Center for American Progress

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The Importance and Promise of American Manufacturing

Why It Matters if We Make It in America and Where We Stand Today

Michael Ettlinger and Kate Gordon April 2011

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Introduction and summary

Manufacturing is critically important to the American economy. For generations, the strength of our country rested on the power of our factory floors—both the machines and the men and women who worked them. We need manufacturing to continue to be a bedrock of strength for generations to come. Manufacturing is woven into the structure of our economy: Its importance goes far beyond what happens behind the factory gates. The strength or weakness of American manufacturing carries implications for the entire economy, our national security, and the well-being of all Americans.

Manufacturing today accounts for 12 percent of the U.S. economy and about 11 percent of the private-sector workforce. But its significance is even greater than these numbers would suggest. The direct impact of manufacturing is only a part of the picture.

First, jobs in the manufacturing sector are good middle-class jobs for millions of Americans. Those jobs serve an important role, offering economic opportunity to hard-working, middle-skill workers. This creates upward mobility and broadens and strengthens the middle class to the benefit of the entire economy.

What's more, U.S.-based manufacturing underpins a broad range of jobs that are quite different from the usual image of manufacturing. These are higher-skill service jobs that include the accountants, bankers, and lawyers that are associated with any industry, as well as a broad range of other jobs including basic research and technology development, product and process engineering and design, operations and maintenance, transportation, testing, and lab work.

Many of these jobs are critical to American technology and innovation leadership. The problem today is this: Many multinational corporations may for a period keep these higher-skill jobs here at home while they move basic manufacturing elsewhere in response to other countries' subsidies, the search for cheaper labor costs, and the desire for more direct access to overseas markets, but eventually many of these service jobs will follow. When the basic manufacturing leaves,

the feedback loop from the manufacturing floor to the rest of a manufacturing operation—a critical element in the innovative process—is eventually broken. To maintain that feedback loop, companies need to move higher-skill jobs to where they do their manufacturing.

And with those jobs goes American leadership in technology and innovation. This is why having a critical mass of both manufacturing and associated service jobs in the United States matters. The "industrial commons" that comes from the cross-fertilization and engagement of a community of experts in industry, academia, and government is vital to our nation's economic competitiveness.

Supplying our own needs through a strong domestic manufacturing sector protects us from international economic and political disruptions.

Manufacturing also is important for the nation's economic stability. The experience of the Great Recession exemplifies this point. Although manufacturing plunged in 2008 and early 2009 along with the rest of the economy, it is on the rebound today while other key economic sectors, such as construction, still languish. Diversity in the economy is important—and manufacturing is a particularly important part of the mix. Although manufacturing is certainly affected by broader economic events, the sector's internal diversity—supplying consumer goods as well as industrial goods, serving both domestic and external markets—gives it great potential resiliency.

Finally, supplying our own needs through a strong domestic manufacturing sector protects us from international economic and political disruptions. This is most obviously important in the realm of national security, even narrowly defined as matters related to military strength, where the risk of a weak manufacturing capability is obvious. But overreliance on imports and substantial manufacturing trade deficits weaken us in many ways, making us vulnerable to everything from exchange rate fluctuations to trade embargoes to natural disasters.

None of this matters, of course, if American manufacturing is too far gone to save. But American manufacturing is, in fact, a success story and it is not a story approaching its end. Notwithstanding employment losses and the relative rise of manufacturing in other countries, the United States led the world in manufacturing value added in 2008. Moreover, the United States ranked third in manufacturing exports in 2008, behind only China and Germany and ahead of Japan and France.

The United States will never again dominate world manufacturing the way it did in the decades immediately following World War II (in fact no country is likely to

ever do so again, barring cataclysm) but manufacturing is, can, and should remain an important part of our economic future. There are many other players in the game now but that doesn't mean America must leave the field.

The purpose of this report is to examine where the United States remains competitive in manufacturing at home and abroad. But we begin our analysis by detailing why manufacturing remains so important to our economy, our society, our national security, and our ability to remain the world's science and innovation leader in the 21st century. Then we look at our domestic manufacturing base and our top manufacturing export sectors to gauge where U.S. manufacturing remains competitive.

This report does not, it should be said up front, outline a manufacturing policy agenda. There is a broad range of views on what U.S. policy toward manufacturing should be. Some believe, although most say this quietly, that U.S. manufacturing is a lost cause and, as such, should be abandoned. Others, however, see U.S.-based manufacturing as of continuing importance. These people argue that our relatively high labor costs and the growth of manufacturing elsewhere do not sound the death knell. They see our nation as still a great manufacturer.

But even among those who still believe in manufacturing, there is a wide range of views on what should be done to nurture it. There are those who see free trade agreements as a way to help manufacturing by boosting exports and those who see those same agreements as subjecting U.S. manufacturers producing for the U.S. market to unfair competition. There are those who see the need for "industrial policy"—a concerted effort to focus our national resources on industries that we believe will be the key manufacturing areas of the future—and those who see any attempt by the government to "pick winners and losers" as foolhardy and doomed to misallocate economic resources and thus undermine the efficiency of our economy. Other policy issues include the importance of investing in human capital to make U.S. workers more productive, investing in basic research so the big new ideas come from the United States, and a range of assistance that can be provided to manufacturing facilities and corporations.

This report does not parse through the variety of policy paths forward. Instead, we argue the threshold question: whether we, as a nation, should respond to the challenges now facing U.S. manufacturing. Our central question is this: Does domestic manufacturing matter and is there something left to fight for? Our answer is a resounding "yes."

Manufacturing matters

The health and future of manufacturing in the United States matters. For starters, it constitutes 12 percent of the U.S. economy. To put that in perspective, when the United States recently lost less than 4 percent of its gross domestic product, or national income, the result was labeled the "Great Recession." Twelve percent of the economy matters a lot.

But the manufacturing sector also boasts an outsized importance that is understated by even that 12 percent. One key reason manufacturing is so important is its position as the cornerstone of the success of many other economically important activities. This role has been the subject of a longstanding debate as to whether the United States should hold onto its manufacturing sector or instead become a "postindustrial" society.

This debate started in the 1980s when Japanese goods started flooding the U.S. market. Some economists argued then that America should move beyond competition for manufacturing jobs and settle instead into a new economic growth pattern based on service jobs in knowledge-based industries. These economists argued that just as the United States shifted away from agriculture and into industry, so should it shift from industry into services as the primary source of economic activity for the future.

But this "manufacturing versus services" argument set up a false dichotomy. A strong manufacturing sector does not come at the cost of a strong service sector—to the contrary, each manufacturing job actually supports multiple jobs in other sectors. As economists Stephen Cohen and John Zysman wrote in the late 1980s, the manufacturing sector does not just include the group of employees who work on the factory floor. Instead, the manufacturing sector has "direct linkages" to high-level service jobs throughout the economy: product and process engineering, design, operations and maintenance, transportation, testing, and lab work, as well as sector-specific payroll, accounting, and legal work.

Furthermore, "the more advanced or modern the production process, the longer and more complicated the chains or linkages," note Cohen and Zysman in their 1988 book *Manufacturing Matters: The Myth of the Post-Industrial Economy*.[1] If anything, the phenomenon Cohen and Zysman observed is even more evident today as manufacturing industries create many indirect jobs for each direct job created. Motor vehicle manufacturing, for example, now creates 8.6 indirect jobs for each direct job. Computer manufacturing creates 5.6 indirect jobs and steel product manufacturing creates 10.3 indirect jobs for each direct job.[2]

So manufacturing creates jobs, not just in the manufacturing sector but in a host of other occupations and industries. But that doesn't settle the issue of the importance of having actual, physical manufacturing take place in the United States. The question remains, can manufacturing happen in, say, China, but still create associated high-quality service jobs here at home? The answer is that it is, indeed, important that the actual, physical manufacturing occur here. Made in America matters.

When shop floor manufacturing jobs depart, other jobs go with them—and with those jobs goes the ability to create and innovate. Declines in the U.S. manufacturing sector mean declines in our nation's overall "industrial commons"—a set of related industries and activities including those in the highly prized knowledge-based economy. According to Harvard economist Gary Pisano, when manufacturing moves overseas so does this industrial commons, meaning that we lose not only production prowess but also the process innovation that comes from colocating research and development, design, engineering, and manufacturing.

When shop floor manufacturing jobs depart, other jobs go with them—and with those jobs goes the ability to create and innovate.

"In addition to undermining the ability of the United States to manufacture high-tech products, the erosion of the industrial commons has seriously damaged the country's ability to invent new ones," writes Pisano in a recent *Harvard Business Journal* online debate.[3] With the loss of the commons and the jobs comes a decline in U.S. workforce skills and the ability to invent and innovate that can only come from the hands-on experience of working in an industry.[4]

The upshot: If we lose our ability to make things, we may well lose our ability to invent them.

There is strong anecdotal evidence that if we cede production on a process invented in the United States then we may lose future iterations of innovation of that process. Solar panels are one example. Invented in New Jersey at Bell

Laboratories in 1954, the production of solar photovoltaic panels has largely moved overseas (China is currently the world's largest producer), and most new innovations in panel production, such as process improvements that make the panels far more powerful by altering their electrical properties, are happening outside of our nation.[5]

Interestingly, this is less true for nonpanel solar power innovations, such as the holographic solar applications pioneered by small startups in Arizona and New York, possibly because these new innovations are still cutting-edge and not yet in commercial production at any real scale.[6] Once these technologies do scale up, however, they too may be produced and improved overseas.

When it comes to advanced manufacturing, we must compete if we want to hold onto our role as global innovators and entrepreneurs.

One industry where the spatial relationship between manufacturing and innovation is most clearly shown by empirical data is the optoelectronics industry, which includes products such as lasers and fiber-optic telecommunications. In a recent set of studies, Carnegie Mellon University engineering professor Erica Fuchs examined the impact of offshoring production on technological innovation. Her key finding: When optoelectronics companies offshored production of their original designs to, for instance, Asia, they tended to produce those initial designs cheaply and efficiently. When these firms then began work on new and improved designs, however, they tended to lose valuable time and knowledge if their operations were off shore.[7]

Thus, moving manufacturing overseas impeded the companies' ability to compete and keep at the forefront of design and production and to efficiently push forward new technologies.[8] Inexorably, then, these companies will follow other manufacturers who have shifted design and innovation closer to their physical operations—witness the photovoltaic manufacturing industry.

Fuchs's findings are critical not only to the question of why basing manufacturing in the United States matters but also to the analysis of what kinds of policies might best support the types of manufacturing that will ultimately put our nation in the best economic position. In the most simplistic terms, Fuchs's research shows that when you're talking about the United States, manufacturing does matter, but advanced and cutting-edge manufacturing matters even more. When such manufacturing leaves, it takes much more than the factory floor jobs—as important as those may be—it takes technology, innovation, and the next generation of products with it.

The United States will clearly never again compete in the most low-wage, labor-intensive areas of industrial production. But when it comes to advanced manufac-

turing that dominates the 21st century, we must compete if we want to hold onto our role as global innovators and entrepreneurs.

Beyond innovation and competitiveness, basing manufacturing in the United States also is important to our overall national and economic security. The most clear-cut example of this, of course, is the importance of being able to produce for the needs of our armed forces. The importance of domestic capabilities in defense manufacturing is obvious—one doesn't want to be dependent on foreign suppliers in a time of conflict. Equally obvious is the importance of keeping innovations in military technology close to home.

This is underscored by a list kept by the State Department known as the International Traffic in Arms Regulations, or ITAR, which designates the manufactured goods and services deemed to be "defense articles" and tightly controls their export and import.[9] The list includes a range of items from firearms and nuclear weapons systems to less obvious items like energy conversion devices that are specifically designed for military application.[10]

Beyond defense, however, manufacturing offers a greater degree of *economic* security. The simple existence of the sector helps balance out other sectors to create a more stable economy overall.[11] Had, for example, manufacturing been a larger share of the economy at the time of the recent housing and financial crises, the fragility of those two sectors would not have been quite as devastating to the overall economy.[12]

Indeed, when multilateral development banks such as the World Bank Group fund international projects in the developing world, they often point to the importance of a "diverse economy"—that is, an economy based on a wide range of profitable sectors, not just a few—as essential to sustained, broad-based economic growth. The same holds true for industrialized nations.

This kind of analysis, however, is seldom done in the United States at the national level because we have had a diverse economy overall. Individual regions and states, however, can be significantly less diversified.[13] For this reason, states often develop economic plans aimed at making their economies more diverse. For instance, former Michigan Gov. Jennifer Granholm specifically set out to diversify her state's economy away from traditional auto manufacturing and into other sectors such as solar technology, wave power, and electric drive trains.

This kind of economic development strategy is rarely tried at the national level, however, perhaps due to concerns about excess involvement of government in the operation of the economy. Still, research abroad and at the regional level in the United States makes clear that putting too many of our eggs in one sectoral basket is a bad bet for long-term stability.[14] Manufacturing, like any sector, is affected by economywide events, but manufacturing's internal diversity—supplying consumer goods as well as industrial goods, serving both domestic and external markets—gives it great potential resiliency in addition to simply adding one more leg for the broader economy to stand on.

Domestic manufacturing is also the key to more balanced trading relationships—a fact recognized by President Obama when he challenged the country to double its level of exports. Of course, that growth in exports doesn't have to all be manufactured goods—but in truth it will need to mostly be notwithstanding the recent growth in services exports.

Domestic manufacturing is also the key to more balanced trading relationships.

That growth in services exports receives a lot of the attention but it is to some degree misplaced. A good deal of that increase is actually a byproduct of the outsourcing of manufacturing overseas. For instance, when a U.S. company sets up a foreign subsidiary to manufacture in another country, its U.S. parent may charge the foreign subsidiary for royalties, licensing fees, accounting, and engineering services. These transactions can be counted as U.S. exports of services and, in fact, appear to explain a large portion of the increase in U.S. exports of services.

Yet these of course do not represent an increase in overall U.S. production—the activities are servicing the same manufacturing they always did—it's just that the manufacturing itself has moved overseas. Hardly a plus for the country, especially given the increasing trend for these associated services to eventually follow on the heels of the manufacturing activities they support.

There also are inherent limitations in the export of services. Certainly bankers in New York can lend to firms in Tokyo, engineering consultants can advise clients in Frankfurt, and U.S. architects can design buildings in São Paulo. But that will always be the exception, not the rule. A Japanese borrower will generally first look to a Japanese lender, a European industrialist to a local engineering firm, and a South American real estate developer to a South American architect.

With manufactured goods it's about the good itself, not the language or the culture or other aspect of a service relationship. While some areas of service exports can

grow—and their promotion is certainly to be encouraged—manufacturing is where our export growth is going to have to come from. The bottom line: Without a robust manufacturing sector, the U.S. balance of payments will deteriorate and the exodus of our national savings and earnings will slowly sap our economic strength.

Finally, manufacturing matters for people. One-tenth of all jobs in the United States are in manufacturing and these pay on average 20 percent more than the national average.[15] They pay decent wages to production workers, many of whom lack a four-year college degree but have technical or associate's degrees in skills related to their manufacturing work. These middle-skill workers make up more than 60 percent of today's workforce.

And manufacturing matters not to just these workers but to all workers. Without manufacturing the downward pressure on wages throughout the economy would increase, with negative consequences for America's overall economic well-being—to wages, to income equality, and to middle-class families.

So manufacturing matters for America.[16] It matters for our technological leadership, national security, economic security, economic stability, national wealth, and the well-being of the middle class that underpins our economic strength. It's important, but is it too far gone to save? No. The good news is that while manufacturing in the United States is under threat, and faces serious challenges, it is by no means a mere relic of the past. It is a vibrant, large sector of our economy—even if sometimes it's hard to see that as manufacturing jobs are lost, as factories close, and as sections of the country deindustrialize. To this we now turn.

The state of American manufacturing

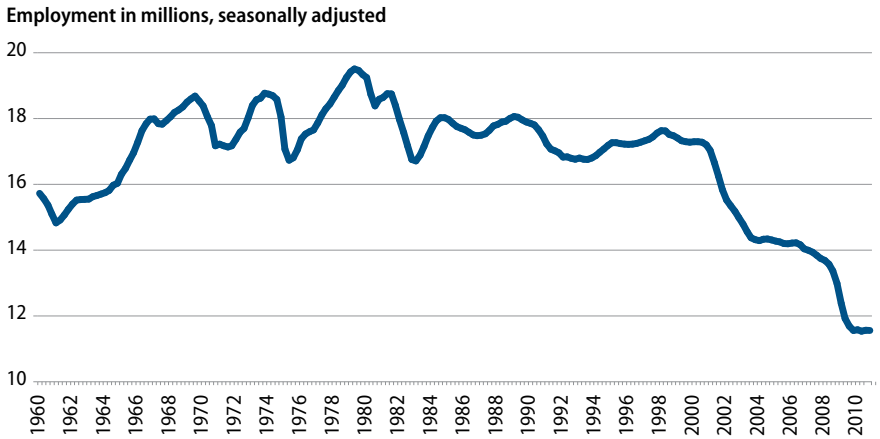
It's easy to paint a bleak picture of American manufacturing. Manufacturing employment dropped from more than 17 million in the 1990s to less than 14 million in 2007 and is down to less than 12 million today. The U.S. share of worldwide manufacturing value added is in decline: dropping from 26 percent in 1998 to less than 20 percent by 2007. Our trade deficit in manufactured goods was running more than $600 billion before the Great Recession; prior to 2000 that deficit had never topped $300 billion. We've gone from a surplus of high-tech goods in 1998 to deficits running more than $80 billion.[17] Almost everything we buy in stores seems to come from other countries, predominantly from China.

With a story like this, it's easy to conclude that U.S.-based manufacturing is no longer competitive. But are goods manufactured in the United States truly not competitive? If so, one would expect, quite obviously, that we would be a small player in the manufacturing world. After all, few are going to buy products that aren't competitive out of charity. The best measure of whether a nation can compete in an economic sector is whether it does. U.S. products don't always win every competition the way they used to but U.S. manufacturing still wins.

FIGURE 1

The decline in manufacturing jobs

Manufacturing employment in the United States, 1960-2010



Source: Bureau of Labor Statistics.

Our nation, for example, ranked first in the world in manufacturing value added in 2008. That is, the value added from work done in the United States by businesses producing products here was greater in total than the value added in

any other country in the world. The value added in U.S. manufacturing doesn't, of course, include only the amount added by the labor and capital on the floor of a U.S. plant. The value of what comes out of a Ford Motor Co., General Motors Corp., Toyota, or Honda factory in the United States is more than just the value of the parts and labor that go into it. The value of the design, engineering, and promotion of a vehicle also is "added."

Thus, the U.S. lead in value added doesn't mean we are atop the world in what happened on the factory floor, but it does mean American-made goods are competing. In fact, though manufacturing employment is falling, value added is going up or, at worst, staying about constant over time.[18] The much-noted improvement in factory productivity is a major culprit here—it just takes many fewer people to make the same goods.

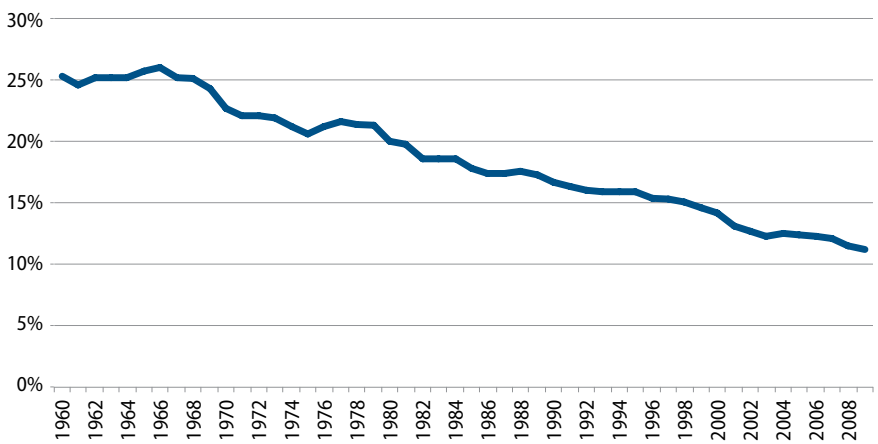
While U.S. manufacturing has been holding its own by some measures, it's also true that the share of U.S. total value added that comes from manufacturing has shrunk. And certainly the U.S. share of total worldwide manufacturing has fallen as other countries' manufacturing sectors have grown greatly (see Figures 2 and 3).

But whether the United States still dominates manufacturing as it once did is a different

FIGURE 2

U.S. manufacturing a smaller share of economy

Manufacturing value added as a share of total U.S. GDP, 1960-2009

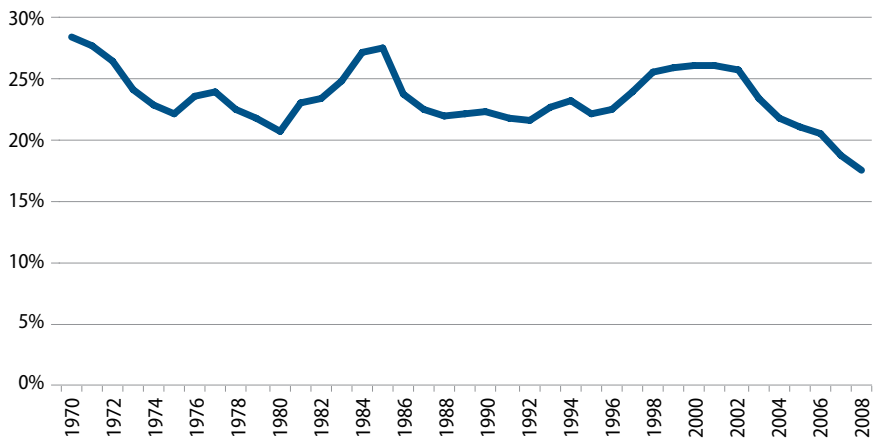


Source: Bureau of Economic Analysis.

FIGURE 3

U.S. manufacturing a smaller share of worldwide manufacturing

U.S. gross manufacturing value added as share of world

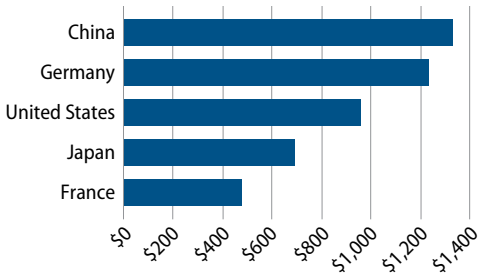


Source: United Nations.

FIGURE 4

The United States remains an export powerhouse

Top five manufacturing exporters in 2008, in billions of dollars



Source: World Trade Organization.

question than whether U.S. manufacturing can compete. The fact is that U.S. manufacturers are successfully making and selling their goods on a massive scale.

Of course, we are also the biggest-consuming country in the world, and one could argue that as a result we cannot avoid being a large manufacturer. There are enough products that are expensive or difficult enough to ship that it's hard to avoid making them here. There's certainly truth to the story that some U.S. manufacturing succeeds because of this advantage. But selling goods in a home market is nothing to be ashamed of. After all, part of how a business competes is being close to its customers. Even aside from that, however, there's clearly more to U.S. manufacturing success than a captive market.

U.S. manufacturing is also a heavy exporter. To the extent those exports are to Canada and Mexico, proximity is still a factor—those two countries account for about a third of U.S. manufacturing exports. But the United States was the third-largest exporter of manufactured goods in the world in 2009. And even if all exports to Canada and Mexico were excluded, the United States would rank fourth.[19] This was true prior to the Great Recession, too, and given the recent resurgence in exports is almost certainly true today.

There's something else interesting about this ranking: the other high-ranking countries. With the exception of China, the list is not dominated by low-wage countries. Other countries not unlike the United States are, like us, competing. This suggests that there is no intrinsic bar to competing even with the presumed handicap of higher wages.

Also, the United States is not alone in using proximity to markets as a basis for competition. It works for Germany, Japan, and even China to some degree. Germany sends 71 percent of its manufacturing exports to the rest of Europe, and Japan sends about half of its exports to the rest of Asia.[20] More than one-third of China's exports are to other Asian countries.[21]

How do U.S. manufacturers compete? That's a different story for different manufacturers and different industries. If the story stopped at wages and comparisons with low-wage countries, then U.S.-based manufacturing obviously couldn't compete. Manufacturing workers in many other countries are

paid lower wages than in the United States. China's migrant industrial workers, for example, took home ¥1,348 (about $197) a month on average in 2009, which is approximately 1/20th of the average monthly wage in America. This is 17 percent more than the same workers took home the year before but it is still an impossible wage for American factories to compete with.[22]

With differences like that, U.S. companies presumably stay competitive for other reasons. Yes, one of these reasons is proximity to the wealthiest market in the world. Another is that, for many products, the labor component of producing the good is simply not that large. For manufacturing overall, labor is about 5 percent to 15 percent of the costs and an obviously smaller share of end price.[23] For other companies, the key location decision factors include proximity to engineering and design centers, access to raw materials, avoiding currency fluctuation risk, knowing their intellectual property will be safe, or the high cost of transporting some goods across long distances.

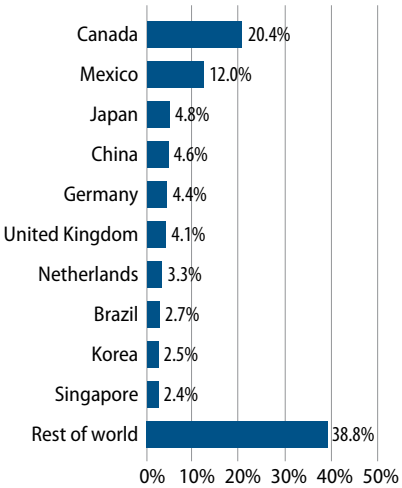
FIGURE 5

Exporting close to home

The United States, Germany, Japan, and China all export heavily to their neighbors

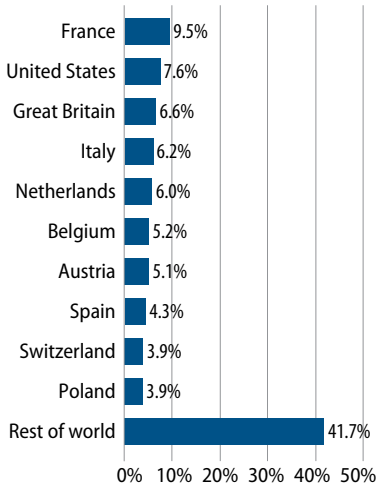
Where does the United States export to?

Percent of exports going to top 10 U.S. manufacturing export destinations and the rest of the world, 2008



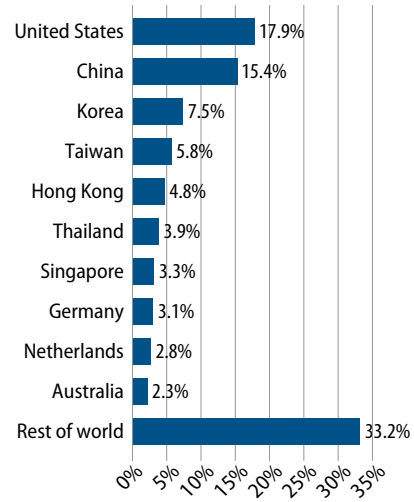
Where does Germany export to?

Percent of exports going to top 10 German manufacturing export destinations and the rest of the world, 2008



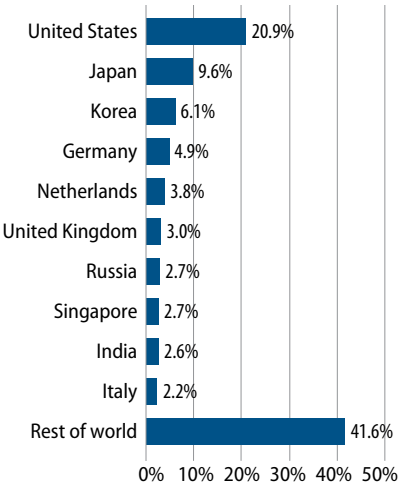
Where does Japan export to?

Percent of exports going to top 10 Japanese manufacturing export destinations and the rest of the world, 2008



Where does China export to?

Percent of exports going to top 10 Chinese manufacturing export destinations and the rest of the world, 2008



Source: United States, Germany, and Japan: OECD. China: IMF.

Data used in this report

Throughout this paper we rely on data from 2007, 2008, and 2009. These years, of course, span the Great Recession—volatile years for our economy. Adding to the challenge of picking a year for which to present data is the fact that the Annual Survey of Manufactures, which this report relies on heavily, was not conducted in 2007, when the economy peaked before tipping into recession beginning in December of that year. This further complicated our decisions of whether to choose a pre-recession year from which to report data, which could be taken as a "normal" year but risks painting an overly rosy scenario given that some manufacturing lost in the Great Recession is lost forever, or pick a recession year that would show things in an aberrational state.

For the most part, though, we found that the data show that most measures of manufacturing and most subsectors and industries expanded between 2006 and 2008, and that the deepest hit on manufacturing didn't occur until 2009. And we also know that after 2009 manufacturing rebounded. So showing data for 2009 when manufacturing was at its bottom would be misleading. And 2009 data is not available for all the data we present.

For these reasons, the year most commonly used in this paper is 2008. In every case, however, we also looked at 2006 or 2007 and 2009 if they are available to ensure the volatility of the recession is not distorting the picture we are presenting. For all of the comparisons offered, between industries and between countries, the relationships we describe hold during the years for which we have data unless otherwise noted.

In some cases, it's simply a matter of a well-run company with a high-quality product choosing to keep its manufacturing in its home country—even if costs are a tad higher and profits a hair lower. The reasons vary as much as the industries.

The U.S. home insulation market, for instance, relies largely on domestic suppliers for two major reasons: access to raw materials (including silica sand, of which our nation is the largest supplier in the world) and the expense of shipping relatively cheap, but bulky, insulation materials overseas.[24] If the United States no longer manufactured insulation, suppliers such as Owens Corning Inc. would have to ship raw materials overseas and ship finished products back, significantly increasing the overall cost to the consumer.

For completely different reasons, the semiconductor industry still builds major manufacturing facilities of its high-end products in the United States. Prominent among the reasons offered by companies such as California-based GlobalFoundries Inc. and South Korea's Samsung Semiconductor for their massive recent investments in new facilities in New York and Texas is the benefit of having manufacturing close to leading centers of research and development and the access to a highly skilled workforce.

There are, however, equally important reasons why our nation has gone from a manufacturing trade surplus to deficits that have, until the most recent years, been growing. One of course is simply that, while U.S. companies compete, the competition is stiffer with more industrialized countries obtaining higher levels of education and efficiency. But there are other barriers as well. For some products with high labor content, U.S.-based manufacturing simply cannot compete—U.S. workers couldn't survive on the low wages it would take. The trade policies and practices of other countries are also a problem, including exchange rates and massive subsidization of targeted industries.

Furthermore, in some areas of manufacturing, the industry has withered to such an extent that we no longer have the expertise or supply chain to sustain a strong manufacturing base in the United States. But even given those restraints and barriers, U.S. manufacturing is still a powerhouse. The reasons vary, but American manufacturers, subsector by subsector, industry by industry, compete. That's the subject of the next section.

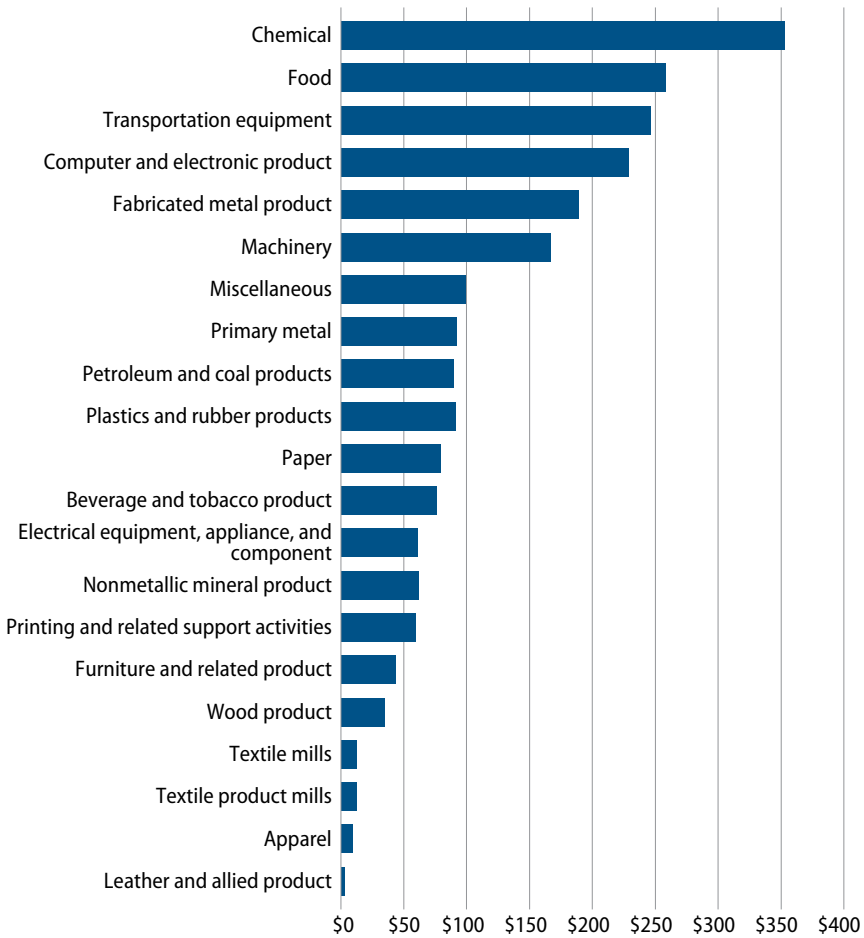
Made in America

If most of what we see every day in the store isn't made in the United States, yet the country leads the world in value added and is a large manufacturing exporter, what exactly is it that is made in America? It turns out that products made in America range from chemicals and pharmaceuticals to transportation equipment and processed foods, and from computer and electronic equipment to fabricated metal and machinery products (see Figure 6).

FIGURE 6

The top U.S. manufacturing subsectors

U.S. manufacturing value added by subsector, 2008



Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

Manufacturing in the United States covers a broad range of activities, though there are six large, broadly defined subsectors that account for the bulk of U.S. manufacturing. The top six subsectors by value added are:

- Chemicals, including pharmaceuticals and other chemical products
- Transportation equipment, including, most prominently, automobiles and aircraft
- Food, which includes everything from steaks to potato chips
- Computer and electronic products, including semiconductors, lab equipment, and a host of other products

- Fabricated metal products, including a range of products from pre-fab sheds to I-beams
- Machinery, which includes goods such as air conditioning units and farm equipment

These six subsectors account for 64 percent of manufacturing value added, 58 percent of the dollar value of product shipments, 58 percent of capital expenditures, 73 percent of manufacturing exports, 62 percent of employee compensation, and 56 percent of production worker hours in manufacturing (see Table 1).

TABLE 1

America's largest manufacturing subsectors

A snapshot of key indicators among the top six manufacturing subsectors as a percent of total manufacturing

Industry	Value added	Shipments	Capital expenditures	Export	Compensation	Production workers hours
Chemical	16%	14%	13%	15%	8%	5%
Transportation equipment	11%	12%	10%	22%	14%	11%
Food	11%	12%	9%	5%	8%	13%
Computer and electronic products	10%	7%	13%	14%	11%	5%
Fabricated metal products	8%	7%	7%	5%	11%	13%
Machinery	7%	7%	6%	13%	9%	8%
Total for top six	**64%**	**58%**	**58%**	**73%**	**62%**	**56%**

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

Manufacturing by the numbers: A guide to the data

Value added. According to the Bureau of the Census, "[v]alue added is considered to be the best value measure available for comparing the relative economic importance of manufacturing among industries and geographic areas." In general terms it reflects the value of the shipments from manufacturing facilities less the cost of materials, supplies, containers, fuel, purchased electricity, and contract work.[25]

Shipments. This is the value of products produced and shipped by producers.

Exports. The value of goods produced by U.S. manufacturers and sold to other countries.

Capital expenditures. Expenditures for additions, alternations to manufacturing establishments, and purchases of machinery and equipment including vehicles, computers and other tools, machines, etc.

Compensation. Includes payroll and fringe benefits for employees.

Production worker hours. "This item covers all hours worked or paid for at the manufacturing plant, including actual overtime hours (not straight-time equivalent hours). It excludes hours paid for vacations, holidays, or sick leave when the employee is not at the establishment."[26]

In the sections below we offer a brief look at each of these subsectors, looking at what they make and some of the factors that make them tick. Note that more detailed tables on each subsector are located in the appendix.

Chemical manufacturing

Chemical manufacturing covers a wide range of products, ranging from petrochemicals, chlorine, and dyes to paint, pharmaceuticals, and soaps. This broad sector has the most value added of its peers, with 16 percent of total manufacturing value added.

Not surprisingly, the total value of shipments is also substantial, accounting for 14 percent, or $740 billion of total manufacturing shipments in 2008. Of all manufacturing subsectors, only petroleum and coal manufacturing (refining and processing) has a greater dollar amount in shipments at $770 billion. But the value added in that sector is relatively small as the bulk of the revenue comes from the value of raw materials (crude oil) and their extraction, not the addition of value by the "manufacturing" branch of the industry.

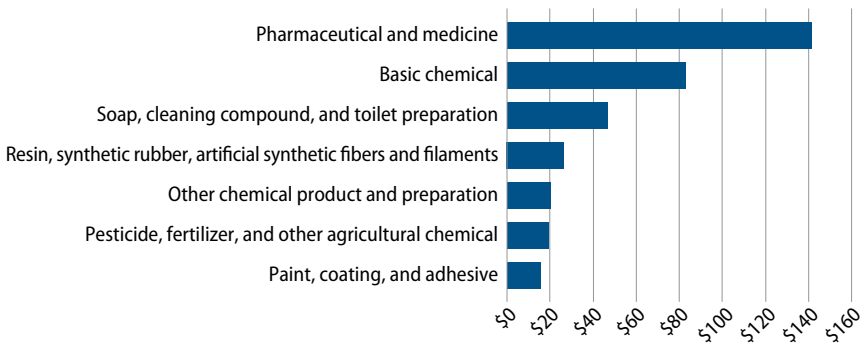
The chemical subsector is not very labor-intensive, using the fewest production hours of the six major manufacturing subsectors, and employee compensation accounts for only 14 percent of value added compared to 27 percent for manufacturing as a whole. This reflects the necessity of automation when working with chemical substances as well as the large dollar value of those substances relative to the number of people it takes to produce them.

Pharmaceuticals is the single biggest chemical subsector, contributing 40 percent of value added. For pharmaceuticals, value added is quite high relative to shipments,

FIGURE 7

Chemical manufacturing breakdown

Chemical subsector value added by industry, 2008, in billions of dollars



Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

with 74 cents of value added per dollar of shipments. That means more of the sales price of the goods sold is due to the involvement of the industry than to the value of the inputs (in contrast, value added in the rest of the chemical sector is 48 cents per dollar of shipments and 41 cents for all manufacturing).

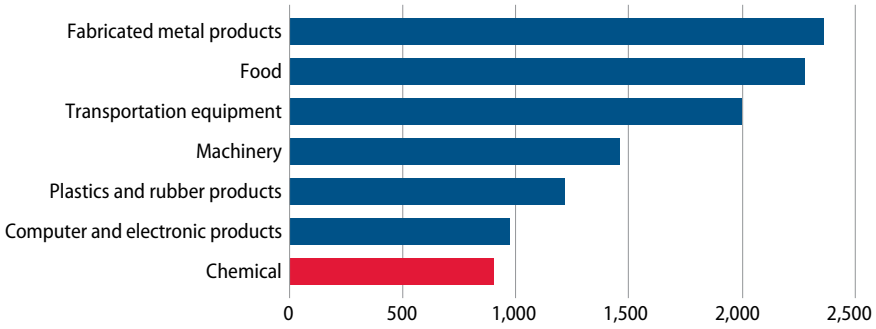
A large share of the value added and profitability in pharmaceuticals is due to the intellectual property, the value in owning the rights to a medicine. This is reflected in relatively low production hours, and capital investment in buildings and machinery, relative to value added.

A variety of factors contribute to the success of the chemical sector in the United States. The bulk nature of much of the industry and the risks of shipping the substances it uses and makes means distances from markets is certainly a factor. Access to raw materials, low labor content, and the need for skilled workers are also important. In the case of the pharmaceutical industry, the strong U.S. university base, public investment in medical research, the "commons" of powerful domestic research capabilities, and the need to produce products to high manufacturing standards are certainly factors working in the favor of U.S.-based production. For these and other reasons, pharmaceuticals is an industry where U.S.-based manufacturing continues to be important and viable.

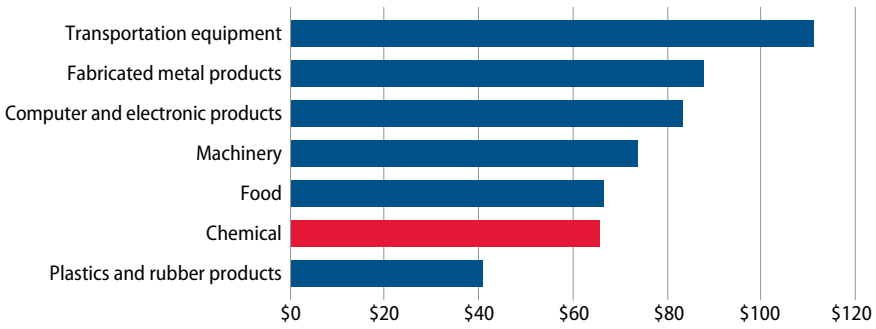
FIGURE 8

Chemical manufacturing not labor intensive

Top seven manufacturing subsectors by production hours, in millions of hours



Top seven manufacturing subsectors by compensation, in billions of dollars



Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

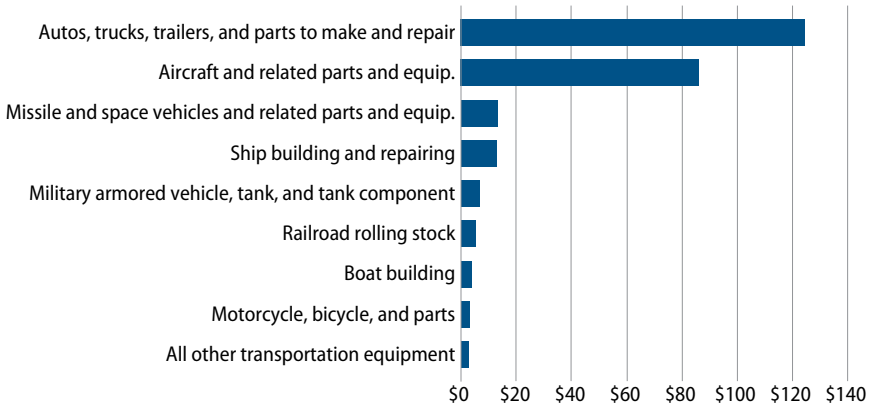
Transportation

Transportation equipment manufacturing includes everything from rockets to bicycles. Automobiles, trucks, and the parts needed for making them make up about 48 percent of the value added in this area of manufacturing, 49 percent of employee compensation, 60 percent of the production worker hours, and 68 percent of the capital expenditures. Aircraft manufacturing is also substantial, accounting for 33 percent of the value added in the sector.

FIGURE 9

Transportation sector breakdown

Transportation subsector value added by industry, 2008, in billions of dollars



Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

Government purchases are an important factor in transportation manufacturing. Missile, space, and armored vehicles combine for 5 percent of the value added in the sector, with the primary customer being, one hopes, the government. If one were to add that to all the aircraft, ships, and other vehicles the federal government buys, public-sector purchases are substantial.

Nevertheless, this is a sector where the United States is quite competitive as a manufacturer with or without government involvement. Both domestic and foreign corporations boast manufacturing facilities in the United States. For a breakdown of the transportation sector, see Figure 9.

Food manufacturing

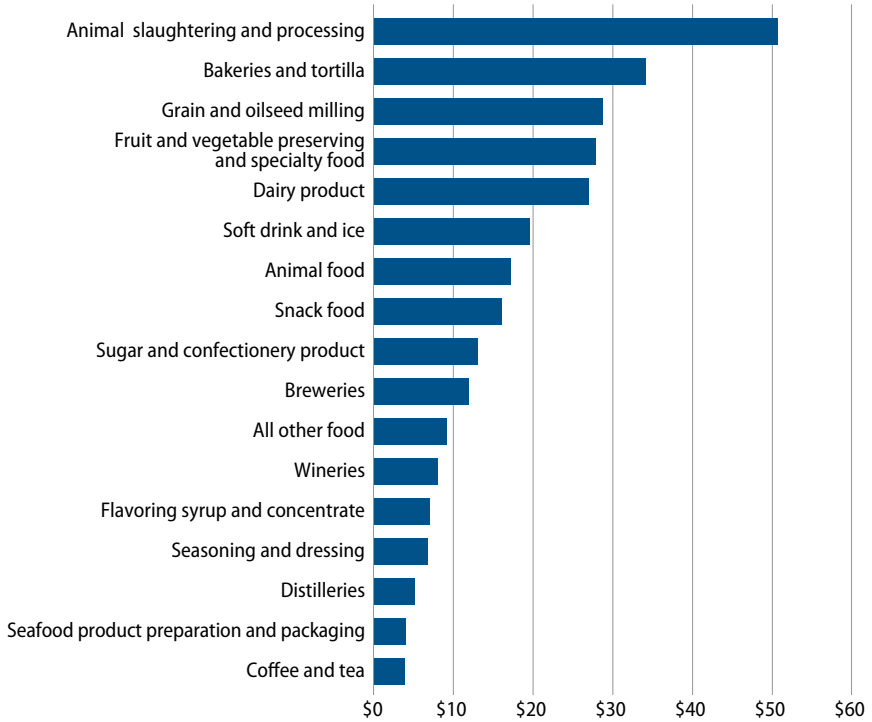
Food manufacturing is, even more than other manufacturing sectors, largely a domestic industry producing for the domestic market. Much of the value added comes from workers on the production floor. "Animal slaughtering and processing" is the largest individual industry, accounting for 21 percent of value added in food manufacturing. This industry is particularly labor intensive, accounting for 41 percent of the food subsector production worker hours.

Formally, beverages are not included in the food manufacturing subsector, falling instead into the "beverage and tobacco" category, but we have included them in the chart and the tables in the appendix on page 33. The beverage and tobacco subsector is a much smaller subsector than food manufacturing with $125 billion in shipments versus $650 billion for food.

FIGURE 10

Food manufacturing breakdown

Food and beverage value added by industry, 2008, in billions of dollars



Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

Food and beverages are, for obvious reasons, manufacturing subsectors that are likely to be served to a substantial degree by domestic sources with enormous inherent advantages over foreign producers. Freshness, shipping issues with perishables, local taste, and other factors are challenges to importers that are not easily or inexpensively overcome for many of the products.

Computer and electronic product manufacturing

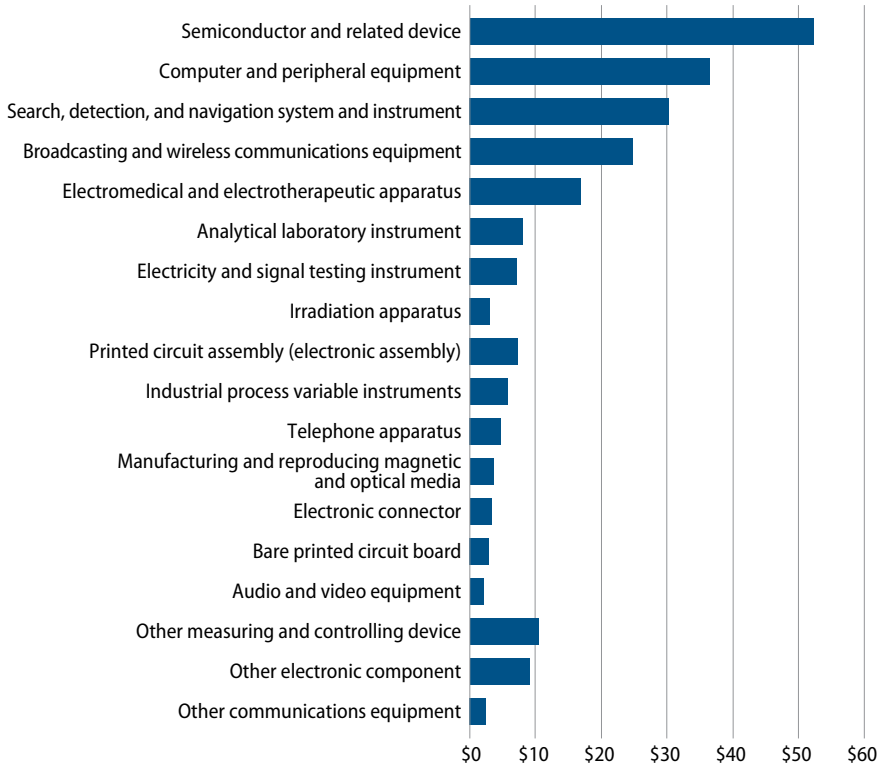
Computer and electronic product manufacturing accounts for 10 percent of U.S. manufacturing value added. Within this subsector, semiconductors account for more than 20 percent of value added. Semiconductor facilities are particularly capital intensive—almost 60 percent of the capital expenditures in support of computer and electronic manufacturing went to semiconductor facilities in 2008.

The manufacturing of computers themselves (and peripherals) accounts for 16 percent of the value added in this sector. Following close behind are: search, detection, and navigation system and instrument manufacturing; broadcasting

FIGURE 11

Computer and electronic parts manufacturing breakdown

Computer and electronic subsector value added by industry, 2008, in billions of dollars



Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

and wireless communications equipment; and electromedical and electrotherapeutic apparatuses. This is an area where the United States was highly competitive in the past and is still competing hard. U.S. companies lead the world in much of the industry and manufacturing in the country remains substantial—even as market share has grown for other countries.

Fabricated metal product manufacturing

Fabricated metal product manufacturing is, essentially, making things out of metal in a way that doesn't fit into another manufacturing sector. The largest industry within this the subsector is "architectural and structural metals manufacturing, " or in everyday English everything from pre-fab metal buildings to gutters to window screens to metal beams, accounting for 24 percent of the value added and highlighting the importance of construction to American manufacturing.

Machinery manufacturing

Machinery manufacturing is about creating machines that apply mechanical force. There's a great deal of metal fabrication in this subsector but for a different purpose than in the fabricated metal manufacturing sector. This, too, is a subsector for which the construction industry is important. Heating, ventila-

tion, and air conditioning, or HVAC, is the largest industry within—comprising 12 percent of the subsector value added. Construction machinery accounts for 8 percent of the value added. As described later, this is a substantial export sector.

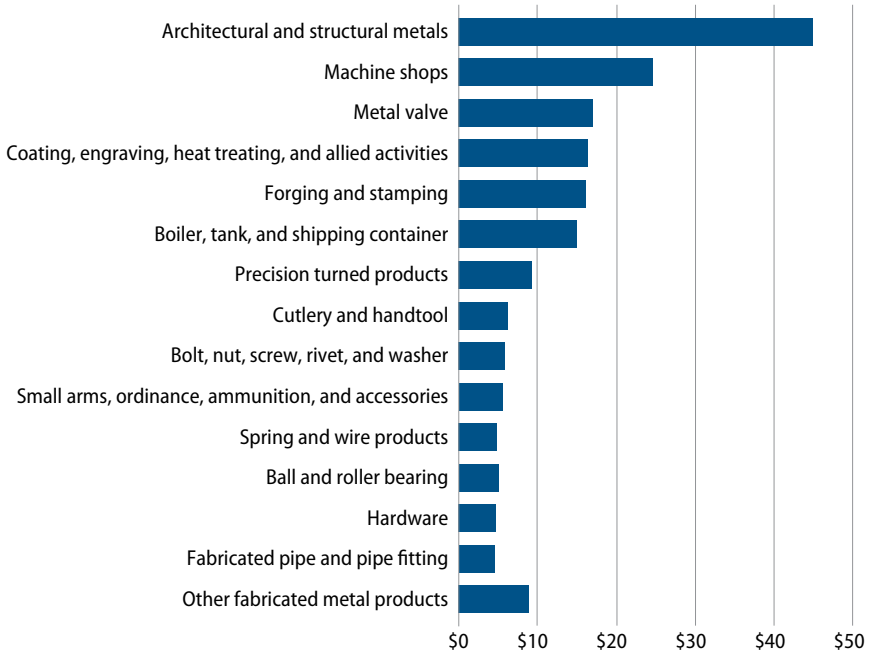
The breadth of American manufacturing

As described above in our discussion of the six largest subsectors, U.S. manufacturing is diverse and robust. The sheer volume and diversity speaks to its continuing viability and competitiveness. Another indication is how goods made in America compete in the rest of the world. We turn to this question now.

FIGURE 12

Fabricated metal products breakdown

Fabricated metals subsector value added by industry, 2008, in billions of dollars

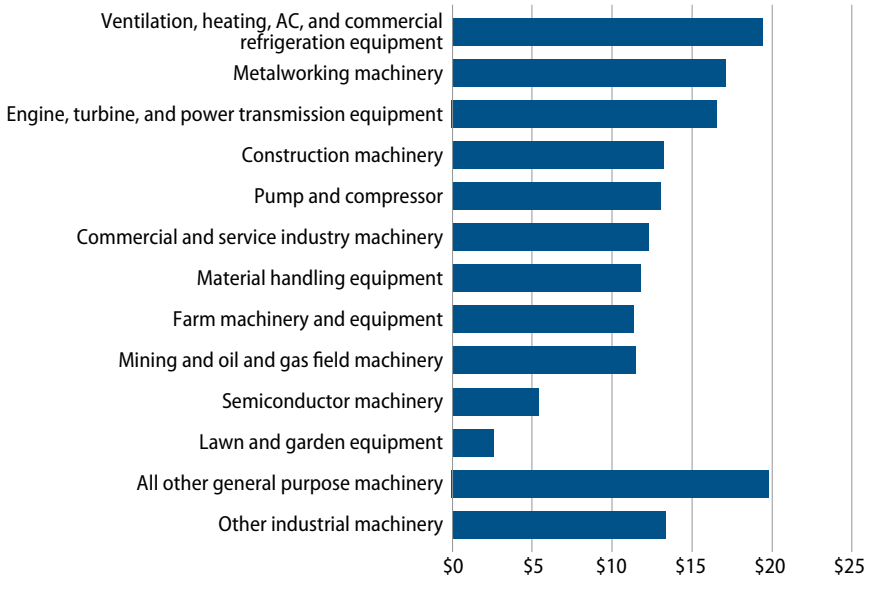


Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

FIGURE 13

Machinery breakdown

Machinery subsector value added by industry, 2008, in billions of dollars



Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

Exports that compete in other countries

The United States is the third-largest exporter of manufactured goods. According to the Organisation for Economic Co-operation and Development, a group comprised of the world's most developed economies, the United States exported $1.3 trillion worth of goods in 2008, of which manufactured goods comprised $1.1 trillion (neither of these numbers includes the $550 billion in services that were exported).[27] Although our top export destinations are close at hand, the destinations span the globe. Consumers, businesses, and governments in countries from Australia to Indonesia, Brazil to Russia, and China to Italy choose to buy goods made in the United States.

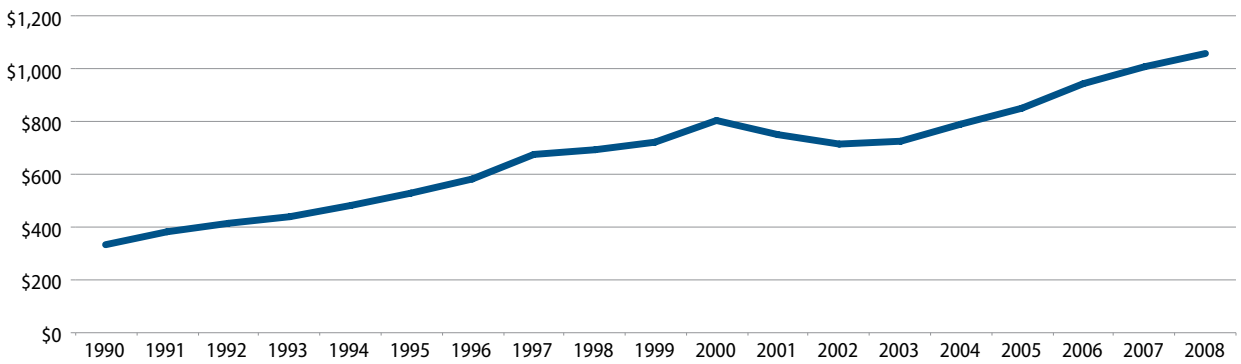
Close to 80 percent of our manufacturing exports are in three manufacturing export categories as defined by the Organisation of Economic Co-operation and Development:

- Machinery and equipment
- Chemicals, rubber, plastics, and fuel
- Transport equipment

FIGURE 14

U.S. manufacturing exports going up

U.S. manufacturing exports, 1990-2008, in billions of 2009 dollars



Source: OECD.

TABLE 2

U.S. manufacturing exports going around the world

U.S. manufacturing exports, 2008, in billions of dollars

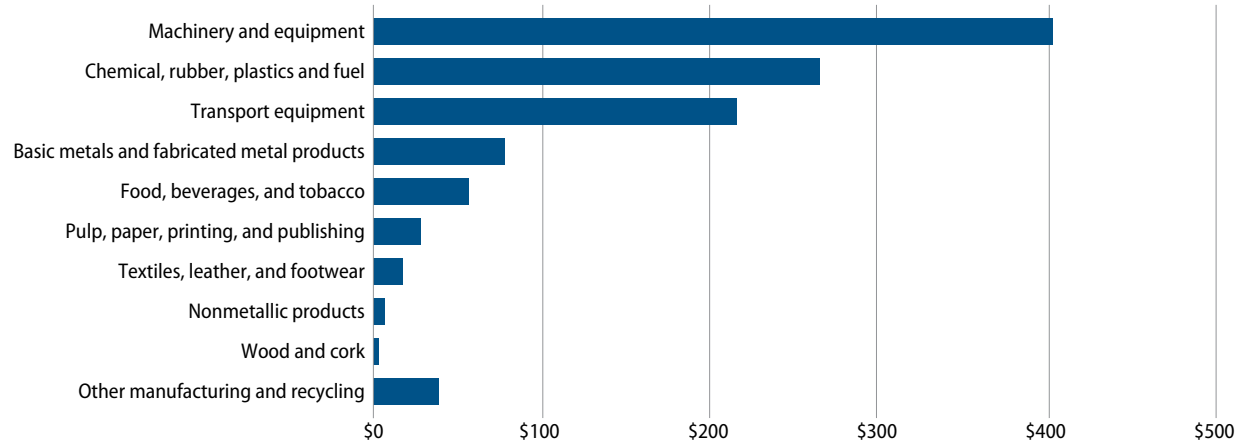
Total world	**$1,132.5**		
Canada	$230.7	Argentina	$7.1
Mexico	$136.0	Turkey	$6.9
Japan	$54.1	South Africa	$5.8
China	$52.6	Sweden	$4.5
Germany	$49.9	Indonesia	$3.9
United Kingdom	$45.9	Poland	$3.6
Netherlands	$36.9	Finland	$3.3
Brazil	$30.8	Norway	$3.1
Korea	$28.0	Denmark	$2.5
Singapore	$27.7	Austria	$2.3
Belgium-Luxembourg	$27.7	Portugal	$2.3
France	$26.8	New Zealand	$2.3
Australia	$21.1	Hungary	$1.4
Chinese Taipei	$20.6	Czech Republic	$1.3
Hong Kong	$19.5	Luxembourg	$0.9
Switzerland	$17.9	Lithuania	$0.8
India	$16.8	Romania	$0.8
Italy	$13.4	Bulgaria	$0.4
Israel	$13.3	Slovak Republic	$0.3
Malaysia	$11.9	Latvia	$0.3
Chile	$11.2	Iceland	$0.3
Spain	$10.2	Slovenia	$0.3
Russia	$8.9	Malta	$0.2
Ireland	$8.3	Estonia	$0.2
Thailand	$7.7	Cyprus	$0.2
Philippines	$7.3	Rest of the world	$91.7

Source: OECD.

FIGURE 15

U.S. manufacturing export breakdown

U.S. manufactured goods exports to the world, 2008, by industry, in billions of dollars



Source: OECD.

Machinery and equipment

In the OECD classification, machinery and equipment is a very broad category, broader than in the data from the U.S. Bureau of the Census used above. It includes everything from electric blankets to X-ray machines to factory machine tools (see Figure 16).

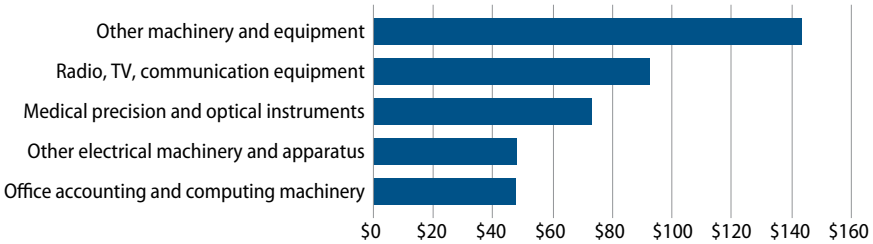
Although the United States is a heavy exporter of machinery and equipment and competing internationally, it is also a heavy importer—importing about a third more than it exports. The broad "other machinery and equipment" category and the medical category do, however, run surpluses.

The top destinations for machinery and equipment exports are Canada and Mexico, accounting for 29 percent of exports in this category. But Asian and European countries are also substantial buyers of these U.S. exports. U.S. consumer

FIGURE 16

Machinery and equipment export breakdown

Manufacturing and equipment exports, 2008, in billions of dollars



Source: OECD.

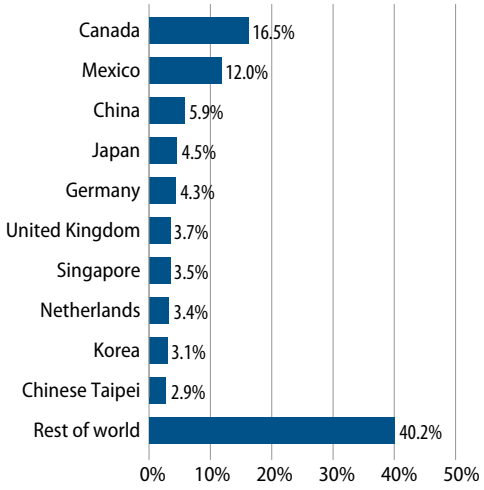
products giant Proctor and Gamble, for example, exports the machines that make single-blade razors to India where local factories make the blades themselves.

Countries not on this top 10 list are prominent within specific industries. Brazil, for example, is the fourth-greatest importer of U.S. office accounting and computing machinery. And neighboring Canada and Mexico don't top the list of every industry; Japan, Germany, and the Netherlands all import more U.S.-manufactured medical precision and optical equipment than Mexico.

FIGURE 17

U.S. machinery and equipment export breakdown

Percent of machinery and equipment exports going to top 10 destinations and the rest of the world, 2008



Source: OECD.

Chemicals, rubber, plastics, and fuel

The chemical industry is one of the few where the United States runs a trade surplus with the rest of the world, amounting to $1.3 billion in 2008. This overall number, however, masks a $23.8 billion deficit in pharmaceuticals and a $25.1 billion surplus in other chemical products.

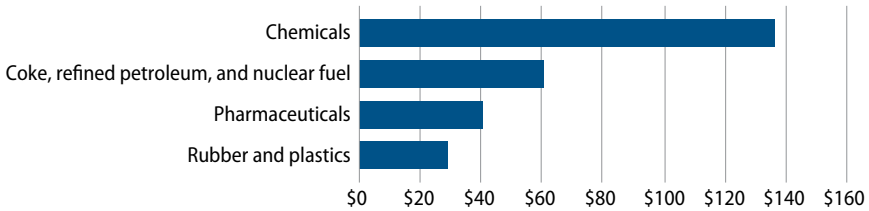
Looking at just U.S. pharmaceuticals exports, the largest recipient is Germany—to which we export $5.7 billion of pharmaceutical manufactured products. Seventy-seven percent of U.S. pharmaceutical exports go to just 10 countries. They are all economically advanced countries that provide higher-quality health care.

Canada and Mexico are the largest recipients of other U.S. chemical exports. This isn't surprising. Because of their bulk and their toxic nature, chemicals are often produced close to their point of use. Proximity runs both ways—with Canada being the country from which we import the greatest amount of chemicals, and with Mexico ranked ninth. Nevertheless, 71 percent of U.S. nonpharmaceutical chemical exports go to overseas destinations—with China receiving the third most.

FIGURE 18

Chemicals export breakdown

Chemical, rubber, plastics, and fuel manufacturing exports, in billions of dollars



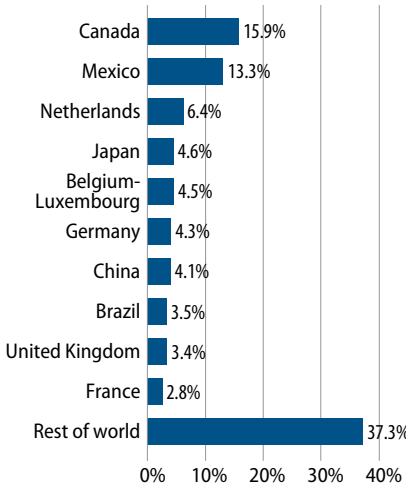
Source: OECD.

FIGURE 19

Chemicals industry export breakdown

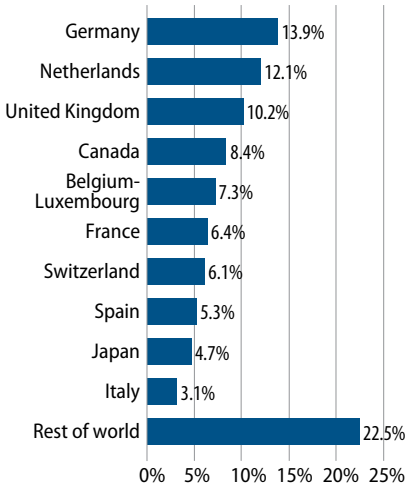
Where does the United States export manufactured chemicals, rubber, plastics, and fuel to?

Percent of exports going to top 10 destinations and the rest of the world, 2008



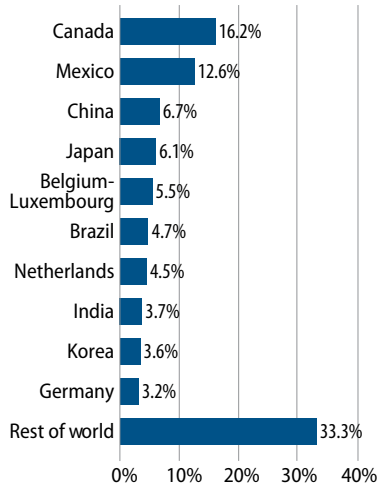
Where does the United States export pharmaceuticals to?

Percent of exports going to top 10 destinations and the rest of the world, 2008



Where does the United States export nonpharmaceutical chemicals to?

Percent of exports going to top 10 destinations and the rest of the world, 2008



Source: OECD.

Transportation equipment

Overall, the United States faces a trade deficit in transportation goods of $30 billion, but this is a product of two contrary export patterns within the subsector—an $87 billion deficit in motor vehicles offset by a $58 billion surplus in aircraft (with a few other goods mixed in). Notwithstanding the large motor vehicle deficit, the United States does export $116 billion in motor vehicles, trailers, and semitrailers.

Not surprisingly, the largest recipient of those exports is Canada, which receives 43 percent of our exports, with Mexico second. Overseas exports, however, account for 43 percent of motor vehicle exports, with Germany accounting for 8 percent. General Motors recently announced a deal to export $900 million of vehicles and parts to China.[28]

Aircraft sales are spread much more broadly. Japan, France, the United Kingdom, Canada, Brazil, China, and Germany were each in the top 10 export destinations in 2008, with each accounting for more than 5 percent of exports. This is a very competitive sector of U.S. manufacturing where there is a favorable trade balance, and which is successful selling to a wide variety of countries the world over. Boeing alone accounted for just less than $29 billion of exports in 2009.

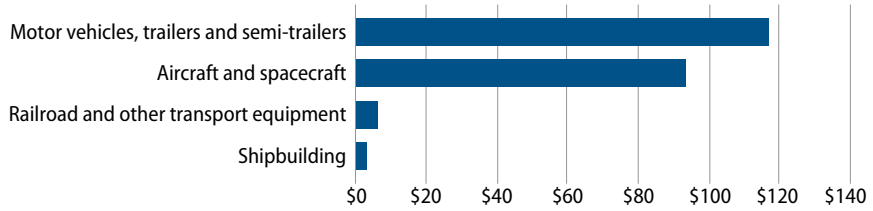
Exporting to the world

Businesses and people around the world are buying U.S. manufactured goods. They're buying goods made by other countries as well. But the success of U.S. manufactured goods in the world market is encouraging as we think about the importance of the future of manufacturing for the U.S. economy.

FIGURE 20

Transportation equipment export breakdown

Transportation equipment manufacturing exports, in billions of dollars



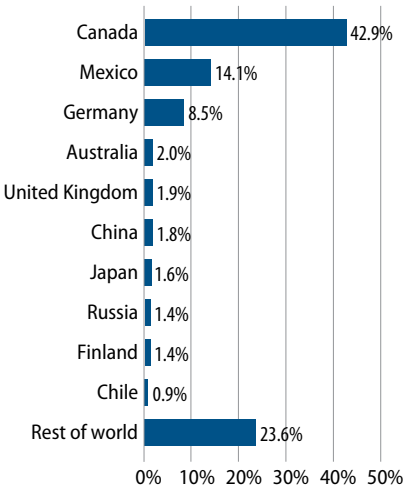
Source: OECD.

FIGURE 21

Transportation equipment export breakdown

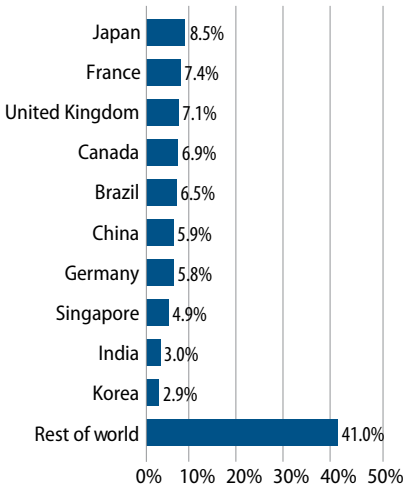
Where does the United States export motor vehicles, trailers, and semi-trailers to?

Percent of exports going to top 10 destinations and the rest of the world, 2008



Where does the United States export aircraft and spacecraft to?

Percent of exports going to top 10 destinations and the rest of the world, 2008



Source: OECD.

Putting it all in perspective

The United States no longer dominates world manufacturing as it once did. And the U.S. manufacturing sector faces extremely tough challenges. But none of this means U.S. manufacturers cannot compete on the world stage or in their own domestic market.

There are certainly many areas of U.S. manufacturing that do compete and compete well—purchasers are not buying more than $5 trillion of shipments from U.S. factories simply out of goodwill. Purchasers in other countries continue to buy $1.1 trillion of manufactured exports from the United States even though these goods face extremely tough competition from those countries' domestic producers and other exporting countries.

But this doesn't mean we should be complacent about U.S. manufacturing. In fact, it shows just the opposite. If our conclusion were that U.S. manufacturing cannot compete, we would be very chary of public policies going to great lengths to make it more competitive. If we thought we couldn't compete, we wouldn't want to try. That would likely be a poor use of resources and attention. What the existing competitiveness of U.S. manufacturing tells us is that there's something worth fighting for here.

A detailed analysis of the competitiveness of U.S.-based manufacturing is beyond the scope of this paper, but suffice it to say that:

- Wage differences aren't everything
- The overall cost differences between countries aren't as large as they are sometimes made out to be
- Different industries care about different costs differently[29]
- Proximity to markets matters
- Proximity to research and management and resources also matters
- Skills matter

These are only some of the reasons why U.S. manufacturers are holding their own in the U.S. and global markets in the key industries examined in this report. Yet without question there are many problems in U.S. manufacturing. Large swaths of our industrial base have moved away. What's more, offshoring and outsourcing can mushroom as bits of different manufacturing supply chains develop elsewhere. U.S. companies that supply these manufacturing operations abroad find it more and more advantageous to go where their factories are, which is why industries can get slowly hollowed out as other countries become the central places of production. The United States risks being relegated to the periphery, which in turn would hurt our capacities at innovation and thus threaten our innovation and technology leadership. Remaining capacity can hang on for a while but the leadership, the concentration of wisdom, and skill slips away—and once gone is hard to recapture.

Then there's that large component of U.S. manufacturing that has traditionally focused on construction. This strength of construction was a major reason why value added and shipments held up in the 2000s. But the construction bubble of that decade is not going to repeat itself.

What's more, our nation's seemingly most competitive manufactured products, high-tech goods, moved from surplus into deficit in recent years, and that deficit is growing.

So long as there is demand in the United States for manufactured goods as well as the innovators, manufacturing workers, and available capital necessary to remain competitive, manufacturing can continue to be important in the U.S. economy. But those things are not foregone conclusions. U.S. workers are nervous about taking jobs in industries that have seen declining employment. Other countries offer enormous subsidies in a variety of ways. And we are not alone in being innovators—and have become much less welcoming to innovators from abroad who wish to live in the United States.

These are important challenges but they are challenges worth taking on. President Obama's focus on manufacturing and exports are welcome signs, as is the introduction of a new "Make It in America" agenda in Congress. The recent rebound in U.S. automobile manufacturing is encouraging as is the spurt in exports. But this is an effort that's going to take more than setting goals and one president's focus.

Other countries recognize the importance of manufacturing, taking steps to nurture it. Some of these steps violate U.S. free-market principles. Some involve significant public expenditures. Other foreign manufacturing industries flourish in part because governments have created domestic markets—particularly in clean energy technologies—leading those industries to become world leaders.[30] The United States needs to get into the game and find the right steps for us that will create an environment where a nation's manufacturing sector can flourish and succeed—not just in selling here, but to the world.

Appendix

Manufacturing by the numbers: A guide to the data

Value added. According to the Bureau of the Census, "[v]alue added is considered to be the best value measure available for comparing the relative economic importance of manufacturing among industries and geographic areas." In general terms it reflects the value of the shipments from manufacturing facilities less the cost of materials, supplies, containers, fuel, purchased electricity, and contract work.

Shipments. This is the value of products produced and shipped by producers.

Exports. The value of goods produced by U.S. manufacturers and sold to other countries.

Capital expenditures. Expenditures for additions, alternations to manufacturing establishments, and purchases of machinery and equipment including vehicles, computers and other tools, machines, etc.

Compensation. Includes payroll and fringe benefits for employees.

Production worker hours. "This item covers all hours worked or paid for at the manufacturing plant, including actual overtime hours (not straight-time equivalent hours). It excludes hours paid for vacations, holidays, or sick leave when the employee is not at the establishment."

TABLE A-1

Manufacturing by industry, 2008

Dollars in billions, hours in millions

	Value added	Shipments	Total capital expenditures	Compensation	Production workers hours
Manufacturing	2,266.4	5,468.1	166.1	784.2	17,781
Chemical	352.4	738.7	21.1	65.7	906
Transportation equipment	258.3	672.8	16.6	111.2	1,999
Food	246.6	649.9	15.7	66.3	2,274
Computer and electronic products	228.4	383.9	22.0	83.2	969
Fabricated metal products	189.1	358.3	11.3	87.7	2,355
Machinery	167.3	355.6	9.6	73.6	1,456
Miscellaneous	99.6	153.4	4.6	37.6	778
Primary metal	91.7	282.6	10.0	30.6	696
Petroleum and coal products	89.7	769.7	18.7	11.2	151
Plastics and rubber products	90.9	203.7	7.7	40.8	1,218
Paper	79.5	179.2	6.3	27.1	655
Beverage and tobacco products	76.2	125.1	3.8	10.2	172
Electrical equipment, appliance, and component	60.8	130.3	3.1	24.8	559
Nonmetallic mineral products	61.8	115.5	5.9	25.2	695
Printing and related support activities	59.6	98.6	4.1	31.0	823
Furniture and related products	43.5	79.8	1.2	20.6	666
Wood products	34.5	87.8	2.5	20.0	725
Textile mills	12.5	32.1	0.9	6.2	224
Textile product mills	12.1	26.8	0.6	5.2	203
Apparel	9.1	19.1	0.2	4.8	211
Leather and allied products	2.6	5.2	0.1	1.3	46

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

TABLE A-2

Industry shares of chemical subsector, 2008

	Value added	Shipments	Capital expenditures	Compensation	Production workers hours
Chemical total (dollars in billions, hours in millions)	**$352**	**$739**	**$21**	**$66**	**906**
Pharmaceutical and medicine	40%	26%	24%	37%	25%
Basic chemical	23%	33%	37%	22%	21%
Soap, cleaning compound, and toilet preparation	13%	12%	10%	11%	14%
Resin, synthetic rubber, and artificial synthetic fibers and filaments	7%	13%	14%	11%	14%
Other chemical product and preparation	6%	6%	5%	10%	13%
Pesticide, fertilizer, and other agricultural chemical	5%	5%	6%	3%	4%
Paint, coating, and adhesive	4%	4%	3%	7%	8%

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

TABLE A-3

Industry shares of transportation subsector, 2008

	Value added	Shipments	Capital expenditures	Compensation	Production workers hours
Transportation total (dollars in billions, hours in millions)	**$258**	**$673**	**$17**	**$111**	**1,999**
Autos, trucks, trailers and parts to make and repair	48%	61%	68%	49%	60%
Motor vehicle parts	24%	26%	41%	30%	38%
Automobile and light duty motor vehicle	19%	28%	24%	12%	11%
Motor vehicle body and trailer	4%	4%	2%	5%	9%
Heavy duty truck	1%	3%	1%	2%	2%
Aircraft and related parts and equipment	33%	24%	19%	31%	22%
Missile and space vehicles and related parts and equipment	5%	3%	3%	7%	3%
Ship building and repairing	5%	3%	4%	6%	7%
Military armored vehicle, tank, and tank component	3%	2%	1%	1%	1%
Railroad rolling stock	2%	2%	1%	2%	2%
Boat building	1%	1%	2%	2%	3%
Motorcycle, bicycle, and parts	1%	1%	1%	1%	1%
All other transportation equipment	1%	1%	1%	1%	1%

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

TABLE A-4

Industry shares of food subsector, 2008

	Value added	Shipments	Capital expenditures	Compensation	Production workers hours
Food total (dollars in billions, hours in millions)	**$247**	**$650**	**$16**	**$66**	**2,274**
Animal slaughtering and processing	21%	26%	27%	28%	41%
Bakeries and tortilla	14%	9%	11%	18%	15%
Grain and oilseed milling	12%	14%	9%	6%	4%
Fruit and vegetable preserving and specialty food	11%	10%	13%	12%	12%
Dairy products	11%	15%	14%	12%	9%
Animal food	7%	8%	7%	4%	3%
Snack food	7%	4%	3%	3%	2%
Sugar and confectionery products	5%	4%	5%	5%	4%
Flavoring syrup and concentrate	3%	1%	1%	1%	0%
Seasoning and dressing	3%	2%	2%	3%	2%
Seafood product preparation and packaging	2%	2%	3%	2%	3%
Coffee and tea	2%	1%	1%	1%	1%
All other food	4%	3%	4%	4%	4%

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

TABLE A-5

Industry shares of beverage and tobacco product subsector, 2008

	Value added	Shipments	Capital expenditures	Compensation	Production workers hours
Beverage/tobacco total (dollars in billions, hours in millions)	**$76**	**$125**	**$4**	**$10**	**172**
Beverage	59%	70%	90%	84%	85%
Soft drink and ice	26%	38%	43%	39%	46%
Breweries	16%	16%	22%	20%	18%
Wineries	11%	11%	22%	19%	16%
Distilleries	7%	6%	3%	5%	6%
Tobacco	41%	30%	10%	16%	15%

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

TABLE A-6

Industry shares of computer and electronic product subsector, 2008

	Value added	Shipments	Capital expenditures	Compensation	Production workers hours
Computer/electronics total (dollars in billions, hours in millions)	**$228**	**$384**	**$22**	**$83**	**969**
Semiconductor and related device	23%	18%	59%	14%	17%
Computer and peripheral equipment	16%	17%	6%	9%	7%
Search, detection, and navigation system and instrument	13%	13%	4%	18%	10%
Broadcasting and wireless communications equipment	11%	11%	7%	11%	7%
Electromedical and electrotherapeutic apparatus	7%	7%	5%	7%	5%
Analytical laboratory instrument	4%	3%	2%	4%	3%
Electricity and signal testing instrument	3%	3%	2%	4%	3%
Irradiation apparatus	1%	2%	1%	2%	1%
Printed circuit assembly (electronic assembly)	3%	6%	2%	5%	9%
Industrial process variable instruments	3%	2%	1%	3%	3%
Telephone apparatus	2%	2%	3%	2%	2%
Manufacturing and reproducing magnetic and optical media	2%	2%	2%	2%	4%
Electronic connector	1%	1%	1%	2%	3%
Bare printed circuit board	1%	1%	1%	2%	5%
Audio and video equipment	1%	2%	0%	1%	1%
Other measuring and controlling device	5%	5%	2%	5%	6%
Other electronic component	4%	4%	3%	6%	11%
Other communications equipment	1%	1%	0%	1%	1%

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

TABLE A-7

Industry shares of fabricated metal subsector, 2008

	Value added	Shipments	Capital expenditures	Compensation	Production workers hours
Fabricated metal total (dollars in billions, hours in millions)	**$189**	**$358**	**$11**	**$88**	**2,355**
Architectural and structural metals	24%	27%	20%	25%	25%
Machine shops	13%	11%	16%	16%	17%
Metal valve	9%	9%	7%	8%	6%
Coating, engraving, heat treating, and allied activities	9%	8%	9%	8%	9%
Forging and stamping	9%	10%	10%	8%	8%
Boiler, tank, and shipping container	8%	9%	9%	7%	6%
Precision turned product	5%	4%	7%	6%	7%
Cutlery and handtool	3%	3%	3%	3%	3%
Bolt, nut, screw, rivet, and washer	3%	3%	3%	3%	3%
Small arms, ordinance, ammunition, and accessories	3%	3%	1%	2%	2%
Spring and wire product	3%	3%	2%	3%	3%
Ball and roller bearing	3%	2%	3%	2%	2%
Hardware	3%	2%	2%	2%	2%
Fabricated pipe and pipe fitting	2%	2%	3%	2%	2%
Other fabricated metal products	5%	5%	4%	5%	5%

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

TABLE A-8

Industry shares of machinery subsector, 2008

	Value added	Shipments	Capital expenditures	Compensation	Production workers hours
Machinery metal total (dollars in billions, hours in millions)	**$167**	**$356**	**$10**	**$74**	**1,456**
Ventilation, heating, AC, and commercial refrigeration equip	12%	11%	11%	11%	14%
Metalworking machinery	10%	8%	11%	14%	15%
Engine, turbine, and power transmission equipment	10%	12%	17%	10%	10%
Construction machinery	8%	10%	15%	6%	7%
Pump and compressor	8%	7%	4%	6%	5%
Commercial and service industry machinery	7%	7%	6%	7%	7%
Material handling equipment	7%	8%	4%	8%	8%
Farm machinery and equipment	7%	7%	6%	5%	5%
Mining and oil and gas field machinery	7%	7%	8%	6%	6%
Semiconductor machinery	3%	3%	2%	3%	1%
Lawn and garden equipment	2%	2%	2%	1%	2%
All other general purpose machinery	12%	11%	9%	13%	12%
Other industrial machinery	8%	7%	5%	10%	8%

Source: Bureau of the Census, *Annual Survey of Manufactures* (Department of Commerce, 2008).

Endnotes

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14 See, for example: Thorvaldur Gylfason, "Natural Resources and Economic Growth: From Dependence to Diversification." Discussion Paper 4804 (Centre for Economic Policy, 2004); Richard Shediac and others, "Economic Diversification: The Road to Sustainable Development" (Booz and Company, 2008), available at http://www.ideationcenter.com/media/file/Economic_diversification2.pdf.

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16 Cohen and Zysman, *Manufacturing Matters*.

17 Christian E. Weller and Luke Reidenbach, "The Case for Strategic Export Promotion: Addressing a Persistent U.S. High-Tech Trade Deficit" (Washington: Center for American Progress, 2011), available at http://www.americanprogress.org/issues/2011/02/high_tech_trade.html.

18 Officially, "value added" has been going up quite dramatically but this is, in part, due to how it is measured across years. In the calculation of "real" value added, adjustments are made to account for the quality of good produced. This is appropriate but can give a somewhat illusionary impression. For example, computers produced today are of much greater value than those produced 20 years ago. This additional value is reflected in the value-added data. Yet in terms of contribution to the national economy and to profits and wages in the computer manufacturing industry, the more valuable computer produced may actually contribute less because prices have fallen so dramatically. Nevertheless, no matter how value added is compared over time, it is evident that at worse it has declined only modestly and at best it has grown robustly.

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25 The complete definition provided by the Bureau of the Census is: "This measure of manufacturing activity is derived by subtracting the cost of materials, supplies, containers, fuel, purchased electricity, and contract work from the value of shipments (products manufactured plus receipts for services rendered). The result of this calculation is adjusted by the addition of value added by merchandising operations (i.e., the difference between the sales value and the cost of merchandise sold without further manufacture, processing, or assembly) plus the net change in finished goods and work-in-process between the beginning- and end-of-year inventories. For those industries where value of production is collected instead of

value of shipments, value added is adjusted only for the change in work-in-process inventories between the beginning and end of year. For those industries where value of work done is collected, the value added does not include an adjustment for the change in finished goods or work-in-process inventories. 'Value added' avoids the duplication in the figure for value of shipments that results from the use of products of some establishments as materials by others. Value added is considered to be the best value measure available for comparing the relative economic importance of manufacturing among industries and geographic areas." "Definitions," available at http://www.census.gov/manufacturing/asm/definitions/index.html.

Note that, in this report, in all cases we use the more widely available measure of "Gross Value Added" instead of "Net Value Added." They differ in their treatment of the depreciated value of capital assets—with the net figure accounting for that depreciation and the gross figure not.

There are other issues in the calculation of value added. The Bureau of Economic Analysis explains why it reports lower value added in manufacturing than the Bureau of the Census: "For the nation, BEA defines gross domestic product by industry, often referred to as 'value added,' as an industry's gross output (sales or receipts and other operating income, commodity taxes and inventory change) minus its intermediate inputs (consumption of goods and services purchased from other industries or imported). The Census Bureau's measure of value added by industry differs conceptually from BEA's in that it includes the purchased services that are used in production of an industry's product, excludes excise and sales taxes from gross receipts, and does not value inventories on a replacement cost basis, as BEA does." Data presented here from the Census Domestic Manufacturing Survey reflect the Census definition of value added while that from the BEA reflects the BEA definition. Most of what's presented here is from the Domestic Manufacturing Survey.

26 U.S. Census Bureau's Annual Survey of Manufactures (ASM) Data, available at http://www.census.gov/manufacturing/asm/definitions/index.html.

27 The keen-eyed reader will notice that the OECD numbers presented in this section for the United States differ from the WTO numbers used at the beginning of the paper. Different sources offer different estimates of the amount of manufacturing exports. This has to do with different definitions of what constitutes a "manufactured" good, whether certain costs associated with export are included in the value, and other factors. The different data sources do not, however, tell substantially different stories.

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30 Kate Gordon, Julian L. Wong, and JT McLain, "Out of the Running? How Germany, Spain, and China Are Seizing the Energy Opportunity and Why the United States Risks Getting Left Behind" (Washington: Center for American Progress, 2010), available at http://www.americanprogress.org/issues/2010/03/pdf/out_of_running.pdf; Kate Gordon and others, "Rising to the Challenge: A Progressive U.S. Approach to China's Innovation and Competitiveness Policies" (Washington: Center for American Progress, 2011), available at http://www.americanprogress.org/issues/2011/01/china_innovation.html.

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