McKinsey Global Institute
McKinsey Operations Practice




November 2012

Manufacturing the future: The next era of global growth and innovation

The McKinsey Global Institute

The McKinsey Global Institute (MGI), the business and economics research arm of McKinsey & Company, was established in 1990 to develop a deeper understanding of the evolving global economy. Our goal is to provide leaders in the commercial, public, and social sectors with the facts and insights on which to base management and policy decisions.

MGI research combines the disciplines of economics and management, employing the analytical tools of economics with the insights of business leaders. Our "micro-to-macro" methodology examines microeconomic industry trends to better understand the broad macroeconomic forces affecting business strategy and public policy. MGI's in-depth reports have covered more than 20 countries and 30 industries. Current research focuses on four themes: productivity and growth; the evolution of global financial markets; the economic impact of technology and innovation; and urbanization. Recent reports have assessed job creation, resource productivity, cities of the future, and the economic impact of the Internet.

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

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

McKinsey Operations Practice

McKinsey & Company founded its Operations Practice in 1997 to assist clients in solving complex strategic and operational problems from diagnosis to hands-on implementation and capability building. Since then, the practice has grown and evolved to become the world's preeminent operations consultancy.

The practice combines practical, global operations expertise with the comprehensive business understanding that underpins all McKinsey disciplines. It works across a wide range of industrial, service, and institutional segments in functional areas that include procurement, product development, supply chain, manufacturing, service operations, and large-scale capital projects.

McKinsey Global Institute
McKinsey Operations Practice

November 2012

Manufacturing the future: The next era of global growth and innovation

James Manyika
Jeff Sinclair
Richard Dobbs
Gernot Strube
Louis Rassey
Jan Mischke
Jaana Remes
Charles Roxburgh
Katy George
David O'Halloran
Sreenivas Ramaswamy

Manufacturing

16% manufacturing share of global GDP

62 million
advanced economy manufacturing jobs in 2000

30–55%
share of service jobs in manufacturing

3 global manufacturing groups where China leads

$342 billion
advanced economies' trade deficit in labor-intensive goods

by the numbers

70% manufacturing share of global trade

45 million
advanced economy manufacturing jobs in 2010

19¢
of service input for every dollar of manufacturing output

2 global manufacturing groups where United States leads

$726 billion
advanced economies' trade surplus in innovative goods

Executive summary

A decade into the 21st century, the role of manufacturing in the global economy continues to evolve. We see a promising future. Over the next 15 years, another 1.8 billion people will enter the global consuming class and worldwide consumption will nearly double to $64 trillion. Developing economies will continue to drive global growth in demand for manufactured goods, becoming just as important as markets as they have been as contributors to the supply chain. And a strong pipeline of innovations in materials, information technology, production processes, and manufacturing operations will give manufacturers the opportunity to design and build new kinds of products, reinvent existing ones, and bring renewed dynamism to the sector.

The factors we describe point to an era of truly global manufacturing opportunities and a strong long-term future for manufacturing in both advanced and developing economies. The new era of manufacturing will be marked by highly agile, networked enterprises that use information and analytics as skillfully as they employ talent and machinery to deliver products and services to diverse global markets. In advanced economies, manufacturing will continue to drive innovation, exports, and productivity growth. In developing economies, manufacturing will continue to provide a pathway to higher living standards. As long as companies and countries understand the evolving nature of manufacturing and act on the powerful trends shaping the global competitive environment, they can thrive in this promising future.

The McKinsey Global Institute undertook the research and analysis that follows to establish a clearer understanding of the role of manufacturing in advanced and developing economies and the choices that companies in different manufacturing industries make about how they organize and operate. We started with an examination of how manufacturing has evolved to this point and then plotted its likely evolution based on the key forces at work in the global manufacturing sector. We also sought to understand the implications of these shifts for companies and policy makers. Our research combined extensive macroeconomic analyses with industry insights from our global operations experts. In addition, we conducted “deep dive” analyses of select industries, including automotive, aerospace, pharmaceuticals, food, steel, and electronics manufacturing.

We find that manufacturing continues to matter a great deal to both developing and advanced economies. We also see that it is a diverse sector, not subject to simple, one-size-fits-all approaches, and that it is evolving to include more service activities and to use more service inputs. And we see that the role of manufacturing in job creation changes as economies mature. Finally, we find that the future of manufacturing is unfolding in an environment of far greater risk and uncertainty than before the Great Recession. And in the near term, the lingering effects of that recession present additional challenges. To win in this environment, companies and governments need new analytical rigor and foresight, new capabilities, and the conviction to act.

MANUFACTURING MATTERS, BUT ITS NATURE IS CHANGING

Manufacturing industries have helped drive economic growth and rising living standards for nearly three centuries and continue to do so in developing economies. Building a manufacturing sector is still a necessary step in national development, raising incomes and providing the machinery, tools, and materials to build modern infrastructure and housing. Even India, which has leapfrogged into the global services trade with its information technology and business process outsourcing industries, continues to build up its manufacturing sector to raise living standards—aiming to raise the share of manufacturing in its economy from 16 percent today to 25 percent by 2022.[1]

How manufacturing matters

Globally, manufacturing output (as measured by gross value added) continues to grow—by about 2.7 percent annually in advanced economies and 7.4 percent in large developing economies (between 2000 and 2007). Economies such as China, India, and Indonesia have risen into the top ranks of global manufacturing and in the world's 15 largest manufacturing economies, the sector contributes from 10 percent to 33 percent of value added (Exhibit E1).

Exhibit E1

Large developing economies are moving up in global manufacturing

Top 15 manufacturers by share of global nominal manufacturing gross value added

Rank	1980	1990	2000	2010
1	United States	United States	United States	United States
2	Germany	Japan	Japan	**China**
3	Japan	Germany	Germany	Japan
4	United Kingdom	Italy	**China**	Germany
5	France	United Kingdom	United Kingdom	Italy
6	Italy	France	Italy	Brazil
7	**China**	**China**	France	South Korea
8	Brazil	Brazil	South Korea	France
9	Spain	Spain	Canada	United Kingdom
10	Canada	Canada	Mexico	**India**
11	Mexico	South Korea[1]	Spain	**Russia**[2]
12	Australia	Mexico	Brazil	Mexico
13	Netherlands	Turkey	Taiwan	**Indonesia**[2]
14	Argentina	**India**	**India**	Spain
15	**India**	Taiwan	Turkey	Canada

1 South Korea ranked 25 in 1980.
2 In 2000, Indonesia ranked 20 and Russia ranked 21.
NOTE: Based on IHS Global Insight database sample of 75 economies, of which 28 are developed and 47 are developing. Manufacturing here is calculated top down from the IHS Global Insight aggregate; there might be discrepancy with bottom-up calculations elsewhere.
SOURCE: IHS Global Insight; McKinsey Global Institute analysis

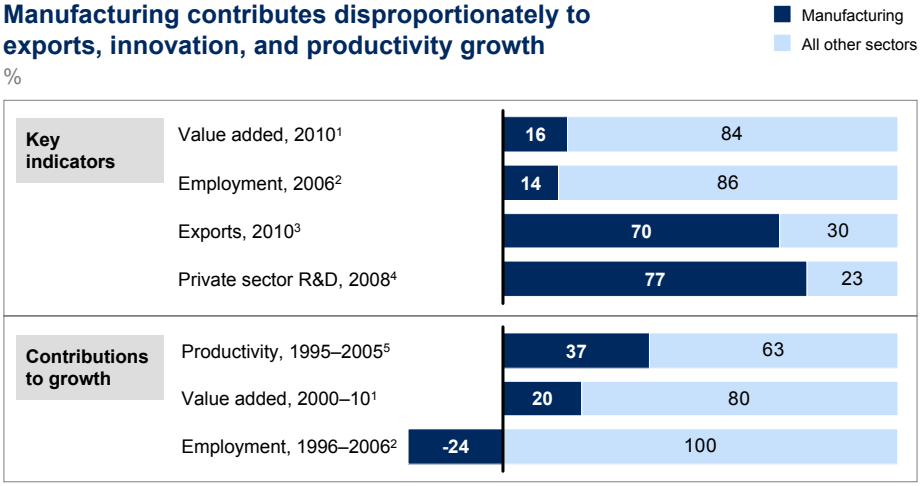
1 India's national manufacturing policy, adopted in November 2011, calls for setting up national manufacturing zones, creating 100 million manufacturing jobs, and raising manufacturing's contribution to GDP from 16 percent today to 25 percent by 2022.

Manufacturing makes outsized contributions to trade, research and development (R&D), and productivity (Exhibit E2). The sector generates 70 percent of exports in major manufacturing economies—both advanced and emerging—and up to 90 percent of business R&D spending. Driven by global competition in many subsectors, manufacturing's share of productivity growth is twice its share of employment in the EU-15 nations and three times its share of US employment. Such productivity growth provides additional benefits, including considerable consumer surplus: since the 1980s, rising efficiency and technological advances have limited increases in the cost of durable goods in the United States to a tenth the rate of consumer price inflation. To capture these economic benefits, countries must create and exploit comparative advantages to convince the most globally competitive and productive companies to participate in their economies.

Exhibit E2

Manufacturing contributes disproportionately to exports, innovation, and productivity growth

%



1 Manufacturing GDP as share of global GDP.
2 2006 data for advanced economies sample of United States, Japan, and EU-15; employment growth contribution calculated for 1996–2006 period.
3 Sample of 28 advanced and 8 developing economies.
4 2008 average of manufacturing share of business R&D spend in Germany and Korea (89%), Japan and China (87%), Mexico (69%), and United States (67%).
5 Manufacturing share of productivity growth in EU-15 for 1995-2005 period.

SOURCE: EU KLEMS; IHS Global Insight; OECD STAN, and ANBERD; Eurostat; World Bank; McKinsey Global Institute analysis

The role of manufacturing in the economy changes over time. Empirical evidence shows that as economies become wealthier and reach middle-income status, manufacturing's share of GDP peaks (at about 20 to 35 percent of GDP). Beyond that point, consumption shifts toward services, hiring in services outpaces job creation in manufacturing, and manufacturing's share of GDP begins to fall along an inverted U curve. Employment follows a similar pattern: manufacturing's share of US employment declined from 25 percent in 1950 to 9 percent in 2008. In Germany, manufacturing jobs fell from 35 percent of employment in 1970 to 18 percent in 2008, and South Korean manufacturing went from 28 percent of employment in 1989 to 17 percent in 2008.

As economies mature, manufacturing becomes more important for other attributes, such as its ability to drive productivity growth, innovation, and trade. Manufacturing also plays a critical role in tackling societal challenges, such as reducing energy and resource consumption and limiting greenhouse gas emissions.

As advanced economies recover from the Great Recession, hiring in manufacturing may accelerate. And the most competitive manufacturing nations may even raise their share of net exports. Whether such a rebound can be sustained, however, depends on how well countries perform on a range of fundamental factors that are important to manufacturing industries: access to low-cost or high-skill labor (or both); proximity to demand; efficient transportation and logistics infrastructure; availability of inputs such as natural resources or inexpensive energy; and proximity to centers of innovation.

Manufacturers in advanced economies will continue to hire workers, both in production and non-production roles, such as design and after-sales service. But in the long run, manufacturing's share of employment will continue to be under pressure in advanced economies. This is due to ongoing productivity improvements, the continued growth of services as a share of the economy, and the force of global competition, which pushes advanced economies to specialize in more high-skill activities. Manufacturing cannot be expected to create mass employment in advanced economies on the scale that it did decades ago.

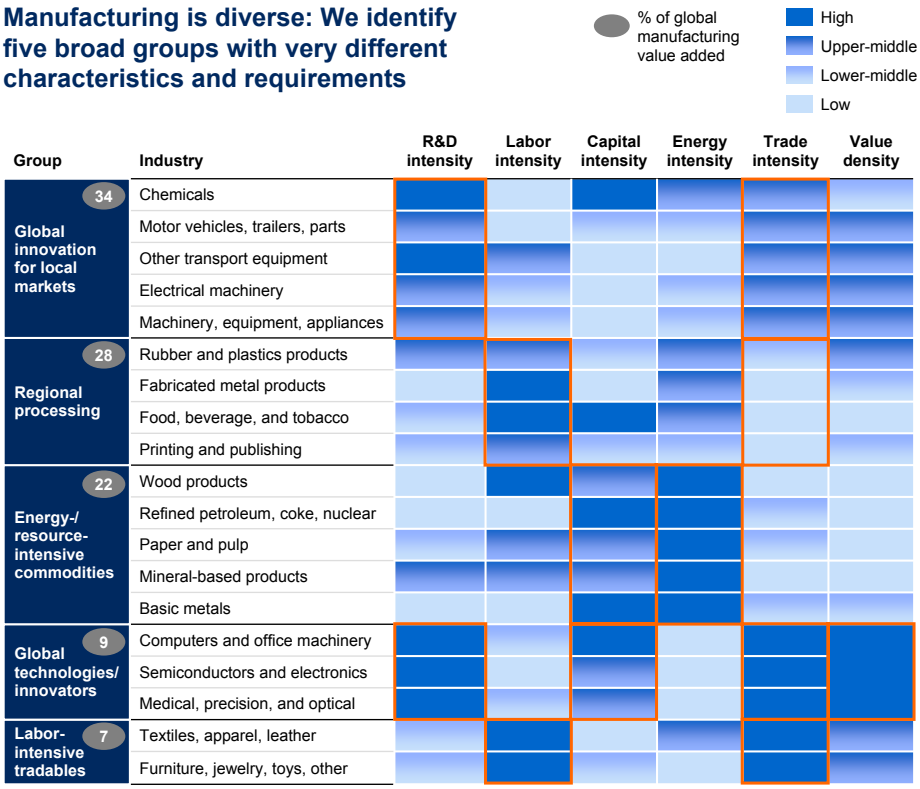
Manufacturing is not monolithic

In order to craft effective business and policy strategies in manufacturing, it is important to start with an understanding of the fundamental differences between manufacturing industries. We identify five broad segments that vary significantly in their sources of competitive advantage and how different factors of production influence where companies build factories, carry out R&D, and go to market. Depending on the industry, factors such as energy and labor costs or proximity to talent, markets, and partners such as suppliers and researchers have greater weight (Exhibit E3). Indeed, many manufacturing companies, including in industries such as automotive and aerospace, are already concerned about a skill shortage.

We find this segmentation a helpful way to see the global nature of different industries, anticipate where manufacturing activities are most likely to take place, and understand the role of innovation in various industries. For companies, the segmentation helps to explain the evolution of different parts of their operations, from individual business units to various stages of their supply chains. The segmentation can also clarify the differences between segments of the same industry—why suppliers of automotive electronic components respond to very different dynamics than suppliers of mechanical parts, for example. The framework also helps explain why the needs and factors of success vary even within the same industry; the carmaker that emphasizes its technological edge and precision engineering has very different requirements than the producer of low-cost models.

Exhibit E3

Manufacturing is diverse: We identify five broad groups with very different characteristics and requirements



SOURCE: IHS Global Insight; OECD; Annual Survey of Manufacturers (ASM) 2010; US 2007 Commodity Flow Survey; McKinsey Global Institute analysis

The largest group is global innovation for local markets, which is composed of industries such as chemicals (including pharmaceuticals); automobiles; other transportation equipment; and machinery, equipment, and appliances. These industries accounted for 34 percent of the $10.5 trillion (nominal) in global manufacturing value added in 2010. Industries in this group are moderately to highly R&D-intensive and depend on a steady stream of innovations and new models to compete. Also, the nature of their products is such that production facilities are distributed close to customers to minimize transportation costs. The footprints of these industries may also be influenced by regulatory effects (e.g., safety standards) and trade agreements.

Regional processing industries are the second-largest manufacturing group globally, with 28 percent of value added, and the largest employer in advanced economies. The group includes food processing and other industries that locate close to demand and sources of raw materials; their products are not heavily traded and not highly dependent on R&D, but they are highly automated. Energy- and resource-intensive commodities such as basic metals make up the third-largest manufacturing group. For these companies, energy prices are important, but they are also tied to markets in which they sell, due to high capital and transportation costs.

Global technology industries such as computers and electronics depend on global R&D and production networks; the high value density of products such as electronic components and mobile phones, make them economically transportable from production sites to customers around the globe. Finally, labor-intensive tradables, such as apparel manufacturing, make up just 7 percent of

value added. The group's goods are highly tradable and companies require low-cost labor. Production is globally traded and migrates to wherever labor rates are low and transportation is reliable.

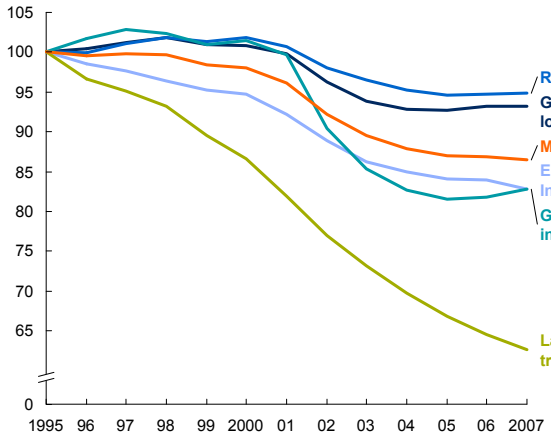
We see that the five segments make very different contributions to the global manufacturing sector and have evolved in dramatically different ways. Industries in just two of the five segments—regional processing and global innovation for local markets—together make up nearly two-thirds of manufacturing value added and more than half of manufacturing employment, both in advanced and emerging economies. Two other industry groups—global technologies and labor-intensive tradables—are both highly traded globally, but exist at opposite ends of the skill spectrum. Together, they make up only 16 percent of value added in both advanced and emerging economies.

The evolution of these manufacturing groups has resulted in some specialization across different types of economies. Advanced economies retain a lead in the global innovation for local markets group and are less competitive in labor-intensive manufacturing. In 2010, advanced economies ran a $726 billion surplus in goods such as automobiles, chemicals, pharmaceuticals, and machinery, and had a $342 billion trade deficit in labor-intensive tradables. While labor-intensive industries in advanced economies have shed 37 percent of their jobs since 1995, regional processing industries (e.g., food manufacturing) have lost only 5 percent of their employment (Exhibit E4).

Exhibit E4

Manufacturing employment in advanced economies has declined across all groups but has fallen most in the labor-intensive tradables group

Manufacturing employment by group in selected advanced economies, 1995–2007[1]
Index: 1995 = 100



Share of manufacturing employment %	1995	2000	2007
Regional processing	33	35	37
Global innovation for local markets	28	29	30
Energy- and resource-intensive commodities	14	14	13
Global technologies/ innovators	8	9	8
Labor-intensive tradables	16	14	12

1 Sample of 17 advanced economies: EU-15, Japan, and United States.
NOTE: Numbers may not sum due to rounding.
SOURCE: EU KLEMS; OECD; McKinsey Global Institute analysis

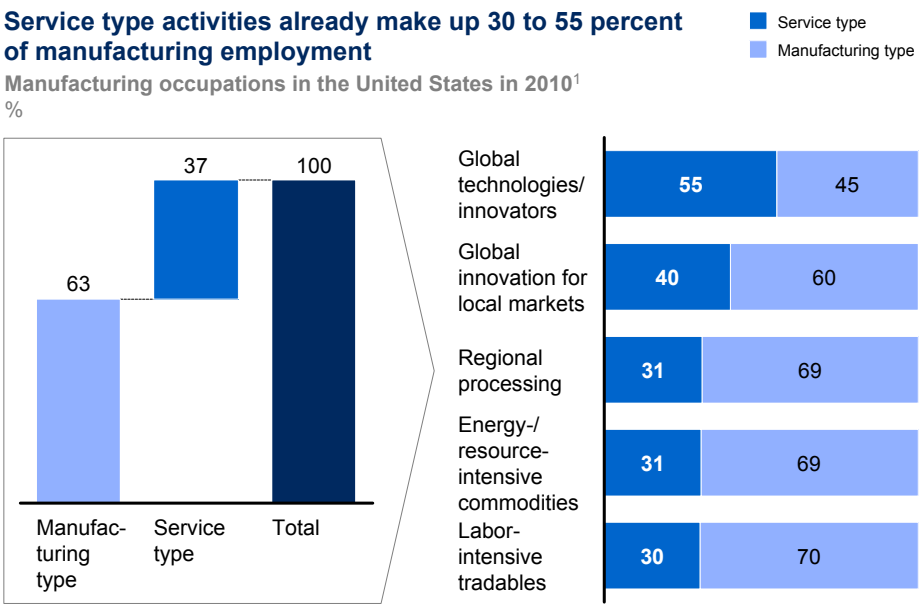
The distinction between manufacturing and services has blurred

Manufacturing has always included a range of activities in addition to production. Over time, service-like activities—such as R&D, marketing and sales, and customer support—have become a larger share of what manufacturing companies do. More than 34 percent of US manufacturing employment is in such service-like occupations today, up from about 32 percent in 2002. Depending on the segment, 30 to 55 percent of manufacturing jobs in advanced economies are service-type functions (Exhibit E5), and service inputs make up 20 to 25 percent of manufacturing output.

Exhibit E5

Service type activities already make up 30 to 55 percent of manufacturing employment

Manufacturing occupations in the United States in 2010[1]
%



1 Manufacturing-type occupations refer to early-stage manufacturing and final assembly. Service occupations include R&D, procurement, distribution, sales and marketing, post-sales service, back-office support, and management.

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

Manufacturing companies rely on a multitude of service providers to produce their goods. These include telecom and travel services to connect workers in global production networks, logistics providers, banks, and IT service providers. We estimate that 4.7 million US service sector jobs depend on business from manufacturers. If we count those and one million primary resources jobs related to manufacturing (e.g., iron ore mining), total manufacturing-related employment in the United States would be 17.2 million, versus 11.5 million in official data in 2010. Including outsourced services, we find that services jobs in US manufacturing-related employment now exceed production jobs—8.9 million in services versus 7.3 million in production.

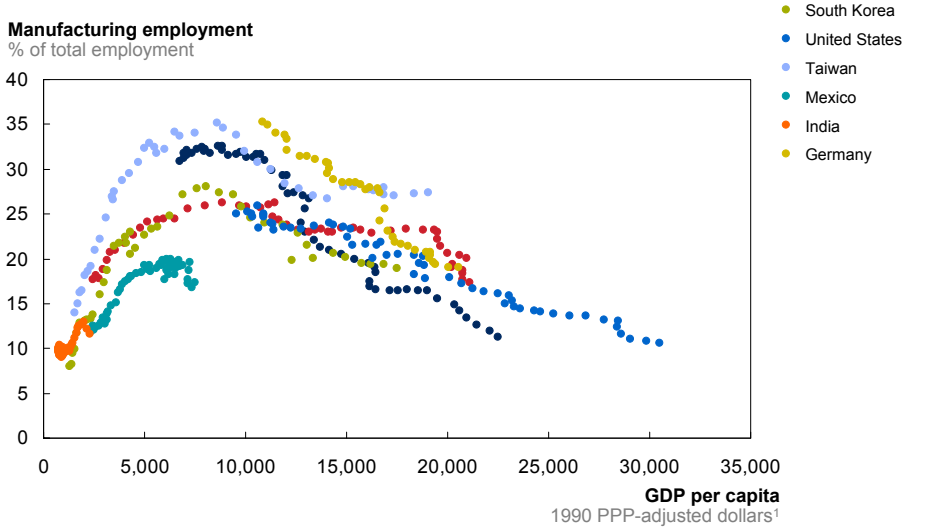
Just as manufacturing creates demand for services inputs, services also create demand for manufactured goods. For every dollar of output, US manufacturers use 19 cents of service inputs, creating $900 billion a year in demand for services, while services create $1.4 trillion in US manufacturing demand. In China manufacturing creates $500 billion in services demand, and services demand $600 billion a year in manufactured goods. And while manufacturing drives more than 80 percent of exports in Germany, services and manufacturing contribute nearly equal shares of value added to the country's total exports.

The role of manufacturing in job creation is changing

Manufacturing's role in job creation shifts over time as manufacturing's share of output falls and as companies invest in technologies and process improvements that raise productivity. Hiring patterns within manufacturing also change, with hiring skewed toward high-skill production jobs and both high- and low-skill service jobs, as hiring in production overall slows. At the same time, growth in service-sector hiring accelerates, raising that sector's share of employment. This pattern holds across advanced economies and will hold for today's developing economies as they become wealthier. As manufacturing's share of national output falls, so does its share of employment, following an inverted U curve (Exhibit E6).

Exhibit E6

Manufacturing's share of total employment falls as the economy grows wealthier, following an inverted U pattern



1 Adjusted using the Geary-Khamis method to obtain a 1990 international dollar, a hypothetical currency unit that allows international comparisons adjusted for exchange rates and purchasing power parity (PPP).

SOURCE: GGDC 10-Sector Database: "Structural change and growth accelerations in Asia and Latin America: A new sectoral data set," *Cliometrica*, volume 3, Issue 2, 2009; McKinsey Global Institute analysis

We find that manufacturing job losses in advanced economies have been concentrated in labor-intensive and highly tradable industries such as apparel and electronics assembly. However, overall in the United States, trade and outsourcing explain only about 20 percent of the 5.8 million manufacturing jobs lost during the 2000-10 period; more than two-thirds of job losses can be attributed to continued productivity growth, which has been outpacing demand growth for the past decade.

Even strong manufacturing exporting nations have shed jobs in the past decade. Germany's manufacturing employment fell by 8 percent and South Korea's by 11 percent. Our analysis indicates that while manufacturing output will continue to rise and manufacturers will hire more high-skill production workers and workers in non-production roles, overall manufacturing employment will remain under pressure in advanced economies; if current trends persist, manufacturing employment in advanced economies could fall from 45 million jobs today to fewer than 40 million by 2030.

Manufacturing has been regarded as a source of "better" jobs than services, offering higher levels of compensation. However, we find that this distinction is far less clear today. It is true that in aggregate, average compensation is higher in manufacturing than in services (17 percent higher in 2006, measured as total labor compensation including social security payments). But when manufacturing and service jobs in industries that have similar factor intensity are compared, the wage differences are small. The gap in average pay between manufacturing and services also is seen in wage distribution. Manufacturing has a disproportionately high number of well-paying jobs in the United States (700,000 more) compared with services and a disproportionately small number of low-paying jobs (720,000 fewer). These wage differences may reflect trade and offshoring effects, unionization, and legacy wage arrangements.

NEW OPPORTUNITIES ARISE IN A MORE COMPLEX AND UNCERTAIN ENVIRONMENT

An exciting new era of global manufacturing is ahead—driven by shifts in demand and by innovations in materials, processes, information technology, and operations. The prospect is for a more "global" manufacturing industry, in which developing economies are the source of new customers as well as the source of low-cost production. It can also be a time of rapid innovation, based on new technologies and methods. However, these opportunities arise in a global environment that is strikingly different from that of the pre-recession period, with shifts in the cost and availability of factor inputs (e.g., labor and natural resources) and rising complexity, uncertainty, and risk.

Some forces are already being felt: the shift of global demand toward developing economies, the proliferation of products to meet fragmenting customer demand, the growing importance of value-added services, and rising wages in low-cost locations. Other trends are now becoming more pronounced, such as a growing scarcity of technical talent to develop and run manufacturing tools and systems, and the use of greater intelligence in product design and manufacturing to boost resource efficiency and track activity in supply chains.

Demand is shifting and fragmenting

The shift in global demand for manufactured goods is happening at an accelerating pace, driven by the momentum of emerging economies. In China, per capita income for more than one billion citizens has doubled in just 12 years, an achievement that took the United Kingdom 150 years with just nine million inhabitants as it industrialized. And China is not alone. With industrialization and rising productivity spreading to other parts of Asia and Africa, some 1.8 billion people are expected to join the global consuming class by 2025, expanding markets for everything from mobile phones to refrigerators and soft drinks.

These new consumers often require very different products to meet their needs, with different features and price points, forcing manufacturers to offer more varieties and SKUs (stock-keeping units). At the same time, customers in more established markets are demanding more variety and faster product cycles, driving additional fragmentation. Finally, customers increasingly look to manufacturers for services, particularly in business-to-business (B2B) markets, creating an additional demand shift.

Innovations create new possibilities

A rich pipeline of innovations promises to create additional demand and drive further productivity gains across manufacturing industries and geographies. New technologies are increasing the importance of information, resource efficiency, and scale variations in manufacturing. These innovations include new materials such as carbon fiber components and nanotechnology, advanced robotics and 3-D printing, and new information technologies that can generate new forms of intelligence, such as big data and the use of data-gathering sensors in production machinery and in logistics (the so-called Internet of Things).

Across manufacturing industries, the use of big data can make substantial improvements in how companies respond to customer needs and how they run their machinery and operations. These enormous databases, which can include anything from online chatter about a brand or product to real-time feeds from machine tools and robots, have great potential for manufacturers—if they can master the technology and find the talent with the analytical skills to turn data into insights or new operating improvements.

Important advances are also taking place in development, process, and production technologies. It is increasingly possible to model the performance of a prototype that exists only as a CAD drawing. Additive manufacturing techniques, such as 3-D printing, are making prototyping easier and opening up exciting new options to produce intricate products such as aerospace components and even replacement human organs. Robots are gaining new capabilities at lower costs and are increasingly able to handle intricate work. The cost of automation relative to labor has fallen by 40 to 50 percent in advanced economies since 1990. In addition, advances in resource efficiency promise to cut use of materials and energy (i.e., green manufacturing). An emerging “circular” economy will help stretch resources through end-of-life recycling and reuse.

An uncertain environment complicates strategy

Even as new markets and technologies open up fresh opportunities for manufacturing companies, a series of changes in the environment creates new challenges and uncertainty. The growth of global value chains has increased exposure of many companies to the impact of natural disasters, as Japan’s 2011 earthquake and Thailand’s flooding have demonstrated. And after years of focusing on optimizing their value chains for low cost, many manufacturing companies are being forced to reassess the balance between efficiency gains from globally optimized value chains and the resilience of less fragmented and dispersed operations.

Catastrophic events are not the only sources of uncertainty facing manufacturing companies. Manufacturers also face fluctuating demand and commodity prices, currency volatility, and various kinds of supply-chain disruptions that chip away at profits, increase costs, and prevent organizations from exploiting market opportunities. Price increases in many commodities in the past decade have all but erased the price declines of the past century. Volatility in raw materials prices has increased by more than 50 percent in recent years and is now at an all-time high.[2] Long-term shifts in global demand are accompanied by

2 *Resource revolution: Meeting the world’s energy, materials, food, and water needs*, McKinsey Global Institute, November 2011 (www.mckinsey.com/mgi).

significant upswings and downswings in demand, driven by changes in customer preferences, purchasing power, and events such as quality problems.

Government action is another source of uncertainty. Governments continue to be active in manufacturing policy, even as the path of economic growth and the outlook for fiscal and financial market stability remain uncertain. All too often government action (and lack of action) simply adds to uncertainty. This is the case with unclear energy and carbon emissions policies. And, while trade barriers continue to fall around the world with the proliferation of preferential trade agreements, there are many exceptions. Government interventions persist—sometimes with protectionist measures—in industries such as autos and steel, which many governments regard as national priorities for employment and competitiveness. Steel tariffs have fallen over the past 20 years, but governments continue to favor domestic steel production in other ways.

As the world works through the aftermath of the financial crisis with household, banking, and public sector deleveraging; as rebalancing of trade propels exchange rate swings; and as the momentum of emerging economies puts friction on natural resource prices, uncertainty will prevail.

Implications for footprints, investment, and competition

Taken together, the opportunities and challenges described here have the potential to shift the basis for how companies pursue new markets and how they will expand their production and R&D footprints. Not only will companies compete in different ways and build new production and supply networks as they respond to new kinds of demand and forces of change in the global environment, but nations also will learn to compete on a wider range of factors than labor cost or tax rates.

For example, rather than simply responding to changing labor rates, manufacturers will need to consider the full range of factor inputs as they weigh the trade-offs between where they produce their goods and where they sell them. Much has been made of rising Chinese labor costs and falling wages in the United States. However, for most manufacturers, the more pressing workforce issue likely will be the struggle to find well-trained talent. Manufacturing is increasingly high-tech, from the factory floor to the back offices where big data experts will be analyzing trillions of bytes of data from machinery, products in the field, and consumers. The global supply of high-skill workers is not keeping up with demand, and the McKinsey Global Institute projects a potential shortage of more than 40 million high-skill workers by 2020. Aging economies, including China, will face the greatest potential gaps.

Global competition will also be affected by demand shifts and changes in the cost and availability of various supply factors. The global footprint of regional processing industries such as food processing will naturally follow demand, but for other industries such as automobiles and machinery, transportation and logistics costs or concerns about supply-chain resilience may trump labor costs.

Assessing the future pattern of costs and availability of resources such as raw materials and energy has become more complex. Resource prices rose rapidly before the recession and remain high by 20th-century standards. Yet access to previously untapped sources, such as shale gas in the United States, can change the relative costs of energy inputs and promote domestic production as

a substitute for imports. Then again, many energy-intensive processing industries such as steel tend to be located near demand, and their footprints are “sticky” due to high capital investments and high exit costs. In many industries, market proximity, capital intensity, and transport and logistics matter as much as energy and labor costs.

Finally, to compete, companies also may need to consider access to centers of innovation. This applies to many industries, not just those that make high-tech products. In the United States, for example, a new auto industry technology cluster is emerging around South Carolina’s auto factories.

For companies, the new mindset for making footprint decisions is not just about where to locate production, but also who the competitors are, how demand is changing, how resilient supply chains have to be, and how shifts in factor costs affect a particular business. As new geographic markets open up, companies will be challenged to make location trade-offs in a highly sophisticated, agile way. They will need to weigh proximity to markets and sources of customer insights against the costs and risks in each region or country.

On their part, policy makers will need to recognize that every country is going to compete for global manufacturing industries. Governments will need to invest in building up their comparative advantages—or in acquiring new ones—to increase their appeal to globally competitive and productive companies. As governments compete, they can help tilt the decisions for these companies by taking a comprehensive view of what multinational manufacturing corporations need: access to talent, reliable infrastructure, labor flexibility, access to necessary materials and low-cost energy, and other considerations beyond investment incentives and attractive wage rates.

MANUFACTURERS WILL NEED DETAILED INSIGHTS INTO NEW OPPORTUNITIES, AGILITY, AND NEW CAPABILITIES

To take advantage of emerging opportunities and navigate in a more challenging environment, manufacturing companies need to develop new muscles. They will be challenged to organize and operate in fundamentally different ways to create a new kind of global manufacturing company—an organization that more seamlessly collaborates around the world to design, build, and sell products and services to increasingly diverse customer bases. These organizations will be intelligent and agile enterprises that harness big data and analytics, and collaborate in ecosystems of partners along the value chain, to drive decision making, enhance performance, and manage complexity. They will have the vision and commitment to place the big bets needed to exploit long-term trends such as rising demand in emerging markets, but also will use new tools to manage the attendant risks and near-term uncertainties.

Conventional strategies will be increasingly risky; granularity is key

Companies that stick to business-as-usual approaches will be increasingly at risk. Manufacturers will no longer succeed by “copying and pasting” old strategies into new situations. They must develop a granular understanding of the world around them—and plan the operations strategy to compete in it.

First, manufacturers must understand the dynamics of their segments (e.g., their labor, energy, or innovation intensity), and how new trends play against those requirements and have the potential to redefine sources of competitive advantage.

They will need to understand the trends thoroughly and how they apply to their industries, markets, and customers to identify new opportunities and develop strategies to capture them.

Second, companies must develop a detailed, granular view of markets and customer segments to identify and tailor products and supply-chain strategies to specific subsegments of markets. A McKinsey study, for example, found that segmenting the Chinese market on a national or even on a regional/city basis was not adequate. By analyzing consumer characteristics, demographics, government policies, and other factors, the study identified 22 distinct market clusters that can be targeted independently. In Africa, Nokia learned that consumers had a very different concept of what was valuable in a mobile handset: it had to be affordable, but it also had to have a built-in flashlight and radio, as well as a waterproof case.

Third, companies must match granular insights with granular operations strategy. This will be critically important for capturing new opportunities in developing economies. Recycling the proven methods from advanced economies or even from other emerging markets won't do. A consumer product manufacturer was frustrated in its attempts to enter an emerging market until it conducted detailed on-the-ground research. Only then did it learn that, unlike in every other nation where it sold this particular product, consumers in this emerging market required packaging that could be reused for other purposes after the contents were used up.

Beyond simple labor-cost arbitrage: total factor performance

The way footprint decisions have been made in the past, especially the herd-like reflex to chase low-cost labor, needs to be replaced with more nuanced, multi-factor analyses. Companies must look beyond the simple math of labor-cost arbitrage to consider total factor performance across the full range of factor inputs and other forces that determine what it costs to build and sell products—including labor, transportation, leadership talent, materials and components, energy, capital, regulation, and trade policy. In doing so, the answers to key questions will often shift: for example, where to locate plants, or whether to automate or not. While companies have talked about taking a total landed cost view for some time, few get it right.

In an increasingly uncertain and volatile world, companies also need to shift strategic and business planning from simple point forecasts to scenario assessments that accurately reflect the variability of key factors and drivers. We find that companies still make simple trade-offs because they are not equipped to deal with complexity and fail to take into account the full range of factors and possible outcomes.

Invest and operate with agility

Manufacturers need to be able to make major commitments and manage risk and uncertainty at the same time. The fundamental shifts in demand that are now under way will play out over decades, requiring long-term strategic bets and investments; it can take seven to ten years for even the most successful multinationals to break even in new emerging markets. Yet, even as companies make these commitments, they will face risk and complexity along the way. To achieve this balance between long-term commitment and risk management, companies are making diverse, agile investments. They are getting adept at

scenario planning and at dividing investments among smaller bets across a portfolio of initiatives. The goal is to make each strategic choice less critical, less permanent, and less costly to reverse or redirect. Manufacturers should also continue to heed the productivity imperative. The pursuit of “lean” manufacturing processes is not finished. There continues to be wide variation among the most and least productive players within industries, and the process of simplifying, consolidating, and removing inefficiencies from operations is extending to new areas, such as resource productivity.

To translate strategies into action and make the most of long-term investments, companies also will need to have agile operations. Agility in operations goes far beyond simply ensuring business continuity in the face of risk; it is also about exploiting opportunity, raising the clock rate, and building resilience to daily shocks. Companies with agile operations not only respond more successfully to the bumps along the way and the opportunities, but they also preempt possible disruptions. For example, agile food manufacturers have developed recipes that can accommodate different forms of sugar in case one variety is in short supply.

Build new capabilities for new times

To act on these new bets and execute with agility, companies also will need to develop new operational capabilities and methods. New data-gathering and analytical tools can help identify opportunities to serve new markets, better manage supply chains, and drive innovation and delivery in services. But to make use of big data and analytics, manufacturing companies will need to build new routines for cross-functional and cross-geography collaboration.

New information technologies and new methods will require new tools, talent, and mindsets. To respond quickly to changes in market requirements and meet the demand for faster product cycles, companies will need to build integrated ecosystems of suppliers, researchers, and partners. To design and manage global footprints, companies will need to develop skills in calculating total factor and lifecycle costs (including exit expenses). And the productivity imperative will not go away, but will continue and expand beyond traditional capital/labor trade-offs to include resource productivity.

Finally, manufacturing companies will need to invest in their organizations. Manufacturers have to fight hard to win the war for talent—everything from experts in big data, to executives with deep understanding of emerging markets, to skilled production workers. In many places, manufacturers will need to get more involved in building a talent pipeline. For example, Siemens is implementing a German-style apprenticeship program in Charlotte, North Carolina. Apprentices graduate from the work-study program with degrees in “mechatronics” (mechanical engineering, systems design, and electronics) and are qualified for employment with Siemens.

POLICY MAKERS WILL NEED NEW APPROACHES AND CAPABILITIES TO BOOST COMPETITIVENESS

As manufacturing evolves, policy makers must adjust their expectations and look at manufacturing not as a source of mass employment in traditional production work but as a critical driver of innovation, productivity, and competitiveness. Policies aimed at promoting the health of manufacturing industries also must incorporate the crucial contributions that service employees, services suppliers, and collaborators make. Take exports: between 2000 and 2011, services exports grew slightly faster than goods exports in most advanced economies. In addition, services such as training and maintenance are a growing complement to equipment and machinery exports.

Policy needs to be grounded in a thorough understanding of the diverse industry segments in a national or regional economy and the wider trends that are affecting manufacturing industries. For example, shapers of energy policy need to be cognizant of what industries will be affected by relative energy costs and how great the impact is likely to be—and what magnitude of difference is likely to trigger a location decision. Policy makers should also recognize that supporting new capabilities at home and forging connections needed to access rapidly growing emerging markets are likely to have greater long-term benefits than fighting against the tide. In the fierce competition for attracting and growing leading global companies, manufacturing policies also need to be evaluated against actions by other governments.

The role of policy in manufacturing is largely about enabling and creating an environment for competitive and innovative companies to flourish, helping create sustainable conditions for local manufacturing. There may also be an economic case for intervening to correct market failures or to support young industries, as with US defense spending on emerging technologies or the support that Taiwanese research institutions provided to that nation's semiconductor industry.[3] As policy makers develop new approaches to support manufacturing, they need to consider the full policy tool kit. They need to remove regulatory barriers to growth (from red tape to trade barriers) and strengthen underlying enablers by supporting R&D and investing in infrastructure. In the increasingly competitive environment to attract global companies and encourage their expansion, governments that are able to coordinate their interventions with the private sector and excel in delivering a competitive ecosystem to sustain talent and innovation are more likely to succeed.

A key policy priority for manufacturing is education and skill development. The basis of competition in most manufacturing sectors is shifting and access to diverse talent pools is critically important. Companies need to build R&D capabilities as well as expertise in data analytics and product design. They will need qualified, computer-savvy factory workers and agile managers for complex global supply chains. In addition to continuing efforts to improve public education, particularly in teaching math and analytical skills, policy makers need to work with industry and educational institutions to ensure that skills learned in school fit the needs of employers.

3 *How to compete and grow: A sector guide to policy*, McKinsey Global Institute, March 2010 (www.mckinsey.com/mgi), includes a detailed discussion of the role different governments played in the early stages of semiconductor industry growth, among other examples.

□ □ □

As we publish this report, five years after the beginning of the Great Recession, we see a new era of global manufacturing beginning to take shape. Even as the global economy continues to deal with the aftermath of the recession and the lingering effects on demand and finance, companies are becoming energized by a new series of opportunities that shifting demand and innovation are creating. This new era of manufacturing unfolds in an environment in which old assumptions, strategies, and policies will no longer suffice. With a thorough understanding of the fundamental factors that matter to different manufacturing industries and a sharp focus on the trends shaping global manufacturing, both manufacturing leaders and policy makers can succeed in this new era. They will need to think and act in new ways, develop new sorts of capabilities, and move with conviction. Then, manufacturing can continue to make its great contributions to both advanced and developing economies.

Related McKinsey Global Institute publications

The archipelago economy: Unleashing Indonesia's potential (September 2012)

Most international businesses and investors know that modern Indonesia boasts a substantial population and a wealth of natural resources. But far fewer understand how rapidly the nation is growing. Home to the world's 16th-largest economy, Indonesia is booming thanks largely to a combination of domestic consumption and productivity growth. But to meet its ambitious growth targets and attract international investment, it must do more.

Beyond the boom: Australia's productivity imperative (August 2012)

Australia has been riding the wave of Asia's economic growth, supplying coal, iron ore, and minerals to meet unprecedented demand in China and other emerging markets. As commodity prices spiked in recent years, the country has attracted a flood of investment into its mines, processing plants, pipelines, and ports. Asia's economic and demographic trends point to sustained demand in the decades ahead, but growth fuelled by demand for natural resources carries risk.

Trading myths: Addressing misconceptions about trade, jobs, and competitiveness (May 2012)

To revive anemic growth in the aftermath of the global financial crisis, policy makers in many mature economies are focusing on manufacturing, amid a perception that these countries are losing ground to emerging markets, thus raising the risk of protectionism. With this in mind, MGI analyzes the performance of mature economies' tradable sectors. We found that reality is often at odds with conventional wisdom.

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

For the United States to return to the employment level before the 2008 recession—finding work for the currently unemployed and accommodating new entrants into the labor force this decade—the US economy will need to create 21 million jobs by 2020, according to MGI's analysis. The report analyzes the causes of slow job creation in the period before the recession and during the recovery, and the implications of these forces for job growth.

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

Big data will become a key basis of competition, underpinning new waves of productivity growth, innovation, and consumer surplus—as long as the right policies and enablers are in place.

How to compete and grow: A sector guide to policy (March 2010)

As we emerge slowly from the first global recession since World War II, many governments have taken a more proactive approach to boost growth and competitiveness, and many business leaders support these efforts. Given the fragility of the business and economic climate—and strained public coffers—the responsibility to get policy right is acute. MGI offers insights from industries around the world on policies that have been successful as well as the industrial policy missteps of the past.

www.mckinsey.com/mgi

E-book versions of selected MGI reports are available at MGI's website, Amazon's Kindle bookstore, and Apple's iBookstore.

Download and listen to MGI podcasts on iTunes or at www.mckinsey.com/mgi/publications/multimedia/

McKinsey Global Institute
November 2012

www.mckinsey.com/mgi
@McKinsey_MGI
McKinseyGlobalInstitute