IHS ECONOMICS

The Market Size and Economic Contributions of the Off-Highway Equipment Industry

A report for the Association of Equipment Manufacturers

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ECONOMIC IMPACT ANALYSIS

IHS Economics | Report

Brendan O'Neil
Managing director

Scott Hazelton
Managing director

Shane Norton
Director

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For more information

Brendan O'Neil
Managing director, IHS Markit
Brendan.Oneil@ihsmarkit.com

For press information

Katherine Smith
Manager media relations, IHS Markit
Katherine.Smith@ihsmarkit.com

IHS Markit (USA) Inc.
1150 Connecticut Avenue NW, Suite 401
Washington, DC 20036

Contents

Project directors

- Brendan O'Neil, Managing director, Consulting, Economics and Country Risk
- Scott Hazelton, Managing director, Consulting, Economics and Country Risk

Project team

- Shane Norton, Director, Consulting, Economics and Country Risk
- Peter Walton, Analyst, Consulting, Economics and Country Risk

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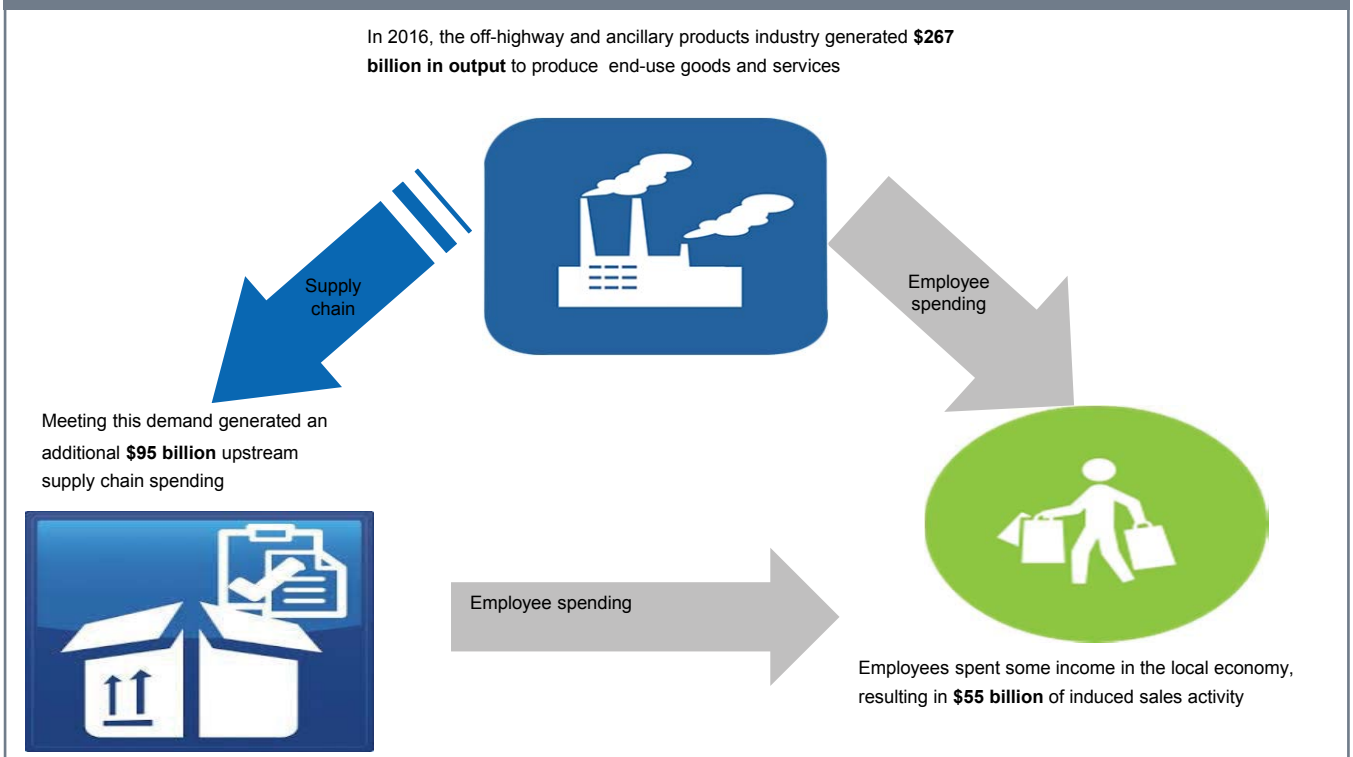
1.0

Executive summary and key findings

The North American off highway equipment industry is a significant component of the nation's manufacturing base and a leader in providing innovative solutions to the global construction, agriculture, mining and forestry sectors. The Association of Equipment Manufacturers (AEM) commissioned IHS to quantify the economic contributions of the North American off-highway equipment and ancillary products[1] industry to the economies of the United States and Canada, and provide enhanced detailed understanding of the industry's extensive supply chain by economic sector at the national and state/provincial level. The key findings of this study measure the economic contribution the industry makes in terms of jobs supported, value added (contribution to GDP), sales (output), labor income, and taxes within the broader economy.

For 2016, the IHS estimates there was $31.3 trillion in total sales activity in the United States across all sectors; of that total, IHS estimates that $416.2 billion in sales was supported by the off-highway equipment and ancillary products industry's economic activity. This occurred through approximately $266.5 billion in direct industry sales activity, such as the sales of equipment like skid steers and combines, which generated additional economic activity as dollars flowed through the equipment manufacturing supply chain. This multiplier effect drove an additional $94.7 billion in indirect sales in the supply chain for goods and services such as steel, electronics and banking services. Further, equipment companies and their suppliers hired and compensated employees, who, in turn, used their incomes to generate additional economic activity through the purchase of consumer goods and services. These third-order or 'induced' effects amount to $55.0 billion in 2016. The following graphic depicts this flow of economic effects.

Flow of US economic impacts from direct spending through income effect



Source: IHS

The economic activity generated through the sales of off-highway equipment and ancillary products triggers additional economic benefits—workers must be hired and retained to fill orders for goods and services, companies reap additional profits and make larger contributions to GDP, and companies and their employees must pay taxes. Taking those variables into account, IHS estimates that in 2016, the off-highway equipment and ancillary products industry directly employed nearly 500,000 people between the United States and Canada in the production of off-highway equipment.

[1] Includes product accessories, tooling, and other supporting components

The equipment manufacturing industry in the United States

- The total direct, indirect and induced employment contribution of the US off-highway equipment and ancillary products industry in 2016 totaled 1.3 million workers engaged in the design, production and sale of goods and services and includes the industry's supporting supply chain and induced local employment.
- Jobs supported by the off-highway equipment and ancillary products industry represent nearly 1% of the US total employment base.
- Of the 424,000 US employees directly involved with firms engaged in the production of off-highway equipment, 163,000 jobs were tied to the construction equipment industry, 114,000 jobs were tied to the agriculture equipment industry, and the remaining 148,000 jobs were tied to the mining equipment industry.
- Direct off-highway equipment and ancillary products industry jobs combined with those supported in the industry's supply chain represented more than 7% of the US manufacturing employment base.
- For every $1 million in direct industry sales, 2.7 jobs are supported within the industry's supply chain in the United States.
- The off-highway equipment and ancillary products industry generated $158.8 billion in economic value, which represented 0.9% of 2016 total nominal GDP in the United States.
- The output (industry sales activity) driven by the off-highway equipment and ancillary products industry directly and through the supply chain represented 5.1% of manufacturing output in the United States.
- Labor income supported by the off-highway equipment and ancillary products industry represented about 1.3% of US total labor income.
- The average US labor income per job within the off-highway equipment and ancillary products industry (both producers of end-use goods and services as well as the supply chain) amounted to just over $78,000—or approximately 58% above the national average—reflecting the highly skilled nature of the workforce.
- Of the total 1.3 million jobs linked to the off-highway equipment industry, the manufacturing sector is the largest total employment contributor at 39 percent, followed by professional and business services at 23 percent and retail trade at 13 percent.
- Texas leads all states with 16% of total US industry-related employment. Illinois, Wisconsin, and Ohio follow with 9%, 8%, and 6% shares, respectively.

The equipment manufacturing industry in Canada

The industry also makes a significant economic contribution in Canada, where it supports about 149,000 total jobs—more than 64,000 people directly employed by industries involved in the production of off-highway equipment and another 84,000 jobs associated with the industry's supply chain and the income effects of the direct and indirect employment. In total, nearly $34 billion in sales activity is generated directly or supported by the industry, which adds nearly $15 billion to Canada's GDP.[2]

- The off-highway equipment and ancillary products industry supports 149,000 total employees in Canada—including 64,000 direct jobs involved in firms producing off-highway equipment.
- Ontario has the largest concentration of direct employment in the manufacturing of off-highway equipment, with just over 25,000 jobs within the province. Alberta and Quebec are home to the bulk of the remaining direct employment, with 15,000 and 12,000 direct employees, respectively.

[2] All Canadian impact results are shown in US dollars

- The equipment manufacturing industry generates $34 billion in total sales activity in Canada, with more than $15.5 billion of that coming from direct industry activity.
- The direct economic contribution driven by the off-highway equipment and ancillary products industry represented about 4.1% of Canada's total share of the manufacturing component of Canada's GDP.
- The 149,000 total jobs supported by the industry generate $9.7 billion in labor income, with an average annual wage for direct industry employees of $73,500.
- The off-highway equipment and ancillary products industry generated $14.9 billion in economic value in Canada, which represented 1% of 2016 total nominal GDP.

The North American off-highway equipment and ancillary products industry is a broad complex of firms performing a variety of functions, including the manufacturing of finished and semifinished goods, raw materials, components, systems, and platforms. For the purposes of this analysis, the equipment industry is defined by a set of relevant sectors categorized under the North American Industry Classification System (NAICS) that which includes firms that produce goods and services for end use by off-highway equipment and ancillary products industry customers, whereas other subsectors are predominately composed of suppliers that support production.

2.0
State of the industry

AEM industry outlook and trends

Overview

The equipment manufacturing industry is ubiquitous in the US economy. Every day, across the country, men and women make use of an array of equipment to help build roads, bridges, and hospitals; produce energy to fuel cars and heat homes; and grow and harvest crops to feed the world. This industry's diversity reflects the extent to which machinery powers our modern economy.

The multitude of sectors that depend on equipment means there are more requirements than ever that shape demand for types of machinery and affect how manufacturers in response adjust production and innovate new technology to meet the economy's needs.

As a result, the equipment manufacturing industry has most recently undergone significant transition. The industry's overall performance in recent years has struggled owing to declining commodity prices (for agriculture, oil, gas, and minerals), inconsistent government support for infrastructure investment, and declining exports attributable in part to the US dollar's strength during a time of relatively weak economic performance in key export markets.

There are, however, good reasons for a positive outlook across this important industry whose mission-critical goods account for about 1% of total US GDP yet enable so much more economic activity in the way of new construction, crop production and energy and mineral extraction.

GRADALL INDUSTRIES, INC.
Where Ingenuity Works

Gradall employs 400 people in an entirely unionized workforce in a single facility in Ohio, where it manufactures Gradall excavators and Vacall vacuum and jetting machines.

All its manufacturing is done domestically, and more than 80% of its sales stay within North America.

Its supply chain has diversified globally over the years, but some purchases remain local, such as steel.

(In this industry) "You live and die by new production and new developments" – Mike Haberman, president

"Hiring has become a challenge. Skill sets are drastically different with respect to technology. If trade schools aren't staying current with technology, you have a really hard time hiring good people."

"Logistics are an advantage for domestic manufacturing. When you're talking logistics, you need to talk infrastructure. As our infrastructure ages, that's going to get more difficult. The entire economy is based on free movement."

Workforce: "We as a country need to stay ahead of the curve on workforce. If we want manufacturing to stay and thrive in this country, we need to stay up-to-date on workforce and development."

The 2016 US presidential and congressional election prompted a noticeable uptick in consumer and business sentiment, and stock-market indices have surged. Many businesses, including equipment manufacturers, are optimistic that the Trump administration and a Republican-controlled Congress will cut taxes, roll back regulations, and make it easier to repatriate profits. President Donald Trump's pledge to make a major investment in US infrastructure has notably spurred positive business sentiment, especially among manufacturers of construction equipment.

IHS expects overall US real GDP growth to improve from 1.6% in 2016 to 2.3% in 2017. This outlook reflects an end to the recent surplus inventory correction as well as a rebound in energy-sector investment. It will take longer for policy-related changes to impact real GDP growth to become apparent. This forecast makes the core assumption that elected leaders will reduce the statutory corporate income tax rate from 35% to 20%, partially offset by a scaling back of tax credits. Even still, the effects of these tax cuts and the effects of any deregulation may not become apparent until late 2017 or early 2018.

IHS projects real GDP will improve to 2.6% in 2018. Consumer spending growth should pick up in 2017 and 2018, supported by gains in consumer confidence, employment, real disposable income, and household net worth.

This forecast is based on an analysis of many of those variables that will drive performance in the equipment manufacturing industry, including construction and energy markets, farm income, interest and exchange rates, and public policies—like tax reform, infrastructure investment, and changes to global trading relationships—that shape all of these issues.

The bottom line for the equipment manufacturing industry is that improving business fundamentals combined with expected policy actions will allow real equipment spending to pick up in the fourth quarter of 2017. We expect spending on equipment will extend into 2018 and beyond, based on many of the key factors outlined in the following sections.

Construction markets

Construction equipment manufacturing accounts for about 38% of the equipment manufacturing industry, as defined by IHS for the purposes of this report. Manufacturers of construction equipment directly employ 163,000 people in the United States and contributed nearly $31 billion to US GDP. This sector's health is shaped by many variables, most significantly public and private investment in home, commercial, and industrial real estate construction; mines and wells; utilities; institutional spending; and traditional infrastructure projects.

We expect a major infrastructure initiative by the Trump administration, combined with continued growth in residential and nonresidential structures, would stimulate additional demand for construction equipment in 2018 and 2019. The resurgence could be accelerated if Congress enacts any tax reform package, especially if it includes favorable bonus depreciation provisions. As a result, we have a cautiously optimistic forecast for construction equipment manufacturing that has even further upside potential.

Kubota manufactures machinery and equipment, including a full line of tractors, and is headquartered in Texas, where it moved from California in response to lower tax rates and the availability of skilled labor. Kubota also has a significant employment impact through its 1,100 dealerships scattered across the nation. Its primary production facilities are in Gainesville and Jefferson, Georgia. Its Lincolnshire, Illinois plant makes OEM engines for all of its product lines.

Skilled labor shortages are a key concern. "We have an internship program, where it allows engineers to work over the summer, and it offers them jobs at the conclusion of the program." – Todd Stucke, Vice President. Finally, Kubota also opens its doors to technical college classes, allowing them on the factory floor to see engineering at work within its facility.

One way Kubota gives back to the community is through a program that supports veterans transitioning to farming by giving away tractors each year through an affiliated charity.

Housing

Sustained growth in employment and real incomes has supported growing demand for housing. Although mortgage rates currently remain low, we expect mortgage interest rates to rise as the US Federal Reserve steadily increases its benchmark rate. However, housing supply is constrained by shortages of labor and available lots. The mismatch between demand and supply has contributed to rising home prices, and the combination of higher prices and higher financing costs is reducing affordability and slowing the residential recovery.

As a result, the US home ownership rate has fallen to a 51-year low as many new households choose to rent rather than own. Lean inventories of unsold homes, low rental vacancy rates, and rising prices will encourage builders to increase construction activity. However, the combination of lower affordability and high college debt loads among younger households suggests multifamily units will account for one-third of housing starts during the forecast. This would represent a significantly higher share for new housing construction than we have observed since 2000, but it also marks a return to the typical pattern of the US housing industry prior to the residential bubble.

Commercial and industrial

Business spending on structures depends on expected economic growth compared with existing capacity, corporate profits, and the cost of capital. Efficiency gains such as increased worker productivity or energy savings have also become increasingly important to businesses as they consider their need for space. Technological advances can also create the need for new or substantially renovated space.

US employment recovered its pre-recession level more than a year ago, and additional employment gains have driven construction growth. This has been particularly true within the commercial segment, and especially regarding offices and hotels within that segment. Hotel construction will subside significantly during the forecast, but office construction should continue at reduced rates. Retail construction has been a drag on the commercial sector as electronic commerce has taken share from big-box stores and shopping malls.

By contrast, construction of manufacturing facilities will slow. This segment had seen significant growth as large downstream petroleum facilities were built to produce ethanol, ammonia, and other byproducts of the shale revolution. Given rising employment costs, there has also been significant investment in new equipment and electronics on shop floors, which registers as construction spending because of the renovation often required. Still, a slowing construction cycle for large projects, combined with increased international production as a result of the strong US dollar, results in a forecast for some contraction in the industrial construction segment. Tax reform may rejuvenate investment, although its effects are too premature to forecast.

Mines and wells

One of the construction segments that buoyed the equipment sector post-Great Recession and is set to enjoy the strongest turnaround since 2014 is mines and wells. The recovery in energy prices in 2016 was welcome news for oil and gas drilling. As importantly, the downturn in energy prices eliminated weaker players, consolidated supply chains, and drove more efficient drilling techniques. As a result, the US fracking industry can operate profitably at lower oil prices. Taken together, we expect a dramatic improvement in activity in 2017 with continued growth to follow. A cautionary note is that this presents a base effect—a sharp recovery from a very low level. With a large, idle base of relatively new equipment, there will be a lag before new drilling activity translates into demand for new equipment.

Institutional spending

Institutional spending is poised for moderate growth. Increased tax revenues at the state and local level will allow construction of previously deferred projects. However, uncertainty about the Affordable Care Act will weigh against significant gains in healthcare construction. We are likely to see demand for healthcare offices around new residential developments and continued growth of specialty care facilities at the expense of large-scale hospitals.

Similarly, weak rates of household formation of recent years, which as a result slows growth in school-age children, will restrain spending on construction of educational facilities.

Infrastructure investment

Our forecast anticipates the passage of some kind of infrastructure legislation under the Trump administration, although the scale and financing of such legislation is uncertain. Trump has called for as much as $1 trillion in infrastructure investment, which could be paid for by methods ranging from bond guarantees to repatriated corporate earnings to general government revenue. This report projects a package of $250 billion over ten years, with a roughly level increase. Although the timing may not be exactly linear, this funding commitment would pump an additional $25 billion into construction spending per year, starting in 2018. This assumption would result in a discrete jump in growth in the construction market in 2018, when the act takes effect, followed by more moderate growth at the higher level of spending. Whereas the following table highlights road construction, we would expect the effects to include airports, seaports, and other public infrastructure.

Construction spending growth for key structure types (constant 2009 US dollars)							
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Residential	3.4	11.8	4.7	2.7	3.1	2.5	2.3
Commercial	19.0	10.1	18.0	6.6	5.7	4.6	4.6
Industrial	12.9	30.8	-4.3	-2.8	-4.3	-6.8	1.2
Mines and wells	5.5	-31.2	-43.9	42.4	12.8	6.9	6.6
Healthcare	-7.1	10.2	4.7	3.7	2.3	1.9	1.9
Utilities	14.5	-10.6	1.9	-1.9	-0.8	-2.2	-1.9
Highways and streets	1.8	0.6	1.4	1.9	6.0	0.4	-0.2
Total	**4.7**	**2.7**	**1.4**	**4.2**	**3.2**	**2.2**	**2.0**

Source: IHS

Agriculture markets

Farm equipment manufacturing accounts for approximately 27% of the equipment manufacturing industry, as defined by IHS for the purposes of this report. Manufacturers of agriculture-related equipment directly employed 114,000 people in the United States in 2016 and contributed nearly $21 billion to US GDP. A variety of interrelated variables shape this sector's health, most significantly the production and prices of major agricultural commodities, farm incomes, ethanol production, and the current supply of idle equipment that can still be put into service.

Commodity crop production

The US Department of Agriculture (USDA) updated its 2016/17 levels for plantings and yields for the 2016/17 crops in its February Crop Production Report. All wheat area harvest is seen at 43.9 million acres, with corn at 86.7 million acres, sorghum at 6.2 million acres, soybeans at 82.7 million acres, cotton at 9.5 million acres, and all rice at 3.1 million acres. Given the very conducive planting season, total principal-crop planted area reached 323.1 million acres in 2016/17, up from 319.4 million acres the previous season. The USDA also revised its projected yields to project new record highs for soybeans and sorghum; projections were reduced for corn, rice, and cotton; and US wheat yields were left unchanged. The USDA could further raise soybean yield levels in subsequent production reports since harvest reports imply a very good crop. Corn crops face bigger questions owing to uneven yield reports from different parts of the United States; nonetheless, a majority of the Corn Belt is on track to witness a large crop, and from a balance-sheet perspective, even if yields are reduced slightly, residual-use reduction will help soften the loss of ending stocks. For the remaining crops being harvested—soybeans, cotton, and sorghum—there appears to be no major concern at this time for harvests moving outside of their respective five-year averages.

For the upcoming 2017/18 planting season, corn plantings are forecast to fall to 89.2 million acres, which is contingent on prevented plantings moving back closer to average and would assume average delays to plantings that did not occur in 2016/17. US soybean plantings are estimated at a new record high of 86.4 million acres, as producers capitalize on stronger soybean price ratios compared with other crops, as well as some level of carryover excitement, given the 2016/17 yield level. Sorghum plantings are seen rising minimally to 7 million acres but are at risk of coming in lower if prices are unable to rise back to their more traditional price ratio. A majority of next season's growth is centered in Texas, which is always at a greater risk for weather difficulties.

We continue to expect yields to move back toward their respective trends, and with another record year in the books, the risks have again increased for a below-trend-line yield event for major commodities, adding to the upward price risk for the end of 2016/17. In 2017/18, US corn yields are forecast at 167.6 bushels per acre, with sorghum at 67.5 bushels per acre, all wheat at 47.1 bushels per acre, all rice at 7,583 pounds per acre, cotton at 831 pounds per acre, and soybeans at 45.4 bushels per acre.

Ethanol production

US ethanol production is expected to reach almost 15.1 billion gallons in the 2016/17 marketing year, with conventional, corn-based ethanol representing almost 98% of that total. US ethanol production is not expected to change dramatically during the next two marketing years, as exports and domestic demand remain flat. The US will continue to lead as a net exporter of ethanol in the immediate future, although this could begin to taper after 2020. The blend wall for ethanol in gasoline sold in the United States is expected to remain at 10% in the short term and is projected to gradually rise, eventually reaching E-13. US gasoline demand is expected to be flat during the 2016/17 marketing year and may begin to trend lower through 2025 before stabilizing. The US-implied retail ethanol price is forecast at $2.22 per gallon in 2016/17, $0.09 per gallon higher than in 2015/16.

Commodity prices and farm income

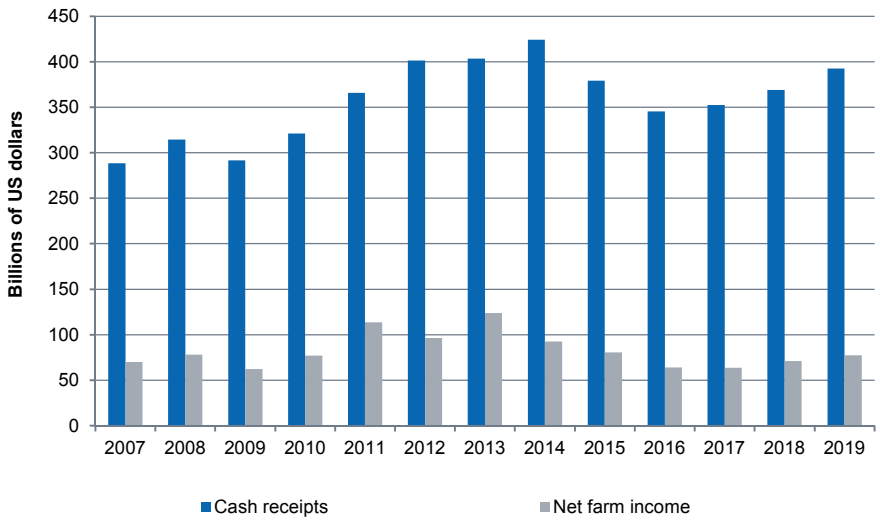
Agricultural commodity prices are expected to rise only slightly in 2017, but energy prices will climb. The result is that agricultural cash receipts and farm incomes are both likely to be down in 2017, with only small increases expected in 2018. Demand for new agricultural equipment is a function of farm income, and because of this, we expect soft domestic demand for farm equipment. Weak domestic demand will be compounded by the strong US dollar, which will diminish manufacturers' ability to export products to foreign buyers.

IHS projects net farm income at $64.1 billion in 2016 and $63.6 billion in 2017. The cattle price outlook has become a bit more bearish as both live cattle and feeders collapsed to lows not seen since 2010 in their respective futures markets. Texas/Oklahoma cash cattle prices traded at $98 per hundredweight in the middle of October, prices not reached since October 2010. Livestock markets have followed in crops' footsteps, and like most bear markets, a little faster than anticipated. Cattle prices bounced back above $100 per hundredweight at the end of October, and if strength builds in futures, prices could support a short-term rally.

We expect net farm income will begin to slowly trend higher past 2018, as commodity prices move above recent lows. Net farm income is finally forecast to push back above $80 billion after 2021. All livestock cash receipts are forecast at $161.3 billion in 2016 and $169.5 billion in 2017. All crop cash receipts are expected to reach $184.1 billion in 2016, down from $189.4 billion in 2015, and fall slightly to $182.8 billion in 2017. The larger US soybean crop and stronger prices have more than offset losses in food grain cash receipts in 2016 and 2017. All cash receipts are forecast to jump back higher in 2018 as commodity prices bottom out around the 2017/18 marketing year. Livestock cash receipts will fail to eclipse crop cash receipts until after 2023.

Total expenses have been moving lower and are expected to be $338.7 billion in 2016 and $336.7 billion in 2017. One of the key drivers for lower expenses is cheaper livestock costs as a result of weaker prices. Costs associated with property taxes have moved higher throughout the forecast period, which moderately offset the savings associated with lower fuel and oil prices. Overall, major expense categories such as feed, fertilizer, and oil remain under pressure through 2018 as a result of weaker commodity prices. Following this slump and

US agricultural recipts improve, but income remains flat in 2017



Source: IHS

a bottoming out of commodity prices, which also includes oils and fertilizers, total expenses will begin to trend higher.

There are anecdotal indicators that the several years of very low crop prices and the downward correction in farm income are beginning to take a toll on farmers. The recent downturn has depleted some farmers' cash reserves and they are forced to borrow to get them through any rough spot in their cash flow. Land prices are also starting to correct. Although the financial difficulties facing farmers are not as grave as during the last crisis, owing to lower interest rates and restrained inflation, it is worth monitoring as farm incomes remain stalled.

Demand for farm equipment

Demand for agricultural equipment is likely to hit bottom soon, a slump compounded by overinvestment in new equipment prior to the recent downturn. Farmers will begin to make purchases they had deferred for several years.

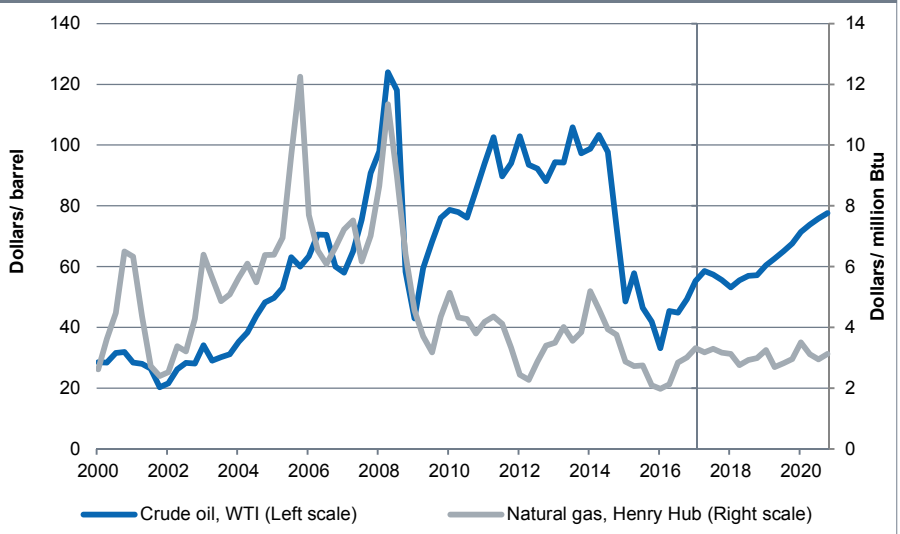
Combines are likely to be the first area to return to their normal replacement cycle. Combines historically have the quickest turn-over interval for the very large commercial farms that represent the core – new combine market. These farmers replace their units every 1 to 3 years because they have a very low tolerance for down-time. Delays at harvest can be very costly, crop condition, yields, and future field work all suffer when you can't complete the harvest. The severe downturn in the agricultural equipment market caused even the most committed farmers to delay their replacement cycle, their management process will not allow them to push off replacements much or any further. The modest turnaround will be limited in part by challenges posed by secondary markets, As the price of trade-ins fall (used combines are selling for $300,000 or more), the cost to replace widens considerably. Farmers that buy good/excellent used combines keep them longer than the first owner (the first owner replaces/rotates combines within one to three years).

For tractors, the bigger they were, the harder they fell—and they continue to fall. There are technologies farmers want to bring online—plug-and-play prescription farming, seeding, fertilizer, auto steering/navigation, etc. Larger farms have equipment with these features, but the next level or two down the size class chain of farms cannot yet afford to buy into these more sophisticated technologies. This is helping prop up the good used tractor market, but it is hard to counter low commodity prices.

Energy markets

Manufacturing of equipment to support exploration and extraction of oil, gas, and minerals accounts for about 35% of the equipment manufacturing industry, as defined by IHS for the purposes of this report. Manufacturers of energy-related equipment directly employed some 148,000 people in the United States in 2016 and contributed more than $26 billion to US GDP. Major factors shaping demand for equipment in this sector include the prices of oil, natural gas, and other minerals and commodities supported by heavy equipment.

Crude oil and natural gas prices



Source: IHS

Oil and gas

The oil and gas exploration and extraction industries have been a drag on equipment demand since late 2014, owing to declining prices. However, market fundamentals are improving. OPEC agreed to cut production by 1.2 million barrels per day (MMb/d) in the first six months of 2017, and non-OPEC countries plan further cuts of more than 0.5 MMb/d. Although actual cuts will likely be smaller, they will be sufficient to drain excess supply and maintain prices above $50 per barrel. Indeed, with global spare production capacity at only 2 MMb/d, the risk is that any sustained supply disruption could lead to an oil-price spike. Importantly, US production will begin to recover in early 2017, led by increases in the Permian Basin. The Trump administration has already put major pipeline projects back on track; reduced regulation, fewer hurdles to further pipeline construction, and a possible opening of public lands to exploration and production would lead to additional long-run oil and gas supplies.

We expect the natural gas market to tighten throughout 2017 as growth in demand outpaces growth in production. A recovery in oil production will lead to associated gas supply increases. Combined with Appalachia pipeline expansions coming online in late 2017, this will bring the market back into balance in 2018. We do not expect natural gas prices to decline, though, because industrial gas demand will increase as new capacity at ammonia, methanol, and ethylene facilities come online. Rising electricity consumption, exports to Mexico, and liquefied natural gas (LNG) exports to other countries could spur further demand growth. The North American gas resource base is expanding, and costs are declining, owing to improved resource recovery and new discoveries.

Mining

With oil and natural gas prices expected to rise further during the forecast, we expect growth in spending on mining structures. The Baker Hughes rig count has rebounded from a 71-year low of 404 rigs in May 2016 to 658 rigs. The biggest challenge for manufacturers of mining equipment is that a large and relatively new inventory of equipment purchased before the 2014 crash has sat idle and can be put into service as commodity prices rebound. Thus, we expect increased demand in 2017 to largely absorb existing equipment, postponing any need for new equipment until 2018. However, we expect demand for new equipment to be strong when it does finally return, and we anticipate double-digit increases in mining equipment production in 2018, 2019, and potentially even 2020.

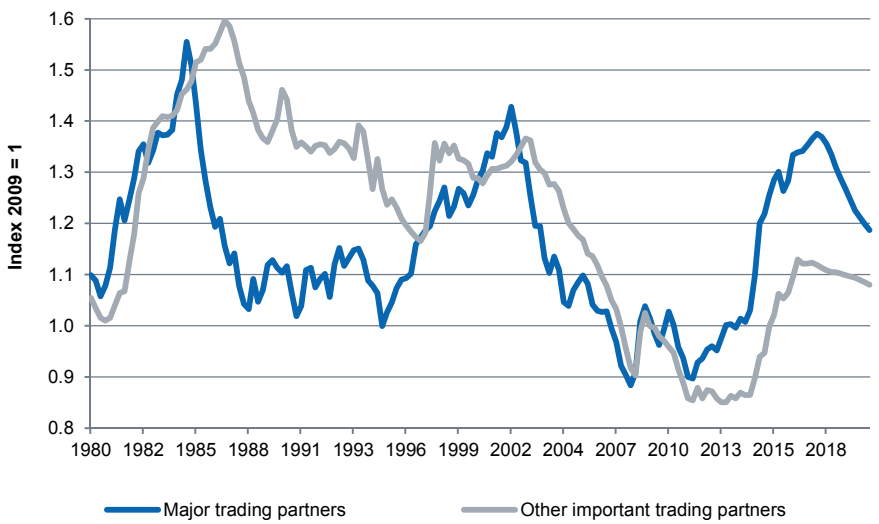
Interest and exchange rates and global trade

Interest rates are another key variable affecting the performance of the equipment manufacturing industry. These rates, in turn, affect exchange rates and global demand for equipment. These factors, combined with potential changes to trading rules sought by the Trump administration, are another significant variable in forecasting the health of the equipment manufacturing industry.

Interest rates

Improving US economic growth increases the likelihood the US Federal Reserve (Fed) will further raise interest rates. The Fed raised rates 25 basis points in December and indicated it expects three more 25-basis-point hikes in 2017. We expect the Fed will raise interest rates 75 basis points

US dollar exchange rate



Source: IHS

annually during the next three years, bringing the policy interest rate to 3.0% by 2020. Increasing interest rates will eventually slow investment growth.

Exchange rates

Entering 2017, the US dollar's strong position relative to other global currencies represents a headwind for manufacturers seeking to sell products overseas. The inflation-adjusted, trade-weighted value of the dollar for the broad index of trading partners is expected to increase 3.2% between fourth-quarter 2016 and fourth-quarter 2017. We assume the dollar will reach its peak value in the fourth quarter of 2017, 5.5% above the 2015 average. We anticipate this steady increase in the dollar's trading value versus other major currencies will give way to a steady decline from 2017 through the end of the forecast period, leading to a 14.8% decrease between 2017 and 2026.

Global trade

Approximately 30% of US agricultural equipment production is intended for export, and nearly 30% of US production of construction equipment is also for export. Slow international growth combined with uncertainty about trading rules under the Trump administration could act as a drag on the equipment manufacturing industry's overall performance.

Although the United States has enjoyed improving growth, much of the world will continue to experience economic challenges. Economic growth in the Eurozone is projected to slow from 1.7% in 2016 to 1.4% in 2017, reflecting increased political instability (France, Germany, and the Netherlands) and banking problems in key countries (Italy). Growth in the United Kingdom will slow as uncertainty surrounding the Brexit process leads to scaled-back investment and employment plans. Meanwhile, China's economic growth will slow further because of imbalances in credit and housing and excess capacity in its industrial sector. The good news is that recessions in Russia and Brazil will end in 2017, although there is little chance of strong recoveries.

Any steps the Trump administration might take to revisit or exit existing trade agreements could further complicate the challenging economic environment outside the United States. It is difficult to precisely forecast how the Trump administration might rewrite existing trading rules, but any steps that make it more difficult for manufacturers to export their products could hinder growth in the industry.

Industrial production growth in key machinery categories

	2014	2015	2016	2017	2018	2019	2020
Construction machinery	5.4	2.3	-4.2	-12.6	4.1	3.6	2.4
Agricultural machinery	-2.8	-10.5	-4.6	-8.7	1.1	3.9	3.4
Mining machinery	1.1	-13.1	-24.3	-7.9	16.0	18.3	10.0
Industrial machinery	-1.3	8.7	2.5	7.3	5.3	5.1	2.5
Engine, turbine, power transmission	0.8	0.8	-12.7	1.2	3.9	3.7	2.4

Source: IHS

Workforce development

One of the most significant long-term issues facing the equipment manufacturing industry involves the availability of skilled labor to fill available positions in the manufacturing workforce. We expect manufacturers' demand for skilled labor will continue to grow as the supply of qualified labor continues to decline.

The issue is partly demographic—tradesmen tend to be older, on balance. The American education system has prioritized postsecondary education in recent decades at the expense of vocational training. As older skilled laborers leave the workforce, there are fewer skilled workers available to take their place. Additional economic factors have exacerbated this trend. The Great Recession prompted many skilled laborers to leave the construction trades for retirement or other occupations. The result is a shortage of qualified workers as the construction industry rebounds. Indeed, a 2015 Associated General Contractors (AGC) national survey found that 86% of contractors had difficulty finding qualified individuals for key construction skills.

Equipment manufacturers face similar workforce challenges. A 2015 study by Deloitte and the Manufacturing Institute indicated 84% of manufacturing executives believed there was a skill shortage in their industry. The same study said that the US economy could generate the need for nearly 3.5 million skilled labor jobs in the next decade, but that 2.0 million of those jobs would go unfilled because of a gap in skills and qualification. As a result, 60% of skilled production workforce openings are vacant owing to skill sets. This affects not only production, but also the ability to implement new technologies.

It may take a comprehensive public policy strategy to address this persistent shortage in skilled labor. One key element of this strategy would reinforce the manufacturing base in the United States through a suite of tax reforms, trade agreements, regulatory relief, and education and workforce development policies.

Whereas much of the policy discussion regarding manufacturing has taken place at a national level, the most effective programs to address skilled labor and vocational training often occur at the state and local level. Many manufacturers are not waiting for government action and have created their own internal training and development programs. Many manufacturers also team with local secondary and vocational schools, as well as community colleges, to offer internships, career days, and even specific training and certification programs to encourage a future career with the company.

Grote

Grote is a lighting and safety systems manufacturer based in Indiana. Its 1,200 employees are primarily within North America, with small facilities in Germany and China.

Its business is a 50-50 split between OEM and aftermarket. Within off-highway, it leans toward OEM 80-20. LED lighting is its specialty.

"The number of regulations are high, but enforcement must also be consistent." – John Grote, vice president, sales and marketing

"Infrastructure investment is critical. We need better access to the interstate, as roads support industry. Improved access to our own markets will allow us to compete with anyone coming from anywhere in the world. Infrastructure spending focused on the ports—that spending benefits importers. Keeping our roads well-maintained and easily used will have a big impact."

Data ownership and monetization from telematics and the move toward higher voltage in the United States and Europe are key trends Grote is watching.

Grote is working with local vocation school students to identify and train students who can then transition to working in its facility.

Technological developments

Creative destruction can be a healthy, even if disruptive, force in any industry, and technology is a principal driver for change for both the equipment manufacturing industry as well as the customer industries this industry services.

Emerging technologies, for instance, are making construction projects more efficient than ever. Building information modeling (BIM) changed how buildings are planned, but innovative technologies—big data, machine learning, drones, robotics, and 3-D printing will change the way they are built. Large-scale construction takes substantial investment and takes time to come to fruition. To the degree that new technologies can reduce the time and investment associated with large-scale construction projects, they will help investors, taxpayers and other beneficiaries of new infrastructure realize their returns more quickly.

Likewise, innovative technologies integrated into farm equipment have helped increase agricultural productivity while making the industry more sustainable than ever. The proliferation of rural broadband technology helps sophisticated farm machinery communicate seamlessly with other farm technologies, and innovations in machinery itself, like precision agriculture technology, have revolutionized the way farmers, the customers of farm equipment, do their work.

Drones are also increasingly used across end-use sectors that utilize off-highway equipment. Drones may be used to complete building inspections as construction is ongoing, for instance, or to inspect the health of a

crop by proxy. Manual inspections in both industries are time-consuming and even dangerous. The use of drones allows coverage of more details in less time, and they can record and send data in real time. Combined with big data, inspection information could be rapidly combined with specifications to help quickly develop plans to address any shortcomings. As Internet of Things (IOT) technology materializes, machine-to-machine (M2M) connectivity portends a new era for sectors deploying off-highway equipment with more data informing equipment applications and new efficiencies in the operation of 'smart' equipment to drive productivity gains.

The advent of 3-D printing is already revolutionizing manufacturing, as well. Manufacturers are increasingly experimenting with how they may use 3-D printing to produce specialty parts for a piece of equipment; some manufacturers have even printed entire functioning pieces of machinery. There are additional applications for the construction industry; 3-D printing could allow contractors to "print" concrete structures at a high speed, which would avoid transportation of large, bulky items, especially to a congested urban worksite.

Automation—i.e., robots—has been a mainstay of large-scale manufacturing for years. Manufacturers already employ robots and automated machinery to streamline production, and automation is itself becoming an increasing feature of machinery sold to end users. Construction equipment can already be programmed to accomplish repetitive tasks like bricklaying, excavation, and painting. With continued improvements to the technology, they will be able to take on more complex work in time. Similarly, agricultural machinery may employ automated planting, spraying, and harvesting technology that improves efficiencies for customers.

VSS Macropaver is a division of Reed International, and it produces the Macropaver, a production machine for slurry seal and microsurfacing. It is based in central California.

"Exchange rates haven't been a problem, as we have always built a better machine." – Jeff Reed, president and CEO of VSS Macropaver

Regulations remain a primary concern. Specifically, the regulatory mismatch between California and the rest of the country has proven difficult.

Skilled labor is a problem, both on the manufacturing side and on the sales side. "We've destroyed the trade school system in this country—particularly in attacking the for-profit trade schools. When you finish at a trade school, you have marketable skills."

"We support the community through pro bono construction work and supplying of building supplies. We've worked with the construction operation that built the local soccer fields and also donated concrete for special projects and road repairs (especially in the run-down part of town)."

Manufacturers will need to continue to evolve to adapt to the new technological environment and their customers' needs. Machinery must be able to interact with the robotics that will assemble components and even entire structures. It must be able to communicate with remote technicians that will run the job site or farm of the future. The machine must be smart enough to recognize mistakes and adapt to situations on the job site without an operator. The focus of machine technology today is to make equipment that is more environmentally friendly, conserves energy, and integrates technology such as the global positioning system (GPS) to improve operator efficiency. The connected machine has already improved the maintenance and operation of equipment thereby improving the lifespan and economic value of equipment to the end-use customer. The next challenge will be to develop equipment that can be even more efficient without the operator.

3.0

Approach and methodology

Defining the industry

IHS performed a detailed analysis of relevant North American Industry Classification System (NAICS) sectors to ensure all sectors providing components directly to the end users of industry categories were properly identified. A joint review of this list with the Association of Equipment Manufacturers (AEM) was necessary to affirm a shared understanding of the market, and both AEM and IHS conducted an extensive review of the definitions and limitations of the industry to ensure clarity and consistency in market sizing. The initial spectrum of investigation included 74 industry sectors. The following are tables outlining the final determination of the 37 NAICS sectors associated with the equipment manufacturing industry. The result of the industry segmentation was a comprehensive picture of the size of the equipment manufacturing industry at the national and state level, broken out by employment for 2016. This data then served as the inputs for the national and state level input-output models that were used to determine the full economic impact of the equipment manufacturing industry.

Industrial production growth in key machinery categories

NAICS code	Description
333120	Construction machinery manufacturing
333111	Farm machinery and equipment manufacturing
333132	Oil and gas field machinery and equipment manufacturing
333995	Fluid power cylinder and actuator manufacturing
333912	Air and gas compressor manufacturing
333613	Mechanical power transmission equipment manufacturing
333612	Speed changer, industrial high-speed drive, and gear manufacturing
333992	Welding and soldering equipment manufacturing
333131	Mining machinery and equipment manufacturing
333996	Fluid power pump and motor manufacturing
333618	Other engine equipment manufacturing
333923	Overhead traveling crane, hoist, and monorail system manufacturing
332912	Fluid power valve and hose fitting manufacturing
333924	Industrial truck, tractor, trailer, and stacker machinery manufacturing
333112	Lawn and garden tractor and home lawn and garden equipment manufacturing
333991	Power-driven handtool manufacturing
333515	Cutting tool and machine tool accessory manufacturing
333922	Conveyor and conveying equipment manufacturing
333911	Pump and pumping equipment manufacturing
332911	Industrial valve manufacturing
332420	Metal tank (heavy gauge) manufacturing
333413	Industrial and commercial fan and blower and air purification equipment manufacturing
332410	Power boiler and heat exchanger manufacturing
333241	Food product machinery manufacturing
333243	Sawmill, woodworking, and paper machinery manufacturing
336211	Motor vehicle body manufacturing
333999	All other miscellaneous general purpose machinery manufacturing
336212	Truck trailer manufacturing
332510	Hardware manufacturing
333414	Heating equipment (except warm air furnaces) manufacturing
333997	Scale and balance manufacturing
333415	Air conditioning and air heating equipment and commercial and industrial refrigeration equipment manufacturing
336360	Motor vehicle seating and interior trim manufacturing
334220	Radio and television broadcasting and wireless communications equipment manufacturing
334419	Other electronic component manufacturing
333511	Industrial mold manufacturing
334513	Instruments and related products manufacturing for measuring, displaying, and controlling industrial process variables

Source: IHS

The foundation of this data was the proprietary IHS Business Market Insights (BMI) service. This is a database (based off the US Census, County Business Patterns data) of employment and output for all six-digit NAICS categories for the US down to the zip-code level that is modeled and maintained by IHS industry experts. This level of sector detail and geographic granularity was necessary to conduct this study while also having a sound estimate for 2016 employment. In order to derive an accurate depiction of the equipment manufacturing industry, it was important to have detailed economic data, not only about the affiliate businesses' classification, but also the location in which they operate.

The NAICS data, including what share of an industry's data was determined to be relevant to the equipment manufacturing industry, were then used as the foundation for a similar analysis of the industry in Canada. In place of the US and state-based BMI data, StatCan data by industry and province was used as the starting point.

Extending the segmentation

Once direct employment at the national level was established, we then used the same methodology to collect state data. Since the BMI database is based in NAICS codes, the error of attributing employment to a sector that does not exist in a given state was diminished. However, in some cases, we have more information than what is provided owing to lags in reporting or changes that occur in classifications. Any new information provided by AEM or IHS industry experts was layered into the analysis for a robust understanding of the sector composition in each state.

IHS also supplemented this top-down methodology with a bottom-up approach to truly understand the regional dynamics within the equipment manufacturing industries. This analysis leveraged AEM's membership list and secondary research on employment and output by business location. Totaling up the employment figures for individual manufacturing plants allowed IHS to fully account for the total economic contributions of companies that cross state lines.

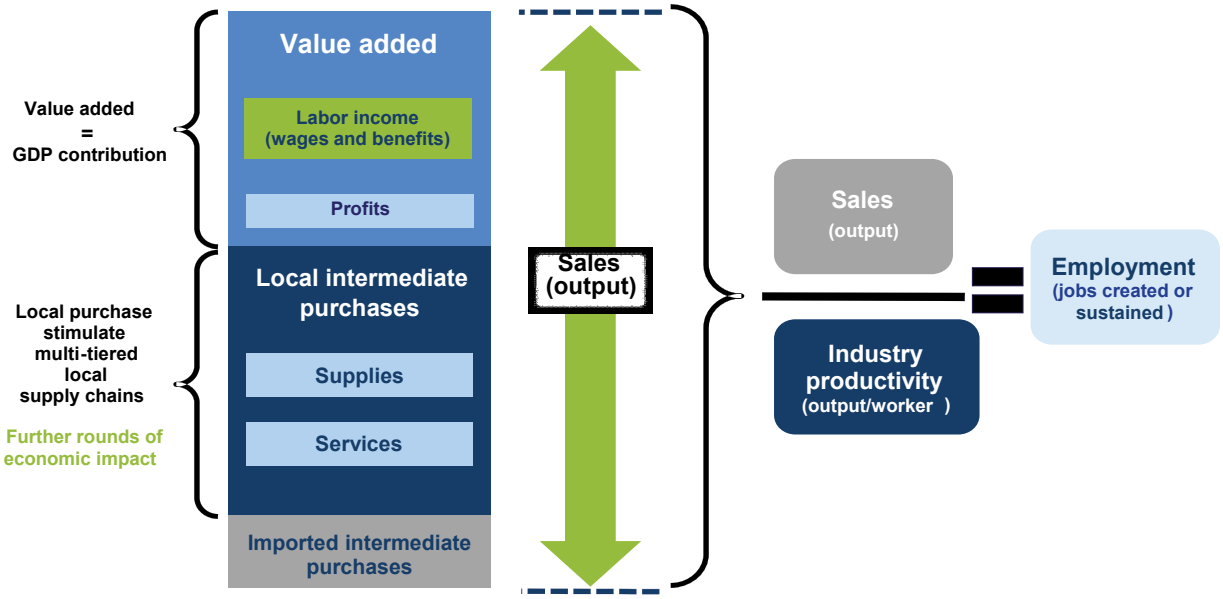
Measuring the contribution of the equipment manufacturing industry

Business transactions with local suppliers and service providers serve as catalysts that trigger a flurry of economic activity throughout the United States. For example, when a supplier sells a product or service to a producer of an end-use good or service, that supplier needs to hire employees (i.e., labor) to transform inputs (raw materials, energy, intellectual capital) into the final product or service. The inflation-adjusted ratio of sales to employees, which economists call output per employee, is a measure of productivity.

The models IHS developed to assess the economic footprint of the US equipment manufacturing industry contain productivity statistics for 440 industry sectors that are produced by IMPLAN, a software package that measures economic impacts. These sectors are aggregations of six-digit NAICS codes and are used to reduce any inconsistencies in state-level data. The IHS BMI employment data provided the starting point in assessing the industry's direct impact. These data enabled an accurate assignment of jobs for each industry sector in the models. Industry-specific productivity data could then be applied to quantify the level of output supported by the business transactions within each industry sector. These contributions occur as a result of direct spending with a tier-1 supplier and are therefore classified as a direct impact.

Sourcing the inputs a supplier requires to produce the product or service ordered by the producer of an end-use good or service invokes additional rounds of economic impact. Referring to the left side of the following figure, when a tier-1 supplier makes a sale, that supplier must then purchase the inputs (supplies and services) needed to produce the final product. Some of these purchases will be imported from outside the US economy and were not included in this analysis. The remaining purchases, which represent sales for local businesses, remain within the US economy. Each supplier must, in turn, hire employees and source additional inputs from its suppliers. This effect occurs as a result of transactions between vendors and their supplier networks (interindustry), and is considered an indirect economic impact.

Flow of US economic impacts from direct spending through income effect



Source: IHS

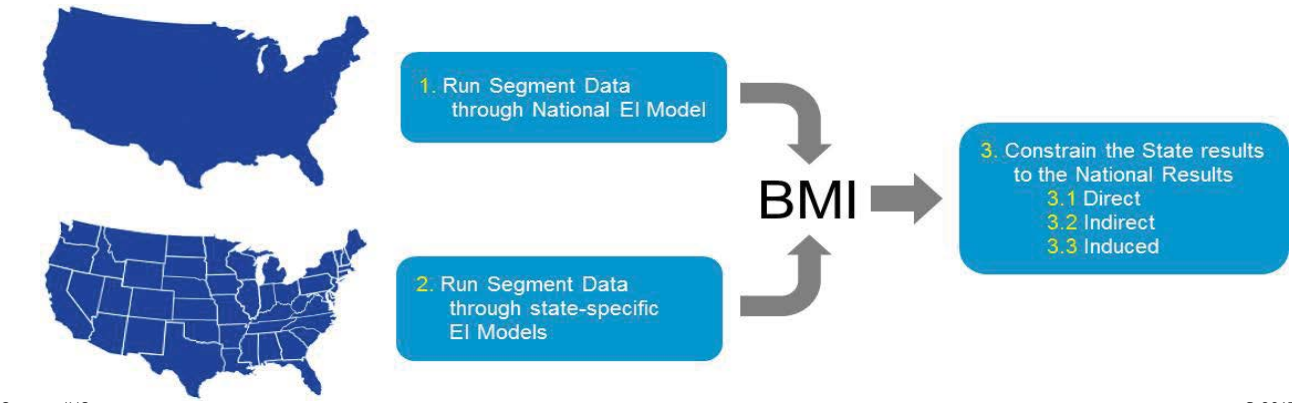
The difference between the value of a sale and the cost of its required nonlabor inputs is known as value added. As its name suggests, this represents how much more valuable a final product or service is relative to its inputs. The sum of all of the value added by all industries within an economy is equivalent to GDP. Using value added guards against the double-counting that occurs when compiling output or revenue data by industry.

GDP is generally considered the broadest measure of the health of a national economy. The models developed by IHS for this study included value-added statistics for each of the 440 industry sectors, allowing IHS to assess the contribution of the equipment manufacturing industry to national GDP.

Finally, the direct and indirect employees spend a portion of their incomes in the regional economy on consumer goods and services. This stimulates yet another round of economic activity, which results in induced effects on employment, value added, and so on.

The results from the national model yielded employment, value added, labor income, and tax revenue generated by the equipment manufacturing industry. State-level models were primarily driven by the levels of direct employment determined in the data analysis and segment breakdown. However, states also experience significant intermediate activities in support of direct economic activity in other states. These results are captured within the national model but can fall out of a state-specific analysis that is driven solely by in-state direct employment. IHS addressed this issue by allocating those remaining intermediate states through our proprietary regional economic models and BMI data. This process ensures our state-level analysis is in harmony with our national models and allocates all data based on existing industry supply capacity. The resulting levels of direct and intermediate impacts then determine the significance of the spin-off impacts for each state. The following graphic highlights the overall sequence of analysis.

Diagram of modeling process



Source: IHS

The results of this analysis provided industry-specific income, employment, and value-added data for each state. IHS maintains broad industry-level data, by state, for employment and gross state product through its US Regional Economics group. The results of our findings not only capture the overall impact of the industry and by segment within the proper context of each state's unique economy, but also highlight the significance of the primary industries within the overall industry of each state—i.e., the equipment manufacturing industry provides X% of total manufacturing employment in state Y, while also supporting Z% of professional services employment. Federal and state tax generation by state was also determined from the economic impact analysis. IHS placed the state taxes generated into the context of the overall share of state government revenue and also determined the per household contribution to state taxes the equipment manufacturing industry provides in each state.

The overall process is similar for the analysis done on the Canadian market. There are fewer underlying industry sectors in the IMPLAN models for Canada and the provinces, but those limitations are primarily outside the key input manufacturing sectors needed for this analysis, so a similar level of industry detail was still available to ensure the industry's impact was properly modeled.

4.0
Economic impact analysis results

The following tables and charts summarize the economic impact results for the US and Canadian off-highway equipment manufacturing industry during 2016. The analysis starts with the industry's direct (end-use) employment, which was determined to be 423,924 in the US and 64,324 in Canada in 2016.

The equipment manufacturing industry in the United States supports an additional 450,420 employees throughout the industry's supply chain, which resulted in a total equipment manufacturing employment base of nearly 875,000 jobs. The equipment manufacturing industry also generated $267 billion in direct sales, which supported an additional $150 million in business activity across the United States. In sum, the equipment manufacturing industry supported $416 million of economic output in 2016.

Economic impact of off-highway equipment manufacturing industry

United States	
Employment (number of workers)	**1,273,396**
Equipment manufacturing industry impact	874,344
End use	423,924
Supply chain	450,420
Induced	399,052
Contribution to GDP (millions of US dollars)	**158,789**
Equipment manufacturing industry impact	124,969
End-Use	77,722
Supply Chain	47,247
Induced	33,820
Labor income (millions of US dollars)	**86,792**
Equipment manufacturing industry impact	68,205
End use	38,279
Supply chain	29,927
Induced	18,587
Government revenues (millions of US dollars)	**25,492**
Federal tax	15,412
State and local	10,079
Canada	
Employment (number of workers)	**148,668**
Equipment Manufacturing Industry Impact	103,893
End use	64,324
Supply chain	39,569
Induced	44,775
Contribution to GDP (millions of US dollars)	**14,878**
Equipment manufacturing industry impact	10,242
End use	6,066
Supply chain	4,177
Induced	4,636
Labor income (millions of US dollars)	**9,663**
Equipment manufacturing industry impact	7,364
End use	4,732
Supply chain	2,632
Induced	2,299

Source: IHS © 2017 IHS

Texas profile: The off-highway equipment industry in Texas covers global players like Kubota and Sandvik as well as many other more specialized firms. The bulk of the industry concentration is from oil and gas field machinery equipment.

The equipment manufacturing industry in Texas directly employs 58,000 people, and an additional 148,000 jobs are supported by the industry's supply chain and downstream effects.

Equipment manufacturers generate $18.7 billion in output within Texas each year, representing both the largest impact the industry has on any single state and 14.5% of the nation's sales within the industry. Total tax revenue from the industry clocks in at $4.3 billion, with more than $1.6 billion of that being allocated to state and local governments.

The process for identifying the direct employment within the industry was reviewed within the Methodology section of this report. The following tables detail the industry-level employment levels. Within the United States, NAICS sector 3331 has been expanded to highlight the subsector details, since this industry makes up nearly one-half of all direct employment.

2016 US direct employment impact of off-highway equipment manufacturing industry

Four-digit NAICS code		Total jobs
3331	Agriculture, construction, and mining machinery manufacturing	199,899
	Construction machinery manufacturing	66,188
	Farm machinery and equipment manufacturing	59,427
	Lawn and garden tractor and home lawn and garden equipment manufacturing	7,352
	Mining machinery and equipment manufacturing	13,064
	Oil and gas field machinery and equipment manufacturing	53,868
3339	Other general purpose machinery manufacturing	109,027
3336	Engine, turbine, and power transmission equipment manufacturing	64,817
3329	Other fabricated metal product manufacturing	20,895
3335	Metalworking machinery manufacturing	8,801
3324	Boiler, tank, and shipping container manufacturing	5,793
3334	HVAC and commercial refrigeration equipment manufacturing	4,119
3362	Motor vehicle body and trailer manufacturing	4,097
3332	Industrial machinery manufacturing	3,146
3325	Hardware manufacturing	1,267
3363	Motor vehicle parts manufacturing	624
3344	Semiconductor and other electronic component manufacturing	512
3342	Communications equipment manufacturing	523
3345	Navigational, measuring, and control instruments manufacturing	404
Grand Total		**423,924**

Source: IHS

2016 Canada direct employment impact of off-highway equipment manufacturing industry

Four-digit NAICS code		Total jobs
3331	Agriculture, construction, and mining machinery manufacturing	30,236
3339	Other general purpose machinery manufacturing	15,001
3336	Engine, turbine, and power transmission equipment manufacturing	6,298
3329	Other fabricated metal product manufacturing	5,532
3335	Metalworking machinery manufacturing	2,350
3332	Industrial machinery manufacturing	1,309
3324	Boiler, tank, and shipping container manufacturing	1,164
3363	Motor vehicle parts manufacturing	685
3362	Motor vehicle body and trailer manufacturing	644
3334	HVAC and commercial refrigeration equipment manufacturing	443
3325	Hardware manufacturing	205
3345	Navigational, measuring, and control instruments manufacturing	193
3342	Communications equipment manufacturing	137
3344	Semiconductor and other electronic component manufacturing	127
Grand total		**64,324**

Source: IHS

Impact results: Employment

The equipment manufacturing industry in the United States supported 1.27 million jobs in 2016. This figure represents almost 1% of the 140 million nonfarm jobs in the United States. Firms producing end-user goods and services directly supported about 424,000 jobs, whereas 450,000 were within supply-chain businesses. An additional 399,000 jobs were the result of changes to income or induced jobs. The impact on employment at the state level was most pronounced in Texas, Illinois, and Wisconsin, which accounted for 29% of the direct employment impact within the equipment manufacturing industry.

Of the 1.3 million jobs supported nationally, about 500,000 can be characterized as manufacturing jobs, whereas information and professional services contribute approximately 200,000 jobs, many as an indirect result of the industry.

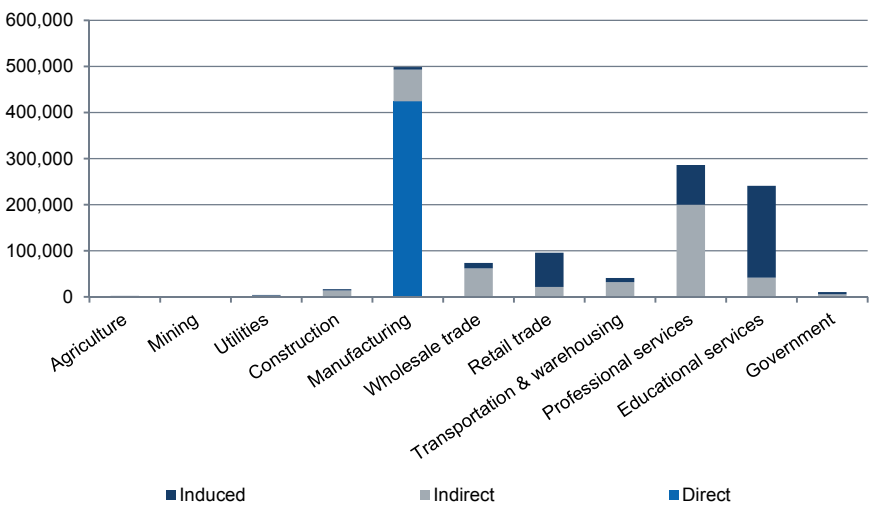
The industry's indirect impacts are far-reaching and span a more diverse set of industries. However, there is still a small concentration of these jobs within the wholesale trade and manufacturing industries, which contribute 61,800 and 68,600 jobs, respectively. The supply-chain impacts are also strong in educational, health, and recreation services (41,900 jobs); transportation and warehousing (32,000 jobs); and retail trade (21,600 jobs).

The direct and indirect jobs supported by the industry provide a further round of economic stimulus as wages flow through unrelated sectors of the economy.

Wisconsin profile: AEM's membership is well-represented within Wisconsin, including manufacturers such as CNH, Chermack Machine, and Waikato Milking Systems. The equipment manufacturing sector in Wisconsin supported 1.3% of the total nonfarm jobs in the state during the last year, with more than 30,000 direct jobs within the industry.

Additionally, $728.0 million was added to state and local government coffers through taxes on the economic activity induced by the equipment manufacturing industry, with an additional $1.1 billion flowing to the federal government through tax revenues. The equipment manufacturing industry further enhanced the gross state product of Wisconsin by $4.8 billion within the industry—and more than $10.0 billion when supply chain and downstream effects are included in the analysis.

Employment impact



Source: IHS

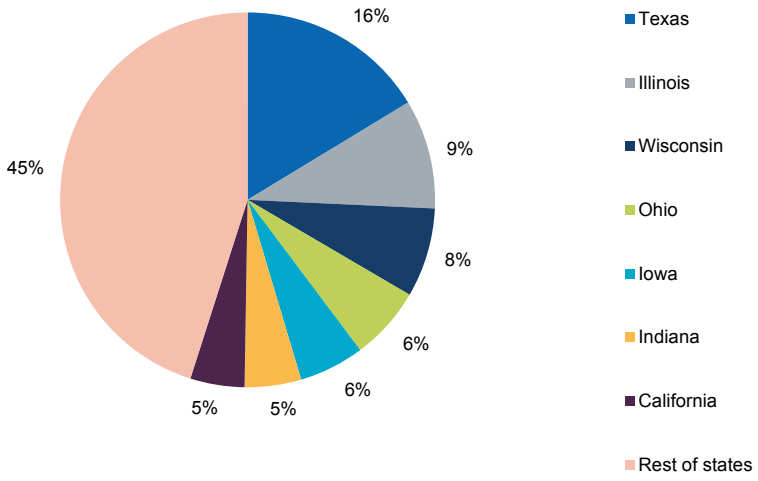
These induced impacts had the largest employment impact in the information and professional services, leisure, and wholesale and retail trade sectors. Many of these induced jobs are in the service sectors of the economy, which benefit from higher levels of employment and therefore higher incomes. Similarly, retail stores and wholesale trade businesses are greatly affected by changes in disposable income that result from fluctuations in employment due to hiring in the industry.

In Canada, the industry's 64,300 direct jobs support nearly 40,000 additional supply-chain jobs, whereas nearly 45,000 jobs are induced by the income effect of the direct and indirect employment supported by the industry. The 149,000 total jobs supported by the equipment manufacturing industry in Canada made up 1% of the total Canadian workforce in 2016.

Sales

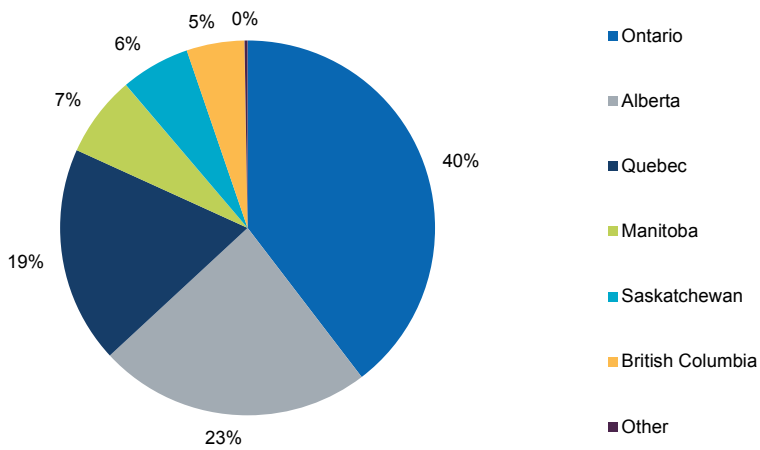
The broadest measure of economic activity generated by the equipment manufacturing industry can be measured in terms of final sales, also known as output. This metric includes value added as well as the purchase of intermediate goods and

Employment impact by top states



Source: IHS

Employment impact by province



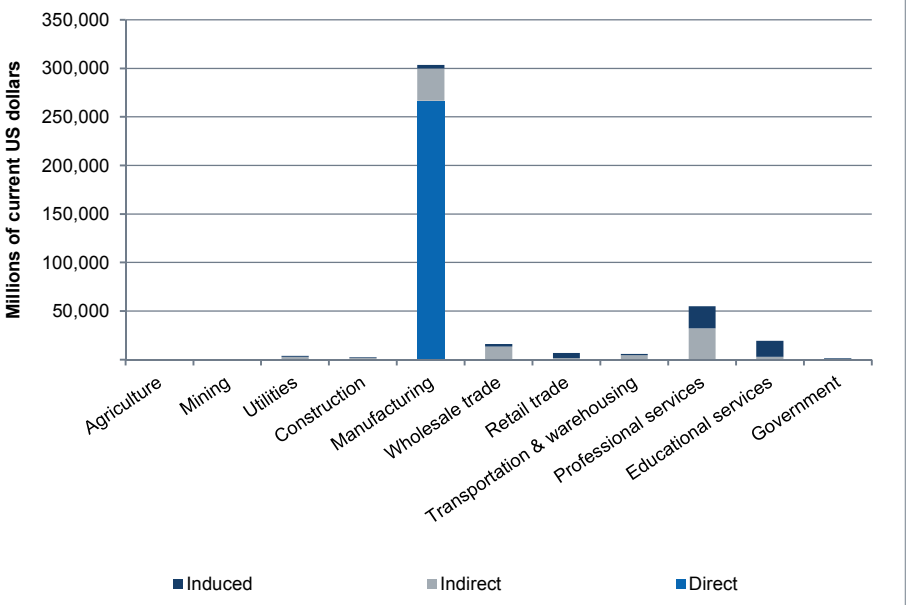
Source: IHS

services, both local and imported. Just as value added can be described as final sales minus the cost of intermediate purchases (hence the additional value created after those purchases), total output is value added plus intermediate purchases.

The US equipment manufacturing industry generated $416 billion in total output and sales activity during 2016.

Industries that are directly associated with equipment manufacturing reached $267 billion and accounted for 64% of the industry's total sales makeup. The indirect effects, which represent sales between the industries with a direct impact and their suppliers, amounted to an average of $95 billion each year, while the re-spending of wages earned in the direct and indirect industries created the induced impacts of $55 billion in total output.

Sales impact



Source: IHS

Within Canada, the total output of the industry and its supported activities was nearly $34.0 billion. Of that total, $15.5 billion came from direct industry activity. Nearly $10.0 billion of activity was generated by the industry supply chain, and the remaining $8.6 billion of industry output was generated by induced industry effects.

Contribution to GDP

The equipment manufacturing industry added approximately $159 billion to US GDP in 2016—1.16% of US GDP. Domestic manufacturing companies directly contributed just under $78 billion to GDP. Industries that benefit directly, such as construction and farm machinery manufacturers, also require supplies and services, creating value added in both upstream and downstream supplier industries. Suppliers to the equipment manufacturing industry had an indirect economic impact of $47 billion. The induced impact of the industry added an additional $34 billion to GDP in 2016.

The industry and its associated supply chain added nearly $15 billion to Canada's GDP in 2016. This equates to 1% of total Canadian nominal GDP for the year. Direct industry activity generated $6.1 billion for the Canadian economy. The indirect impact of the industry was $4.1 billion, whereas the induced effect of the industry was $4.6 billion.

Labor income

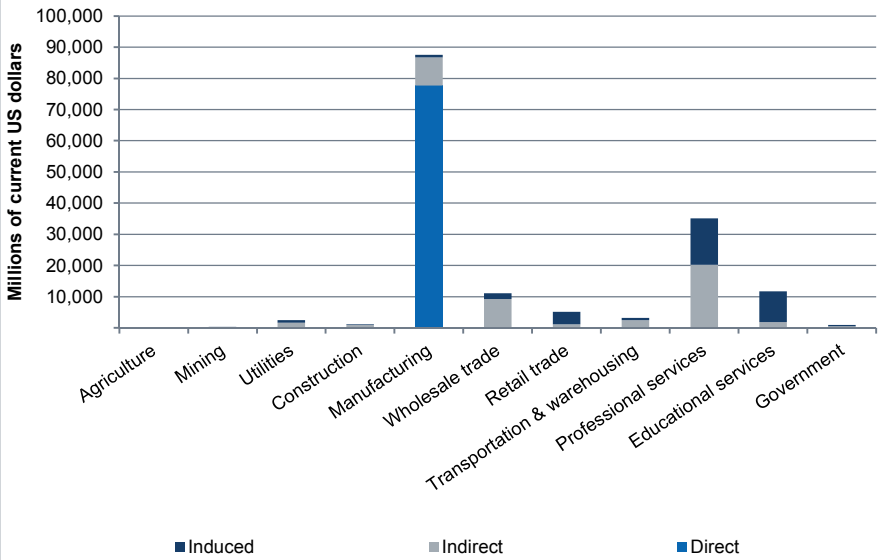
A large portion of each industry's value added is contained in the wages and proprietor's income paid out to individuals. The equipment manufacturing industry generated nearly $87 billion in wages and benefits in 2016. Direct compensation of labor income makes up the bulk of this ($38 billion), with indirect labor accounting for almost $30 billion; the remaining $18 billion is made up of downstream impacts. The $86 billion in labor income equates to an average annual salary of $78,000 per industry-supported employee.

In Canada, the industry generated total labor income of $9.7 billion. The industry directly generated $4.7 billion. The supply chain accounted for $2.6 billion, whereas the induced effect made up the remaining $2.3 billion. The average annual wage generated by this income effect is $65,000.

North Carolina profile: The off-highway equipment manufacturing sector supports a large swath of the economy in North Carolina. The industry directly employs more than 12,000 people, with an additional 25,000 jobs created within the state through supply-chain and downstream channels.

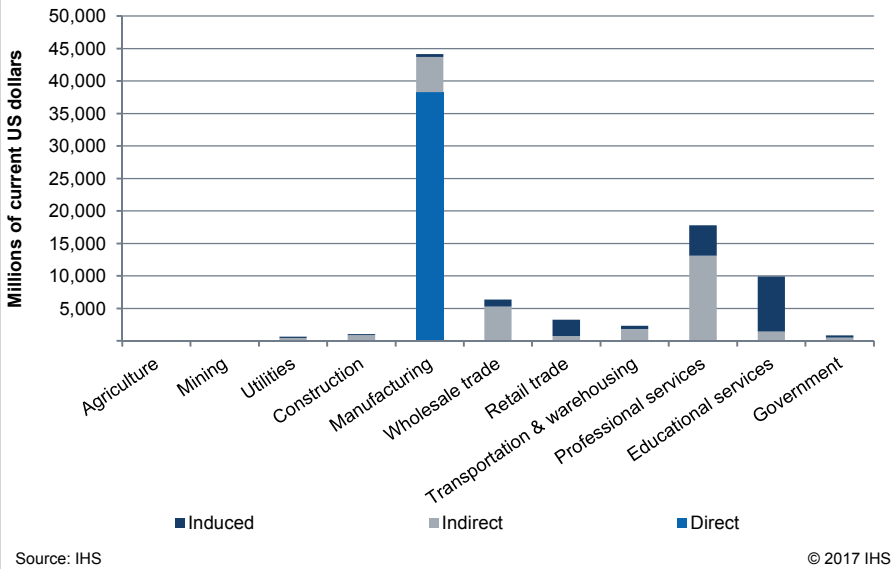
These AEM members further added $13.7 billion to the gross state product of North Carolina, which represented more than 1% of total state output in 2016.

Value-added impact



Source: IHS

Labor income impact



Source: IHS

Taxes

2016 US Industry Tax Impact	
Millions of dollars	
Total	**25,492**
Federal tax	15,412
State and local tax	10,079

Source: IHS

Firms that operate within the equipment manufacturing industry contribute taxes at both the federal and state level. In the United States, these firms paid a total of $25.4 billion in federal and state taxes in 2016. Taxes paid at the federal level amounted to $15.4 billion, which accounts for more than 0.5% of total US federal tax collections in 2016. State and local governments also received an estimated $10.0 billion in 2016, which is larger than the combined state budgets of New Hampshire ($5.4 billion) and South Dakota ($4.3 billion).

5.0
Appendix

Appendix I: Segment, state, and provincial economic impact result tables

2016 US Sector Impact Summary				
	Construction	**Agriculture**	**Mining**	**Total**
Employment	500,143	320,726	452,525	1,273,393
Direct	162,678	113,672	147,572	423,922
Indirect	175,655	111,952	162,813	450,420
Induced	159,450	99,056	140,546	399,052
Output (millions of US dollars)	165,510	101,971	148,722	416,203
Direct	105,822	65,721	94,965	266,509
Indirect	37,593	22,895	34,164	94,652
Induced	21,995	13,663	19,386	55,043
Contribution to GDP (millions of US dollars)	62,850	39,942	55,996	158,789
Direct	30,641	20,692	26,389	77,722
Indirect	18,613	11,719	16,915	47,247
Induced	13,514	8,395	11,911	33,820
Labor income (millions of US dollars)	34,651	21,574	30,567	86,792
Direct	15,784	9,668	12,827	38,278
Indirect	11,769	7,393	10,765	29,927
Induced	7,427	4,614	6,546	18,587

Source: IHS

2016 US and State Employment Impact Summary

		Direct employment	Indirect employment	Induced employment	Total employment
United States	US	423,922	450,420	399,052	1,273,393
Alabama	AL	4,432	4,102	2,915	11,449
Alaska	AK	76	49	33	158
Arizona	AZ	3,468	3,894	3,506	10,868
Arizona	AR	2,170	1,856	1,245	5,271
California	CA	18,255	22,694	18,535	59,485
Colorado	CO	1,792	1,960	1,818	5,570
Connecticut	CT	3,054	2,227	2,108	7,389
Delaware	DE	51	25	25	102
Florida	FL	5,275	6,418	5,425	17,117
Georgia	GA	5,582	6,489	5,340	17,410
Hawaii	HI	-	2	1	3
Idaho	ID	1,346	1,226	884	3,456
Illinois	IL	35,562	41,215	43,078	119,856
Indiana	IN	20,904	21,791	19,331	62,026
Iowa	IA	26,142	24,811	20,590	71,542
Kansas	KS	7,889	6,706	5,184	19,779
Kentucky	KY	8,752	7,412	5,971	22,136
Louisiana	LA	8,188	7,373	6,724	22,286
Maine	ME	837	658	521	2,016
Maryland	MD	2,095	2,247	1,699	6,041
Massachusetts	MA	1,491	920	1,135	3,547
Michigan	MI	17,252	18,586	17,923	53,761
Minnesota	MN	13,192	13,898	12,712	39,802
Mississippi	MS	5,559	4,410	3,238	13,208
Missouri	MO	6,095	6,128	5,352	17,575
Montana	MT	177	202	130	508
Nebraska	NE	7,188	6,048	4,847	18,083
Nevada	NV	324	241	152	718
New Hampshire	NH	1,515	929	1,035	3,479
New Jersey	NJ	2,792	1,884	2,278	6,954
New Mexico	NM	743	539	333	1,615
New York	NY	14,386	10,059	10,007	34,453
North Carolina	NC	12,374	14,386	11,589	38,349
North Dakota	ND	4,607	3,873	2,392	10,872
Ohio	OH	27,143	27,350	26,151	80,644
Oklahoma	OK	11,914	12,239	9,417	33,569
Oregon	OR	4,416	4,777	3,914	13,107
Pennsylvania	PA	15,676	16,987	14,977	47,640
Rhode Island	RI	145	59	70	274
South Carolina	SC	6,802	5,568	5,184	17,554
South Dakota	SD	5,043	4,211	3,006	12,259
Tennessee	TN	5,324	5,687	4,694	15,705
Texas	TX	58,260	78,648	70,915	207,823
Utah	UT	2,843	3,443	2,791	9,077
Vermont	VT	11	9	8	28
Virginia	VA	5,537	4,675	3,820	14,031
Washington	WA	4,652	3,977	3,486	12,116
Washington DC	DC	-	-	-	-
West Virginia	WV	1,423	1,025	850	3,298
Wisconsin	WI	30,541	36,065	31,437	98,043
Wyoming	WY	622	443	276	1,342

Source: IHS

2016 US and State Output Impact Summary
(Millions of US dollars)

		Direct Output	Indirect Output	Induced Output	Total Output
United States	US	266,509	94,652	55,043	416,203
Alabama	AL	2,491	816	358	3,665
Alaska	AK	43	9	5	57
Arizona	AZ	1,925	696	475	3,096
Arizona	AR	1,278	374	156	1,808
California	CA	8,554	5,380	3,014	16,948
Colorado	CO	988	414	252	1,654
Connecticut	CT	1,368	493	319	2,180
Delaware	DE	17	4	3	24
Florida	FL	2,788	1,175	732	4,695
Georgia	GA	4,026	1,307	711	6,045
Hawaii	HI	-	0	0	1
Idaho	ID	832	186	104	1,122
Illinois	IL	28,490	9,762	6,498	44,750
Indiana	IN	15,026	4,873	2,505	22,404
Iowa	IA	20,864	4,617	2,572	28,052
Kansas	KS	4,962	1,170	662	6,794
Kentucky	KY	5,325	1,328	743	7,396
Louisiana	LA	5,014	1,333	850	7,197
Maine	ME	426	98	63	588
Maryland	MD	1,727	482	238	2,447
Massachusetts	MA	574	193	166	934
Michigan	MI	10,355	3,907	2,339	16,601
Minnesota	MN	7,455	2,914	1,816	12,186
Mississippi	MS	3,286	815	396	4,497
Missouri	MO	3,471	1,140	683	5,295
Montana	MT	127	30	15	172
Nebraska	NE	4,270	1,033	602	5,905
Nevada	NV	147	41	21	209
New Hampshire	NH	524	172	136	832
New Jersey	NJ	1,198	404	352	1,953
New Mexico	NM	386	82	41	509
New York	NY	6,748	2,407	1,585	10,740
North Carolina	NC	9,289	2,951	1,519	13,758
North Dakota	ND	3,843	671	301	4,815
Ohio	OH	13,216	5,666	3,437	22,319
Oklahoma	OK	7,518	2,311	1,211	11,040
Oregon	OR	2,174	1,008	501	3,682
Pennsylvania	PA	8,931	3,846	2,088	14,865
Rhode Island	RI	38	11	9	58
South Carolina	SC	3,840	1,029	581	5,450
South Dakota	SD	3,139	688	371	4,198
Tennessee	TN	3,816	1,111	628	5,555
Texas	TX	38,429	17,536	10,288	66,253
Utah	UT	1,440	716	359	2,514
Vermont	VT	8	1	1	10
Virginia	VA	3,398	944	532	4,874
Washington	WA	2,761	854	537	4,152
Washington DC	DC	-	-	-	-
West Virginia	WV	818	183	101	1,102
Wisconsin	WI	18,772	7,402	4,133	30,306

Source: IHS

2016 US and State Value Added Impact Summary

		Direct value added	Indirect value added	Induced value added	Total value added
United States	US	77,722	47,247	33,820	158,789
Alabama	AL	577	369	216	1,163
Alaska	AK	10	5	3	18
Arizona	AZ	404	369	298	1,071
Arizona	AR	238	182	94	514
California	CA	2,357	2,589	1,862	6,809
Colorado	CO	270	211	156	637
Connecticut	CT	462	294	217	972
Delaware	DE	4	3	2	9
Florida	FL	494	625	452	1,571
Georgia	GA	1,018	687	440	2,145
Hawaii	HI	-	0	0	0
Idaho	ID	143	96	60	299
Illinois	IL	11,463	5,156	4,095	20,713
Indiana	IN	4,499	2,179	1,525	8,203
Iowa	IA	6,963	2,258	1,550	10,770
Kansas	KS	1,111	626	404	2,142
Kentucky	KY	1,234	660	443	2,337
Louisiana	LA	1,411	696	512	2,620
Maine	ME	71	54	39	164
Maryland	MD	330	251	152	733
Massachusetts	MA	205	115	107	427
Michigan	MI	2,293	1,904	1,403	5,601
Minnesota	MN	1,693	1,540	1,110	4,343
Mississippi	MS	716	384	236	1,336
Missouri	MO	781	592	413	1,785
Montana	MT	7	15	9	31
Nebraska	NE	1,356	545	364	2,265
Nevada	NV	25	23	14	62
New Hampshire	NH	167	94	87	349
New Jersey	NJ	435	245	228	907
New Mexico	NM	42	42	25	109
New York	NY	1,979	1,418	1,057	4,454
North Carolina	NC	2,821	1,454	941	5,217
North Dakota	ND	1,062	382	186	1,631
Ohio	OH	3,772	2,745	2,086	8,602
Oklahoma	OK	1,926	1,115	726	3,768
Oregon	OR	391	487	302	1,180
Pennsylvania	PA	2,174	1,830	1,290	5,294
Rhode Island	RI	13	6	6	25
South Carolina	SC	1,184	492	351	2,027
South Dakota	SD	762	368	222	1,352
Tennessee	TN	933	566	391	1,890
Texas	TX	12,512	8,711	6,279	27,503
Utah	UT	265	364	209	838
Vermont	VT	1	1	1	3
Virginia	VA	1,092	521	342	1,956
Washington	WA	1,001	459	337	1,797
Washington DC	DC	-	-	-	-
West Virginia	WV	149	82	62	292
Wisconsin	WI	4,833	3,396	2,493	10,722
Wyoming	WY	73	39	22	133

Source: IHS

2016 US and State Labor Income Impact Summary

		Direct labor income	Indirect labor income	Induced labor income	Total labor income
United States	US	38,278	29,927	18,587	86,792
Alabama	AL	306	228	114	648
Alaska	AK	5	3	2	10
Arizona	AZ	299	232	165	696
Arizona	AR	125	106	49	280
California	CA	1,594	1,732	1,047	4,373
Colorado	CO	157	144	90	391
Connecticut	CT	275	196	122	593
Delaware	DE	3	2	1	6
Florida	FL	398	393	251	1,042
Georgia	GA	400	428	241	1,069
Hawaii	HI	-	0	0	0
Idaho	ID	84	61	33	178
Illinois	IL	4,205	3,283	2,255	9,743
Indiana	IN	1,985	1,308	804	4,097
Iowa	IA	2,332	1,401	815	4,547
Kansas	KS	564	390	217	1,171
Kentucky	KY	659	405	241	1,305
Louisiana	LA	767	419	278	1,464
Maine	ME	45	36	21	102
Maryland	MD	169	163	86	418
Massachusetts	MA	141	81	66	288
Michigan	MI	1,553	1,239	774	3,565
Minnesota	MN	1,055	1,001	608	2,665
Mississippi	MS	378	223	121	723
Missouri	MO	466	394	238	1,098
Montana	MT	10	10	5	25
Nebraska	NE	505	351	200	1,056
Nevada	NV	17	15	7	39
New Hampshire	NH	119	63	49	231
New Jersey	NJ	311	161	129	601
New Mexico	NM	37	27	13	77
New York	NY	1,372	954	607	2,933
North Carolina	NC	994	891	494	2,379
North Dakota	ND	322	228	97	647
Ohio	OH	2,271	1,775	1,151	5,197
Oklahoma	OK	996	688	401	2,084
Oregon	OR	313	312	173	797
Pennsylvania	PA	1,275	1,220	731	3,225
Rhode Island	RI	9	4	3	16
South Carolina	SC	519	307	191	1,017
South Dakota	SD	332	221	117	670
Tennessee	TN	398	358	222	978
Texas	TX	6,603	5,314	3,477	15,393
Utah	UT	213	191	115	519
Vermont	VT	1	0	0	2
Virginia	VA	416	340	181	937
Washington	WA	383	284	178	845
Washington DC	DC	-	-	-	-
West Virginia	WV	122	53	33	208
Wisconsin	WI	2,722	2,270	1,366	6,359
Wyoming	WY	50	23	11	84

Source: IHS

2016 Canada Sector Impact Summary

	Construction	Agriculture	Mining	Canada Total
Employment	51,440	44,397	52,831	148,668
Direct	22,290	19,199	22,836	64,324
Indirect	13,670	11,827	14,072	39,569
Induced	15,480	13,372	15,923	44,775
Output (millions of US dollars)	11,693	10,086	12,008	33,787
Direct	5,372	4,626	5,513	15,511
Indirect	3,355	2,899	3,445	9,699
Induced	2,966	2,562	3,050	8,577
Contribution to GDP (millions of US dollars)	5,144	4,443	5,291	14,878
Direct	2,098	1,810	2,158	6,066
Indirect	1,444	1,248	1,485	4,177
Induced	1,603	1,385	1,649	4,636
Labor income (millions of US dollars)	3,341	2,886	3,436	9,663
Direct	1,636	1,413	1,683	4,732
Indirect	910	787	936	2,632
Induced	795	686	817	2,299

Source: IHS

2016 Canada and Province Impact Summary

	Ontario	Alberta	Quebec	Other Provinces	Canada Total
Employment	62,770	28,117	29,672	28,109	148,668
Direct	25,474	15,116	12,021	11,714	64,324
Indirect	17,347	6,726	8,065	7,431	39,569
Induced	19,949	6,275	9,587	8,964	44,775
Output (millions of US dollars)	14,287	6,358	6,714	6,428	33,787
Direct	6,187	3,589	2,870	2,865	15,511
Indirect	4,241	1,539	2,086	1,833	9,699
Induced	3,860	1,229	1,759	1,730	8,577
Contribution to GDP (millions of US dollars)	6,312	2,785	2,932	2,850	14,878
Direct	2,414	1,402	1,125	1,124	6,066
Indirect	1,819	709	852	796	4,177
Induced	2,078	674	955	929	4,636
Labor income (millions of US dollars)	4,079	1,845	1,908	1,831	9,663
Direct	1,882	1,094	881	875	4,732
Indirect	1,157	439	541	495	2,632
Induced	1,040	312	486	461	2,299

Source: IHS

Appendix II: BMI and IMPLAN model

IHS Business Market Insights

Business Market Insights (BMI) is a robust database that provides market-leading forecast views of business employment and output at the state, metropolitan statistical area (MSA), and county level. Using advanced modeling techniques and a rich dataset from the US Census Bureau, our teams of economists and business specialists leverage the IHS internationally recognized US macroeconomic, industry, and regional forecasts to generate business activity indicators by county and detailed four-digit North American Industry Classification System (NAICS) code. Private companies, financial institutions, and government agencies use this one-of-a-kind database to get a deep look at US markets. It enables users to estimate the size and growth potential of a specific industry in a particular geography, even when regional data are limited. The database is designed to allow users to easily aggregate our historical data and forecasts by market area or industry.

Database coverage includes

- Employment
- The number of establishments
- Sales (output) in current and constant dollars
- Four-digit NAICS Code
- US states, MSAs, counties, and census regions
- Annual data, the 25-year forecast, and 15-plus years of history
- IMPLAN model

Impact Analysis for Planning (IMPLAN) is a widely used, commercially available model for input/output analysis. Minnesota IMPLAN Group, Inc., is responsible for the production of the IMPLAN data, model, and software. Using classic input/output analysis in combination with region-specific social accounting matrices and multiplier models, IMPLAN provides a highly accurate and adaptable model for its users. The IMPLAN database contains country, state, zip code, and federal economic statistics, which are specialized by region. IMPLAN accounts closely follow the accounting conventions used in the "Input-Output Study of the US Economy" by the US Bureau of Economic Analysis (BEA) and the rectangular format recommended by the United Nations. The IMPLAN system was designed to serve three functions:

- Data retrieval
- Data reduction and model development
- Impact analysis

Comprehensive and detailed data coverage of the entire United States by geography and the ability to incorporate user-supplied data at each stage of the model-building process provide a high degree of flexibility both in terms of geographic coverage and model formulation. There are two components to the IMPLAN system, the software and databases. The databases provide all information to create regional IMPLAN models. The software performs the calculations and provides an interface for the user to make final-demand changes.

The IMPLAN system consists of two major parts:

- A national-level technology matrix
- Estimates of sectoral activity for final demand, final payments, industry output, and employment for each detailed geography in the United States along with the aggregate region

Input-output accounting describes commodity flows from producers to intermediate and final consumers. The total industry purchases of commodities, services, employment compensation, value added, and imports are equal to the value of the commodities produced.

Purchases for final use (final demand) drive the model. Industries produce goods and services for final demand and purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the region (imports and value added) stop the cycle.

These indirect and induced effects (the effects of household spending) can be mathematically derived. The derivation is called the Leontief inverse. The resulting sets of multipliers describe the change of output for each and every regional industry caused by a one-dollar change in final demand for any given industry.

Creating regional input-output models requires a tremendous amount of data. The costs of surveying industries within each region to derive a list of commodity purchases (production functions) are prohibitive. IMPLAN was developed as a cost-effective means to develop regional input-output models.

IMPLAN easily allows the user to

- Develop multiplier tables
- Develop a complete set of social accounting matrix (SAM) accounts
- Change any component of the system, production functions, trade flows, or database
- Generate type I, II, or any true SAM multiplier internalizing household, government, and/or investment activities
- Create custom impact analysis by entering final-demand changes
- Obtain any report in the system to examine the model's assumptions and calculations

IMPLAN software

Minnesota IMPLAN Group developed the current version of IMPLAN Professional® version 3.0 in 2009. It is a Windows-based software package that performs the calculations necessary to create the predictive model. The software reads the database, creates the complete set of social accounting matrices (SAM), the input/output accounts, and integrates all user-defined inputs to produce an alternative scenario.

The IMPLAN Input/Output System derives the predictive multipliers. The software also enables the user to make changes to the data, trade flows, or technology. It also enables the user to make final-demand changes, which result in the impact assessment.

Features of IMPLAN Professional® include:

- Windows file and printer management
- An economic database editor
- A complete social accounting matrix (SAM) structure
- A choice of trade-flow assumptions: supply-demand pooling, regional purchase coefficients, location quotients
- A production function editor, i.e., the tools and opportunity necessary to modify the "absorption" and "byproducts" matrices
- Libraries for production functions and impact analysis expenditures
- Flexible model aggregation tools
- A report generator with many preset reports for all stages of model building and analysis
- An export feature to many major PC file formats
- Flexible assumptions for induced effects
- Type SAM – true SAM multipliers that allow internalizing any number of institutions
  - Type II - Based on personal consumption expenditure (PCE) and SAM-based local income relationship
  - Type II - Based on user-specified disposable income rate
  - Type III (CPMM) - Traditional Forest Service employment–based multipliers
- A menu structure for easy impact analysis
- Event-based impact databases
- Built-in and editable transaction margins
- Built-in and editable deflators
- Technical support by MIG, Inc.
- Data in Access Database format

Database

Each database has information for these components for all 440 industrial sectors in the IMPLAN model. This 440-sector scheme was revised in 2007 and was originally the basis for the BEA's Benchmark Input-Output Study. This scheme is nearly six-digit NAICS for manufacturing and more aggregate for service sectors. By necessity, IMPLAN's sectoring is very similar. However, in some cases, six-digit NAICS code data have been aggregated for certain IMPLAN sectors. A full NAICS-to-IMPLAN mapping document can be downloaded from www.implan.com.

Employment is total wage and salary and self-employed jobs in a region. In the 1985 database, employment was measured as full-time equivalent jobs. This meant total employment in a region would generally be below most published estimates because these are generally full-time and part-time workers. In the 1990 and subsequent

databases, employment includes both full-time and part-time workers. Employment in the 1990 and subsequent databases are measured in total jobs.

There are four subcomponents for value added:

- Employee compensation
- Proprietary income
- Other property-type income
- Indirect business taxes

Employee compensation is wage and salary payments as well as benefits, including health and life insurance, retirement payments, and any other noncash compensation. This provides a measure of income to workers paid by employers.

Proprietary income consists of payments received by self-employed individuals as income. This would be recorded on Federal Tax Form 1040C. This includes income received by private business owners, doctors, lawyers, and so forth. Any income a person receives for payment of self-employed work is counted here.

Other property-type income consists of payments from rents, royalties, and dividends. This includes payments to individuals in the form of rents received on property, royalties from contracts, and dividends paid by corporations. This also includes corporate profits earned by corporations.

Indirect business taxes consist primarily of excise and sales taxes paid by individuals to businesses. These taxes are collected during the normal operation of these businesses but do not include taxes on profit or income. Goods and services purchased for their ultimate use by an end user are called final demands. For a region, this would include exports, since those are a final use for that product. In an input-output framework, final demands are allocated to producing industries with margins allocated to the service sectors (transportation, wholesale and retail trade, insurance) associated with providing that good to the final user.

Thus, final demands are in producer prices. There are 13 subcomponents for final demands:

- Personal consumption expenditures (PCE)—nine income levels
- Federal government military purchases
- Federal government nonmilitary purchases
- Federal government capital formation purchases
- State and local government noneducation purchases
- State and local government education purchases
- State and local government capital formation purchases
- Inventory purchases
- Capital formation
- Foreign exports
- State and local government sales

- Federal government sales
- Inventory sales

All final demands in the original data are on a commodity basis. The distinction between industries and commodities is as follows from the 1972 Input-Output Definitions and Conventions Manual:

- An input-output industry is a grouping of establishments, as classified by Standard Industrial Classification (SIC)[3].
- An input-output commodity consists of the characteristic products of the corresponding input-output industry wherever made. There are several industries that have no commodities. This is a result of departures from the strict SIC. Also, some commodities have no associated industry. An example of this is noncomparable imports.

PCE consists of payments by individuals/households to industries for goods and services used for personal consumption. Individuals tend to buy little directly from industries other than retail trade. In an input-output table, though, purchases made by individuals for final consumption are shown as payments made directly to the industry producing the good. PCE is the largest component of final demand.

Federal government purchases are divided between military and nonmilitary uses and capital formation. Federal military purchases are those made to support national defense. Goods range from food for troops to missile launchers. Nonmilitary purchases are made to supply all other government functions. Payments made to other governmental units are transfers and are not included in federal government purchases.

State and local government purchases are divided between public education and noneducation and capital formation. Public education purchases are for elementary, high school, and higher education. Noneducation purchases are for all other government activities. These include state government operations and operations including police protection and sanitation. Private-sector education purchases are not counted here. Private education purchases show up in IMPLAN sectors 495 and 496.

Inventory purchases are made when industries do not sell all output created in one year. This is generally the case. Each year, a portion of output goes to inventory. Inventory sales occur when industries sell more than they produce and need to deplete inventory. Inventory purchases and sales generally involve goods-producing industries (e.g., agriculture, mining, and manufacturing).

Capital formation is private expenditures made to obtain capital equipment. The dollar values in the IMPLAN database are expenditures made to an industrial sector producing the capital equipment. The values are not expenditures by the industrial sector.

Foreign exports are demands made to industries for goods for export beyond national borders. These represent goods and services demanded by foreign parties. Domestic exports are calculated during the IMPLAN model creation and are not part of the database.

The national transactions matrix is based on the most current BEA National Benchmark Input-Output Model. It is resectored to IMPLAN industrial sectoring. We use our IMPLAN data for the current year to update the most recent National Benchmark study.

IMPLAN multipliers

The notion of a multiplier rests on the difference between the initial effect of a change in final demand and the total effects of that change. Total effects can be calculated either as direct and indirect effects, or as direct, indirect, and induced effects. Direct effects are production changes associated with the immediate effects or final-demand changes. Indirect effects are production changes in backward-linked industries caused by the changing input needs

[3] The IMPLAN sector scheme is now currently based on NAICS definitions and is revised as necessary after each five-year economic census is released.

of directly affected industries (for example, additional purchases to produce additional output). Induced effects are the changes in regional household spending patterns caused by changes in household income generated from the direct and indirect effects.

Five different sets of multipliers are estimated by IMPLAN corresponding to five measures of regional economic activity: total industry output, personal income, total income, value added, and employment. For each set of multipliers, four types of multipliers are generated: Type I, Type II, Type SAM, and Type III.

Type I multiplier

A Type I multiplier is the direct effect produced by a change in final demand, plus the indirect effect divided by the direct effect. Increased demands are assumed to lead to increased employment and population with the average income level remaining constant. The Leontief inverse (Type I multipliers matrix) is derived by inverting the direct coefficients matrix. The result is a matrix of total requirement coefficients, the amount each industry must produce for the purchasing industry to deliver one dollar's worth of output to final demand.

Type II multipliers

Type II multipliers incorporate induced effects resulting from household expenditures from new labor income. The linear relationship between labor income and household expenditure can be customized in the IMPLAN Professional® software. The default relationship is PCE and total household expenditures. Each dollar of workplace-based income is spent based on the SAM relationship generated by IMPLAN. The second possibility is a Regional Input-Output Modeling System (RIMS II) style of Type II multiplier, where PCE is adjusted to represent only the spending of the disposable income portion of labor income. In this way, there is a direct one-to-one relationship to labor income and PCE. Then, a ratio that the user can specify is applied to convert total income to disposable income before the rounds of induced effects are calculated.

Type SAM

Type SAM multipliers are the direct, indirect, and induced effects, where the induced effect is based on information in the social account matrix. This relationship accounts for social security and income tax leakage, institution savings, and commuting. It also accounts for interinstitutional transfers. This multiplier is flexible, in that you can include any institutions you want. In other words, if you want to create a model closed to households and state and local government, you can. If you select this option, an additional dialog box with be displayed allowing you to select the institutions you want to include.

Output multipliers

This report shows the total industry output multipliers and per capita personal consumption expenditures. Output multipliers can be used to gauge the interdependence of sectors; the larger the output multiplier, the greater the interdependence of the sector on the rest of the regional economy. A Type I entry represents the value of production (from direct and indirect effects) required from all sectors by a particular sector to deliver one dollar's worth of output. Type II, SAM, and III add in the induced requirements.

Example: If a Type I multiplier for the dairy farm industry is 1.0943, for each dollar of output produced by the dairy farm sector, 0.0943 dollar's worth of indirect output is generated in other local industries. If the Type SAM dairy farm multiplier is 1.3140, 0.3140 dollar of indirect and induced output is generated in other local industries. The induced output would be 1.3140 minus 1.0943, or 0.2197 dollar for each dollar of output produced by the dairy farm sector.

Labor income multipliers

The labor income multiplier report shows the direct, indirect, and induced employee compensation plus proprietor income effects generated per dollar of output. The Type I personal income multiplier is the direct and indirect employee compensation plus proprietor income divided by the direct income. The Type II, Type SAM, and Type III multipliers add the induced effects component.

Example: If the Type I multiplier for the dairy farm sector is 1.4761 and the Type SAM multiplier is 2.7067, then for each dollar of direct income generated by this industry, 0.4761 dollar of indirect and 1.2306 dollars of induced income are generated.

Employee compensation multipliers

Employee compensation represents all payroll costs of wage and salary workers. The Type I, Type SAM, Type II, or Type III total income multipliers are listed in this report, along with the direct, indirect, and induced total income effects generated from the production of one dollar's output.

Proprietor income multiplier

Proprietor income is the income earned by the owners of a private, nonincorporated business—i.e., the self-employed. The Type I, Type SAM, Type II, and Type III total income multipliers are listed in this report, along with the direct, indirect, and induced total income effects generated from the production of one dollar's output.

Other property-type income

Other property-type income represents corporate income, rental income, and interest. The Type I, Type II, Type SAM, and Type III total income multipliers are listed in this report, along with the direct, indirect, and induced total income effects generated from the production of one dollar's output.

Value-added multipliers

Type I, Type II, Type SAM, and Type III value-added multipliers are listed in this report, along with the direct, indirect, and induced value-added effects generated from the production of one dollar of output. Value-added includes employee compensation, proprietary income, other property-type income, and indirect business taxes.

Employment multipliers

Type I, Type II, Type SAM, and Type III employment multipliers are listed in this report along with the direct, indirect, and induced employment effects from the production of $1 million of output. Employment is in terms of full-time and part-time jobs.

Example: If a dairy farm Type I employment multiplier is 1.1158, for each job created directly by the dairy farm industry, 0.1158 job is created indirectly.

IHS Customer Care:

CustomerCare@ihs.com
Americas: +1 800 IHS CARE (+1 800 447 2273)
Europe, Middle East, and Africa: +44 (0) 1344 328 300
Asia and the Pacific Rim: +604 291 3600