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MAKING IT IN AMERICA: REVITALIZING US MANUFACTURING

NOVEMBER 2017

EXECUTIVE SUMMARY

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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.

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Sree Ramaswamy | Washington, DC
James Manyika | San Francisco
Gary Pinkus | San Francisco
Katy George | New Jersey
Jonathan Law | New York
Tony Gambell | Chicago
Andrea Serafino | New Jersey

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.

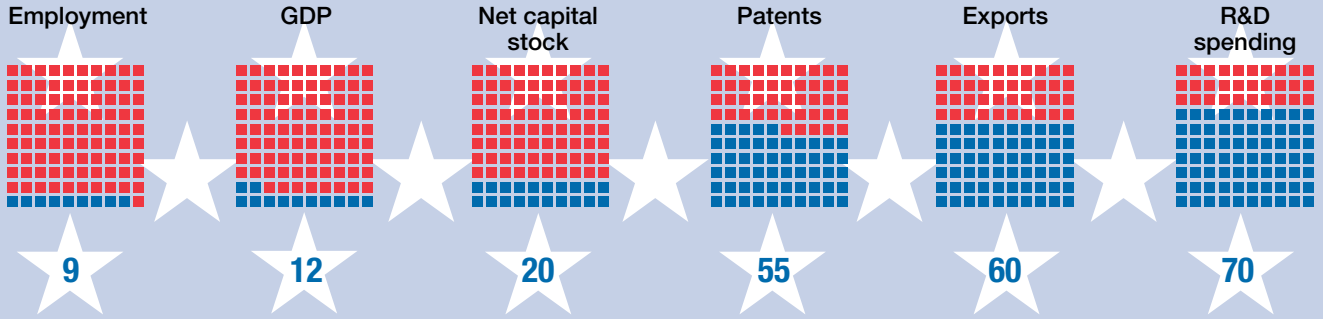
- Despite the loss of global market share over two decades, manufacturing continues to punch above its weight, especially in the 500 counties where it is still the main economic activity. Manufacturing makes up 9 percent of employment and 12 percent of US GDP but drives 35 percent of productivity growth, 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

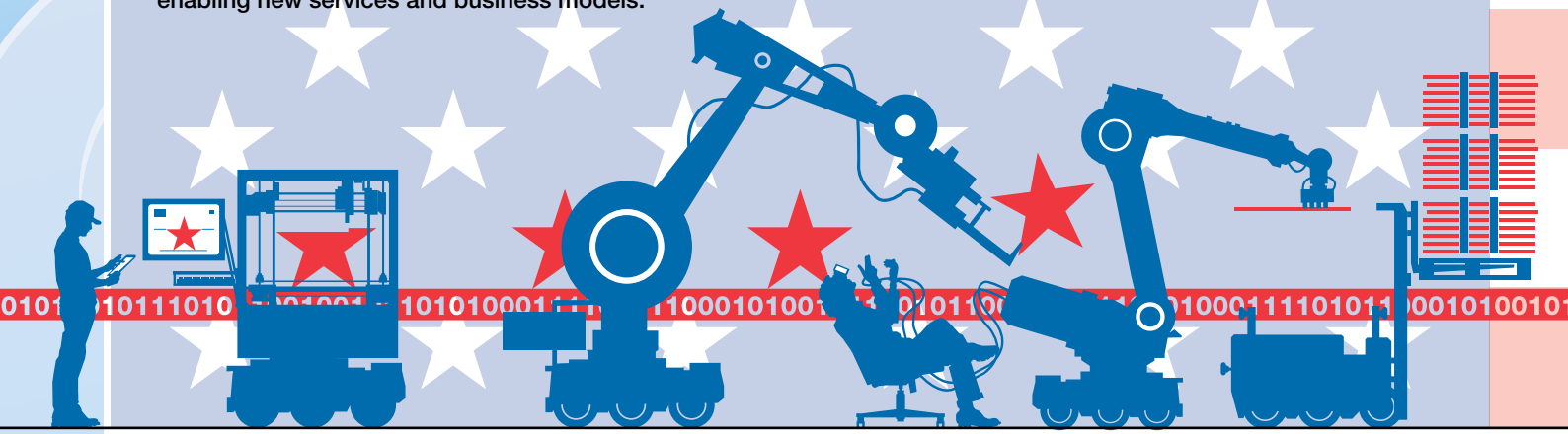
Manufacturing plays an outsized role in national competitiveness

Manufacturing as % of US total, 2016 or latest



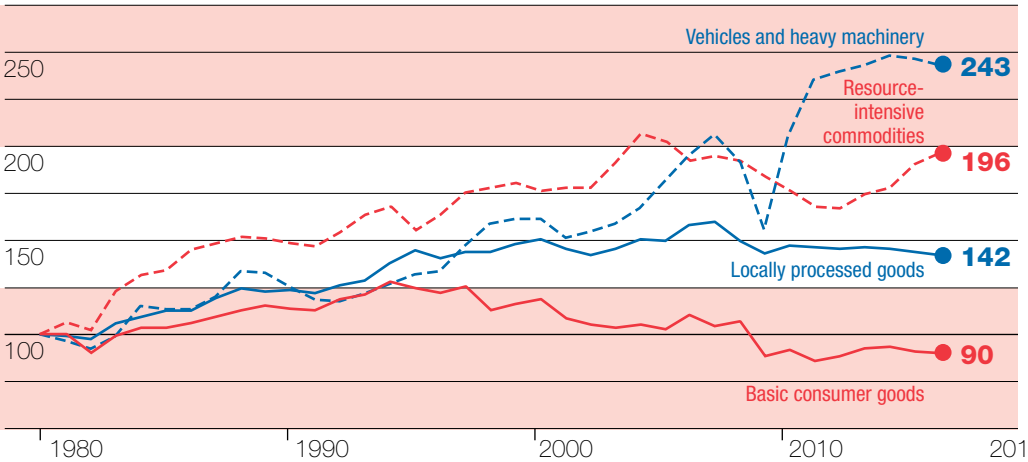
The future of production is digital

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 industries[1]

Index: 100 = 1980



Compound annual growth rate

%

	1990–2016	2000–2016	2007–2016
Vehicles and heavy machinery	2.6	2.6	1.8
Resource-intensive commodities	1.1	0.7	0.1
Locally processed goods	0.5	–0.4	–1.3
Basic consumer goods	–0.9	–1.7	–1.6

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

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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.

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

500
US counties in which manufacturing is still the primary sector

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 (%)

Relative importance of inputs[1]

Low | Low–Medium | Medium–High | High

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

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).

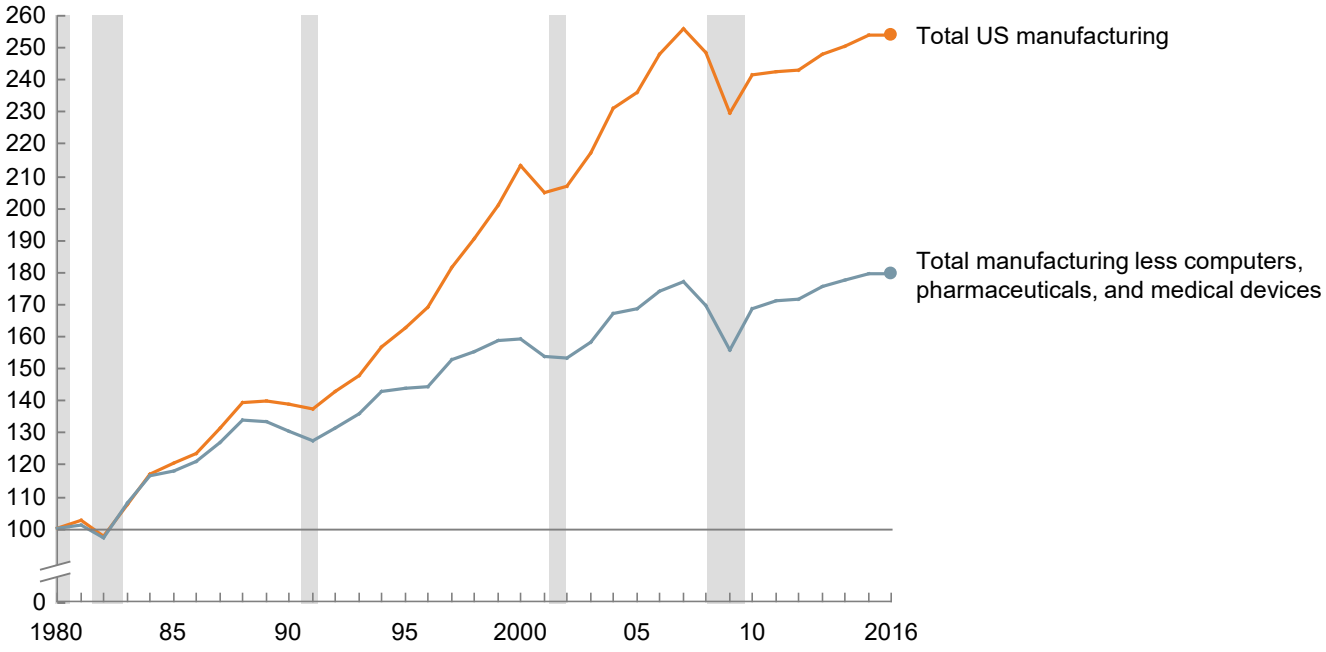
Exhibit E2

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

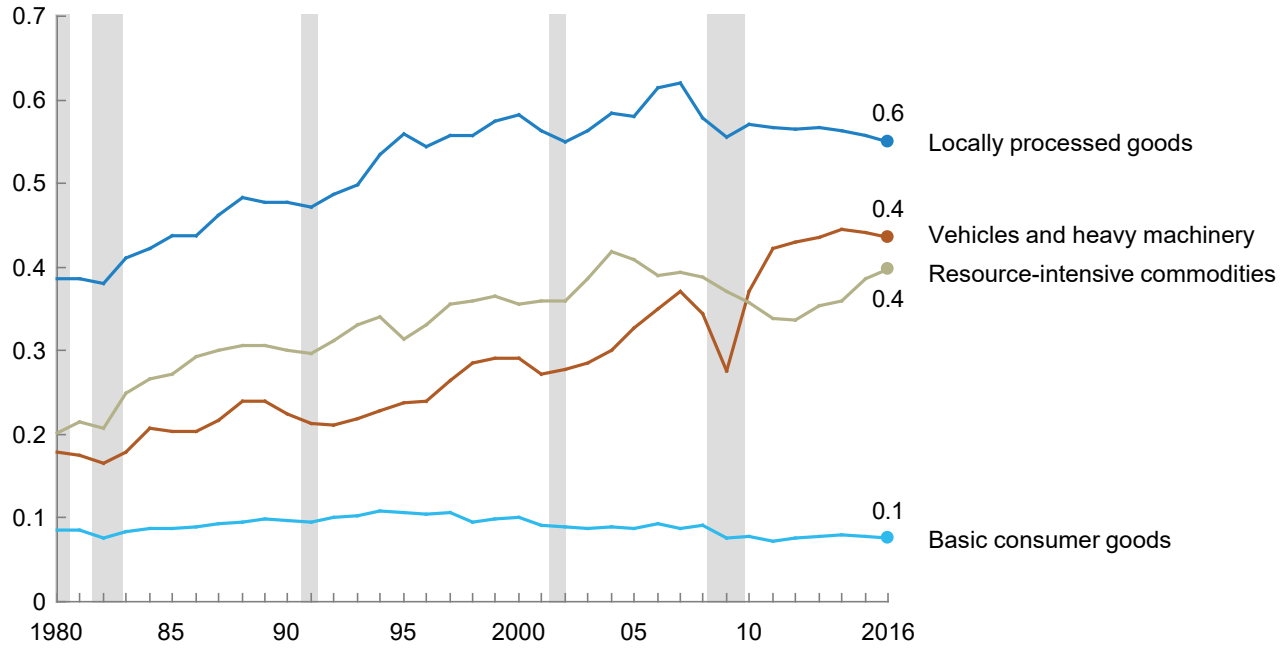


Absolute values[1]
2009 $ trillion

	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.

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

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]

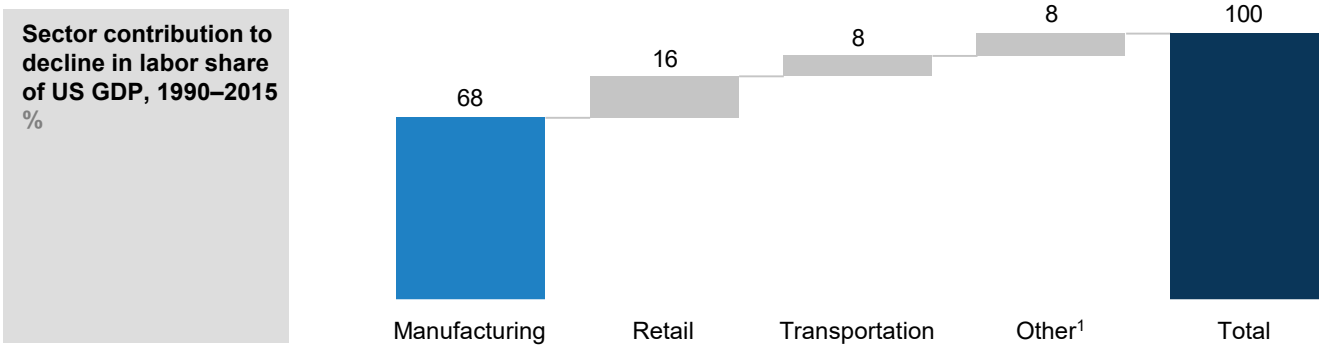
Declining employment and wage stagnation in manufacturing have weakened the health of many local economies. Eighty percent of manufacturing counties have posted weaker income growth or higher unemployment than the national average, even during the recent manufacturing recovery. This is a striking reversal 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).

[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 (%)

	Manufacturing	Retail	Transportation	Other[1]
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.

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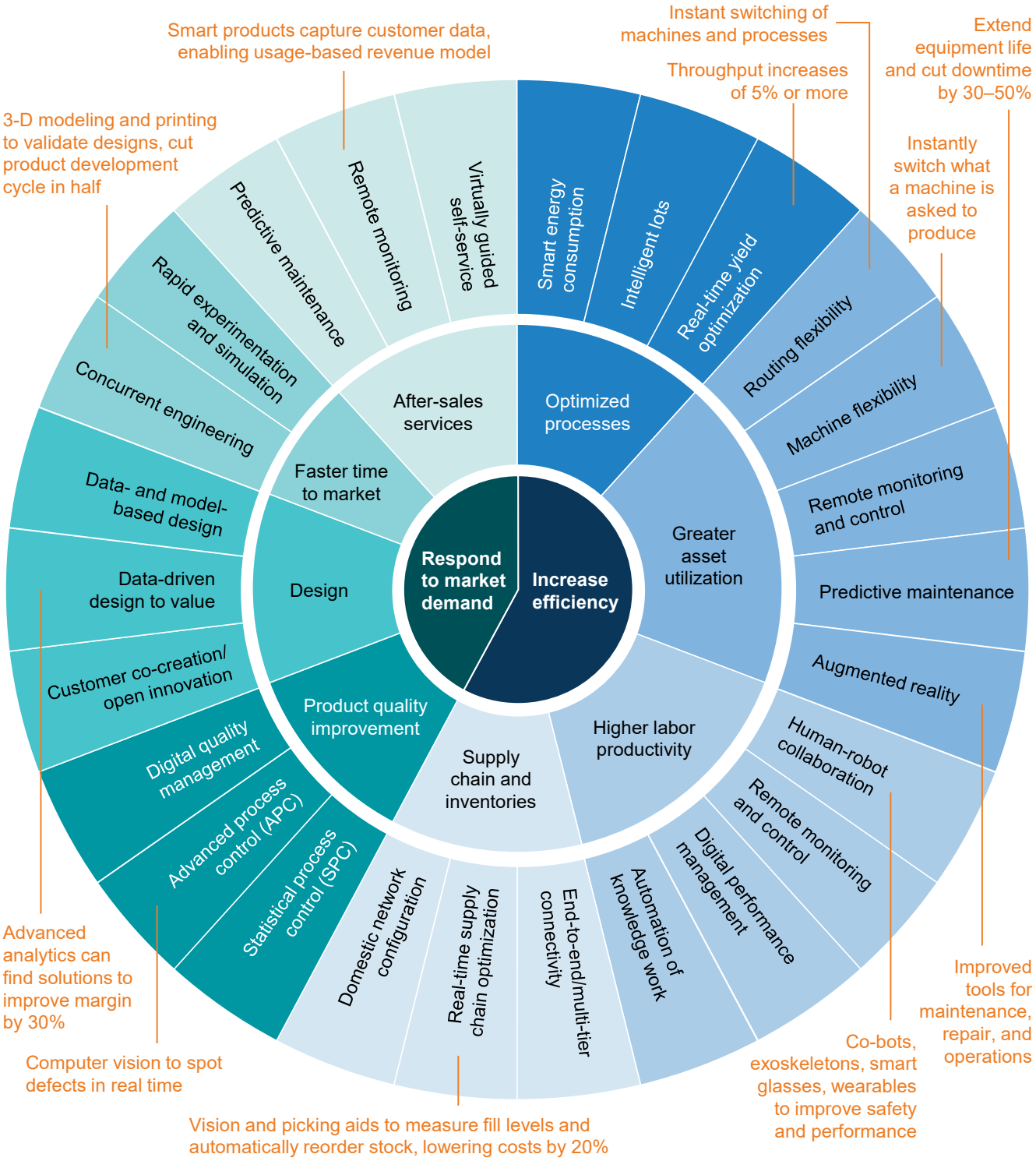
6 *Urban world: Cities and the rise of the consuming class*, McKinsey Global Institute, June 2012.

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.

Exhibit E4

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.

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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.

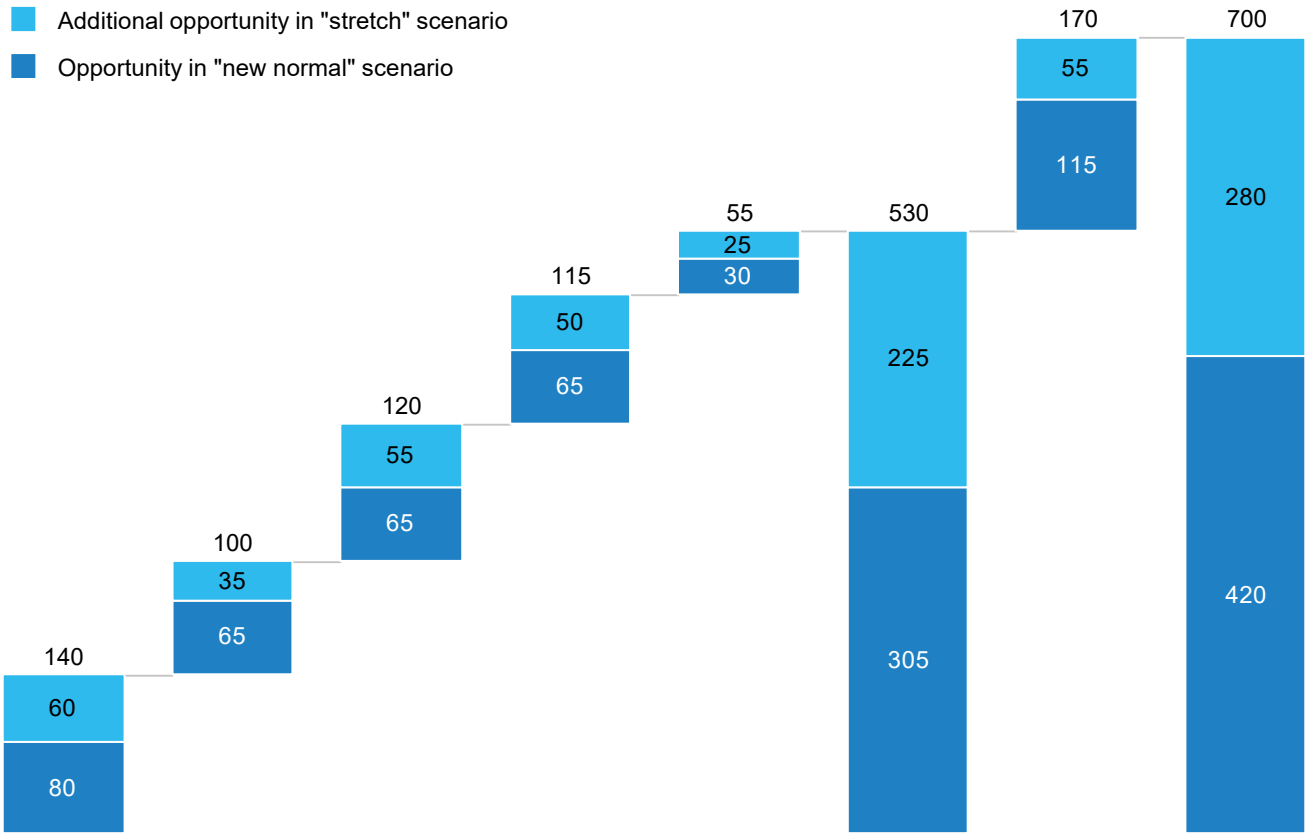
We also consider a “new normal” scenario in which the United States maintains the current level of domestic content in finished goods in most industries, arresting the decline. In this case, value added across the manufacturing sector would hit $2.8 trillion by 2025, an increase of some $300 billion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

Vehicles and heavy machinery	Tech-driven innovative products	Locally processed goods	Resource-intensive commodities	Basic consumer goods	Total manu-facturing	Non-manu-facturing industries[1]	Total economy
390–665	130–200	490–880	160–260	200–365	1,370–2,370	675–960[2]	2,045–3,330

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.

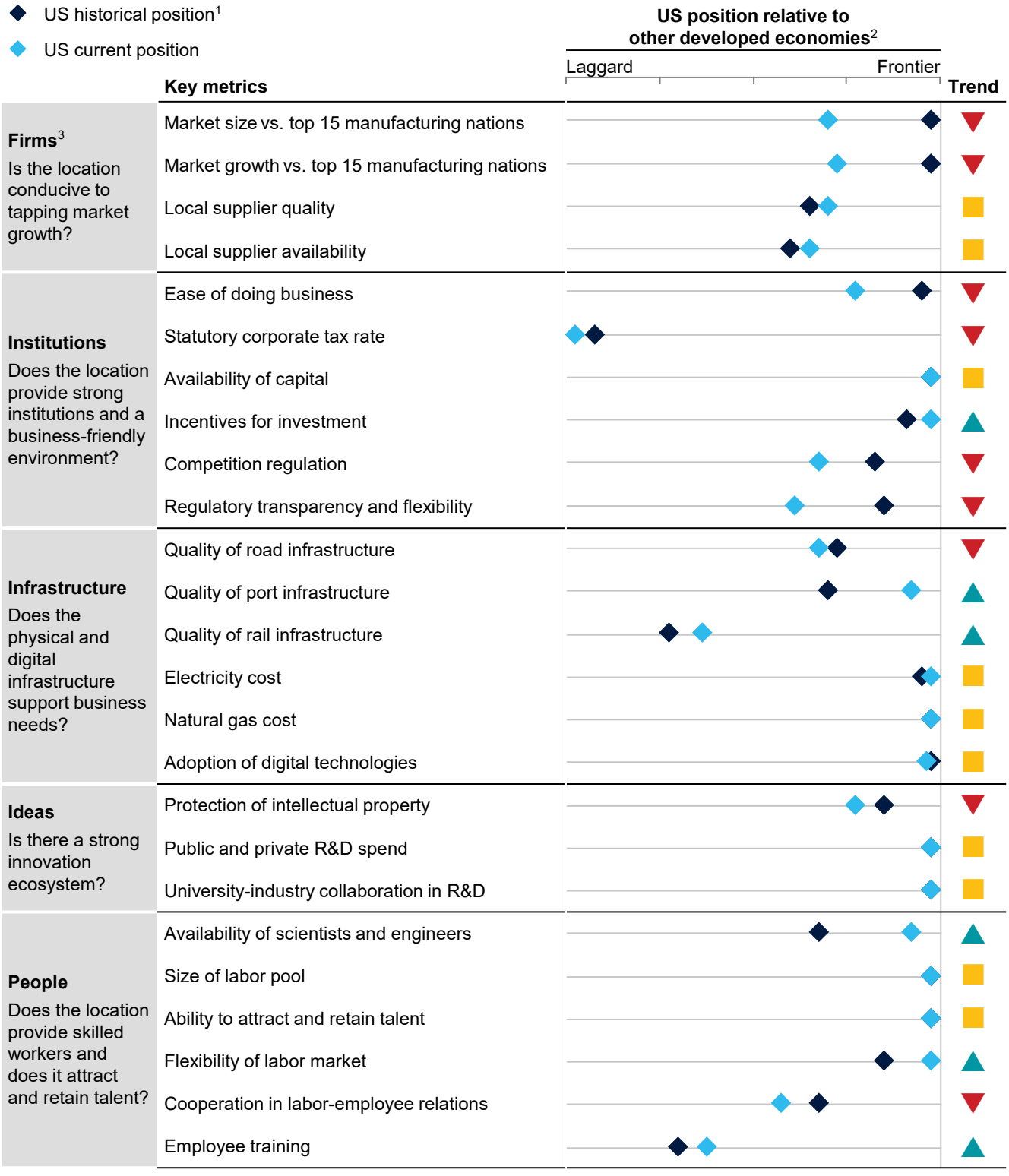
US MANUFACTURING NEEDS TO SCALE UP EFFORTS ON MULTIPLE FRONTS TO COMPETE IN THE FUTURE

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



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

<1%
share of US firms that export

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.

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[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.

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[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.

$40B
estimated annual cost of a national apprenticeship program

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

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.

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

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.

[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.

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