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THE CHINA EFFECT ON GLOBAL INNOVATION

OCTOBER 2015

EXECUTIVE SUMMARY

MCKINSEY GLOBAL INSTITUTE

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IN BRIEF

CHINA CAN BECOME A GLOBAL INNOVATION LEADER

China has the potential to evolve from an innovation sponge—absorbing and adapting global technologies and knowledge—to an innovation leader. Chinese companies are performing well in some types of innovation, by filling consumer needs with better products and services and wielding the power of China's manufacturing ecosystem to make innovations in production processes. China has yet to take the lead in more challenging forms of innovation, such as scientific discovery and engineering, but Chinese companies are using a distinctly Chinese way to nimbly accelerate experimentation and learning on a large scale.

- **China faces an innovation imperative.** As two sources of growth—labor force expansion and heavy capital investment—fade, innovation (broadly defined) will need to contribute up to half of GDP growth by 2025, or $3 trillion to $5 trillion in value per year. We identify opportunities to create value of $1 trillion to $2.2 trillion per year in 2025 through innovations to expand and raise the productivity of the service sector and further improve manufacturing efficiency through digitization.

- **Performance varies across the four "archetypes" of innovation.** We gauge innovation impact by examining 30 industries in four innovation archetypes. China performs well in customer-focused and efficiency-driven archetypes, but is catching up in engineering- and science-based archetypes.

- **China's large and dynamic market gives it an edge in customer-focused innovation.** Chinese innovators use China's massive consumer market (more than 100 million mainstream consumer households today) to commercialize new ideas quickly. Chinese consumers enable innovation by accepting early iterations of products and services and providing feedback for rapid refinement.

- **China's manufacturing ecosystem enables efficiency-driven innovation.** China has the world's most extensive manufacturing ecosystem, with more than five times the supplier base of Japan, 150 million manufacturing workers, and modern infrastructure.

- **Accelerated learning is essential for engineering-based innovation.** Purchasing by government-owned enterprises, facilitation of technology transfers, and introduction of market discipline are accelerating learning needed for engineering-based innovation in such industries as communications equipment, wind power, and high-speed rail.

- **Chinese companies are trying to catch up in science-based innovation using novel approaches.** The government push to raise R&D spending, train scientists, and file for patents has yet to give China a lead in science-based innovation. Today, Chinese companies in science-based industries are developing their own approaches to catch up—taking advantage of China's lower cost and large pool of researchers to industrialize and accelerate experimentation and discovery.

In the next ten years the "China effect" on innovation will be felt around the world as more companies use China as a location for low-cost and rapid innovation. The overall China effect could be disruptive, bringing large-scale yet nimble innovation to serve unmet needs in emerging markets and produce new varieties of goods and services for advanced economies. Around the world consumers could benefit from better goods at lower prices.

China can become a global innovation leader

China faces an innovation imperative

Two traditional sources of growth are fading...

The labor force is no longer growing
Aging is expected to reduce the working-age population by **16% by 2050**

Return on fixed asset investment is declining
It takes **60% more capital** to generate a unit of GDP than it did from 1990 to 2010

...so to sustain 5.5–6.5% growth rates through 2025, innovation would need to contribute up to 50% of GDP growth[1]

Up to 50%
$3T–$5T by 2025

China has opportunities in 4 "archetypes" of innovation

	Efficiency driven	Customer focused	Engineering based	Science based
China's advantages	Extensive manufacturing ecosystem (suppliers, labor, infrastructure)	Massive domestic market for rapid commercialization	Government creates local demand, enables learning	Rapidly increasing, low-cost R&D capacity
Current performance[2]	**Strong** • Solar panels (51%) • Construction machinery (19%)	**Rapidly improving** • Household appliances (36%) • Internet software (15%)	**Mixed** • High-speed rail (41%) • Commercial aviation (1%)	**Opportunities** • Branded pharmaceuticals (<1%) • Semiconductor design (3%)
Future opportunity	Next-generation manufacturing ($450B–$780B by 2025)	Internet-enabled innovation in service sector ($550B–$1.4T by 2025)	Opportunities in targeted industries, including nuclear power, medical equipment	Drug discovery, genomics

Accelerating the China effect to make innovation cheaper, faster, and more global

Companies

Make bigger bets
Invest more in China-based innovation

Operate at China speed
Rapid, nimble innovation processes

Discover new sources of insights
Find ideas through open innovation processes

Build a Chinese talent pool
Recruit and develop talent in novel ways

Government

Enable innovators
Remove barriers and encourage competition

Raise the bar for quality
As purchaser, be a demanding customer

Reward innovators
Reform capital-raising processes and strengthen intellectual property protection

Support innovation clusters
Improve lifestyle factors to attract top talent

[1] Innovation measured as contribution from multifactor productivity growth.
[2] % = Chinese companies' share of global revenue pool.

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EXECUTIVE SUMMARY

How innovative is the Chinese economy? By some common measures of innovation, China has already become a global innovation leader. Each year it spends more than $200 billion on research (second only to the United States) and turns out close to 30,000 PhDs in science and engineering. It leads the world in patent applications (more than 820,000 in 2013). However, when it comes to the actual impact of innovation—as measured by the success of companies in commercializing new ideas and competing in global markets—the picture is mixed. China has become a strong innovator in some industries, largely by serving domestic demand. In the more challenging types of innovation, such as creating new drugs and designing new commercial airliners, China is still not globally competitive.

In this research we have examined the state of innovation across major sectors of the Chinese economy—identifying factors that drive successful innovation in different types of industries and the policies that can advance innovation. We find that China has some unique strengths in innovation, including the largest base of consumers of any country, which enables rapid commercialization of new ideas. It also has the world's most extensive manufacturing ecosystem, enabling continuous innovations in production processes that reduce costs and improve quality. And, thanks to investments over the past three decades, China has created capacity for research with a growing number of universities and research institutions, as well as an expanding pool of talent. We also have identified obstacles to innovation, such as slow regulatory processes and weak intellectual property protections.

$1.0–2.2T

Value of specific innovation opportunities in manufacturing and services

Our conclusion is that China has the potential to build on its strengths in innovation and become a global leader—creating a "China effect" on innovation around the world. This conclusion is based on China's momentum in consumer-facing industries and manufacturing, and its growing capacity for innovation in industries where it is not yet globally competitive. Not only can China serve as the locus of innovation for a growing number of companies that want to penetrate China and other fast-growing emerging markets, but the Chinese approach to innovation also can spread, helping companies everywhere turn ideas into products and services more quickly and for less cost.

Completing the journey from innovation sponge—absorbing and adapting existing technology and knowledge from around the world—to global innovation leader is not just a way to signal China's progress as an economy and society. The boost to productivity that innovation provides is critically important for sustaining China's growth. We also identify specific innovation opportunities in manufacturing and service industries that can contribute $1.0 trillion to $2.2 trillion in value by 2025, or equivalent to as much as 24 percent of total GDP growth.

CHINA'S INNOVATION IMPERATIVE

As the events of 2015 have illustrated, China is in the midst of a very challenging transition to a slower-growing, more consumption-driven economy. For 30 years, from 1985 to 2015, China's GDP rose by 9.4 percent per year on average. However, two forces that helped to drive this growth—a constant flow of new workers into the labor force and massive investments in housing, infrastructure, and industrial capacity—are receding. Because of aging, China's labor force will soon peak—perhaps as soon as 2016—and begin a long decline that could reduce its size by 16 percent by 2050. And macroeconomic returns on fixed asset investments have fallen: it now takes 60 percent more capital to produce one unit of GDP in China than it did, on average, from 1990 to 2010.[1] Investment is also constrained by China's debt, which, at 282 percent of GDP, exceeds debt-to-GDP ratios in the United States and Germany.

It now takes 60 percent more capital to produce one unit of GDP in China than it did, on average, from 1990 to 2010.

Without labor force expansion and investment to propel growth, China must rely more heavily on innovation that can improve productivity. We use multifactor productivity—growth that does not come from factors of production such as labor and capital investment—as a proxy for the macroeconomic impact of innovation broadly defined (including productivity gain from catch-up). The contribution to GDP of multifactor productivity has been falling in China, from nearly half of yearly GDP growth in the 1990 to 2000 decade to 30 percent in the past five years. To reach the growth target of 5.5 to 6.5 percent per year (the current consensus view from five leading economic institutions), multifactor productivity growth will need to contribute 35 to 50 percent of GDP growth, or two to three percentage points per year of GDP (Exhibit E1).[2]

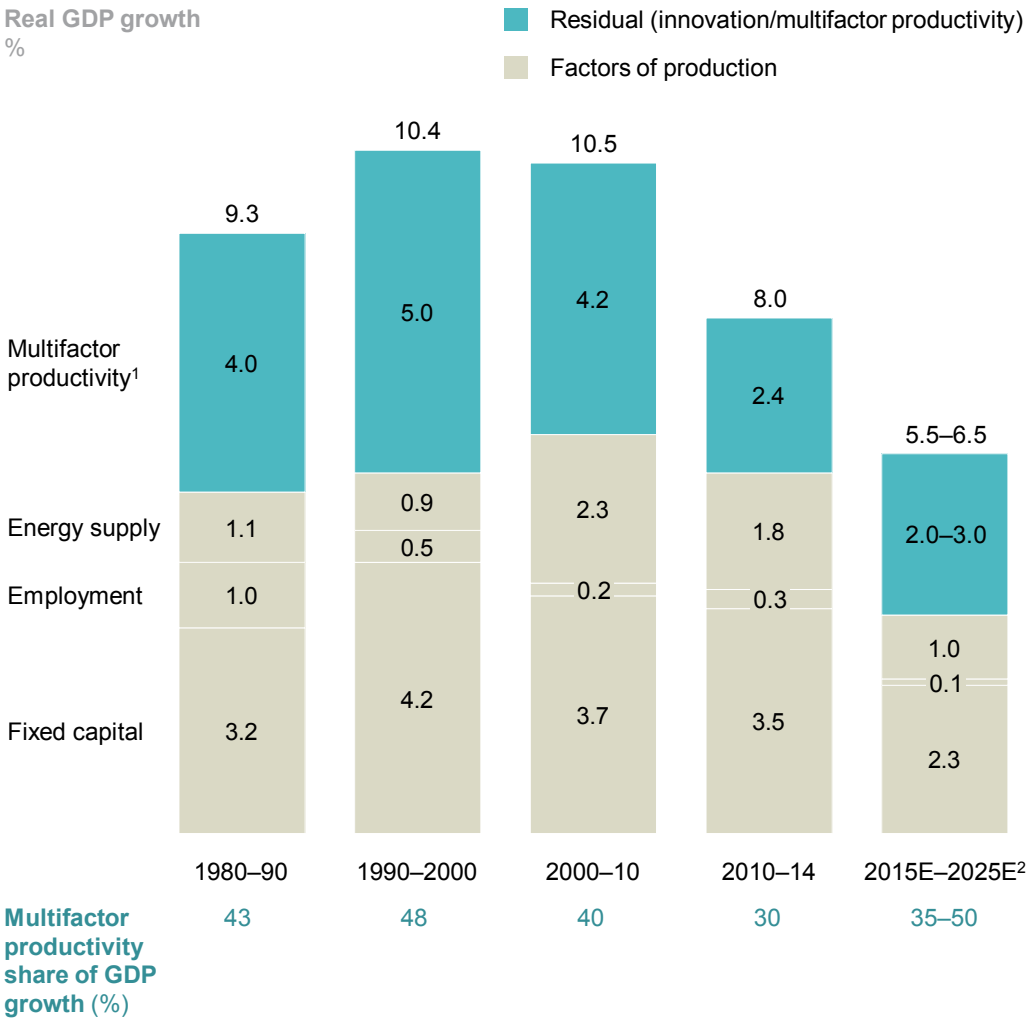
Improving innovation performance would have additional benefits—helping China's transition to a more balanced, consumption-driven economy by expanding the service sector and providing more high value-added jobs. Rising productivity is also critical for creation of the well-paying jobs that can raise living standards and employ a growing urban population.

1 This is based on the incremental capital-output ratio (ICOR), which averaged 3.4 from 1990 to 2010 and stood at 5.4 in 2010 to 2014.

2 Consensus is based on projections from The Economist Intelligence Unit, IHS Global Insight, the International Monetary Fund, the Oxford Economics Forecast, and the World Bank.

Exhibit E1

Innovation (broadly defined) can contribute 2 to 3 percentage points of GDP growth in China by 2025, accounting for 35 to 50 percent of total GDP growth



1 Calculated as total GDP growth minus three factors of production (energy, labor, and capital), multifactor productivity broadly measures the impact of innovation on the economy.
2 Baseline GDP estimate developed by regressing more than 100 variables from historical trends, assuming no major economic shocks. Key variables include demographic change, unemployment rate, interest rate, factor cost changes, depreciation, inflation, and urbanization rate.
NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

HOW INNOVATION HAPPENS: FOUR DIFFERENT ARCHETYPES

To develop a view of the impact of innovation, we identify four archetypes of innovation: customer-focused, efficiency-driven, engineering-based, and science-based. We believe the archetype-based analysis produces a more nuanced picture of innovation performance than national-level metrics and provides more useful insights on which to base company strategies and public policy. We gauge the success of innovation in industries in these archetypes by metrics such as the share of global revenue and profits and the share of global exports that companies have achieved.

Industries that fall into the four archetypes innovate in very different ways. Household appliance and smartphone manufacturing and Internet services fall into our customer-focused archetype. For these businesses, innovation involves identifying and addressing customer needs to develop new products, services, and business models—then using market feedback for frequent modifications and updates. Efficiency-driven innovation involves improving processes in production, product design, and supply-chain management to reduce cost and accelerate time to market. In engineering-based industries such as autos and aerospace, companies innovate by solving engineering problems using accumulated know-how and integrating technologies from suppliers and partners—to engineer cars for better fuel economy, for example. Science-based innovation is about generating new discoveries and turning them into products—a new drug or a semiconductor design.

36%
Chinese share of global household appliance revenue

From the archetype analysis, we see that Chinese companies in some customer-focused and efficiency-driven industries have, in fact, performed well as innovators based on both their shares of global revenue and export markets. Exhibit E2 plots the revenue of Chinese players in the four archetypes in relation to what would be their expected share of global sales in their industries based on China's share of global GDP (12 percent in 2013). We see that in customer-focused innovation, Chinese players have captured more than their GDP-based shares in three out of seven sectors we analyzed. In some of these industries, such as appliances, Chinese companies have high shares of both global revenue and exports—36 percent of global revenue and 20 percent of global exports in appliances, for example. In Internet services and software and Internet retailing, Chinese companies have more than their share of global revenue (15 percent and 14 percent, respectively).

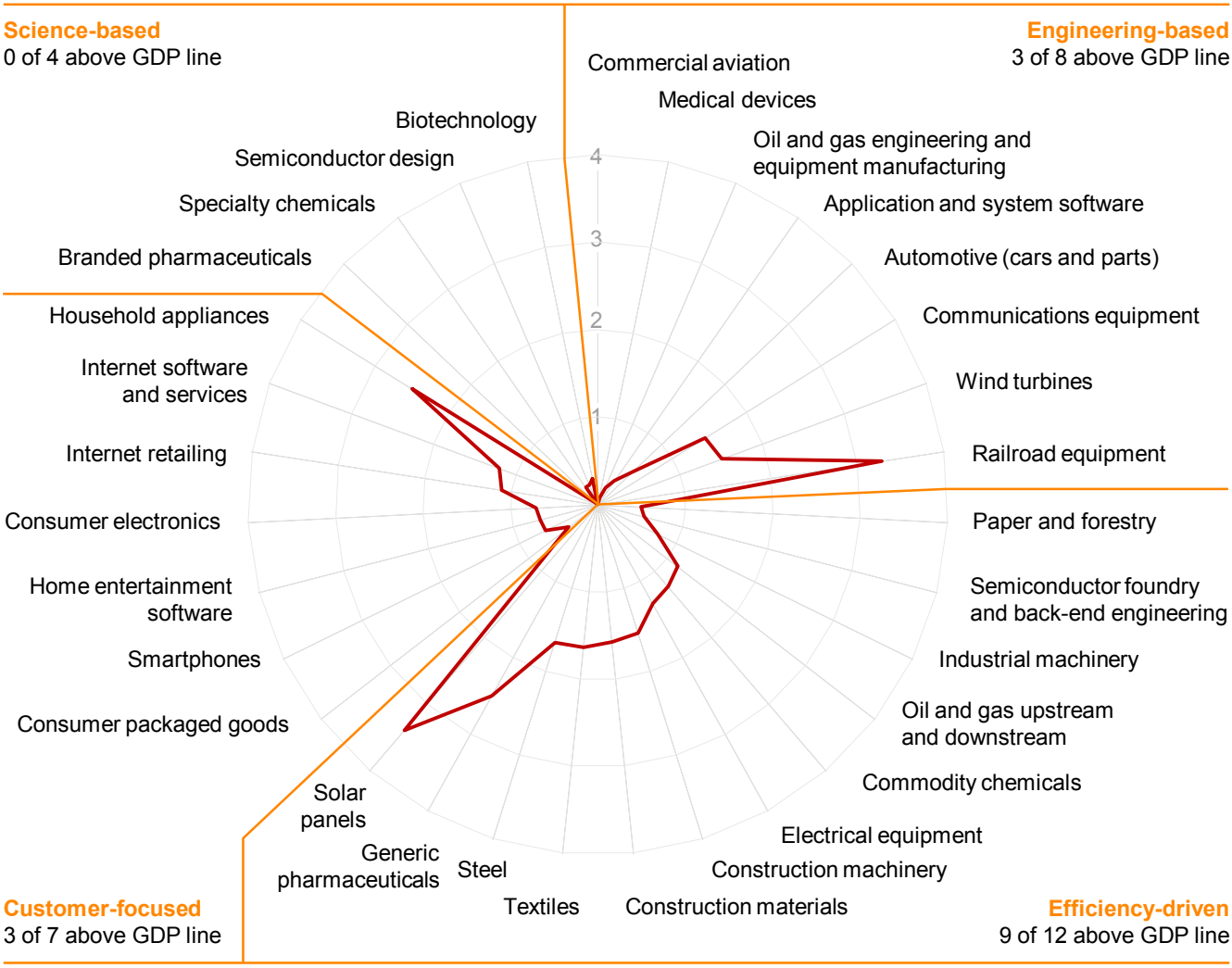
In efficiency-driven industries, China has more than its GDP-based share of global revenue in nine of 12 sectors we analyzed, including in solar panel production, where Chinese players have 51 percent of global revenue. Chinese players in efficiency-driven industries are also increasingly successful in higher value-added segments, such as construction machinery and electrical equipment, where they had 19 and 16 percent of global revenue in 2013, respectively. They are also competing more effectively in global markets, capturing 9 and 6 percent of global exports in 2013, respectively, up from just 1 percent in 2005.

In engineering- and science-based innovation, the picture is mixed. Chinese companies get far more than their share of global revenue in engineering-based businesses such as railroad equipment (41 percent) and wind power (20 percent), but less than their GDP-based share in others, such as autos and commercial aviation. In autos, Chinese manufacturers have only 8 percent of global revenues and 2 percent of exports. In the four industries we analyze in science-based innovation—branded pharmaceuticals, biotechnology, semiconductor design, and specialty chemicals—Chinese players have less than 3 percent of global revenue.

Exhibit E2

China has established strength in efficiency-driven and customer-focused innovation, but lags in science- and engineering-based innovation

Revenue fair share of Chinese companies, 2013[1]
Index: 1 = GDP share



1 This is the ratio of a country's share in the global revenue pool to its share of global GDP.

SOURCE: International Data Corporation; McKinsey Corporate Performance Analysis Tool; company annual reports, IHS Global Insight; iSuppli; McKinsey Global Institute analysis

HOW CHINESE COMPANIES ARE INNOVATING TODAY AND HOW INNOVATION IS EVOLVING

Looking at innovation across the Chinese economy, we see not only that companies in certain archetype industries are doing better than others, but we also see that their success often relies on their ability to take advantage of certain characteristics of the Chinese economy. Internet services and other constituents of our customer-focused archetype, for example, benefit enormously from the sheer size of China's consumer market, which enables rapid and large-scale commercialization of new ideas. Indeed, in China, a niche market such as online gaming is bigger than a major industry such as autos in other countries. For industries that depend on efficiency-driven innovation, China's unique advantage is its extensive manufacturing ecosystem, which provides an unmatched environment for process innovation, with the world's largest supplier base, a massive manufacturing workforce, and a modern supply-chain infrastructure. In the engineering-based group, government policy has played an important role—accelerating innovation by creating local demand in high-speed rail and wind power, for example. And while the massive government push to raise research and development (R&D) spending, train more scientists, and file for more patents has not yet led to leadership in science-based innovation, we see that Chinese companies are taking advantage of China's unique characteristics to catch up. In biotech, for example, companies are using massive scale to speed up the process of drug discovery.

Here we look at the state of Chinese innovation in the four archetypes and consider what's next for innovation for players in each archetype industry.

200M+
Mainstream consumer households by 2025

Customer-focused innovation: The Chinese commercialization machine

As China's consuming class has grown (it now numbers more than 100 million households and is expected to reach more than 200 million by 2025), Chinese companies have learned to read the needs of a rapidly urbanizing nation and quickly scale up new products and services to meet those needs.[3] The first wave of customer-focused innovators were manufacturers of appliances and other household goods whose innovations were "good enough" products—refrigerators or TV sets that had perhaps 80 percent of the features and quality of products made by global players, but that sold for a fraction of the price.

Lately, consumer expectations have been rising along with incomes, and for a growing segment, good enough products no longer suffice. Now companies such as Xiaomi are responding with "cheaper and better" products that are intended to be as good as the models of global brands but are still priced for the Chinese market (Exhibit E3). Xiaomi also exemplifies another trait of customer-focused innovators in China—it uses consumers as collaborators in innovation. Chinese consumers are willing to buy 1.0 versions of products and give feedback that helps manufacturers (or service providers) refine their offerings. Xiaomi relies on more than one million "fans" who vote online for new features that then appear in weekly software updates.

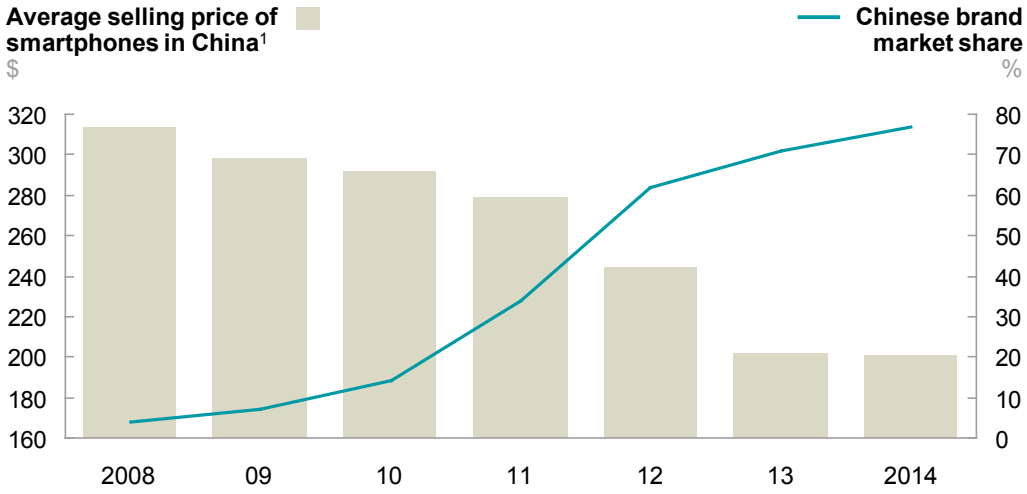
Internet services have been a major source of customer-focused innovation in China. In addition to Alibaba, companies such as Tencent and Baidu have become global leaders in online services simply by serving the Chinese market. These companies have found new ways to meet the needs of the Chinese market. With its online bazaar, for example, Alibaba addressed the need for better retail options for Chinese consumers, particularly those residing in smaller cities and rural areas. Among its innovations to make the online market work in China was Alipay, a service that holds vendor payments in escrow until goods are delivered. Tencent has built a very different model than other social media platforms use for monetizing traffic to its sites. Rather than depending on advertising, which is a relatively

[3] We define the mainstream consuming class as households with disposable annual income of 103,000 to 222,000 renminbi ($16,000 to $34,000).

small business in China, Tencent makes 90 percent of its revenue from sales of virtual goods to online gamers, payments, and e-commerce. In 2014, this innovative business model allowed the company to generate $6 more revenue per user than Facebook did.

Exhibit E3

"Cheaper and better" innovation is helping Chinese brands gain share in smartphones



1 Real value, using 2013 constant prices.

SOURCE: International Data Corporation; Euromonitor; McKinsey Global Institute analysis

$550B–1.4T

Potential value per year from service sector innovations by 2025

In the coming decade, we see an enormous opportunity for customer-focused innovation to reshape large swaths of China's service sector, where productivity is just 15 to 30 percent of the average for service businesses across Organisation for Economic Co-operation and Development (OECD) economies. The government is pushing modernization of traditional businesses through the "Internet Plus" initiative announced in March 2015. Innovations are needed to expand access to services (through remote health monitoring using Internet of Things technology, for example), improve quality (more choices and better customer experiences), and optimize operations (higher asset utilization). We expect more platforms and apps to connect online consumers to services in the physical world (cab hailing via smartphone, for example). We estimate that innovation in service-sector businesses could generate value of $550 billion to $1.4 trillion per year by 2025, equivalent to 11 to 29 percent of service-sector growth. These innovations would not only raise Chinese productivity, but growing the service sector would also help make the economy more consumption-driven, while also benefiting consumers with better services, greater convenience, and lower cost.

Another opportunity for Chinese companies is to use their skills in customer-focused innovation to take the lead in emerging markets. The experience of Chinese consumer goods suppliers in their home market and China's cost advantages give these companies a potential edge over other global players in defining and meeting the needs of new middle- and low-income consumers in developing economies. In Myanmar, Huawei already dominates the mobile phone market with a 50 percent share, and in Brazil, Midea has almost 35 percent of the air conditioner market. There are many similar opportunities in emerging markets for Chinese players—if they can build the sales and marketing skills to turn innovation into market share.

To achieve the potential growth in customer-focused industries in the next ten years, companies will need to build new capabilities. For the most part, Chinese companies have enjoyed unusually favorable circumstances—serving rising domestic demand from a rapidly expanding consuming class and, in many industries, facing no foreign competition. As Chinese consumers become more demanding, more markets open, and Chinese companies compete abroad, success in customer-driven innovation will be more difficult.

Efficiency-driven innovation: The ecosystem advantage

In becoming the "factory to the world," China also became a leading innovator in efficiency-driven innovation. No longer simply a source of low-cost labor, Chinese manufacturing companies are gaining in knowledge-intensive manufacturing categories such as electrical equipment (16 percent of global revenue and 9 percent of global exports) and construction equipment (19 percent of revenue and 6 percent of exports). This progress has been enabled by the vast scale of China's manufacturing ecosystem. China has more than five times the supplier base of Japan, 150 million factory workers, and modern transportation. The combination of supply-chain advantages from this ecosystem and large scale gives Chinese solar panel manufacturers a cost advantage of 22 cents per watt, or about 15 to 20 percent, over foreign peers, according to a Massachusetts Institute of Technology study.[4]

Chinese companies are driving efficiency in a variety of ways, including agile manufacturing, modular design, and a flexible approach to automation. Everstar, an apparel manufacturer, has invested in automated equipment and online design and e-commerce systems that allow consumers to customize clothing and receive finished goods within 72 hours. Modularization saves money by breaking products down into subassemblies. This approach is even being used to industrialize construction. Broad Construction assembled a 57-story hotel in Changsha in 19 days from prefabricated components to demonstrate its innovations. And, while China has become the number one purchaser of robots, companies such as Chint, a maker of electrical equipment, have found that semiautomation—selectively mixing robots and other machinery with labor—provides greater efficiency and flexibility than full automation.

An important development in efficiency-driven innovation is the evolution of open manufacturing platforms. The "maker" movement has taken off in China, and the ecosystem that supports individuals and small entrepreneurs can also work on a global scale. In Shenzhen, a network of component suppliers, design services, business incubators, and outsourced assembly capacity is enabling rapid prototyping and scaling up of manufacturing businesses. HAX Accelerator operates incubators in Shenzhen and San Francisco and brings startup teams from around the world to Shenzhen when they are ready for prototyping.

Open manufacturing platforms are made possible by the rich Chinese manufacturing ecosystem, which is exemplified by Shenzhen itself. The city has 2,000 electronic component and product manufacturers, more than 1,000 makers of electrical parts and equipment, 300 apparel makers, and a labor force of nine million (Exhibit E4). Design firms in Shenzhen can turn ideas into prototypes in as little as one-fifth the time and at half the cost for doing such work in-house. The city's modern infrastructure then speeds goods to world markets.

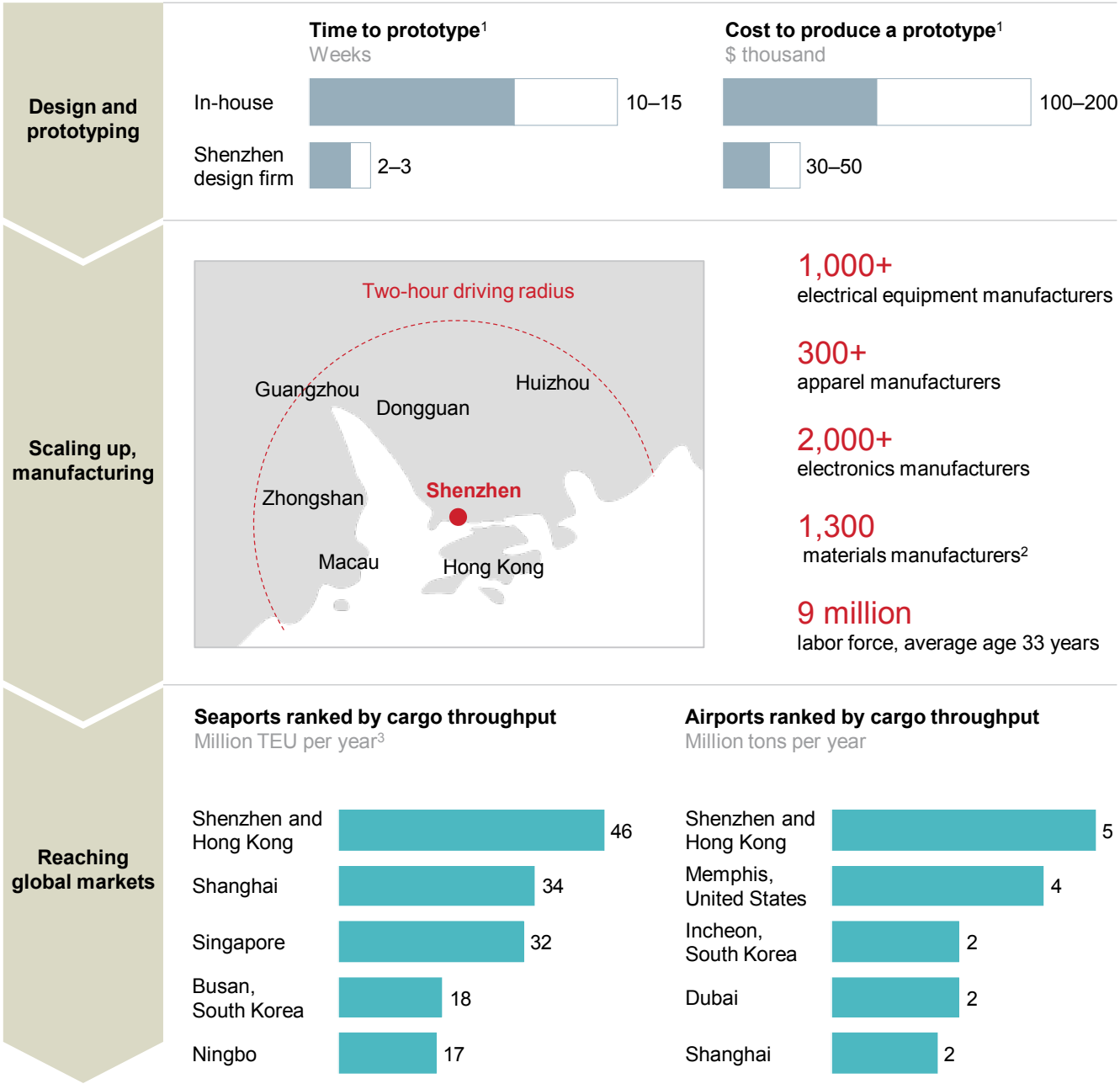
Chinese companies will have to innovate in new ways to retain China's lead in manufacturing. Not only are rising wages in China making it a less competitive site for labor-intensive work such as low-end apparel manufacturing, but there is also a worldwide shift in the manufacturing sector to the "Industry 4.0" model in which major processes of

[4] Alan C. Goodrich et al., "Assessing the drivers of regional trends in solar PV manufacturing," *Energy & Environmental Science*, issue 10, October 2013.

manufacturing and logistics are digitally linked. Next-generation manufacturing promises significant gains in asset utilization, supply/demand matching, and quality control. It also has the potential to shift the basis of competition in manufacturing, providing an opening for advanced economies to take back some lost ground. Germany, the United States, and other advanced economies are using policy and investment to seize the lead in the Industry 4.0 era. China has announced a series of programs to support its bid for leadership, too, starting with "Made in China 2025," unveiled in March 2015.

Exhibit E4

Shenzhen has a strong ecosystem advantage in manufacturing



1 Low-tech electronics example.
2 Chemicals, rubber, minerals, metals, textiles.
3 Twenty-foot equivalent unit, a measure of cargo ship capacity.

SOURCE: Shenzhen Statistical Yearbook 2014; Drewry Container Market; Airport Council International; McKinsey Global Institute analysis

$450B–780B

Potential annual value of next-generation manufacturing approaches in 2025

As Chinese companies move to the next-generation manufacturing model, the nation's manufacturing ecosystem can provide additional advantages—extending benefits beyond individual factories and across a digitally linked ecosystem that can enable a new level of rapid, flexible manufacturing, and mass customization. With a massive supplier base, factories can be adapted to many types of manufacturing, modern logistics, and digital links to customers around the world. Chinese companies can become virtual manufacturing resources, offering manufacturing as a service to companies around the world and even filling custom orders for individual consumers. We estimate that if China can prevail in the Industry 4.0 era, manufacturing could create value of $450 billion to $780 billion per year in 2025, equivalent to 12 to 22 percent of GDP growth in manufacturing by 2025.

Engineering-based innovation: Succeeding in "learning" industries

Engineering-based innovation is part science, part art, and it almost always requires deep experience and learning. For developing economies that are trying to catch up with global competitors in engineering-based industries such as autos, high-speed rail, and wind turbines, gaining knowledge and experience is critical. China has had mixed success in engineering-based innovation. The best performers have been in markets where government has supported an infant industry by providing local demand, while also facilitating technology transfer agreements with foreign partners. This formula has been used most successfully in high-speed rail, where China now has 41 percent of the global market, as well as in wind power (20 percent) and communications equipment (18 percent). Learning and innovation have been slower in automotive manufacturing, where exploding demand and strong profits from joint ventures have limited the need for state-owned enterprises to learn and innovate. Chinese automakers have relied on platforms contributed by their global partners or designs that they have commissioned from outside design firms to get products to market more rapidly. As a result, even though China has become the world's largest car market, Chinese companies have only an 8 percent share of global revenue.

Chinese companies that have succeeded in engineering-based innovation have acquired the knowledge they need in a variety of ways. In wind power, for example, the government's Wind Power Concession Project, launched in 2003, sparked a massive investment in wind generation and a rapid transfer of knowledge to Chinese players. The plan required 50 percent local content, which led foreign suppliers to establish joint-venture plants in China. This helped spread knowledge. In high-speed rail, the Ministry of Railways launched a 3 billion renminbi ($470 million[5]) program in 2008 to develop a new generation of high-speed trains. The Chinese high-speed rail initiative has driven 86 percent of global growth in the market since 2008, while technology transfers from overseas partners have helped Chinese companies build the knowledge to innovate on their own. The CRH380, the first locomotive designed by the Chinese industry, has a top speed of 380 km/hour.

Telecom equipment maker Huawei set out to systematically acquire "end-to-end" engineering knowledge when it realized that its foreign partners were not likely to share cutting-edge technology. Through a painful trial-and-error process, Huawei began creating increasingly sophisticated designs of its own; it spends 12 percent of revenue on R&D and operates 19 innovation centers around the world with joint-venture partners.

In the next ten years, Chinese players are likely to catch up in other forms of engineering-based innovation. The government has identified several industries for policy support, including nuclear power, medical equipment, and electric vehicles. Based on recent history, the success of government interventions will depend on two core elements—creating local market demand and ensuring that Chinese companies gain knowledge they need to

[5] Renminbi to US dollar conversion is for reference. We use average exchange rate in 2014 throughout the report (1 USD = 6.14 RMB).

innovate on their own. Of the targeted industries, nuclear power has progressed furthest on the learning curve, thanks to an ambitious government plan to build 58 gigawatts of capacity by 2020 to help meet the goal of getting 30 percent of energy from renewable sources by 2030. Construction of the Hualong One, China's Generation III reactor design, is underway and export agreements have already been signed.

Progress is also being made in medical equipment. A new crop of players, such as Mindray and United Imaging, are making inroads against foreign suppliers in categories such as CT scanners and MRI machines, thanks in part to government subsidies of hospital purchases of Chinese-made equipment. Both are strengthening R&D capabilities, and both are pushing into overseas markets. Mindray spends 10 percent of its revenue on R&D and makes 55 percent of its sales outside of China.

30%
goal for supply of energy from renewable sources by 2030

Other industries have not had similar opportunities to gain engineering know-how. Commercial aircraft are massively complex—even global leaders are challenged to manage the millions of components that go into a plane—and China's nascent industry has fallen behind schedule in delivering its first commercial passenger jets. In electric vehicles, the government has invested 37 billion RMB ($6 billion) in research, subsidies, and recharging infrastructure, but electric hybrids and fully electric vehicles (plug-ins) still represent a far smaller share of auto sales in China than in advanced economies. Barriers include high tariffs on imports and buyer subsidies that apply only to cars produced in China—limiting competition and learning.

Science-based innovation: Catching up, using novel Chinese approaches

China has made science-based innovation an important priority and has invested substantially in building the institutions and capabilities needed for discovery and invention. Chinese companies are making progress in science-based businesses such as biotechnology, but China is not yet a top global competitor: it has less than a 1 percent share of global revenue in branded pharmaceuticals, 3 percent in biotech, semiconductor design, and specialty chemicals. However, we also find that Chinese companies are taking distinctively Chinese approaches to speeding up science innovation.

In our research we identify a number of reasons for slow progress in science-based innovation, not least of which is that this type of work takes a long time to pay off: it might be 10 to 15 years before an idea moves from a laboratory to a bottle of pills in a hospital dispensary. Among the issues that are seen to inhibit science-based innovation in China are slow regulatory processes, questions about intellectual property protection, inefficient allocation of government research funding, and underinvestment by private-sector players. And, despite the large numbers of Chinese students being trained in scientific and technical fields, companies still struggle to find capable talent. The government is addressing some of these obstacles. Reforms to the drug approval process could reduce the time it takes to get a new drug to patients by two years. Also, efforts such as the Thousand Talents program are helping to bring overseas Chinese scientists home to work in industry and universities and to launch companies.

In the meantime, Chinese drug companies are taking innovative approaches to speed up drug development. BeiGene has created an approach to accelerate drug discovery by using a proprietary system to test substances on human tissue (cancerous tumors, for example) to get an early indication of potential issues during human trials. WuXi AppTec, a contract research organization, uses an industrial approach to accelerate drug discovery by deploying massive scale. It employs 7,500 researchers and is expanding the scope of its service scope from preclinical testing through clinical trials. In genomics research, BGI, a biotech company, is also using massive scale—more than 2,000 PhDs and more than 200 gene-sequencing machines—to power through science problems.

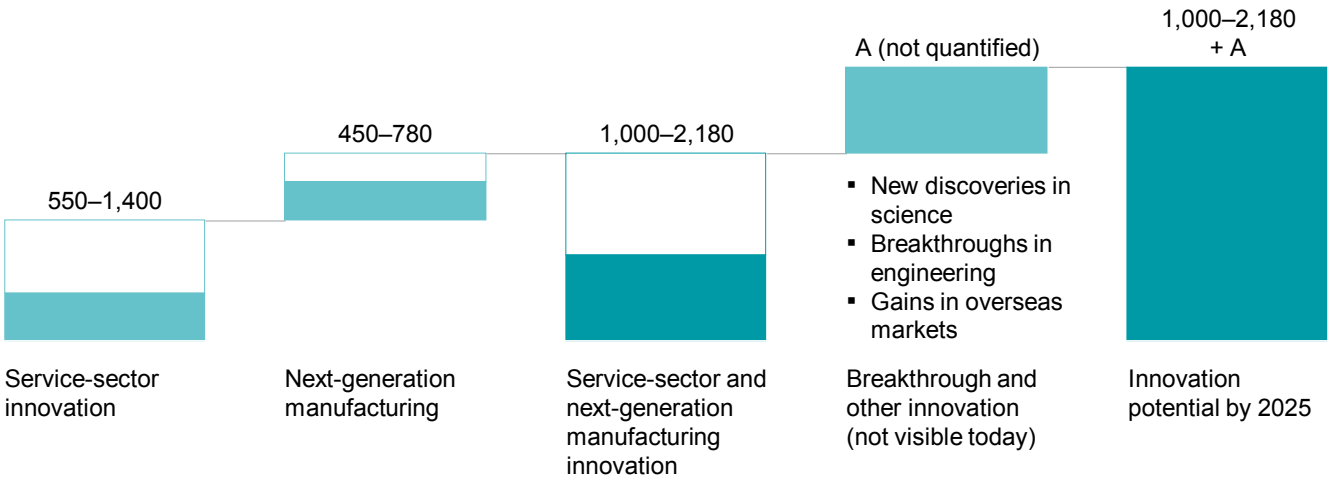
THE CHINA EFFECT ON GLOBAL INNOVATION : CHEAPER, FASTER AND GLOBALLY CONNECTED

Based on the recent performance of Chinese industries, the investments made to build innovative capacity, and the opportunities for greater innovation success we outline above, we believe that China can not only meet its innovation imperative, but can also emerge as a dominant force in innovation globally. We estimate that progress in service- and manufacturing-sector innovation can contribute $1.0 trillion to $2.2 trillion per year in value to the Chinese economy by 2025. Additional value can arise from innovations in science- and engineering-based innovations, which we do not estimate (Exhibit E5). Equally important, we would expect to see a "China effect" on innovation globally, which could disrupt markets and industries. China can become a platform for accelerated innovation, not just for Chinese companies, but also for foreign multinationals that want to take advantage of Chinese cost and speed to produce innovations for China, emerging markets, and the world. Moreover, the Chinese model for rapid, low-cost, and nimble innovation can be adapted for use around the world. The overall effect could be accelerated innovation globally, challenges to market leaders from new innovators, and new, lower-cost products and services that fill unmet needs of emerging-market consumers and keep up with the shifting demands of consumers in advanced economies.

Exhibit E5

Innovation in services, manufacturing, and other areas can help China meet its innovation imperative

Potential value in 2025[1]
2014 $ billion



1 Value includes increased output and company profit as well as consumer surplus (benefits such as lower prices and higher quality).
NOTE: Numbers may not sum due to rounding.

SOURCE: McKinsey Global Institute analysis

What companies can do to accelerate innovation in China

Companies can start by making a larger commitment to innovation in China. For foreign companies, this could mean locating more R&D activity in China, as Microsoft has done with the 3,000 scientists and engineers in its Asia-Pacific Research and Development Group in Beijing, which does global research. Or, as Phillips and GE have done, companies might relocate global headquarters of entire business units to China to take advantage of low-cost R&D talent and get closer to Chinese customers. Similarly, Chinese companies can strengthen innovation capabilities by adding R&D facilities in other markets or using overseas R&D joint ventures. Lenovo executives credit having dual headquarters in Beijing and North Carolina with helping the company achieve global leadership in PC sales.

Both domestic and foreign companies in China can adopt the rapid development and commercialization processes—"China speed"—that have helped China's innovation leaders. Chinese companies can speed up innovation by flattening hierarchical organizations and empowering all workers to suggest ideas for products or process improvements. Organizational changes to accelerate decision making and innovation processes in China can also benefit global companies. All companies operating in China can discover new ideas and commercialize them faster by tapping into China's emerging open innovation ecosystem. Some are already crowdsourcing ideas internally and externally through competitions and incentives.

What Chinese policy makers can do to support innovation

For Chinese policy makers to support and accelerate innovation, it will be important to continue to craft coordinated, coherent policies that set the conditions for innovation by market competitors. Broadening access to funding for entrepreneurs and small and medium-sized enterprises, for example, can help more Internet innovators commercialize their ideas and more small manufacturers innovate process improvements. Small manufacturing companies also can benefit from programs that provide free or subsidized training in innovation skills, which countries such as the Netherlands have used.

Government can raise the bar for innovation by being a demanding purchaser and as an educator for end consumers. Market creation in high-speed rail and wind-turbine industries certainly helped local innovation, but "guaranteed" markets for local players can impede innovation in the future. Government can raise the bar for innovation by requesting challenging tasks, as the National Health Service in the United Kingdom did with its purchasing policies to encourage innovations in medical products. At the same time, the government can educate the public to speed the acceptance of innovation. Fuel-economy and energy labeling standards have helped drive innovations in motor vehicles and appliances in advanced economies.

Continuing market reforms that open up more areas of the economy to competition will lead to more innovation, too. And reforms to the initial public offering process (simpler and more predictable listing based on clear rules) and stronger intellectual property enforcement can ensure that innovators enjoy the rewards of their labors—and encourage more Chinese to pursue their creative ideas.

Finally, in addition to providing enabling infrastructure, government can help make China's innovation clusters more attractive to top talent. The success of an innovation cluster depends heavily on the quality of talent it can attract, and top talent can afford to be picky about quality-of-life issues such as housing costs, cultural diversity, and pollution. In these "soft" factors, Chinese cities are currently at a disadvantage.

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China has reached a point where innovation is no longer a conceptual idea—an aspiration that would reflect the rising power and sophistication of the Chinese economy. In the coming decade, innovation will be a vital tool for China to raise productivity and sustain growth. Innovation will be key to retaining and extending China's competitiveness in global markets. At the same time, China can become a global center of innovation and its rapid, nimble approaches could be adopted around the world. A decade from now, the world may acknowledge a "China effect" on innovation.

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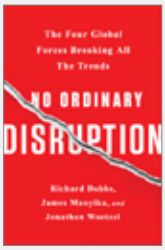

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