesses to increase sales to international markets, and that goal can be a key plank of any US export strategy.

To capitalize, manufacturers first have to do their homework to learn what growth opportunities are out there, what these new customers want, and what local competitors are doing. Competing in these markets involves managing more complex production footprints, navigating different regulatory regimes, and finding the right distributors and retailers. Bringing domestic suppliers along to capture these export opportunities can help to mitigate some of the challenges and risks for larger firms.

Agencies such as the US Commercial Service are already engaged in helping US companies of all sizes find new markets and investment partners. Many state and local governments have similar programs. Kansas Global Trade Services, for example, offers

⁷⁸ Nancy J. Miller, Terry Besser, and Avinash Malshe, “Strategic networking among small businesses in small US communities,” *International Small Business Journal*, volume 25, number 6, 2007.

⁷⁹ Connecticut Department of Economic and Community Development; and “*Making our future: What states are doing to encourage growth in manufacturing through innovation, entrepreneurship, and investment*,” National Governors Association, January 2013.

⁸⁰ David H. Autor et al., “Trade adjustment: Worker-level evidence,” *The Quarterly Journal of Economics*, December 2014; and David Riker, *Do jobs in export industries still pay more? And why?* Office of Competition and Economic Analysis, US Department of Commerce International Trade Administration, Manufacturing and Services Economics Brief number 2, 2010.

⁸¹ *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.

workshops and online guidance to help small firms with exporting and compliance. But more US companies need awareness. Thirty-seven percent of firms surveyed by the National Small Business Association cited a lack of knowledge about international markets as their reason for not exporting. Small companies also need more access to trade finance, since exporting entails many extra costs.⁸² Customs procedures and requirements, originally established for big corporations to export vast quantities of goods, also need to be retooled for small businesses filling small orders from overseas customers.

The United States cannot afford to pass up the growth opportunities associated with global trade, but it also needs to address the dislocations caused by trade shocks more effectively. Although Trade Adjustment Assistance was designed specifically to address trade-related displacement, it has had mixed success; investment in this program represents only a small fraction of the economic value created by trade deals.⁸³

20%
share of US
manufacturing
employment
supported by FDI

Deeper global engagement also means attracting a greater share of cross-border investment flows. Many foreign companies want to gain proximity to the US market, and the United States is already the largest recipient of foreign direct investment globally. But most of its inbound FDI flows go toward M&A in the high-tech and pharmaceutical industries. As a share of GDP, greenfield FDI into the US averages only two-thirds of the amount received by other advanced economies.

Some individual state and local governments are making a substantial push for more overseas investment. Tennessee is a notable success story, with investment offices around the world. More than 900 foreign-based companies have invested more than \$30 billion in the state, supporting almost 135,000 jobs. The presence of the largest German automaker, Volkswagen, has in turn attracted the operations of VW suppliers. In the past six years, the state's exports have risen by 21 percent.⁸⁴

Growth-generating greenfield FDI tends to be concentrated in a few counties. Many manufacturing regions have missed out altogether—and even some that did manage to attract greenfield FDI have not seen job and income growth follow. In the absence of a coordinated strategy, state and local governments have raised the stakes with tax incentives, exacerbating an already-large economic gap among counties.

A coordinated investment promotion strategy can help address these issues. The International Trade Administration's SelectUSA initiative is a solid start, but its 2016 annual budget of \$10 million is roughly the same as that of Sweden's investment promotion agency—although the US economy is 30 times larger than Sweden's. SelectUSA is also required to maintain “geographic neutrality” when advocating for US opportunities with foreign investors. But this can limit its ability to facilitate matches and direct investment where it is most needed, as most investment promotion agencies do in other countries around the world. Germany's investment promotion agency, for example, has been part of a broader national strategy to achieve economic parity across the country; it prioritizes linking potential investors with the underdeveloped region of eastern Germany.

⁸² Kati Suominen and Jessica A. Lee, *Bridging trade finance gaps: State-led innovations to bolster exporting by small and medium-size firms*, Brookings-Rockefeller Project on State and Metropolitan Innovation, January 2015.

⁸³ See the US Government Accountability Office reports on trade adjustment assistance in 2001 (number GAO-01-998) and 2006 (number GAO-06-43). Also see Kara M. Reynolds and John S. Palatucci, “Does trade adjustment assistance make a difference?” *Contemporary Economic Policy*, volume 30, issue 1, January 2016.

⁸⁴ Tennessee Department of Economic and Community Development.

INDUSTRY 4.0 TECHNOLOGIES CAN TAKE PRODUCTIVITY TO A NEW LEVEL AND HELP COMPANIES RESPOND TO FRAGMENTING DEMAND

The entire manufacturing sector needs to step up its productivity performance (see Box 4, “The productivity slowdown in US manufacturing”). Many firms have fallen far behind the industry leaders—and major gaps in productivity can exist even among different plants owned by the same company.⁸⁵ This indicates that there is room for improvement by bringing existing best practices to lagging firms and plants. On the other hand, many larger companies have already exhausted traditional approaches for increasing productivity by wringing as much efficiency as possible out of labor, suppliers, and processes. Now they need an entirely new way to boost productivity, and the stakes are higher than ever in a more fragmented and fast-paced global marketplace.

The US manufacturing sector’s relatively slow pace of digital adoption has been a drag on productivity.⁸⁶ The falling cost of robotics, analytics software, and other Industry 4.0 technologies is lowering barriers to their adoption. Nevertheless, a recent McKinsey survey of 400 manufacturers found that roughly half had no digital road map. Although it is only one indicator among many, the intensity of industrial robot usage remains lower in the United States than in countries such as Germany, Japan, and South Korea (Exhibit 17). While US plants turning out vehicles and electronics are generally highly automated, robots have relatively little penetration in large US industries such as metals and food processing. Several issues still need to be overcome, including technology readiness among lower-tier suppliers; interoperability issues across legacy plants, equipment, and firms in the supply chain; and concerns around data privacy, ownership, and security.

40-50%

share of US manufacturing assets that need to be upgraded for digital readiness

The pace of technological change has made some companies hesitate, but it actually increases the urgency of getting started on the digital journey. It is risky to assume that an organization can wait now and leapfrog later. It is critical to begin identifying the right digital tools, integrating them into physical assets and workflows, and fostering a digital culture. Successful companies start by identifying strategic use cases for technology and linking their digital initiatives to their broader business strategy. Then they need to begin capturing, integrating, and analyzing data from across their operations and ecosystems, with a careful eye on cybersecurity. Today many inefficiencies stem from information that is lost at points where functions, sites, and suppliers intersect. Creating a more seamless flow of data can itself yield substantial productivity gains. All of this requires attracting the right tech talent—particularly people who combine analytic skills with deep manufacturing know-how.

Companies also need to take part in broader industry efforts to develop interoperability and data security standards, and to encourage adoption. Part of this, as mentioned above, requires helping suppliers make the leap to digital manufacturing. Another element is playing a role in forming new alliances and platforms and building a deeper pool of workforce skills.⁸⁷

Industry 4.0 will require upgrading about 40 to 50 percent of today’s asset base across US manufacturing industries. Machinery will need to be upgraded or replaced to accommodate IoT sensors and actuators, and sophisticated analytics systems are needed to process all the data that is captured. Encouraging this investment may require policy incentives, a topic we will return to below.

⁸⁵ *Manufacturing the future: The next era of global growth and innovation*, McKinsey Global Institute, November 2012.

⁸⁶ This assessment is based on an analysis of every sector in the US economy, looking at indicators measuring digital assets, digital usage, and digital labor. See *Digital America: A tale of the haves and have-mores*, McKinsey Global Institute, December 2015.

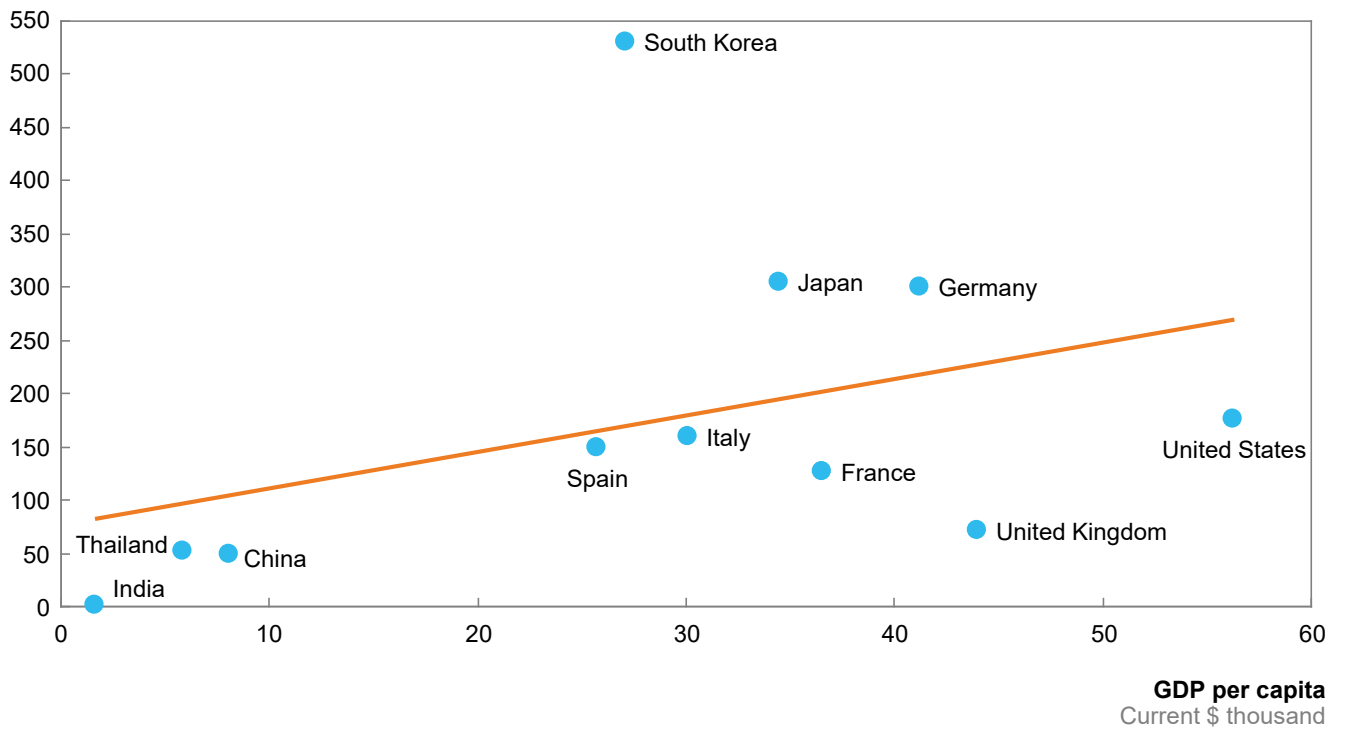
⁸⁷ *Industry 4.0: How to navigate digitization of the manufacturing sector*, McKinsey Digital, 2015.

Exhibit 17

The intensity of industrial robot deployment is lower in the United States than in South Korea, Japan, and Germany

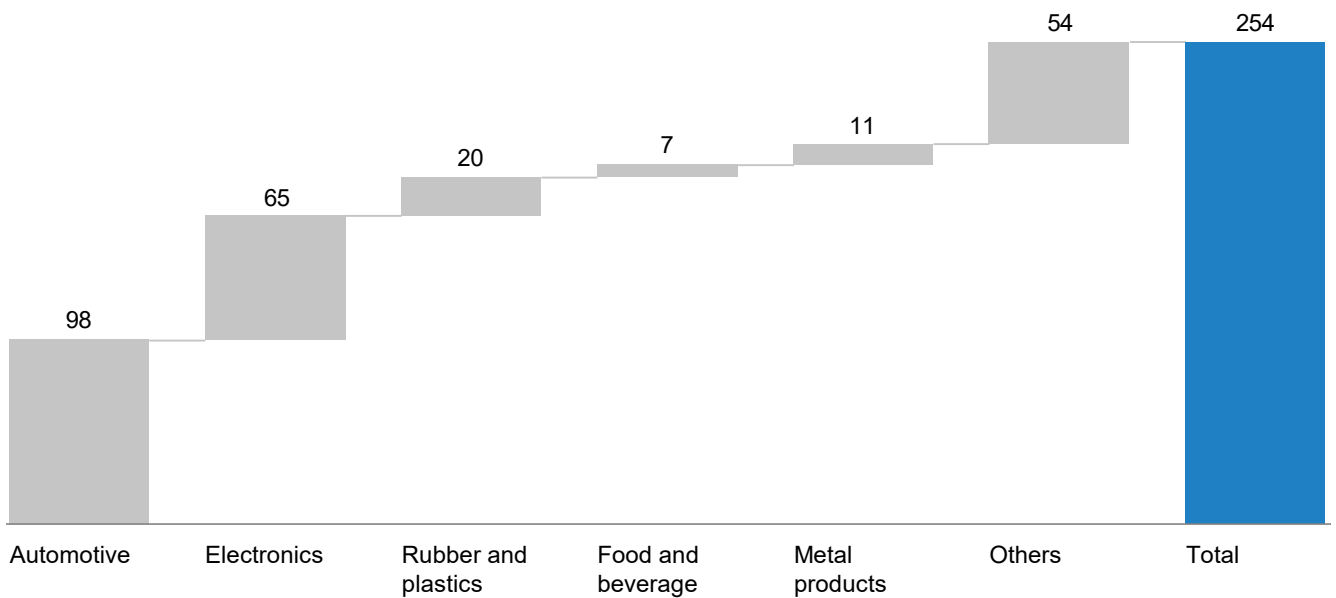
Intensity of industrial robot usage

Number of robots per 10,000 manufacturing workers



Global shipment of industrial robots, 2015

Thousand units



NOTE: Numbers may not sum due to rounding.

SOURCE: International Federation of Robotics; World Bank; McKinsey Global Institute analysis

Box 4. The productivity slowdown in US manufacturing

The manufacturing sector has historically had an outsized impact on the nation's productivity growth relative to its share of GDP. Since 1995, manufacturing has driven 35 percent of average annual US productivity growth, with the computer and electronics manufacturing industry being the primary contributor. Over the longer term, productivity improvements in manufacturing have had spillover benefits to other parts of the economy, primarily in the form of lower prices and higher product quality.

All segments of manufacturing participated in a broad-based productivity surge between 1996 and 2004, though to different degrees. Manufacturers of vehicles, heavy machinery, and basic consumer goods, for instance, achieved annual increases in labor productivity of over 5 percent during this period, although manufacturers of locally processed goods managed less than half that rate.

Multiple factors help to explain productivity differences across manufacturing industries. These include tradability and global supply chains, adoption of digital technologies, shifts in product mix, and greater returns to scale. Labor productivity was two to three times higher in industries that were more exposed to trade and had a greater weighting of large firms as compared with industries that were more domestically focused and more heavily populated by smaller firms, for instance. Large firms benefit from economies of scale, which aids productivity, though the effect varies by industry.¹ Advanced industries such as high-tech, pharmaceutical, aerospace, and automotive manufacturing have higher R&D intensity and are more digitized. They account for three-quarters of manufacturing's productivity contribution to the total economy. Process improvements that reduce downtime and improve throughput also help, as does learning by experimentation.²

These productivity differences between manufacturing industries have persisted in the past decade even as productivity growth has slowed in the overall sector and the broader economy since 2005. Between 2005 and 2016, labor productivity growth averaged 2 percent annually in manufacturing overall; 3 percent in vehicles and heavy machinery industries; and near zero in locally processed goods (Exhibit 18). Excluding computers and electronics, the US manufacturing sector has contributed only 6 percent to overall labor productivity growth, underperforming its GDP and employment contribution. Several factors contributed to the decline in manufacturing's productivity growth, including slower growth in capital investment, uneven gains from digital adoption, and persistent productivity gaps between large and small companies. Previous MGI research found 40 percent differentials between high- and low-performing plants in the same industry.³ Other academic research indicates that the gap may be even higher, with plants at the 90th percentile producing almost twice as much (with the same inputs) as plants at the 10th percentile.⁴ These trends are reinforced in many US manufacturing industries as firms face real declines in market share, financial pressures in the supply chain, and aging plants and equipment.

¹ Wei Gao and Matthias Kehrig, *Returns to scale, productivity, and competition: Empirical evidence from US manufacturing and construction establishments*, University of Texas at Austin, May 2017.

² Igal Hendel and Yossi Spiegel, "Small steps for workers, a giant leap for productivity," *American Economic Journal: Applied Economics*, volume 6, issue 1, January 2014.

³ *Manufacturing the future: The next era of global growth and innovation*, McKinsey Global Institute, November 2012.

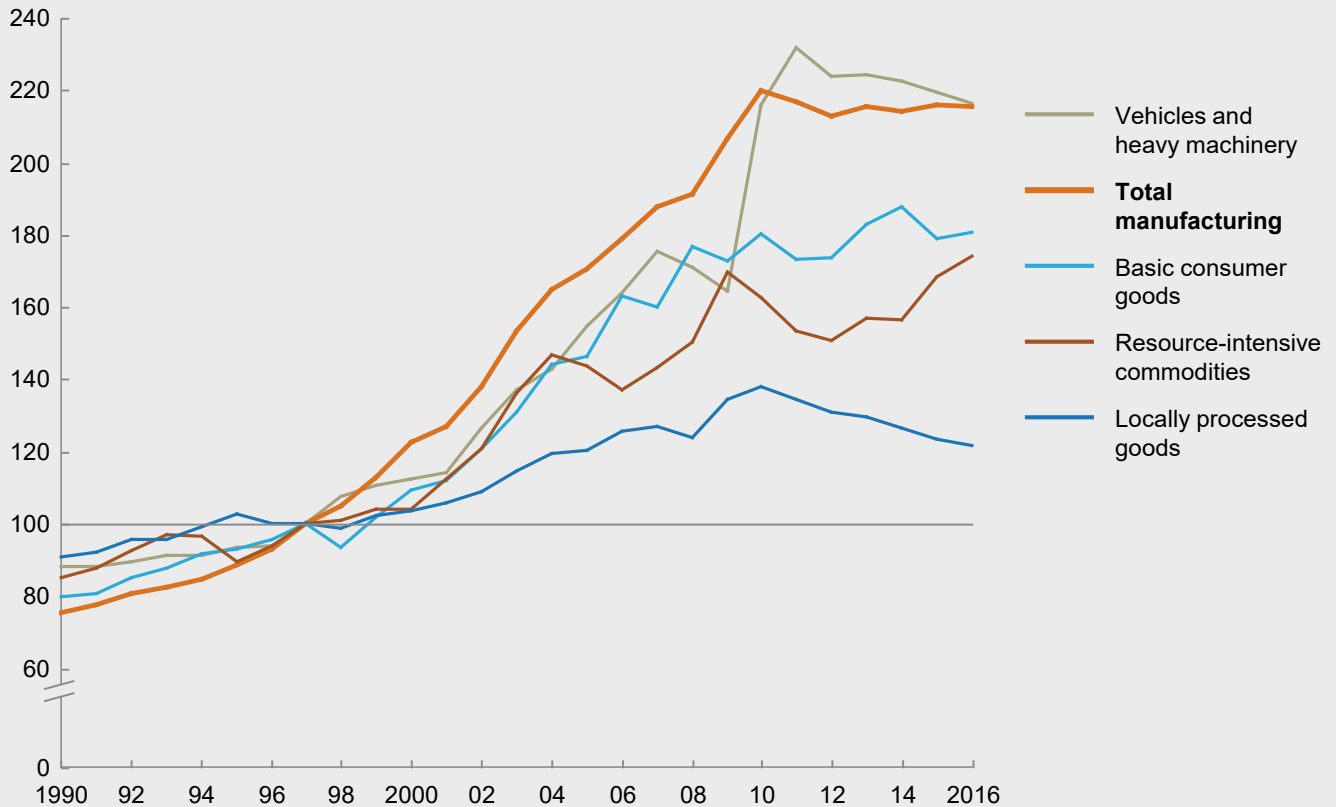
⁴ Chad Syverson, "What determines productivity?" *Journal of Economic Literature*, volume 49, number 2, June 2011.

Exhibit 18

Productivity has declined or stagnated in most US manufacturing segments in the past decade

Productivity by manufacturing segment¹

Index: 100 = 1997



¹ Productivity calculated as real value added over total working hours by segment. The tech-driven innovative products segment, which has grown to 880 from a normalized value of 100 in 1997, is excluded from the graph.

SOURCE: BLS; Moody's; BEA; McKinsey Global Institute analysis

There are new opportunities to turn this situation around, thanks to the technology disruptions described in this report. But they will require deliberate actions: upgrading the capital base, bolstering the supplier ecosystem, accelerating technology adoption, and attracting high-caliber talent. Recent research indicates strong correlations between productivity growth and capital investment, R&D investment, and the ability to attract and retain higher-skilled human capital; it also finds evidence of productivity spillovers across industries through supply-chain linkages and geographic clusters.⁵ There is a need for more rapid and sustained diffusion of productivity-enhancing best practices, particularly in smaller plants and firms. But firms are better able to undertake these actions against a backdrop of growth; their investment and long-term thinking are constrained when their market share, margins, and returns to capital are under pressure.

Forthcoming MGI research will explore some of these issues in more detail, including the causes of productivity slowdown in the United States and Western Europe as well as prospects for raising productivity growth in the future.

⁵ Cliff Waldman, *Productivity dynamics in US manufacturing: An industry-based analysis*, Manufacturers Alliance for Productivity and Innovation, March 2016.

50 YRS
median age of
workers in the
aerospace supply
chain

LOOK FOR NEW SOURCES OF VALUE

Companies need to question their old assumptions as the world evolves. More value is being generated today from design, data, solutions, and brands. Changing factor costs, risks, and digitization make this an opportune moment for companies to reassess past location and sourcing decisions—and even their business models and balance sheets.

Digitization is opening up new sources of revenue. Connected products that capture data on usage can cement the customer relationship through software updates, maintenance agreements, training, or other types of after-sales services. Some companies are even shifting from selling machinery to offering use of their products as a service on a pay-by-usage or subscription model. Even more ambitiously, other firms have created platforms or ecosystems in which they secure a control point. Qualcomm, for instance, has focused on driving standardization efforts for wireless technology—and since many of those standards are based on the company's own products, it now derives a significant share of its business from licensing royalties. Another new type of business model would involve offering production capacity itself as a service.

To find the opportunities, manufacturers need to begin by evaluating their current assets to find untapped sources of potential value. Then they need to look for ways to deepen and secure customer relationships and to take advantage of any proprietary data they hold. There is often value to be had upstream or downstream from production activities—and in fact, digitization makes it possible for companies to blur traditional sector boundaries. Makers of computer hardware can also be providers of IT and professional services, carmakers can branch into ride-sharing, and manufacturers of farming equipment can provide real-time agricultural advisory services based on current conditions.

Integrating products with service offerings can deepen customer relationships and block out competitors. Products themselves have to have “smart” capabilities that can capture usage data, enable predictive maintenance, and “push” information back to the company and its sub-contractors. In addition, companies with a long history of designing, manufacturing, and selling products may need to make organizational changes such as adding more customer-facing teams, deepening digital capabilities, and developing a more service-oriented culture. They also need to evaluate the bottom-line impact of shifting the business model from one-times sales of goods to steady recurring service revenues.

BUILD THE MANUFACTURING WORKFORCE OF THE FUTURE

There is ongoing debate about whether the “skills gap” is overblown and whether employers could take action to solve it.⁸⁸ Nevertheless, many manufacturers do report difficulties filling open positions. The skills gap takes many forms. Some firms say they struggle to find entry-level candidates with basic math, reading, and soft skills. Others report challenges finding workers with the know-how to handle advanced machinery. Over the longer term, these issues seem likely to worsen as aging workers retire. According to BLS data, the median US worker in the aerospace supply chain, for instance, is 50 years old.

Manufacturing jobs are requiring progressively higher skills. The number of low-skill team assemblers (that is, line workers in factories and warehouses) fell by 15 percent from 2000 to 2016. Over the same period, the number of manufacturing workers who lack high school diplomas fell by 46 percent, while the number with postgraduate degrees rose by 35 percent and those with academic associate degrees increased by 23 percent.⁸⁹ **The sector is increasingly adding jobs in areas such as software programming, engineering design,**

⁸⁸ See, for example, Andrew Weaver and Paul Osterman, “Skills demands and mismatch in US manufacturing,” *ILR Review*, July 2016.

⁸⁹ Marc Levinson, *Job creation in the manufacturing revival*, US Congressional Research Service, May 2017.

logistics, and inventory management. **This trend could increase as manufacturers look for revenue in new parts of the value chain.**

As working side-by-side with machines becomes the norm, more jobs in the sector will require specialized digital and technical training. Technologies they will entail are still very new, and they never stop evolving. Education systems need to do a better job of ensuring that all graduates have a baseline level of math and digital skills, but they cannot solve all of the technical mismatches that will arise. Given the industrial diversity of the United States, the large number of SMEs in its manufacturing industries, and their broad and fragmented set of skill requirements, even vocational and technical schools can only address portions of the skill gap.

Manufacturing apprenticeships can be a greater part of the solution, particularly to address the need for specialized skills. Apprenticeships can vary in length and structure, but the common feature is that they pay trainees while they learn on the job and culminate in full-time jobs. They are integrated into the education system in some European countries, where they provide a well-established career path into manufacturing and other skilled trades. In fact, foreign multinationals such as Siemens, Toyota, Bosch, and BMW have set up apprenticeship programs in Kentucky, Tennessee, and the Carolinas.

Apprenticeships are much less common in the United States, but the model is gaining traction. Some employers have their own programs, while others partner with industry groups, labor unions, or non-profits. One approach combines classroom training with hands-on experience in the workplace under the watchful eyes of mentors. Most apprenticeships are designed to train new hires, but Ford and the United Auto Workers offer a joint program that also helps experienced workers gain new skills. After completing courses in subjects such as shop arithmetic and machine tool blueprint reading at a local community college or online, apprentices learn core skills at a Ford training center and work in a series of rotational on-the-job assignments. The entire program runs for three and a half years.⁹⁰

Bolstered by \$265 million in federal administrative grants in 2015 and 2016, the number of apprenticeships registered with the US Department of Labor has surpassed 500,000, with an average starting wage above \$50,000. Ramping up a program to serve nearly 1 million workers (which would be proportional in size to programs in Austria, Germany, or Switzerland) might cost \$40 billion a year. Much of this would come from private employers, but the public sector can increase grant funding and tax incentives to offset the cost for small and midsize firms. An important component of an expanded apprenticeship program would be ensuring that credentials are nationally recognized and portable across companies, industries, and states. Portability creates more options for workers to change firms and industries, which in turn enables higher productivity and wage growth.

Manufacturing industry groups, governments, and technology providers could work together to collect better workforce data and create large-scale digital hiring platforms. Pure Michigan Talent Connect, for example, aggregates regional job listings and training opportunities. More broadly, these types of platforms can track the demand for specific skills and occupations and the effectiveness of specific training programs and educational institutions.⁹¹ Washington State's Workforce Training and Education Coordinating Board surveys businesses in priority industries such as aerospace manufacturing about skills

\$40B
estimated annual
cost of a national
apprenticeship
program

⁹⁰ *The benefits and costs of apprenticeship: A business perspective*, Case Western Reserve University and the US Department of Commerce, November 2016.

⁹¹ For more on this topic, see *A labor market that works: Connecting talent with opportunity in the digital age*, McKinsey Global Institute, June 2015.

and hiring trends; it feeds information about the proficiencies needed in the workplace into education systems.⁹²

Many major employers and industry groups work closely with community colleges to offer certificate programs that are tailored to industry needs. Siemens, for example, has partnered with North Carolina's Central Piedmont Community College to train apprentices in mechatronics and other technical disciplines.

Companies will also need to consider how to make manufacturing careers more attractive to the next generation. After decades of weak wage growth and well-publicized struggles, US manufacturers have a bigger challenge in attracting and retaining top talent than their European and Asian competitors. A 2016 Universum survey showed that while US engineering students ranked aerospace and defense manufacturing companies among their most desired employers, US business and computer science students were less likely than their German peers to aspire to go into manufacturing. Some efforts to counter the persistent negative narrative around manufacturing jobs are already under way. The NEW (Northeast Wisconsin) Manufacturing Alliance, for example, works with educators and local business groups to promote manufacturing careers to young people; its program includes labs that give students hands-on experience. A coalition of industry groups sponsors "Manufacturing Day," an annual event in which thousands of manufacturing firms open their doors for student tours and talks.

THINK BIG AND INVEST FOR THE LONG TERM

Faced with competitive pressures and shareholders focused on quarterly results, many US manufacturers have adopted a cost-cutting mentality. But "short-termism" can yield diminishing returns and turn self-defeating over time. McKinsey's Corporate Horizon Index examined patterns of investment, growth, earnings quality, and earnings management for publicly held US companies. The ones characterized as "long-term" companies consistently invested more and continued to increase R&D expenditures—and, interestingly, they dramatically outperformed other companies in revenue growth, earnings growth, job growth, and return to shareholders.⁹³

25 YRS
age of the average
US factory

Faced with a period of weak demand, many US manufacturers have deferred investment. But now they have aging assets that need to be upgraded, particularly for digital readiness. According to BEA data, the average US factory was 16 years old in 1980, but today it is 25 years old. Inside the plant, the average piece of equipment was seven years old in 1980 but is nine years old today (Exhibit 19). Production assets are even older in metals, machinery, and equipment manufacturing—industries that are critical suppliers to the automobile, aerospace, and electronics industries.

\$115B
estimated annual
cost to upgrade
the sector's asset
base

MGI estimates that upgrading the capital base would require \$115 billion in annual investment over the next decade. There is no time to waste. Many industries have long capex cycles; it can take years to build petrochemical processing plants or semiconductor factories. Companies that put off investing will not be positioned to capitalize when growth picks up. Investors will need to take the long view and give them enough breathing room to make big bets.

The federal government has always recognized the importance of manufacturing and supported the sector through multiple programs already in existence, such as the Manufacturing Extension Partnership for small and medium-size firms and SelectUSA for attracting FDI. But these and other efforts generally have smaller budgets, less certainty of ongoing funding, and more constraints on their mandates than comparable programs in

⁹² "Revisiting top trends in state economic development," National Governors Association, 2016.

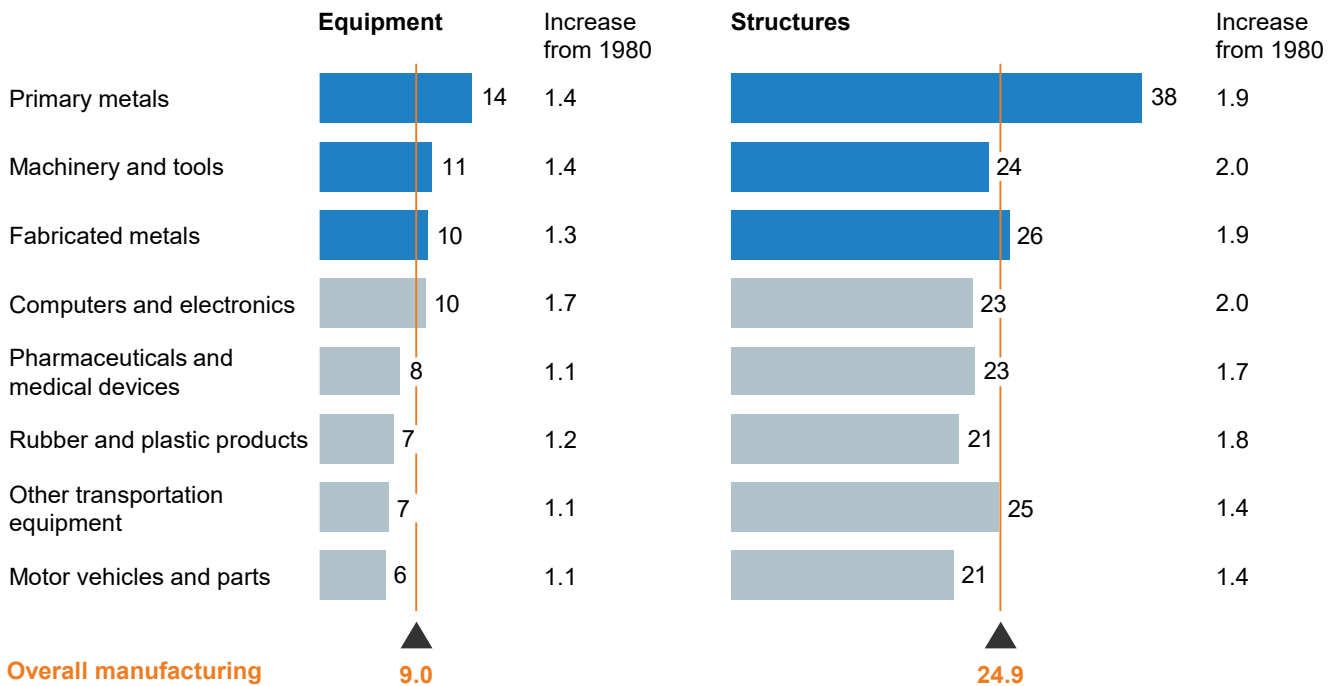
⁹³ *Measuring the economic impact of short-termism*, McKinsey Global Institute discussion paper, February 2017.

other countries. Policy makers should determine which existing initiatives show the most promising results, then scale up those efforts and commit to them for the long term.

Exhibit 19

Production assets are oldest in primary metals, machinery, and fabricated metals, which are critical suppliers to the automotive, aerospace, and electronics industries

Average age (years)



SOURCE: BEA; McKinsey Global Institute analysis

Local policy makers, too, can fall into a short-term mindset. Announcing a brand-new manufacturing plant to their constituents is a political win. But it is too often accomplished by awarding poorly designed subsidies to a patchwork of individual companies without ensuring a sufficient return—and when various US regions try to poach and outdo one another with incentives, the result can be a race to the bottom. Investment incentives, such as job creation tax credits or property tax abatements, have tripled as a share of GDP since 1990, and manufacturing firms have received the largest share of these incentives.⁹⁴

Subsidies are part of the toolbox, but it is critical to insist on a rigorous business case for them and to use them in a targeted way that supports a solid and more holistic economic development plan. Most subsidies are geared to greenfield investment. But a number of advanced manufacturing industries, including computers and electronics, fabricated metals and machinery, pharmaceuticals, and other transportation, have plant utilization rates of less than 70 percent. In those industries, new builds may not make sense. Incentives for brownfield investment could help to modernize legacy assets, making existing manufacturing capacity more productive. It may not be as splashy as opening a new factory, but keeping existing firms and plants competitive is critical to ensuring that regional economies thrive.

Any regional effort to revitalize manufacturing will need to start with an analysis of the region’s sector strengths charted against their future growth trajectories. Exhibit 20

⁹⁴ Timothy J. Bartik, “A new panel database on business incentives for economic development offered by state and local governments in the United States,” prepared for the Pew Charitable Trusts, 2017.

shows an example of how this might look for the Midwest. Such an analysis can provide a road map and rationale for setting strategic priorities. Regions that want to grow their manufacturing base or bounce back from industry losses can then use the targets to identify and sustain investment in workforce skills, infrastructure, institutions, and quality of life over the long haul.

Exhibit 20

Designing a regional economic development strategy starts with reviewing current industry strengths in light of their expected growth rates

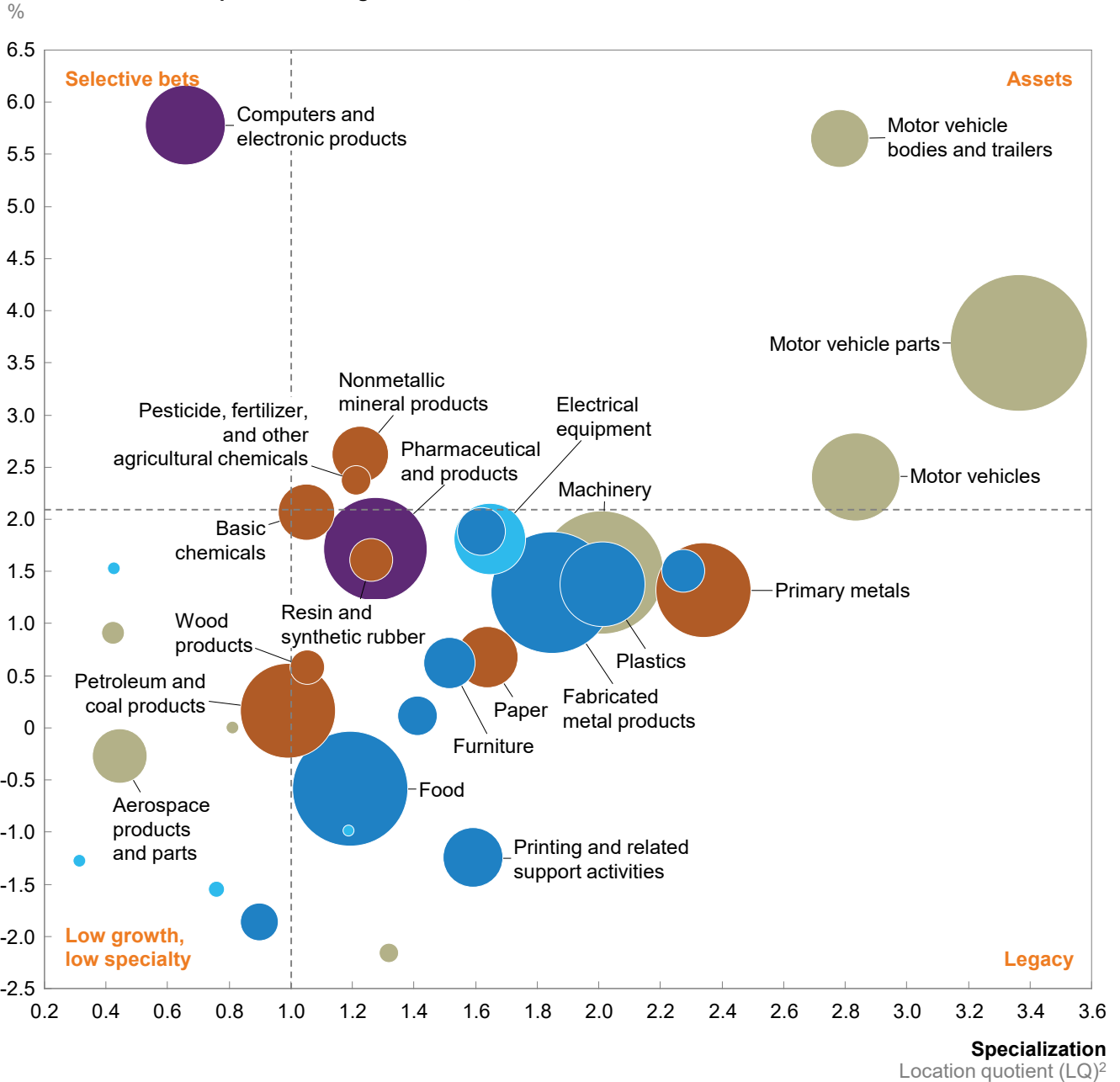
Illustrative example from the Midwest region¹

○ Size of bubble = 2016 real value added

----- US average

- Basic consumer goods
- Locally produced goods
- Tech-driven innovative products
- Resource-intensive commodities
- Vehicles and heavy machinery

Real value added compound annual growth rate, 2016–26



¹ Illinois, Indiana, Michigan, Ohio, Wisconsin.

² Measured as the ratio of a sector's share of 2016 employment in a region to that sector's share of 2016 employment in the United States.

SOURCE: BEA; BLS; Moody's; McKinsey Global Institute analysis



It is not hard to find industry success stories and promising initiatives in US manufacturing, but isolated examples have not created broad momentum. The United States has a huge amount of ground to cover in this race. Revitalizing the entire sector will require dramatically scaling up what works—and the task is too big for any single entity. Manufacturing needs supportive government programs and policies with long-term certainty and funding. It also needs regional coalitions with everyone at the table: large and small manufacturers, workers, technology experts, educators, public officials, and investors. Manufacturing plays such a central role in exports, innovation, investment, and productivity growth that the United States has to ensure that it can thrive and compete in the 21st century.



BIBLIOGRAPHY

A

Autor, David H., David Dorn, Gordon H. Hanson, and Jae Song, "Trade adjustment: Worker-level evidence," *The Quarterly Journal of Economics*, December 2014.

Autor, David, David Dorn, Lawrence F. Katz, Christina Patterson, and John Van Reenen, "Concentrating on the fall of the labor share," NBER working paper number 23108, January 2017.

Autor, David, David Dorn, Lawrence F. Katz, Christina Patterson, and John Van Reenen, "The fall of the labor share and the rise of superstar firms," NBER working paper number 23396, May 2017.

B

Baily, Martin Neil, and Barry P. Bosworth, "US manufacturing: Understanding its past and its potential future," *Journal of Economic Perspectives*, volume 28, number 1, winter 2014.

Baily, Martin Neil, and Robert Z. Lawrence, "Competitiveness and assessment of trade performance," in *C. Fred Bergsten and the world economy*, Peterson Institute for International Economics, 2006.

Bartik, Timothy J., "A new panel database on business incentives for economic development offered by state and local governments in the United States," prepared for the Pew Charitable Trusts, 2017.

Berger, Suzanne, *Making it in America*, MIT Press, 2013.

Bernanke, Ben S., "The global saving glut and the US current account deficit," remarks delivered at the Sandridge Lecture, Virginia Association of Economists, Richmond, Virginia, March 10, 2005.

Brynjolfsson, Erik, and Lorin M. Hitt, "Computing productivity: Firm-level evidence," *Review of Economics and Statistics*, volume 85, number 4, November 2003.

Burru, Simon, Jessica Ghansiam, and Ceren Altincekic, *The effects of exchange rate fluctuations on Canada's automotive industry*, Automotive Policy Research Centre, March 2017.

C

Case Western Reserve University and the US Department of Commerce, *The benefits and costs of apprenticeship: A business perspective*, November 2016.

Chevan, Albert, and Randall Stokes, "Growth in family income inequality, 1970–1990: Industrial restructuring and demographic change," *Demography*, volume 37, issue 3, August 2000.

Choi, Thomas Y., Benjamin B. M. Shao, and Zhan Michael Shi, "Hidden suppliers can make or break your operations," *Harvard Business Review*, May 2015.

Congressional Research Service, *Job creation in the manufacturing revival*, May 2017.

Congressional Research Service, US manufacturing in international perspective, January 2017.

E

Empire State Development, *Buffalo Niagara's strategic plan for prosperity*, January 2017.

Executive Office of the President and the US Commerce Department, *Supply chain innovation: Strengthening America's small manufacturers*, March 2015.

G

Gao, Wei, and Matthias Kehrig, *Returns to scale, productivity, and competition: Empirical evidence from US manufacturing and construction establishments*, May 2017.

George, Katy, Sree Ramaswamy, and Lou Rassey, "Next-shoring: A CEO's guide," *McKinsey Quarterly*, January 2014.

H

Helper, Susan, *Supply chains and equitable growth*, Washington Center for Equitable Growth, October 2016.

Helper, Susan, and Janet Kiehl, "Developing supplier capabilities: Market and non-market approaches," *Industry and Innovation*, volume 11, numbers 1-2, March-June 2004.

Helper, Susan, Timothy Krueger, and Howard Wial, *Why does manufacturing matter? Which manufacturing matters? A policy framework*, Metropolitan Policy Program at Brookings, February 2012.

Helper, Susan, and Howard Wial, "Strengthening American manufacturing: A new federal approach," Metropolitan Policy Program at Brookings, September 2010.

Hendel, Igal, and Yossi Spiegel, "Small steps for workers, a giant leap for productivity," *American Economic Journal: Applied Economics*, volume 6, issue 1, January 2014.

Hidalgo, César A., Bailey Klinger, Albert-László Barabási, and Ricardo Hausmann, "The product space conditions the development of nations," *Science*, volume 317, issue 5837, July 2007.

I

IMF, *2017 external sector report*, July 2017.

J

Jacobs, Ken, Zohar Perla, Ian Perry, and Dave Graham-Squire, *Producing poverty: The public cost of low-wage production jobs in manufacturing*, UC Berkeley Center for Labor Research and Education, May 2016.

L

Lobao, Linda, Jamie Rulli, and Lawrence A. Brown, "Macrolevel theory and local-level inequality: Industrial structure, institutional arrangements, and the political economy of redistribution, 1970 and 1990," *Annals of the Association of American Geographers*, volume 89, number 4, December 1999.

M

Mall, Zeresh, Saqib Jafarey, Shabib Haider Syed, and Ijaz Hussain, "Exchange rate exposure on the automotive industry: Evidence from USA and Japan," *Forman Journal of Economic Studies*, volume 7, January-December 2011.

McKinsey & Company, *The great re-make: Manufacturing for modern times*, June 2017.

McKinsey & Company, *Managing the OEM-supplier interface: Challenges and opportunities for the passenger car industry*, 2007.

McKinsey & Company, *Winning the \$30 trillion decathlon: Going for gold in emerging markets*, August 2012.

McKinsey & Company, Advanced Industries Practice, *Connected car, automotive value chain unbound*, September 2014.

McKinsey & Company, Advanced Industries Practice, *Monetizing car data: New service business opportunities to create new customer benefits*, September 2016.

McKinsey Digital, *Industry 4.0: How to navigate digitization of the manufacturing sector*, 2015.

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

McKinsey Global Institute, *Digital America: A tale of the haves and have-mores*, December 2015.

McKinsey Global Institute, *Digital globalization: The new era of global flows*, March 2016.

McKinsey Global Institute, *Game changers: Five opportunities for US growth and renewal*, July 2013.

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

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

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

McKinsey Global Institute, *Measuring the economic impact of short-termism*, discussion paper, February 2017.

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

McKinsey Global Institute, *Urban world: Cities and the rise of the consuming class*, June 2012.

McKinsey Global Institute, *Urban world: The global consumers to watch*, April 2016.

McKinsey.com, "Digital manufacturing: The revolution will be virtualized," August 2015.

McKinsey.com, "Digitization: The next stop for the apparel-sourcing caravan," September 2017.

McKinsey.com, "How to achieve and sustain the impact of digital manufacturing at scale," June 2017.

McKinsey.com, "Human + machine: A new era of automation in manufacturing," September 2017.

McKinsey.com, "Manufacturing: Analytics unleashes productivity and profitability," August 2017.

McKinsey.com, "Manufacturing's next act," June 2015,

McKinsey.com, "Simpler is (sometimes) better," December 2016.

McKinsey on Business Technology, "How technology can drive the next wave of mass customization," number 32, winter 2013.

Miller, Nancy J., Terry Besser, and Avinash Malshe, "Strategic networking among small businesses in small US communities," *International Small Business Journal*, volume 25, number 6, 2007.

N

Nanry, John, Subu Narayanan, and Louis Rassey, "Digitizing the value chain," *McKinsey Quarterly*, March 2015.

National Governors Association, "*Making*" our future: What states are doing to encourage growth in manufacturing through innovation, entrepreneurship, and investment, January 2013.

National Governors Association, "Revisiting top trends in state economic development," 2016.

O

OECD, *Cardiac arrest or dizzy spell: Why is world trade so weak and what can policy do about it?* Economic Policy Paper number 18, September 2016.

OECD, *The next production revolution: Implications for governments and business*, 2017.

P

Palley, Thomas I., "The overvalued dollar and the US slump," in *Dollar overvaluation and the world economy*, Peterson Institute for International Economics, 2003.

R

Reynolds, Kara M., and John S. Palatucci, "Does trade adjustment assistance make a difference?" *Contemporary Economic Policy*, volume 30, issue 1, January 2012.

S

Schwab, Klaus, *The fourth industrial revolution*, Crown Business, 2017.

Strube, Gernot, Karel Eloit, Nadine Griessmann, Rajat Dhawan, and Sree Ramaswamy, "Trends in the commercial aerospace industry," in *Supply chain integration challenges in commercial aerospace: A comprehensive perspective on the aviation value chain*, Klaus Richter and Johannes Walther, eds., Springer International Publishing, 2016.

Suominen, Kati, and Jessica A. Lee, *Bridging trade finance gaps: State-led innovations to bolster exporting by small and medium-sized firms*, Brookings-Rockefeller Project on State and Metropolitan Innovation, January 2015.

Syverson, Chad, "What determines productivity?" *Journal of Economic Literature*, volume 49, number 2, June 2011.

T

Tassef, Gregory, "Competing in advanced manufacturing: The need for improved growth models and policies," *Journal of Economic Perspectives*, volume 28, number 1, winter 2014.

Timmer, Marcel P., Bart Los, Robert Stehrer, and Gaaitzen J. de Vries, *An anatomy of the global trade slowdown based on the WIOD 2016 release*, University of Groningen, Groningen Growth and Development Centre, December 2016.

U

US Bureau of Labor Statistics, *Manufacturers' outsourcing to temporary help services: A research update*, working paper 493, January 2017.

US Council of Economic Advisers, *Benefits of competition and indicators of market power*, issue brief, updated May 2016.

US Department of Commerce, International Trade Administration, Office of Competition and Economic Analysis, *Do jobs in export industries still pay more? And why?* Manufacturing and Services Economics Brief number 2, 2010.

US Department of Commerce and Office of the US Trade Representative, *The United States of trade: 50 stories in 50 states that show the impact of trade across the US*, April 2015.

US Department of Commerce, Economics and Statistics Administration, *Foreign direct investment in the United States: Update to 2013 report*, June 2016.

US Government Accountability Office, reports on trade adjustment assistance in 2001 (number GAO-01-998) and 2006 (number GAO-06-43).

V

Vodafone, *M2M Barometer 2015*, July 2015.

W

Waldman, Cliff, *Productivity dynamics in US manufacturing: An industry-based analysis*, Manufacturers Alliance for Productivity and Innovation, March 2016.

Weaver, Andrew, and Paul Osterman, "Skills demands and mismatch in US manufacturing," *ILR Review*, July 2016.

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