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The Ohio Motor Vehicle Report

December 2016

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THE OHIO MOTOR VEHICLE INDUSTRY

DECEMBER 2016

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EXECUTIVE SUMMARY

- 1,618,000-plus light vehicles were assembled in Ohio in 2015 (an increase of 3.3 percent from 2014); 701,000-plus by Honda, nearly 565,000 by Fiat Chrysler Automobiles, 299,000-plus by General Motors, and 52,800-plus by Ford.

- Tens of thousands of medium- and heavy-duty trucks and buses are assembled by Ford, Navistar and Kenworth.

- Ohio is at the center of the motor vehicle industry with 70.5 percent of N. American light vehicle production either in Ohio or within 500 miles (805 kilometers) of its borders.

- 11 light vehicle models currently are made in Ohio's six high-volume light vehicle plants. These included over 150,000 each of some of the nation's best-sellers in 2015: Honda Accords and CR-Vs, Chevrolet Cruzes, and Jeep Wranglers and Cherokees; at least six medium- and heavy-duty truck models also are assembled here.

- Ohio ranked second in light vehicle output, reflecting its second and third ranks in car and light truck production in 2015 according to Automotive News; it ranked second in value-added in parts production; and it ranked third in value-added for combined assembly, bodies, trailers and parts operations according to the latest Census Bureau data.

- Honda is the largest motor vehicle industry employer in Ohio with about 12,200 employed in manufacturing operations, followed by General Motors with 9,600, 6,200 at Fiat Chrysler Automobiles (6,950, if partners are included), and 5,900 at Ford; 19 more companies each employ at least 1,000 people at their facilities in Ohio.

- Five companies supplying parts to the motor vehicle industry and on Fortune's U.S.-1,000 list maintain their world headquarters in Ohio: Cooper Tire & Rubber, Dana, Goodyear Tire & Rubber, Parker-Hannifin and Worthington Industries.

- 21 more companies on Fortune's U.S.-1,000 or Global-500 lists have industry plants in Ohio.

- 580 active establishments in Ohio directly or indirectly supply motor vehicle assemblers – 8.4 percent of such in N. America – ranking the state second only to Michigan among the surrounding states and provinces.

- 94,800-plus people were employed in Ohio's motor vehicle and related industries according the latest comprehensive statistics compiled from various sources; these cover assembly, bodies, trailers, parts, battery and motor vehicle tire manufacturing plus two diesel engine plants and one foundry dedicated to engines.

- 78 of Ohio's 88 counties have at least one motor vehicle or related industry establishment.
- Three of every five motor vehicle and related industry jobs were located in 15 counties: Cuyahoga, Defiance, Franklin, Hamilton, Hancock, Logan Lorain, Lucas, Montgomery, Ross, Shelby, Trumbull, Union, Wayne and Wood.
- More than 90 companies (or their subsidiaries) from 16 foreign nations employ approximately 58,200 people in assembly and parts production in Ohio; 11 of them are on Fortune's Global 500 list.
- $5.8 billion in private investment for 185 projects in Ohio's motor vehicle and related industries was announced by 133 companies during the previous four years; 10,700 new jobs were anticipated upon completion.
- Motor vehicle and related industries annual wages and salaries in Ohio averaged more than $61,500 according to the latest comprehensive data.

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DESCRIPTION OF OHIO'S MOTOR VEHICLE INDUSTRY

THE MOTOR VEHICLE INDUSTRY'S IMPACT ON OHIO'S ECONOMY

Cluster / Sector	Output (millions)	Value Added (millions)	Compensation (millions)	Employment (rounded)
Direct				
Motor Vehicles	$38,519.4	$5,048.7	$2,536.2	27,190
Motor Vehicle Parts	$35,157.3	$7,670.6	$5,506.4	70,860
Motor Vehicle Related	$2,208.8	$660.9	$450.8	5,700
Motor Vehicle Cluster Direct Impact^	**$75,885.5**	**$13,380.3**	**$8,493.5**	**103,750**
Indirect: Supplier Network				
Other Manufacturing	$10,218.7	$2,838.1	$1,869.6	25,990
Other Goods & Utilities	$1,432.6	$636.1	$242.0	3,730
Wholesale / Transportion / Warehousing	$8,477.0	$5,046.1	$3,030.0	41,690
Retail / Restaurants	$955.4	$616.4	$383.4	12,450
Services	$3,168.3	$1,809.8	$815.1	13,600
Engineering / Management / Administration	$5,873.1	$3,735.0	$3,055.7	38,550
Government	$85.0	$24.4	$28.1	290
Supplier Impact^	**$30,210.4**	**$14,706.2**	**$9,423.9**	**136,550**
Induced: Employee Spending				
Consumer Spending in the Economy^	**$16,328.6**	**$9,409.1**	**$5,156.1**	**116,490**
Total Motor Vehicle Production Cluster Impact^	**$122,424.5**	**$37,495.7**	**$23,073.5**	**356,540**
State Total Economy	$1,184,930.1	$593,487.1	$357,514.1	6,749,240
Motor Vehicle Production Cluster as Percentage of Ohio's Economy^	**10.33%**	**6.31%**	**6.45%**	**5.20%**

Notes: * - Output, value-added and compensation are reported in 2016 dollars. Motor vehicle cluster numbers are the direct impact of the selected industries; the remaining seven sector groups report the indirect impact across Ohio's economy, while induced spending is the summary of activity across all sectors of the state's economy.

^ - Components may not sum to higher levels due to rounding, which in turn may affect percentages.

Source: IMPLAN 4.1.0 by MIG, Inc. / Ohio Model (2014 data).

Prepared by: Office of Research, Ohio Development Services Agency (SK, 9/16).

The Minnesota IMPLAN Group (a private company specializing econometric analyses) offers this assessment of the motor vehicle industry's impact on Ohio's economy:

- The Ohio motor vehicle industry directly employed 103,750 workers in 2014.

- A broader view of the industry's role in the economy takes into account a cluster of industries supplying capital equipment, parts, materials and even facilities.

  - An estimated 25,990 workers in Ohio made goods incorporated into motor vehicles, bodies, trailers and parts, or that were used in the process. Examples of the former include windshields and windows, springs, nuts, bolts, bearings, valves, electronic parts, paints and metal coatings, adhesives, and sealing devices. These were often made of steel, aluminum, glass, rubber, plastics or other chemical products. Examples of the latter include capital equipment and paperboard products.

  - About 3,730 more non-manufacturing goods-producing jobs – notably in construction – depended on presence of the motor vehicle industry here.

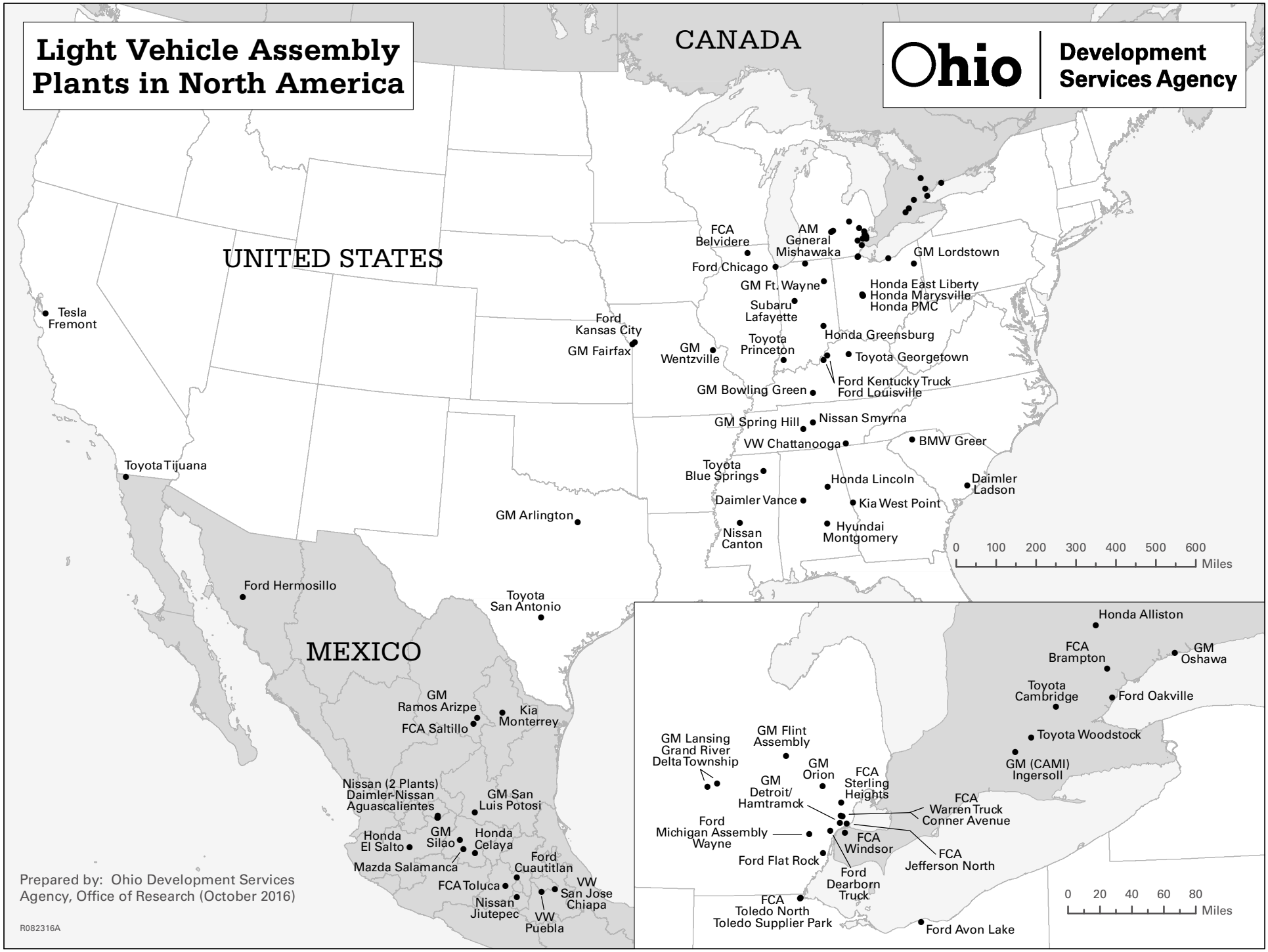
- Additional service industries outside of goods production are integrated with or depend on the motor vehicle industry and employ 106,830. These bring total indirect employment to 136,550.

- Combining the impact of the goods-producing and service clusters with the 116,490 jobs added by induced employee spending across the economy means that a total of 5.20 percent of all Ohio workers (356,540/ 6,749,240) were directly or indirectly dependent on the motor vehicle industry cluster for their livelihoods. The corresponding net value-added of the goods and services amounted to 6.31 percent of the economy.

- The associated aggregate output of the $75.9 billion direct and $30.2 billion indirect impacts plus the $16.3 billion induced by employee spending – a total of $122.4 billion – was 10.33 percent of $1.18 *trillion* in sales and revenues in Ohio (Minnesota IMPLAN Group, 2016).

Light Vehicle Assembly Plants in North America

Ohio Development Services Agency



Prepared by: Ohio Development Services Agency, Office of Research (October 2016)

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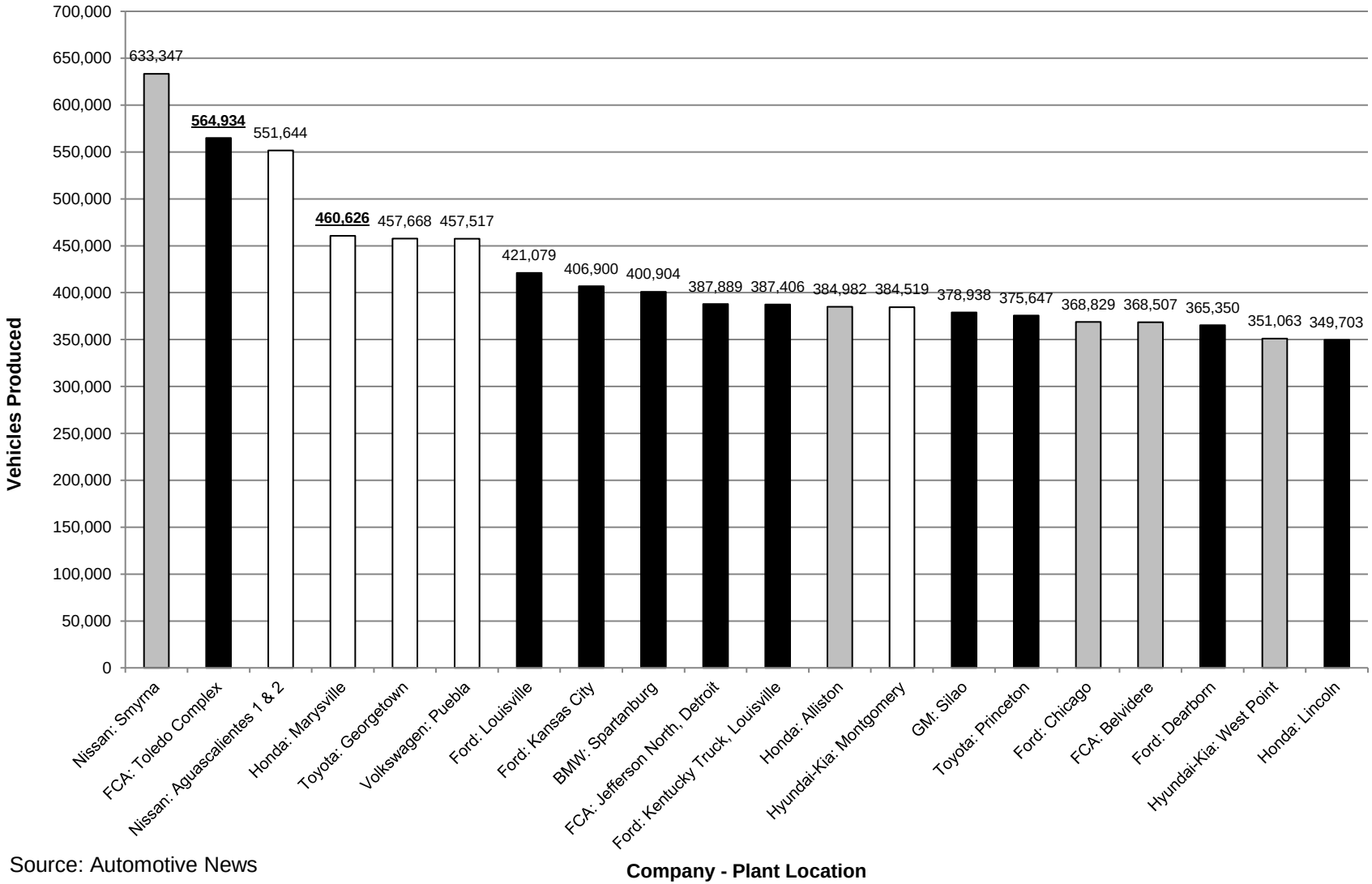
N. American Light Vehicle Production in 2015:

the 68 Plant/Complex Total -- 17,630,531

the 20 with the Highest Volumes are Shown

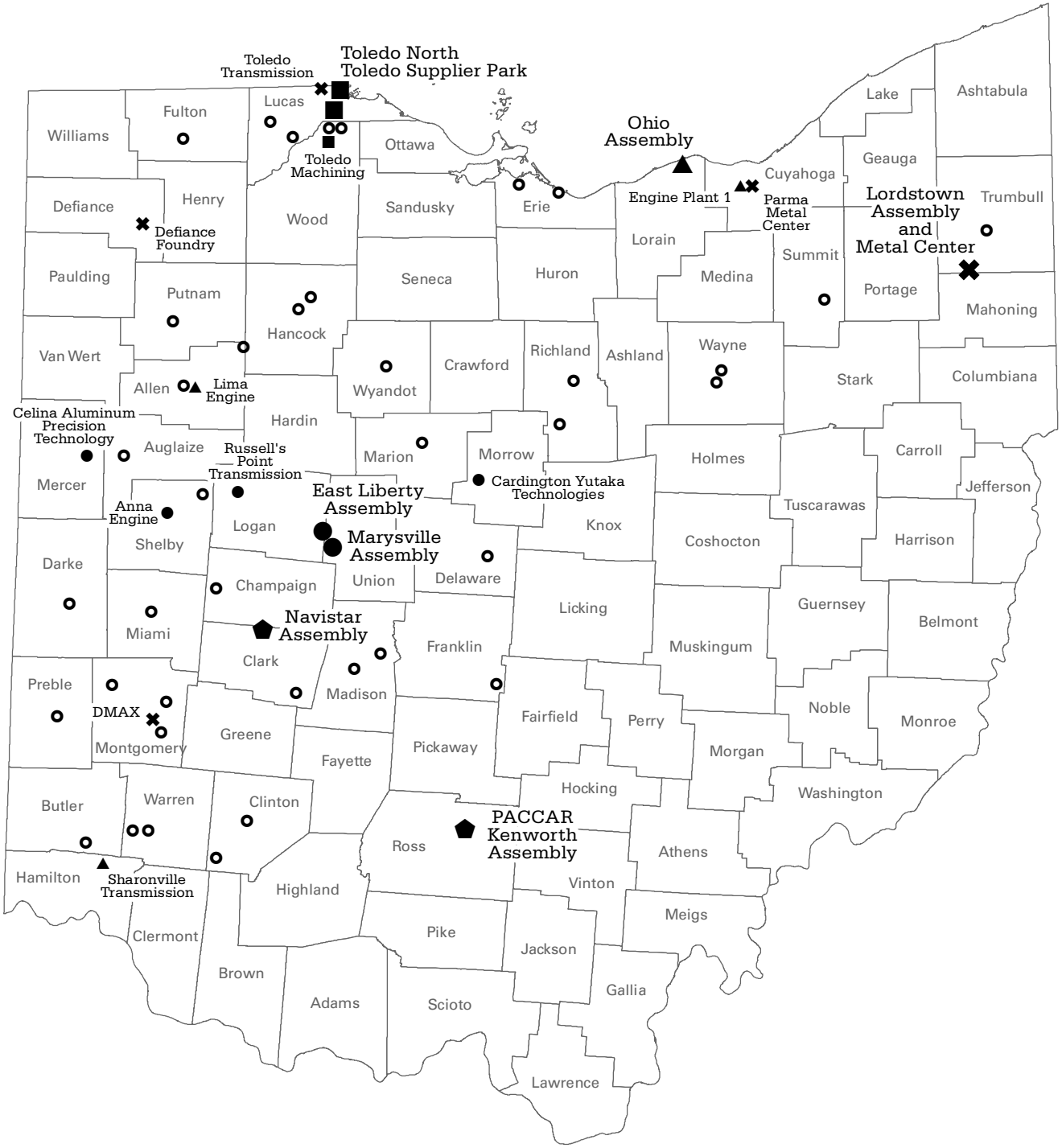
White: Cars Black: Light Trucks Gray: Both



Source: Automotive News

Ohio

Notable Establishments* in Ohio's Motor Vehicle Industry



Establishment Location

- ■ Fiat/Chrysler (FCA)
- ▲ Ford
- ✖ General Motors
- ● Honda
- ⬟ Navistar, PACCAR
- ○ Other

*Establishments believed to employ 500 or more

Prepared by: Office of Research, Ohio Development Services Agency
December 2016

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NOTABLE MOTOR VEHICLE INDUSTRY MANUFACTURERS IN OHIO

Twenty-nine companies on Fortune magazine's US-1,000 or Global-500 lists have motor vehicle industry establishments in Ohio, with five maintaining world headquarters here: Cooper Tire & Rubber, Dana, Goodyear Tire & Rubber, Parker-Hannifin and Worthington Industries. Honda is the largest industry employer with nearly 12,300 in manufacturing operations (including subsidiaries). (Honda's total employment in Ohio is about 14,300 when other activities are included. An additional 5,900-plus are employed at companies Honda described as affiliates.) General Motors (GM) follows with 9,600 (9,950 when non-manufacturing activities are included). Fiat Chrysler Automobiles (FCA) employs 6,200 (plus 100 more in non-manufacturing), with its two partners at its Toledo complex combining for 750 more. Ford employs 5,900. Other companies thought to employ at least 1,000 in Ohio include Autoliv, Cooper Tire & Rubber, Dana, Flex-N-Gate's Ventra, Fuyao Glass, Goodyear Tire & Rubber,[1] International Automotive Components (IAC), Johnson Controls, KTH Parts, Magna International, Mahle Behr, Navistar, Nihon Plast's Neaton Auto Parts, Paccar's Kenworth division, Peugeot's Faurecia, Schaeffler Technologies' LuK (sic), Showa, Stanley Electric and Toledo Molding & Die.

Establishments with non-motor vehicle industry NAICS codes have been included when their specific products are used by the industry. Examples include GM's and Daimler's diesel engine plants (Daimler rebuilds engines on an assembly line), GM's foundry, automotive glass operations, and Toledo Molding and Die's plastic products.

The map above shows the locations of the 59 manufacturing establishments with 500 or more employees. The list below includes the Fortune companies, usually with at least 50 people at a site, as well as other companies employing 500 or more in Ohio and mostly having 50-plus at a site.[2] It is organized by NAICS code and includes the city where the site is located. Parts operations may not be the primary businesses of some of the companies on the list, but their sites are included because their primary NAICS codes – or products their clients buy – make them as part of the industry.

Parent / Company / Division	Primary NAICS#	City	Jobs at Site~
Transportation equipment industry codes:			
33611: Automobiles and Light-Duty Motor Vehicles			
Honda Motor Co., Ltd.*/Honda of America Mfg., Inc.^	336111	Marysville	4,000
Honda Motor Co., Ltd.*/Honda of America Mfg., Inc. (Performance Mfg. Center)[27]	336111	Marysville	70
Hyundai MOBIS Co., Ltd.*/Mobis NA LLC (integrated with FCA's assembly plants)	336111	Toledo	500
General Motors Co.*[1, 26] (jobs include a small adjacent stamping plant)	336111/7	Lordstown	4,500
FCA US LLC*^ (North & South combined)	336112	Toledo	5,160
Ford Motor Co.*[1] (aka Ohio Assembly)	336112	Avon Lake	1,469
Honda Motor Co., Ltd.*/Honda of America Mfg., Inc.^	336112	E. Liberty	2,250

Parent / Company / Division	Primary NAICS#	City	Jobs at Site~
33621: Medium- and Heavy-Duty Trucks			
Navistar International Corp.* (aka International Truck & Engine)[12]	33612	Springfield	1,500
Paccar, Inc.*/Kenworth Truck Co.[13]	33612	Chillicothe	1,850
3362: Motor Vehicle Bodies and Trailers			
Kuka AG/Kuka Toledo Production Operations LLC (integrated with FCA's assembly plants)	336211	Toledo	250
Truck Hero, Inc./ARE, Inc.[22]	336211	Massillon	475
Truck Hero, Inc./ARE, Inc.[22]	336211	Mt. Eaton	275
Berkshire Hathaway, Inc.*/Scott Fetzer Co./Stahl Co.	336212	Wooster	115
MAC Trailer, Inc.[9]/MAC LTT	336212	Kent	224
MAC Trailer, Inc.[9]/MAC Mfg., Inc.	336212	Salem	165
MAC Trailer, Inc.[9]/MAC Refuse, Inc.	336212	Alliance	100
MAC Trailer, Inc.[9]/MAC Trailer Mfg., Inc.	336212	Alliance	475
Thor Industries, Inc.*/Airstream, Inc.[18]	336213	Jackson Center	670
33631: Motor Vehicle Gasoline Engines and Engine Parts			
Dover Corp.*/Wiseco Piston Co., Inc.[6]	33631	Mentor	315
Ford Motor Co.*[1] (Engine Plant #1)	33631	Brookpark	1,607
Ford Motor Co.*[1]	33631	Lima	1,204
Honda Motor Co., Ltd.*/Honda of America Mfg., Inc.^	33631	Anna	2,850
Mahle Behr GmbH & Co. KG/Mahle Dayton LLC^	33631	Dayton	1,300
Mahle Behr GmbH & Co. KG/Mahle Engine Components USA, Inc.^	33631	McConnelsville	115
33632: Motor Vehicle Electrical and Electronic Equipment			
Delphi Automotive plc/Delphi Automotive Systems LLC^[5]	33632	Vienna	120
Delphi Automotive plc/Delphi Automotive Systems LLC^[5]	33632	Warren	500
Mitsubishi Electric Corp.*/Mitsubishi Electric Automotive America, Inc.^	33632	Mason	550
Stanley Electric Co., Inc./Stanley Electric US Co., Inc.^	33632	London	1,270
Stoneridge, Inc.[15]	33632	Lexington	760
33633: Motor Vehicle Steering and Suspension Components			
F-Tech, Inc./F&P America Mfg., Inc.^	33633	Troy	690
Showa Corp./American Showa, Inc.^	33633	Sunbury	550
Showa Corp./American Showa, Inc.^	33633	Blanchester	575
ThyssenKrupp AG*/Bilstein of America, Inc.^	33633	Hamilton	210
Yamada Mfg. Co., Ltd./Yamada N. America, Inc.^	33633	S. Charleston	600
33634: Motor Vehicle Brake Systems			
Aisin Seiki Co., Ltd.*/Advics Mfg. Ohio, Inc.^	33634	Lebanon	700
Autoliv, Inc.*-Nissin Kogyo Co., Ltd. (JV)/Autoliv Nissin Brake Systems^	33634	Findlay	455
Autoliv, Inc.*-Nissin Kogyo Co., Ltd. (JV)/Nissin Brake Ohio, Inc.^	33634	Findlay	565

Parent / Company / Division	Primary NAICS#	City	Jobs at Site~
33634: Motor Vehicle Brake Systems (continued)			
Cooper-Standard Holdings, Inc.*/Cooper-Standard Automotive, Inc.	33634	New Lexington	352
ZF Friedrichshafen AG/TRW[24]	33634	Fayette	215
33635: Motor Vehicle Transmissions and Parts			
FCA US LLC*^ (machining)	33635	Perrysburg	1,040
Ford Motor Co.*[1]	33635	Sharonville	1,628
General Motors Co.*[1]	33635	Toledo	2,028
Honda Motor Co., Ltd.*/Honda Transmission Mfg. of America, Inc.^	33635	Russell's Point	1,150
33636: Motor Vehicle Seating and Interior Trim			
Intl. Automotive Components (IAC) Group SA/IAC Group N. America, Inc.^	33636	Sidney	350
Johnson Controls, Inc.*[8]/Johnson Controls Interiors Mfg.	33636	Bryan	250
Johnson Controls, Inc.*[8]/Setex, Inc. (JV with Tachi-S Co., Ltd.)	33636	St. Mary's	450
Magna Intl., Inc.*/Gramag Truck Interior Systems LLC (JV with Grammar AG)^	33636	London	30
Magna Intl., Inc.*/Magna Seating of America, Inc.^	33636	Strongsville	60
Magna Intl., Inc.*/Magna Seating of America, Inc.^[26]	33636	Warren	320
Nihon Plast Co., Ltd./Neaton Auto Parts Mfg., Inc.^	33636	Eaton	1,100
TS Tech Co., Ltd./Trim Industries, Inc.^	33636	Canal Winchester	600
TS Tech Co., Ltd./TS Tech USA Corp.^	33636	Reynoldsburg	360
33637: Motor Vehicle Stampings			
ArcelorMittal*/ArcelorMittal Tailored Blanks^	33637	Pioneer	110
General Motors Co.*[1]	33637	Parma	1,367
G-TEKT Corp./Jefferson Industries Corp.^	33637	W. Jefferson	750
Kasai Kogyo Co./Kasai N. America, Inc. (fka M-Tek, Inc.)^	33637	Upper Sandusky	540
Magna Intl., Inc.*/Magna Cosma International (aka Vehtek)^	33637	Bowling Green	420
Magna Intl., Inc.*/Norplas Industries, Inc. (aka Magna Exteriors)^	33637	Northwood	1,100
Midway Products Group, Inc./Findlay Products Corp.[2]	33637	Findlay	179
Midway Products Group, Inc./P & A Industries, Inc.[2]	33637	Findlay	140
Midway Products Group, Inc./Progressive Stamping, Inc.[10]	33637	Ottoville	215
MTD Holdings, Inc./Shiloh Industries, Inc. (aka Medina Blanking)	33637	Valley City	50
MTD Holdings, Inc./Shiloh Industries, Inc. (aka Welded Blank or 3D Metals)	33637	Valley City	n.a.
MTD Holdings, Inc./Shiloh Industries, Inc. (includes HQ)	33637	Valley City	n.a.
MTD Holdings, Inc./Shiloh Industries, Inc.[11]	33637	Wellington	220
Tower Intl., Inc.*/Tower Automotive Operations USA I LLC[20]	33637	Bluffton	189
Worthington Industries, Inc.*/Artiflex Mfg., LLC (aka Gerstenslager)[23]	33637	Wooster	750
33639: Other Motor Parts			
Cooper-Standard Holdings, Inc.*/Cooper-Standard Automotive, Inc.[3]	33639	Bowling Green	142
Dana, Inc.*/Dana Driveshaft Mfg. LLC[4]	33639	Lima	621

Parent / Company / Division	Primary NAICS#	City	Jobs at Site~
33639: Other Motor Parts (continued)			
Flex-N-Gate Corp./Ventra Sandusky LLC (fka Ford's Automotive Components Holdings)	33639	Sandusky	1,344
Hitachi, Ltd.*/AAP St. Marys Corp.^	33639	St. Mary's	525
Honda Motor Co., Ltd.*/AY Mfg., Ltd.^	33639	Columbus	175
Honda Motor Co., Ltd.*/Cardington Yutaka Technologies, Inc.^	33639	Cardington	725
Honda Motor Co., Ltd.*/US Yachiyo, Inc.^	33639	Marion	170
Intl. Automotive Components (IAC) Group SA/IAC Group N. America, Inc.^	33639	Huron	600
Intl. Automotive Components (IAC) Group SA/IAC Group N. America, Inc.^	33639	Wauseon	650
Johnson Controls, Inc.*[8]/Johnson Controls Interiors LLC	33639	Northwood	580
Kirchoff Holding GmbH & Co. KG/Kirchoff Van-Rob, Inc. (aka VR)	33639	Waverly	580
KTH Parts Industries, Inc.^	33639	St. Paris	1,150
KTH Parts Industries, Inc./Kalida Mfg. Inc.^	33639	Kalida	500
Magna Intl., Inc.*/Magna Modular Systems, Inc. (aka Magna Exteriors & Interiors)^	33639	Toledo	200
Moriroku Holdings Co./Greenville Technology, Inc.^	33639	Greenville	770
Pacific Industrial Co., Ltd./Pacific Mfg. Ohio, Inc.^	33639	Fairfield	530
Parker-Hannifin Corp.*/Hose Products Division	33639	Wickliffe	271
Peugeot SA*/Faurecia Exhaust Systems, Inc.^	33639	Franklin	390
Peugeot SA*/Faurecia Exhaust Systems, Inc.^	33639	Northwood	50
Peugeot SA*/Faurecia Exhaust Systems, Inc.^	33639	Toledo	130
Peugeot SA*/Faurecia Exhaust Systems, Inc.[14]	33639	Toledo	200
Peugeot SA*/Faurecia Exhaust Systems, Inc.^	33639	Troy	300
Sankei Giken Co., Ltd./Newman Technology, Inc.^	33639	Mansfield	820
Schaeffler Technologies GmbH & Co. KG/LuK-Schaeffler Group USA, Inc.^	33639	Wooster	1,170
Tanaka Seimitsu Kogyo Co., Ltd./FT Precision, Inc.^	33639	Fredericktown	400
Tenneco, Inc.*[16]	33639	Kettering	478
Tenneco, Inc.*[17]	33639	Napoleon	450
Tokai Kogyo Co., Ltd./Green Tokai Co., Ltd.^	33639	Brookville	570
Tower Intl., Inc.*/Tower Automotive Operations USA I LLC[21]	33639	Bellevue	234
Related Industries			
Intl. Automotive Components (IAC) Group SA/IAC Group N. America, Inc.^	32619	Fremont	315
Toledo Molding and Die, Inc. (3 sites: HQ, test lab & plant)[19]	32619	Toledo	n.a.
Toledo Molding and Die, Inc.[19]	32619	Bowling Green	n.a.
Toledo Molding and Die, Inc.[19]	32619	Delphos	n.a.
Toledo Molding and Die, Inc.[19]	32619	Tiffin	n.a.
Toledo Molding and Die, Inc./WEK[19]	32619	Jefferson	n.a.
TS Tech Co., Ltd./Tri-Mold LLC^	32619	Circleville	230
Cooper Tire & Rubber Co. (includes HQ)*[2]	326211	Findlay	1,800
Intl. Automotive Components (IAC) Group SA/IAC Group N. America, Inc.^	32622	Canton	10

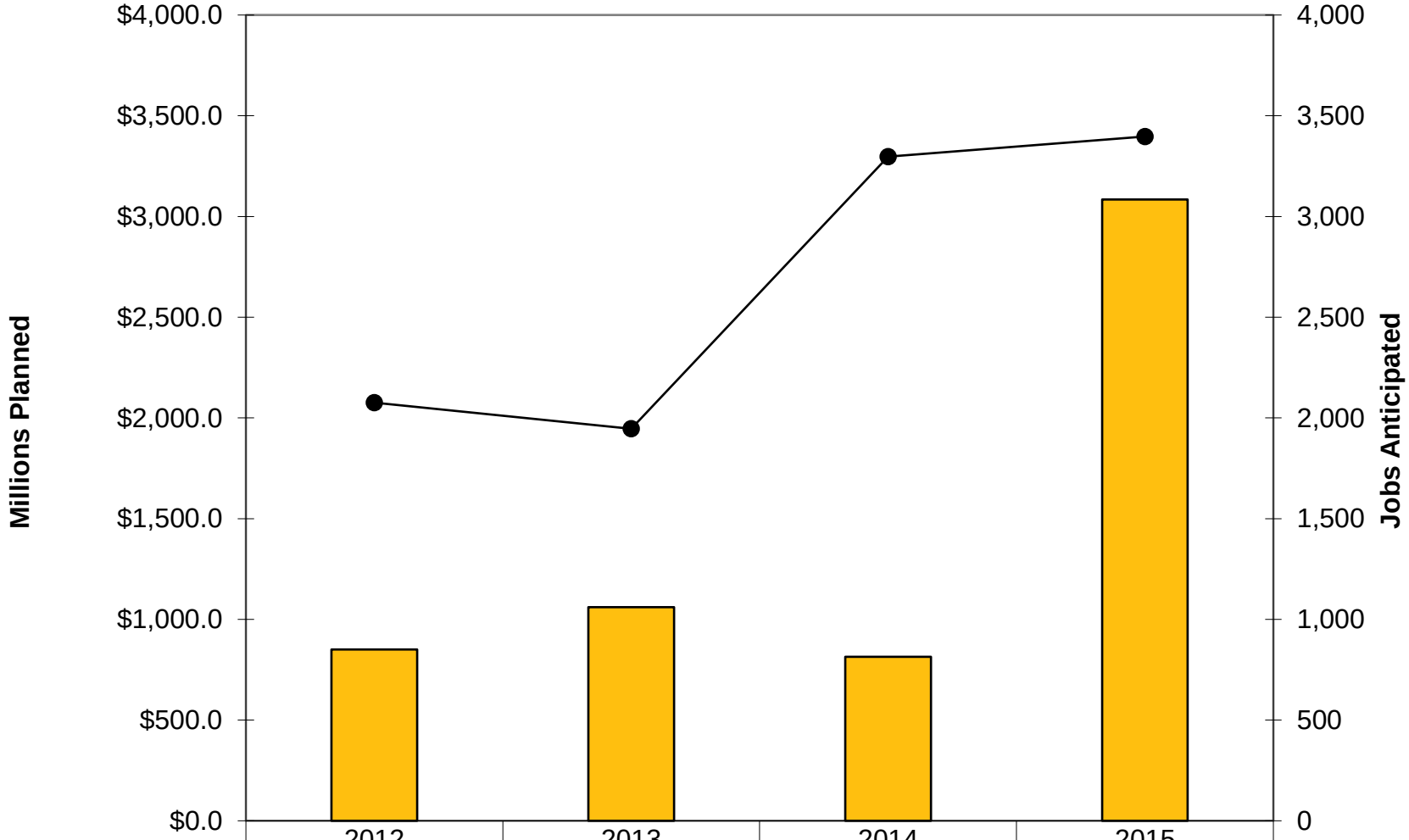
Parent / Company / Division	Primary NAICS#	City	Jobs at Site~
Related Industries (continued)			
EG Industries, Inc./FPE (fka Florida Production Engineering)[28]	32619	Circleville	200
EG Industries, Inc./Marion Industries, Inc.[28]	32619	Marion	753
Intl. Automotive Components (IAC) Group SA/IAC Group N. America, Inc.^	32622	Holmesville	300
Tokai Rubber Industries Ltd./DTR Industries, Inc.^	32622	Bluffton	610
Asahi Glass Co., Ltd./AGC Automotive N. America, Inc.^	32721	Bellefontaine	485
Asahi Glass Co., Ltd./Belletech Corp.^	32721	Bellefontaine	115
Fuyao Glass Industry Group Co., Ltd.^	32721	Dayton	1,400
General Motors Co.*[1] (iron and aluminum foundry products)	33151/2	Defiance	1,128
Ahresty Corp./Ahresty Wilmington Corp.[1]	33152	Wilmington	898
Honda Motor Co., Ltd.*/Celina Aluminum Precision Technology, Inc.^	33152	Celina	550
Sanoh Industrial Co., Ltd./Sanoh America, Inc.^	3329	Archbold	70
Sanoh Industrial Co., Ltd./Sanoh America, Inc.^	3329	Findlay	280
Sanoh Industrial Co., Ltd./Sanoh America, Inc.^	3329	Mt. Vernon	220
Honda Motor Co., Ltd.*/Honda Engineering N. America, Inc. (in-house metal working facility)^	3335	Marysville	350
Daimler AG*/Detroit Diesel Remanufacturing East^	333618	Byesville	490
General Motors Co.*[1]/DMAX (JV, Isuzu Motors Ltd. owns 40 percent of the engine plant)	333618	Moraine	576
Johnson Controls, Inc.*[8]/Johnson Controls Battery Group, Inc.	335911	Holland	600
Robert Bosch GmbH*/Robert Bosch Battery Systems[25]	335911	Springboro	56
Dana, Inc.* (HQ)	551114	Maumee	500
Goodyear Tire & Rubber Co. (includes HQ)*[7]	551114	Akron	3,000

Abbreviations, notes and sources: aka/fka - also/formerly known as; HQ - headquarters; Intl. - International; JV - Joint Venture; Mfg. – Manufacturing; n.a. - not available; NAICS - North American Industry Classification System; # - non-industry NAICS codes are included if production is principally for motor vehicles; ~ - Jobs figures are the latest available from either (1) privates sector sources – Hoovers (2016), frequently excepted as noted – or (2) Office of Research (2016a); the latter estimates are noted by "^" after the name; * - A Fortune U.S.-1,000 or Global-500 company or parent; 1 - Jobs figure from a company website (2016); 2 - Jobs figure from The Alliance (2015); 3 - Jobs estimated from Rockwell (2015); 4 - Jobs figure from the Lima News (2016); 5 - Layoffs may occur in the near future (McCoy, 2016); 6 - Jobs figure from Scott (2014); an additional 100 were planned at the time; 7 - Jobs figure from the City of Akron (2016); 8 - Johnson Controls keeps battery business but spin-offs automotive part to a new company called Adient and/or a joint venture with Yanfeng, a Chinese company (Linkhorn, 2015; Snavely, 2016); Bryan employment the class minimum from Manta (2016); Northwood employment from Linkhorn (2015); 9 - Alliance job estimates from company website and Hall (2015); Kent figure from Tank Transport Trader (2014); Salem figure from Shields (2011); sources expected more manufacturing jobs; 10 - Jobs figure from the Better Business Bureau, Lima (2016); 11 - Jobs figure from Muncey (2014); 12 - Jobs figure from Sanctis (2016); 600 more jobs are anticipated in 2018 as contracts with GM are implemented; 13 - Based on Balusik (2016); 14 - Estimate based on Linkhorn (2014): 100+100 out of 150 anticipated; more jobs may be added; 15 - Jobs figure from Caudill (2015); 16 - Jobs figure from Navera (2016); more may be added; 17 - Jobs figure from CIC of Henry Co. (2014); 18 - Jobs figure from RV Pro Staff (2016); additional jobs are anticipated; 19 - Total Ohio employment is 1,126; 20 - Jobs figure from 4-Traders.com (2016); 21 – Jobs figure from Sandusky Co. Economic Development Corp. (2016); 22 - Jobs figure from Pritchard (2014); 23 - Jobs figure from Wayne Co. Economic Development Corp. (2015); 24 - Jobs figure from Fulton Co. Economic Development Corp. (2016); 25 – Jobs figure from Bloomberg (2015); 26 – 1,200-plus will be furloughed from GM and 83 from Magna in the near future due to reduced demand (Staff, 2016); 27 – Jobs figure from Sakakibara (2016); 28 – Jobs figures from ODSA (2016).

See Table A1

Investment Announcements in Ohio's Motor Vehicle Industry, 2012-2015

Four-Year Totals: $5,807.7 Million; 10,716 Jobs



	2012	2013	2014	2015
Millions Planned	$849.8	$1,060.2	$813.8	$3,084.0
New Jobs Anticipated	2,076	1,946	3,297	3,397

Sources: Office of Research, ODSA; Priddle & Snavely

RECENT EXPANSION AND ATTRACTION ANNOUNCEMENTS

133 companies announced 185 major projects during the last four years. They planned to invest $5.8 billion in establishing new plants or expanding or updating existing ones, with 10,700 new jobs upon completion. The chart above shows the largest portion of these totals – $3 billion-plus and 3,400 new jobs – were announced in 2015; these figures are 53.1 and 31.7 percent of the corresponding totals.

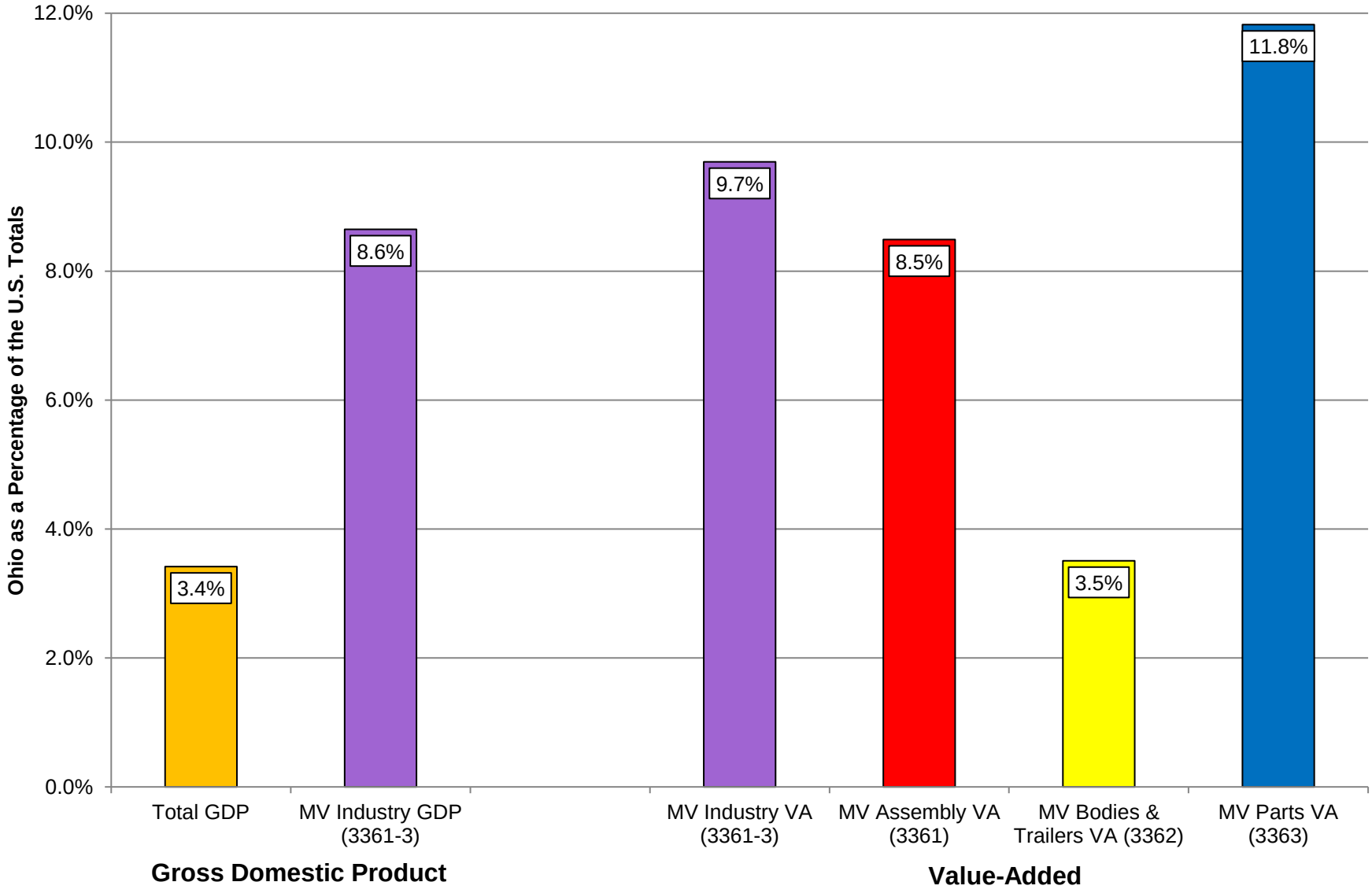
$4.83 billion, or 83.2 percent of the four-year total, was intended for the parts group (NAICS 3363) and related industries (automotive glass and batteries, plastic parts, paints, etc., specifically for motor vehicles); 9,950 new jobs – 89.1 percent of the total – were expected at these facilities. An additional $850 million was intended for assembly and chassis plants (3361), with 530 new jobs anticipated – 16.5 and 4.9 percent of the respective totals. The remaining $20.4 million was for establishments making bodies, trailers, motor homes and campers (3362), intending 636 jobs – 0.4 and 5.9 percent of the respective totals.

Assembly companies dominated the spending plans, although the vast majority of dollars were for parts their plants: Ford – $2.01 billion, Honda – $1.27 billion, General Motors (including its joint venture partner, Isuzu Motors) – $506.3 million, Navistar – $40.9 million, and FCA – $20.0 million; the combined total was $3.85 billion. Parts and related industries companies announcing investments of $50.0 million or more included Aisin Seiki's Advics, Bendix Commercial Vehicle Systems, Borgers USA, Fuyao Glass America (the largest at $360 million), Hirschvogel, Minth N. America, Mitsubishi Electric, Nissin Kogyo, Schaeffler Technologies' LuK (sic), and Stanley Electric. Fuyao planned hiring 1,550, followed by Honda at 530 (all but 150 of those at parts plants). Other companies anticipating at least 200 new jobs included Advics, Borgers USA, Faurecia, Imasen Bucyrus Technology, KTH Parts, Minth N. America, LuK, Navistar, and ThyssenKrupp's Bilstein.

These counts are part of the Ohio Private Investment Survey annually compiled by the Office of Research, Ohio Development Services Agency (2013b-2016b). A major project must meet one of three criteria: at least 20,000 square feet of new space, $1 million to be spent for land, buildings, or equipment, or 20 to 50 new jobs. Many of the planned expenditures are phased-in over a two-to-three-year cycle, with employees added after project completion. Planned investments are not comparable with annual capital expenditures discussed elsewhere in this report.

See Table A2

The Concentration of the Motor Vehicle Industry in Ohio
by Group, and Based on 2014 Dollar Values



Sources: U.S. Bureau of the Census, U.S. Bureau of Economic Analysis

THE CONCENTRATION OF THE INDUSTRY IN OHIO: GROSS DOMESTIC PRODUCT AND VALUE-ADDED

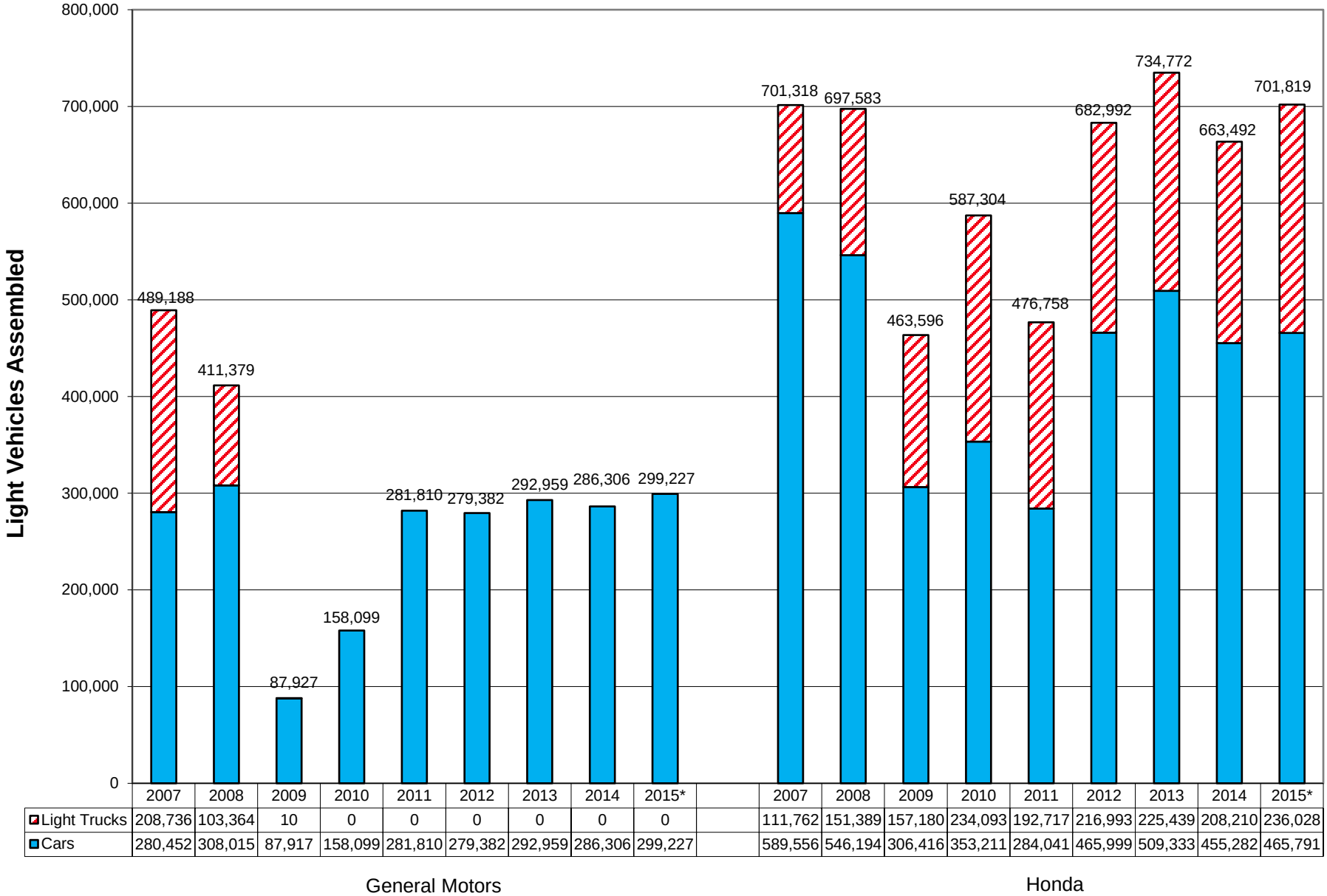
The chart above shows 8.6 percent of the U.S. motor vehicle industry's (NAICS 3361-3) net output in 2014 came from Ohio. By comparison, 3.4 percent of the net value of all goods and services produced and provided in America during 2014 originated in Ohio, according to the latest gross domestic product (GDP) figures from the U.S. Bureau of Economic Analysis (2016a). The greater portion of motor vehicle industry production here compared to total output indicates the concentration of the industry here.

Value-added (VA) data from the Census Bureau (2016a), also shown in the chart above, illustrate how the industry's concentration varied by group in 2014. While the overall concentration of the industry (3361-3) was 9.7 percent,[3] parts production (3363) was notably concentrated with Ohio's plants producing 11.8 percent of the national total. It was followed by assembly operations (3361) and body-and-trailer production (3362) with 8.5 and 3.5 percent of the corresponding national totals.

More-specific industry data, available only from the quinquennial Census of Manufacturers and listed in table A3, show greater variations in concentrations here. Based on the 2012 value-added figures, 21.0 percent of medium- and heavy-duty truck production (33612) in the U.S. originated in Ohio compared with 9.5 percent of the much larger volume of light vehicle output (33611, cars, vans, pick-ups and SUVs combined). (The former largely reflects output from Navistar's and PACCAR/Kenworth's two plants here.) More concentrated parts industries included stampings (33637), transmissions and power train parts (33635) and seating and interior trim (33636), which ranged from 17.1 to 12.8 of national totals. Other parts industries closer to the group average of 11.2 percent were electrical and electronic equipment (33632) and brake systems (33634). The remaining parts and related industries (3363p, 32621 and 335991) were more mildly concentrated in Ohio, ranging from 4.1 to 9.0 percent of national value-added.

See Table A3

A Nine-Year Summary of Light Vehicle Production in Ohio:
General Motors and Honda



	General Motors									Honda								
	2007	2008	2009	2010	2011	2012	2013	2014	2015*	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Light Trucks	208,736	103,364	10	0	0	0	0	0	0	111,762	151,389	157,180	234,093	192,717	216,993	225,439	208,210	236,028
Cars	280,452	308,015	87,917	158,099	281,810	279,382	292,959	286,306	299,227	589,556	546,194	306,416	353,211	284,041	465,999	509,333	455,282	465,791

Note: * - Initial, subject to revision. Sources: Automotive News & Ward's.

COMPANY SUMMARIES OF LIGHT VEHICLE PRODUCTION IN OHIO

The charts on the preceding and following pages illustrate light vehicle production in Ohio during the last nine years for the four high-volume light vehicle assemblers. Each had one or two assembly plants here in this time period. A summary of data on the charts indicates the severity of the recession: collective production of light vehicles in Ohio fell 55 percent from 1,748,000 in 2007 to 783,000 in 2009. Car and light truck production fell at nearly the same rate over the two years, although light trucks dropped first with the high gasoline prices of 2008, and cars followed in 2009. All four assemblers shared more or less in this production plunge. Production recovered to an estimated 1,619,000 in 2015, an increase of 106.6 percent from 2009, but still below the 2007 level.

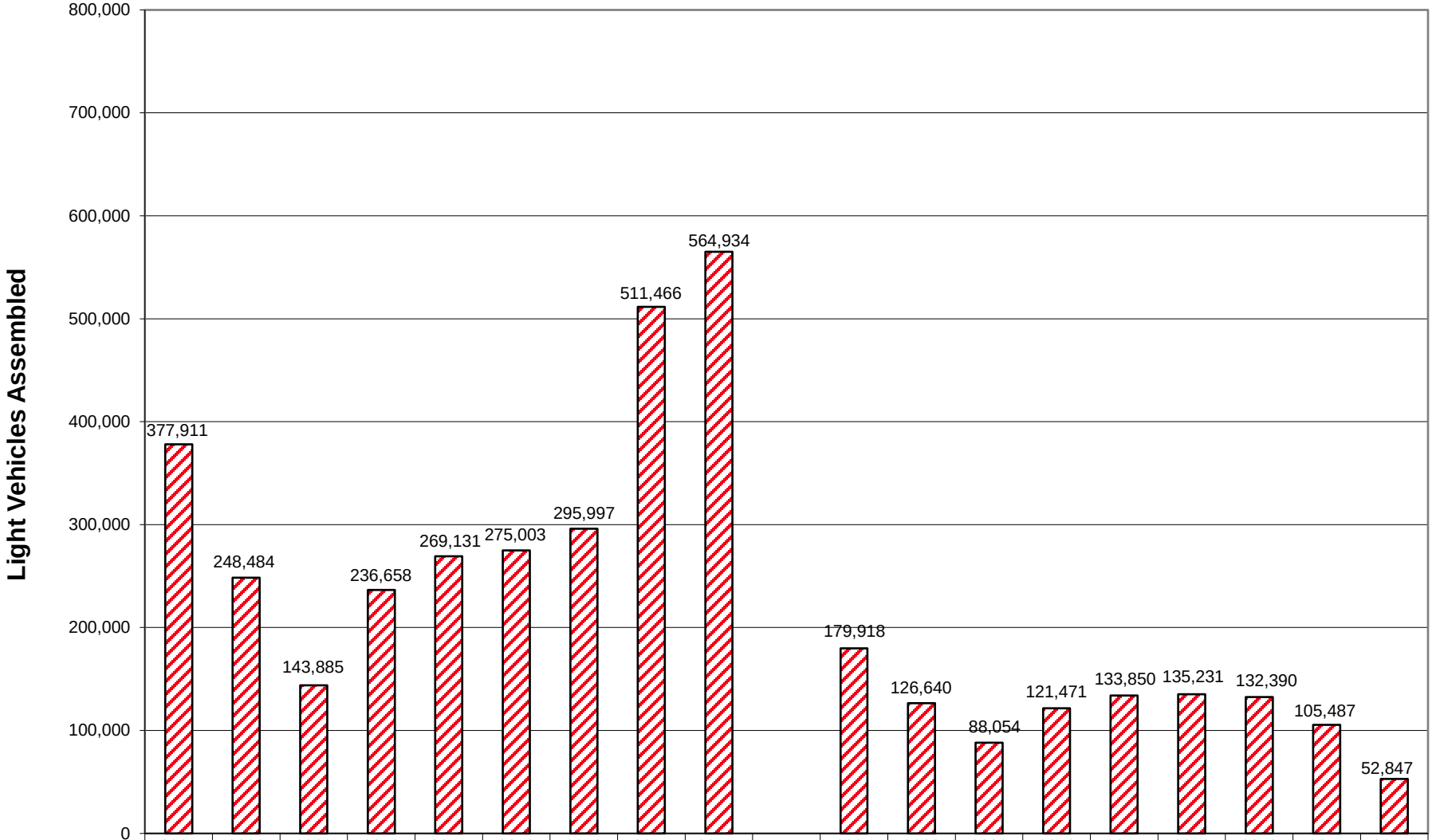
However, more than the recession and recovery affected company variations in assemblies. Honda, the highest-volume assembler in Ohio, saw combined production from its two plants fall by one-third (the least of the four companies) from 701,000 in 2007 to less than 464,000 in 2009. Production rose 26.7 percent to 587,000 the next year as part of the national economic recovery. However, 2011 output fell to less than 477,000 due to natural disasters in Japan and Thailand disrupting parts production. The constraints on Honda's production lasted into the first few months of 2012.

The summary car and light truck production figures mask more complex changes at Honda's plants. The E. Liberty plant now assembles only two sport-utility vehicles (SUVs) – more CR-Vs than Acura RDXs – after Civic production was transferred out of state in 2009, and Crosstour production terminated in 2015. (Element SUV production ended in 2011.) The Marysville plant has assembled only cars – mostly Accords with various near-luxury Acura models – after RDX production moved to E. Liberty in early 2012. Honda's year-to-date 2016 output is slightly less than comparable 2015 output, with production of most models a bit lower.

In contrast to Honda, GM's production fell 82 percent, from 489,000 to less than 88,000, but has recovered to 285,000-plus. The recession and high gasoline prices in 2008 – and the subsequent drop in demand for mid-size SUVs – were factors in the decision to officially close the Moraine plant in December. (It appears 10 vehicles were assembled in January, 2009, before it was permanently closed.) As with Honda, though, there is more to GM's drastic output drop than the impact of the recession. Car production in Lordstown increased by 27,000-plus to 308,000 in 2008 before plummeting to less than 88,000 in 2009. At least part of the drop could be due to the termination of the Pontiac G5 in preparation for the Cruze, which replaced the Cobalt in 2010. By 2011, production in Lordstown had returned to its pre-recession level and has since remained relatively steady. Year-to-date 2016 Cruze output is a higher than comparable 2015 output.

See Tables A4a and A11

A Nine-Year Summary of Light Vehicle Production in Ohio:
FCA and Ford



	FCA									Ford								
	2007	2008	2009	2010	2011	2012	2013	2014	2015*	2007	2008	2009	2010	2011	2012	2013	2014	2015*
Light Trucks	377,911	248,484	143,885	236,658	269,131	275,003	295,997	511,466	564,934	179,918	126,640	88,054	121,471	133,850	135,231	132,390	105,487	52,847
Cars	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: * - Initial, subject to revision. Sources: Automotive News & Ward's.

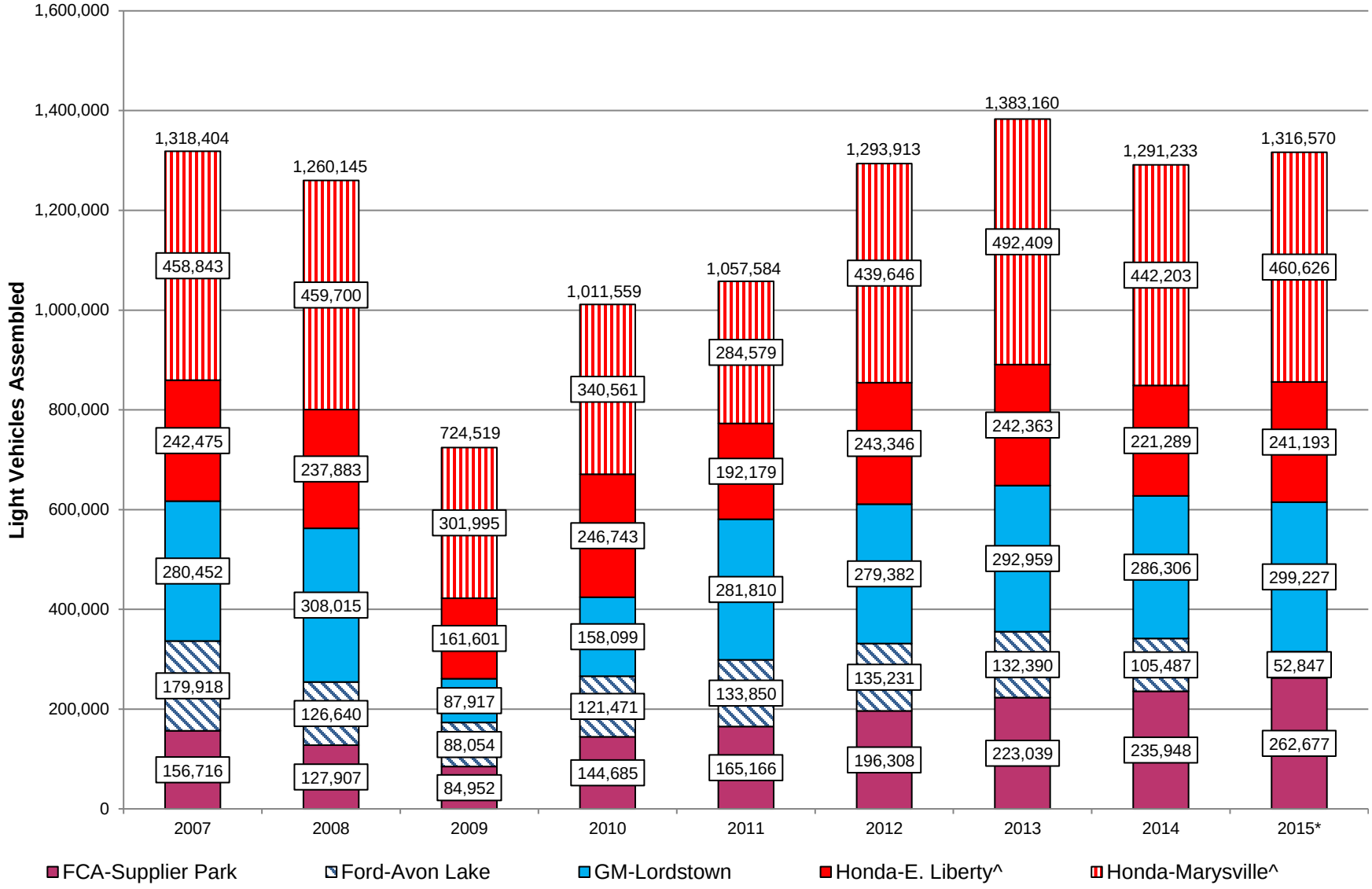
Fiat Chrysler Automobiles (FCA) and Ford made only light trucks in Ohio. FCA's SUV production fell 61.9 percent from almost 378,000 in 2007 to less than 144,000 in 2009. Production recovered to 275,000 in 2012, an increase of 91.1 percent from 2009, but still less than the pre-recession level of 2007. As with Honda, the summary figures do not convey the complicated changes at FCA's plants. Output from Supplier Park, which assembles Jeep Wranglers, surpassed the 2007 pre-recession mark by 2011 and passed 262,000 in 2015. This contrasts with production at Toledo North, which made the Dodge Nitro and the Jeep Liberty. Assemblies of Nitros and Liberties rose out of the 2009 recession trough, but FCA terminated Nitro production in December, 2011, and Liberty production in August, 2012, to retool the plant for Jeep Cherokee production, which started in June, 2013.[4] Cherokee production quickly surpassed the growing Wrangler production, topping 302,000 in 2015. Combined output from the Toledo complex with both parts operating full years reached 511,000 in 2014 and nearly 565,000 in 2015. However, year-to-date 2016 output is less than comparable 2015 output; production of all models is less.

Ford assembled Econoline vans at its Ohio Assembly plant in Avon Lake. Production fell 51 percent from nearly 180,000 in 2007 to 88,000 in 2009. Output rose in 2010, but plateaued in the 132,000-136,000 range for 2011-2013. Figures for those years are about three-quarters of 2007's production. Econoline production has since fallen because Ford shifted most of it out of state after June, 2014, as the plant re-tooled for medium-duty truck production, which began in 2015. Remaining Econoline production – still the largest part of Avon Lake's output, as judged by model counts – is focused on a smaller market segment. Year-to-date 2016 output is a bit higher than comparable 2015; Ford also started producing class 3-5 light- and medium-duty truck cabs in 2016.

Summary year-to-date 2016 light vehicle production in Ohio is a bit less than that of first-half 2015, as decreased light truck production more than offset increased car production.

See Table A4a

Light Vehicles Assembled in Ohio
at Plants Operating Throughout 2007-2015



Note: * - Initial, subject to revision; ^ - production constrained by floods in East Asia during 2011 and 2012. Sources: Automotive News, Wards

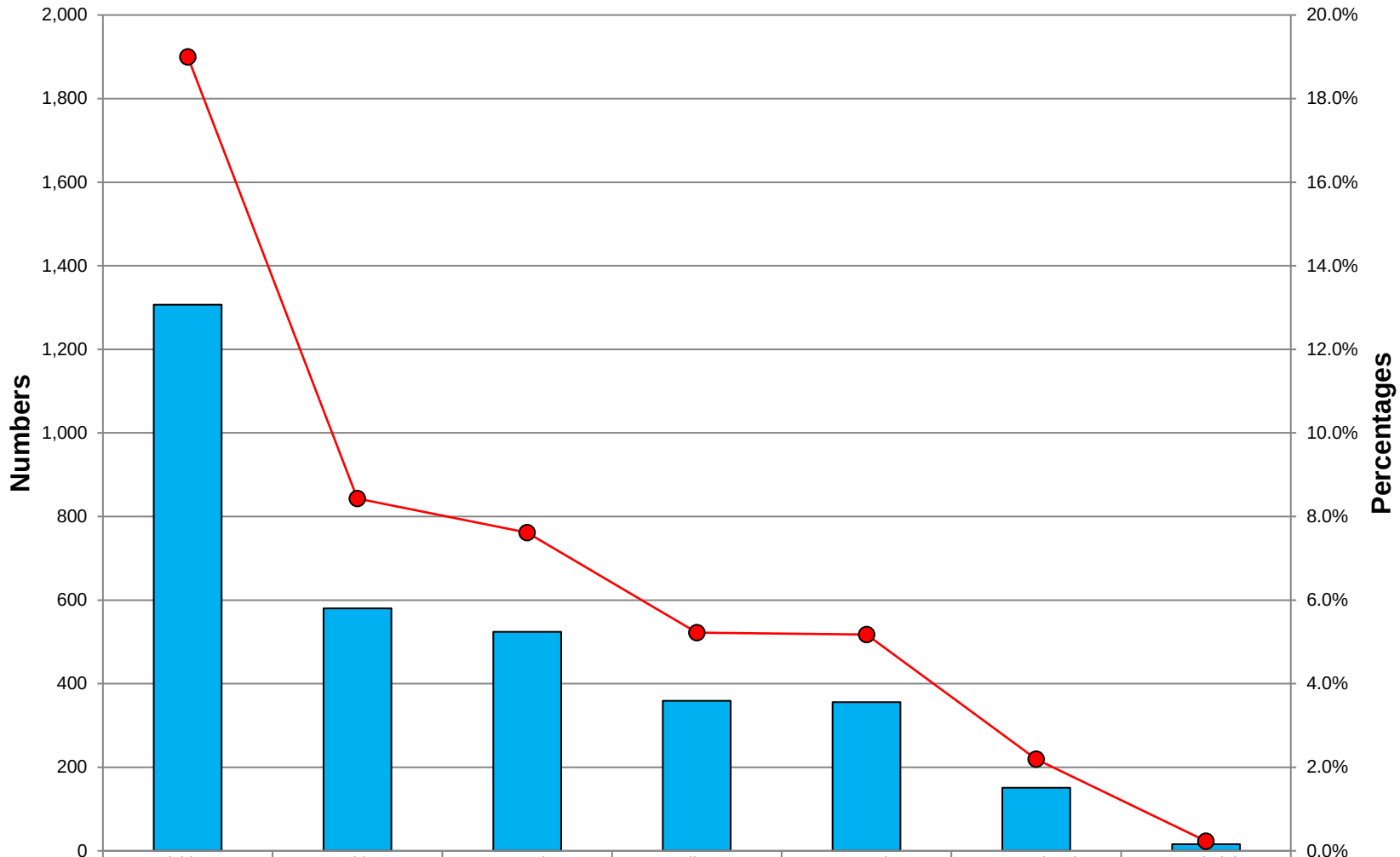
LIGHT VEHICLE ASSEMBLIES AT CONTINUOUSLY OPERATING PLANTS: 2007-2015

In one sense, the aggregate production figures in the preceding section lead to an overly negative conclusion regarding the recovery of the motor vehicle industry in Ohio. It is true total output in 2015 was still only 92.6 percent of output in 2007 (less than 1,619,000 vs. 1,748,000-plus), and the wind-down and closure of GM's Moraine plant beginning in 2008 undoubtedly had a substantial negative impact on the state's economy. However, a different picture of the industry and its recovery emerges when the focus is limited to those plants continuously operating from January, 2007, through December, 2015.

The chart above shows the annual light vehicle production in Ohio for each of the five high-volume assembly plants in continuous operation from 2007 through 2015 (i.e., excluding Moraine and Toledo North). The effect of the recession is still evident as aggregate output fell 45.0 percent from 1,318,000-plus in 2007 to less than 725,000 in 2009. However, aggregate output in 2013 was greater than that of 2007, which means that light vehicle production in Ohio had completely recovered from effects of the 2008-2009 recession and the 2011 East-Asian floods. Variations in 2014 and 2015 probably reflect the aggregate effects of planned changes by companies as well as merely fluctuating market demand. Although production in Ohio may never return to 1990s levels in the foreseeable future, it appears to have reached a new normal by 2012.

See Tables A4b and A11

Estimated Numbers and Percentages of Active Supply Plants
in Ohio and Bordering States and Provinces, 2016
N. American Total = 6,879



	Michigan	Ohio	Ontario	Indiana	Kentucky	Pennsylvania	W. Virginia
Number	1,307	580	524	359	356	151	16
Pct. of N.A.	19.0%	8.4%	7.6%	5.2%	5.2%	2.2%	0.2%

Source: ELM Analytics

PARTS SUPPLIERS

All assemblers either have their own parts plants (notably for powertrain and large-size stamped components) or deal with independent parts suppliers. ELM Analytics has information on nearly 6,900 such plants in N. America. They include tier-1 plants directly supplying assemblers as well as indirect suppliers (tier-2 plants making sub-assemblies; and tier-3 plants supplying raw materials). The chart illustrates the numbers and percentages of such plants in Ohio and bordering states plus Ontario. The seven collectively form a contiguous area with 47.9 percent of all suppliers in N. America. The estimated 580 establishments in Ohio – 8.4 percent of those in N. America – rank the state second in this group and the U.S.[5]

Some companies concentrate on supplying original equipment (OE) to assemblers. The larger include Delphi Automotive, Goodyear Tire & Rubber, Johnson Controls, Magna International, Superior Industries, Tenneco, Visteon and ZF TRW Automotive Holdings. Other OE companies, such as Allied Signal, Eaton, General Electric, 3M, PPG Industries, Textron, and United Technologies, have motor vehicle operations, but receive most of their revenue from outside of the motor vehicle industry. Some companies make parts that are more likely to be sold in the aftermarket (AM) as replacements; the larger include Cooper Tire & Rubber, Federal-Mogul and Meritor. This distinction is usually one of emphasis, as many produce goods for both markets, and most parts – tires are the big exception – are OE despite variations from one company to another (Haider, 2016; Miles, 2016; O'Hollaren, 2016; Peters, 2016; Petrillo, 2016. Many of these companies have establishments in Ohio and are found in the "Notable" section. The same diversity may characterize many of the smaller companies in ELM's database.

Parts companies survive by making a few specialized items requiring a high degree of skill, and doing so more efficiently than assemblers. Their ability to spread research, development, and equipment expenditures over several contracts – as well as selling their expertise to a number of assemblers – gives them a cost advantage over assemblers. They also are less likely to have a unionized labor force. Tier-1 companies try to maintain a diversified tier-2 and -3 supply base to ensure a steady flow of parts at competitive prices. However, assemblers and tier-1 companies have been occasionally willing to provide financial and managerial assistance to the latter to maintain timely parts production (Levy, 2014: 26-27).

OE sales tend to be cyclical because they follow the sales of new vehicles. AM sales have been affected by two countervailing trends: the improved durability of OE has depressed demand more than the in-recession tendency of owners to keep and repair vehicles instead of purchasing new ones (Levy, 2014: 27).

The role of tire makers in the industry is often discussed separately from other parts makers. AM sales constitute the vast majority of tires sales, and are the more profitable segment on a per-unit basis. Despite the lower profit margins of OE sales, though, OE sales are important for several reasons. OE sales help AM sales because owners tend to replace tires

with the same brand. In turn, this means a larger market share than could be attained in the AM alone, and greater economies of scale reduce per-unit operating costs, distribution and advertising expenses (Levy, 2014: 28).

The tire industry is highly capital intensive. Research and development efforts, production technology, and operations are very expensive. Consequently, the industry is dominated by a small number of vertically integrated giants; Bridgestone, Goodyear, and Michelin together account for about one-half of worldwide tire production. (The vertical integration does not extend into distribution and retail sales. Other large companies dominate this part of the business.) The tire industry consolidated long ago to become a global industry. Foreign–based manufacturers now own a substantial portion of U.S. domestic capacity. Goodyear and Cooper are the only two publically-traded tire companies with U.S. headquarters (Levy 2014: 12).

Cost pressures and the increased number of niche markets compelled the giants to adopt flexible manufacturing techniques. These more sophisticated processes allow producers to economically meet customers' specifications. Global tire makers also pursue technical improvements in their products as a means of drawing attention in a competitive market (Prat, 1998). Tires have indeed become better at resisting wear according to the National Highway Traffic Safety Administration. Consumers can search the Administration's website starting at http://www.safercar.gov/.

The remainder of the motor vehicle-related rubber industry includes belts, hoses, motor mounts, bushings, window and door moldings, seals, etc., and their circumstances and fortunes are quite like other parts makers (Levy, 2014: 28).

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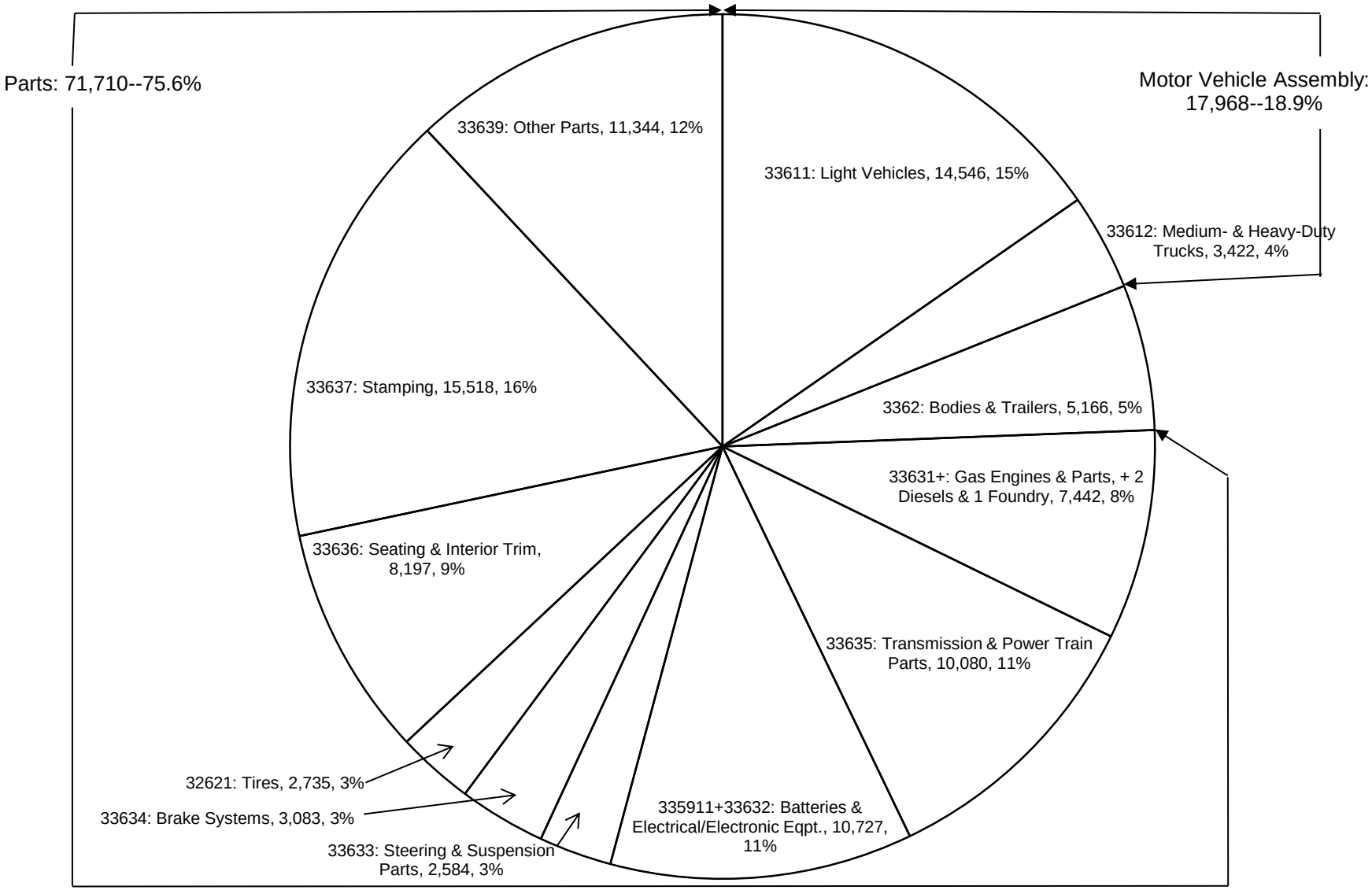
Employment in Ohio's Motor Vehicle Industry
Estimated Total, 2014: 94,844--100%



Sources: Company websites, ODSA, & U.S. Census Bureau

THE COMPOSITION OF OHIO'S MOTOR VEHICLE INDUSTRY – EMPLOYMENT AT THE PLANTS

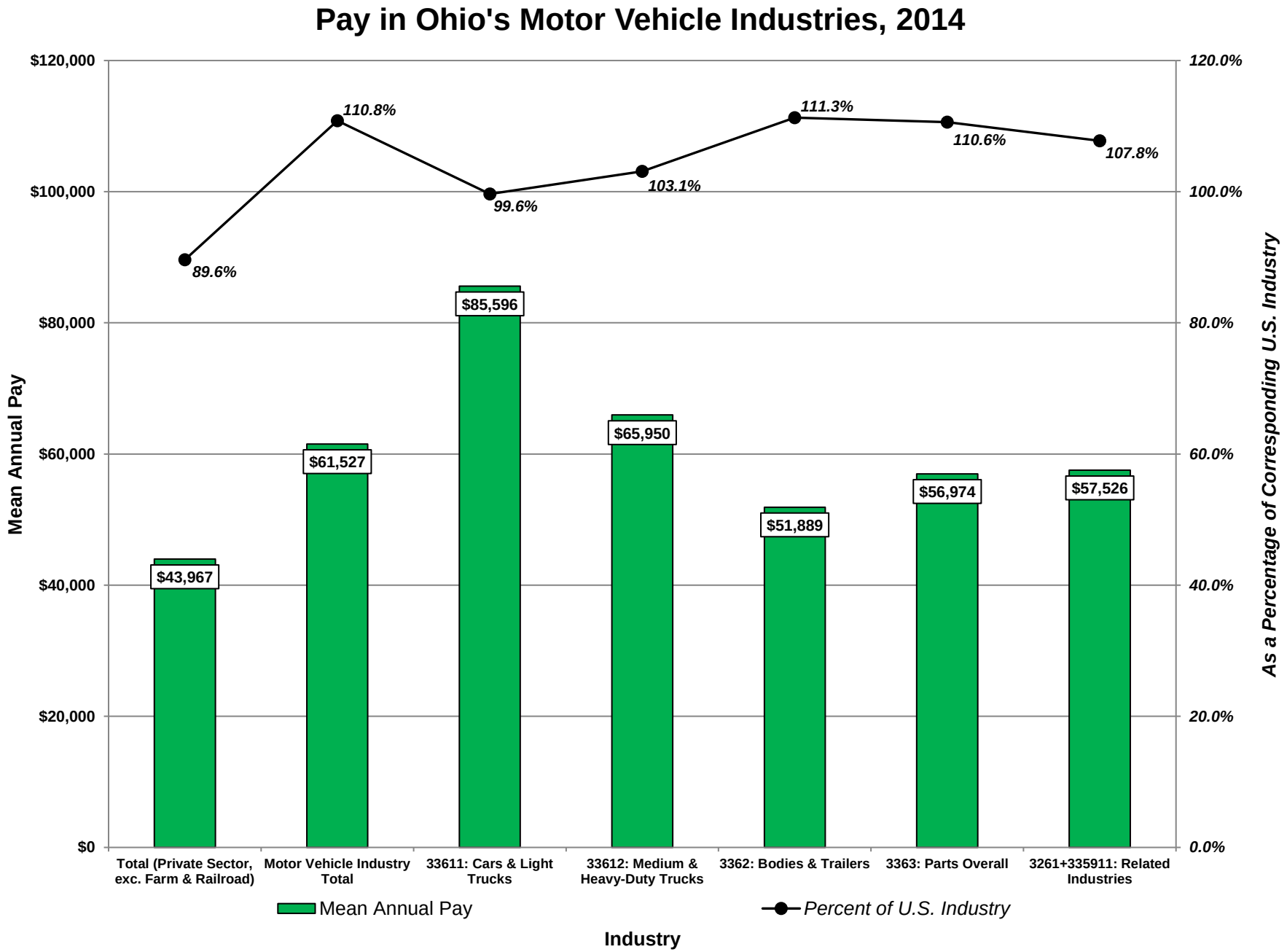
The latest detailed data from the Census Bureau's County Business Patterns (CBP), combined with figures from other sources, lead to an estimated 94,800-plus people working in Ohio's motor vehicle industry. The chart above illustrates the distribution of employment by industry segment. 17,900-plus, or 18.9 percent, worked at assembly plants (NAICS 3361), with about 14,500-plus – 15.3 percent – in the light vehicle subgroup (33611) and 3,400-plus – 3.6 percent – at establishments assembling buses and medium-to-heavy-duty trucks (33612). The 5,100-plus producing bodies, trailers, motor homes and campers (3362) were 5.4 percent of the industry total.

71,700, or 75.6 percent, worked in parts industries including tires, storage batteries, and those employed at a foundry and two diesel engine plants (3363, 32621, 335911, 33151 and 333618, respectively).[6] Stamping (33637) was the largest industry within the parts group: 15,500 jobs, or 16.4 percent of the motor vehicle industry total. It was followed by the combination of electrical and electronic equipment with storage batteries (335911 & 33632), 10,700 – 11.3 percent, transmission and power train parts (33635), 10,000-plus, and other motor vehicle parts (33639), about 11,300 – 12.8 percent. The only other subgroups employing at least 7,000 people were engines and components (including the foundry and two diesel plants) – 7.8 percent, and seating and interior trim – 8.6 percent.

Light vehicle assembly plants are the largest in the industry, averaging 900 employees each, followed by medium- and heavy-duty truck plants at 380. These averages incorporate the dichotomies between the high-volume plants, all but one of which employ at least 2,000 people in Ohio, and the much smaller, specialized operations serving niche markets (e.g., customized cars, stretch limos, rescue vehicles, mobile facilities, fire engines, concrete mixers, etc.). A similar dichotomy may characterize new-tire plants (326211). The smallest plants in the industry typically are those manufacturing bodies, trailers, etc. (3362) and retreading tires (326212), while battery and parts plants (335911 and 3363) frequently employ between 100 and 400. However, parts plants owned by high-volume assemblers often employ more than 1,000.

Comparisons with national figures (based solely on CBP) point to specific industry concentration here. Overall motor vehicle industry employment is concentrated in Ohio, with 10.6 percent of the national industry's workers here. By comparison, 3.8 percent of all employees in the nation (excluding those on farms, at railroad companies, and in government) worked in Ohio. The overall concentration is driven by specific industries especially concentrated here: medium- and heavy-duty trucks, electrical and electronic equipment, brake systems, transmission and power trains, seating and interior trim, and stamping. The concentration of employment closely corresponds with the concentration of value-added.

See Tables A1, A3 & A5



Source: U.S. Census Bureau, 2016

INDUSTRY WAGES

Census Bureau County Business Patterns data charted above show that employees in Ohio's motor vehicle industry were estimated to have averaged about $61,500 in wages and salaries. This figure is 110.8 percent of the corresponding national average, and over $17,500 above the average for all private sector employees in Ohio (again excluding the agricultural sector and railroad transportation industry). There is considerable variation within the industry: work at light vehicle assembly plants (33611) paid $85,600 per year, while work in medium- and heavy-truck plants (33612) averaged just under $66,000. Bodies and trailers (3362) paid about $51,900, and parts (3363) averaged just under $57,000. People working in the related tires and batteries cluster averaged more than $58,500. All of these specific segment averages equaled or modestly exceeded corresponding national averages.

Data in Appendix table A6 show there was substantial variation between the individual industries within the parts group. On one hand, electrical/electronic equipment paid almost $72,600, followed by transmissions and powertrain parts with $69,900 and gasoline engines and components close to $67,900. On the other hand, employees in seating and interior trim were paid less $41,100. One possible explanation for the higher wages in engine and transmission plants is that a large portion of employment is at subdivisions of high-volume assemblers, while those in other groups are less likely to work for assemblers.

See Table A6

Ohio

Number of Establishments in Ohio's Motor Vehicle Industry

Statewide: 580

Establishments in County

- None
- 1 - 4
- 5 - 9
- 10 - 19
- 20 - 60

Sources:
2014 County Business Patterns,
U.S. Census Bureau and various
private sector publications

Prepared by: Office of Research,
Ohio Development Services Agency
December 2016

R082316A

THE DISTRIBUTION OF INDUSTRY ESTABLISHMENTS ACROSS OHIO

The motor vehicle industry is widely distributed across Ohio. The latest available data, mapped above, show 580 establishments[7] in 78 counties. However, the majority of establishments could be found in 15 counties: Cuyahoga – 60, Montgomery – 33, Franklin – 28, Lucas – 26, Summit – 24, Lorain – 17, Hancock, Stark and Wayne – 16 each, Medina and Trumbull – 15 each, and Clark and Hamilton – 13 each. Five more counties each had 10 to 12 establishments: Lake, Richland, Shelby, Williams and Wood. Twenty-six counties had from five to nine establishments, and 34 had from one to four.

It is interesting to note that the seven counties with the eight high-volume assembly plants – Clark, Logan, Lorain, Lucas, Ross, Trumbull, and Union – had a total of 81 industry establishments. This is a larger-than-proportional count (an average of 11.6 each compared to 6.2 for the other 81 counties), and 14.0 percent of the state total, but far from the majority.

See Table A7

Ohio

Total Employment in Ohio's Motor Vehicle Industry Statewide: 94,844

Employment in County

- None
- 1 - 499
- 500 - 1,249
- 1,250 - 3,999
- 4,000 - 7,850

Sources:
2014 County Business Patterns,
U.S. Census Bureau and various
private sector publications

Prepared by: Office of Research,
Ohio Development Services Agency
December 2016

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THE DISTRIBUTION OF INDUSTRY EMPLOYMENT ACROSS OHIO

The map above shows the distribution of motor vehicle industry employment by county. The seven counties with high-volume assembly plants – Clark, Logan, Lorain, Lucas, Ross, Trumbull, and Union – had 81 industry establishments (14.0 percent of the total), but 29,100-plus industry jobs (31.0 percent of the total). High-volume assembly plants are large employers and may support a number of parts or related industries jobs close by. Counties fitting this pattern included Lucas (well over 7,300 jobs, with around 3,500 at the assembly plants at the time), and Trumbull (8,700-plus with about 4,000 at the assembly plant at the time).

The other assembly-plant counties have fewer industry jobs, but border counties that have large numbers of parts employees. Almost all of the 3,300-plus jobs in Union were at the plant, with around 1,400 parts jobs in Franklin and 1,700-plus in Madison. In Logan, the substantial majority of the 3,200 jobs were at the assembly plant, with 3,000 parts jobs in Shelby. In Lorain, close to 1,900 of the 2,900-plus jobs were at the assembly plant, with 4,700-plus parts jobs in Cuyahoga. One thousand of the 1,900 jobs in Clark were at the assembly plant, with 4,000 parts jobs in Montgomery. Note Lucas also fits this pattern with 1,200-plus and 2,600 parts jobs in Fulton and Wood, respectively. Ross is the exception to this pattern; approximately 2,000 of its 2,500 total were at the plant, but no bordering county had at least 500 parts jobs.

Other counties that had large numbers of parts, bodies-and-trailer and/or related industries jobs were Allen – 1,500-plus (including a Ford engine plant), Butler – 1,300, Champaign – about 1,400; Defiance – nearly 2,200 (including a GM foundry), Erie – 1,300, Hamilton – 2,400 (including a Ford transmission plant), Hancock – well over 4,800 (including Cooper Tire & Rubber), Licking – 1,300-plus, Richland – 1,600-plus, Sandusky – 1,000, Summit – 1,100 (excluding Goodyear's headquarters), Warren – well over 1,900, and Wayne – 2,900-plus.

Trumbull had the largest number of total industry jobs – about 7,800-plus, followed by Lucas with 7,300-plus. Six counties had between 3,000 and 5,000: Cuyahoga, Hancock, Logan, Montgomery, Shelby and Union. Seven counties had between 2,000 and 3,000: Defiance, Franklin, Hamilton, Lorain, Ross, Wayne and Wood. These 15 counties combined for 60.8 percent of the industry jobs in Ohio. Thirteen counties had between 1,000 and 2000, 17 counties had between 500 and 1,000 jobs, and 33 counties had between 1 and 500.

See Table A7

FOREIGN INVESTMENT IN OHIO

More than 90 foreign-based companies have subsidiaries and/or joint ventures in Ohio's motor vehicle industry; 11 of them are on Fortune's Global 500 list. The following list identifies them, the countries where the home offices are located, their subsidiaries in Ohio, and the total number of employees in the state. Sometimes the arrangements are complex, as evidenced by Honda's subsidiaries and affiliates in Ohio. The affiliates may be partially owned by the Honda Motor Co., a joint venture between it and other companies, or they may be independent but have Honda as their principal customer.

Foreign Parents	Country	Ohio Subsidiaries ^	Assembly-plus or Parts Only	Total Jobs~
Aisin Seiko Co., Ltd.	Japan	ADVICS Mfg. Ohio, Inc.	Parts Only	700
Amtek Auto Ltd.	India	Tekfor, Inc.	Parts Only	250
Aoki Holdings, Inc.	Japan	Aoki Mfg. Columbus, Inc.	Parts Only	40
ArcelorMittal SA*	Luxembourg	ArcelorMittal Tailored Blanks	Parts Only	110
Asahi Glass Co., Ltd.	Japan	(total)		600
		AGC Automotive N. America, Inc.	Parts Only	485
		Belletech Corp.	Parts Only	115
Autoneum Holding AG	Switzerland	Autoneum N. America, Inc.	Parts Only	450
Borgers AG	Germany	Borgers Ohio, Inc.	Parts Only	90
Daimler AG*	Germany	Detroit Diesel Re-Mfg. East	Parts Only	490
Delphi Automotive plc	United Kingdom	Delphi Automotive LLP	Parts Only	620
Dia Seiko Co., Ltd.-ABC Group (JV)	Japan-Canada	ABC Inoac Exterior Systems LLC	Parts Only	480
Eaton Corp. plc	Ireland	Eaton Corp.	Parts Only	150
Fehrer Enterprise Corp.	China (Taiwan)	NC Works, Inc.	Parts Only	30
Feintool International Holding AG	Switzerland	Feintool Cincinnati, Inc.	Parts Only	300
Fiat Chrysler Automobiles NV*	U.K.-Netherlands	FCA US LLC	Assembly-plus	6,200
Fine Sinter Co., Ltd.	Japan	American Fine Sinter Co., Ltd.	Parts Only	125
F-Tech, Inc.	Japan	F&P America Mfg., Inc.	Parts Only	690
Fuserashi Co., Ltd.	Japan	Fuserashi Intl. Technology, Inc.	Parts Only	65
Fuyao Glass Industry Group Co., Ltd.	China	Fuyao Glass America, Inc.	Parts Only	1,400
GKN plc	United Kingdom	GKN Driveline N. America, Inc.	Parts Only	190
GS Electech, Inc.	Japan	GSW Mfg., Inc.	Parts Only	300
G-Tekt Corp.	Japan	Jefferson Industries Corp.	Parts Only	750
Hayashi Telempu Co., Ltd.	Japan	Hayashi Telempu N. America Corp.	Parts Only	250
Hirschvogel Holding GmbH	Germany	Hirschvogel, Inc.	Parts Only	325
Hitachi Ltd.*	Japan	AAP St. Mary's Corp.	Parts Only	525
Hoerbiger Stiftung	Switzerland	Altronic LLC	Parts Only	150
Honda Motor Co., Ltd.*	Japan	(total)		12,290
		AY Mfg. Ltd.	Parts Only	175
		Cardington Yutaka Technologies, Inc.	Parts Only	725
		Celina Aluminum Precision Technology, Inc.	Parts Only	550
		Honda of America Mfg., Inc.	Assembly-plus	9,116

Foreign Parents	Country	Ohio Subsidiaries ^	Assembly-plus or Parts Only	Total Jobs~
Honda Motor Co., Ltd.* (continued)				
		Honda Engineering N. America, Inc.[1]		350
		Honda Transmission Mfg. of America, Inc.	Parts Only	1,150
		US Yachiyo, Inc.	Parts Only	170
Honda affiliates:		(total)		6,125
Autoliv, Inc.*-Nissin Kogyo Co., Ltd. (JV)	Sweden-U.S.-Japan	(subtotal)		1,020
		Autoliv Nissin Brake Systems	Parts Only	455
		Nissin Brake Ohio	Parts Only	565
KTH Parts Industries, Inc.	Japan	(subtotal)		1,650
		Kalida Mfg., Inc.	Parts Only	500
		KTH Parts Industries, Inc.	Parts Only	1,150
Nihon Plast Co. Ltd.	Japan	Neaton Auto Parts Mfg., Inc.	Parts Only	1,100
Tanaka Seimitsu Kogyo Co., Ltd.	Japan	FT Precision, Inc.	Parts Only	400
Toyo Denso Co., Ltd.	Japan	Weastec, Inc.	Parts Only	165
TS Tech Co., Ltd.	Japan	(subtotal)		1,190
		TriMold LLC	Parts Only	230
		TS Tech USA Corp.	Parts Only	360
		TS Trim Industries, Inc.	Parts Only	600
Yamada Mfg. Co., Ltd.	Japan	Yamada N. America, Inc.	Parts Only	600
Howa Textile Industry Co., Ltd.	Japan	American Howa Kentucky, Inc.	Parts Only	135
Hyundai Mobis Co., Ltd.*	S. Korea	Mobis NA LLC[2]	Parts Only	500
Ikeda Mfg. Co., Ltd.	Japan	Sunfield, Inc.	Parts Only	100
Imasen Electric Industrial Co., Ltd.	Japan	Imasen Bucyrus Technology, Inc.	Parts Only	220
Intl. Automotive Components Group SA	Luxembourg	IAC Group N. America, Inc.	Parts Only	2,225
Isuzu Motors Ltd.-General Motors Co.* (JV)	Japan-U.S.	DMAX Ltd.	Parts Only	576
Johnson Electric Holding Ltd.	China (Hong Kong)	Johnson Electric	Parts Only	450
Kaneta Kogyo Co., Ltd.	Japan	Bucyrus Precision Tech, Inc.	Parts Only	270
Kasai Kogyo Co., Ltd.	Japan	Kasai N. America, Inc.	Parts Only	540
Keihin Corp.	Japan	Keihin Thermal Technology of America, Inc.	Parts Only	355
Kirchhoff Holding GmbH & Co. KG	Germany	Kirchoff Van-Rob, Inc. (aka VR)	Parts Only	580
Knott GmbH	Germany	Knott Brake Co.	Parts Only	90
Kongsberg Automotive Holding ASA	Norway	Kongsberg Automotive	Parts Only	70
Kuka AG	Germany	Kuka Toledo Production Operations LLC[2]	Parts Only	250
Magna Intl., Inc.*	Canada	(total)		2,130
		Magna Cosma Intl. (aka Vehtek)	Parts Only	420
		Magna Decoma Intl.	Parts Only	200
		Magna Seating of America, Inc.	Parts Only	380
		Norplas Industries, Inc. (aka Magna Exteriors)	Parts Only	1,100
Magna Intl., Inc.*-Grammar AG (JV)	Canada-Germany	Gra-Mag Truck Interior Systems LLC	Parts Only	30
Mahle GmbH	Germany	(total)		1,450
		Mahle Behr Dayton LLC	Parts Only	1,300
		Mahle Engine Components USA, Inc.	Parts Only	115
Matsu Mfg., Inc.	Canada	Matsu Ohio, Inc.	Parts Only	120

Foreign Parents	Country	Ohio Subsidiaries ^	Assembly-plus or Parts Only	Total Jobs~
Miba AG	Austria	Miba Bearings US LLC	Parts Only	305
Mitec Automotive AG	Germany	MITEC Powertrain, Inc.	Parts Only	30
Mitsubishi Corp.*	Japan	Mitsubishi Electric Automotive America, Inc.	Parts Only	550
Moriroku Holdings Co.	Japan	Greenville Technology, Inc.	Parts Only	770
Motherson Sumi Systems Ltd.	India	MSSL Wiring Systems, Inc.	Parts Only	100
Muro Corp.	Japan	Murotech Ohio Corp.	Parts Only	130
Nagata Co., Segawa Co. & Marubeni Corp. (JV)	Japan	Ohio Metal Technologies, Inc.	Parts Only	70
Nihon Tokeshu Toryo Co., Ltd.	Japan	UGN, Inc.	Parts Only	150
Nippon Seiki Co., Ltd.	Japan	New Sabina Industries, Inc.	Parts Only	400
OC Oerlikon Corp. AG	Switzerland	Oerlikon Metco	Parts Only	185
Ohashi Technica, Inc.	Japan	Ohashi Technica USA, Inc.	Parts Only	20
Okamoto Industries	Japan	Okamoto Sandusky Mfg. LLC	Parts Only	100
Pacific Industrial Co., Ltd.	Japan	(total)		542
		Pacific Industries USA, Inc.	Parts Only	12
		Pacific Mfg. Ohio, Inc.	Parts Only	530
Peugeot SA*	France	Faurecia USA Holdings, Inc.	Parts Only	870
Pioneer Corp.	Japan	Pioneer Automotive Technologies, Inc.	Parts Only	175
Qingdao Sunsong Co., Ltd.	China	Harco Mfg. LLC	Parts Only	100
Rank Group Ltd.	New Zealand	FRAM Group Operations LLC	Parts Only	415
Robert Bosch GmbH*	Germany	Robert Bosch Battery Systems	Parts Only	56
Röchling SE & Co. KG	Germany	Roechling Automotive Corp. USA LLP	Parts Only	110
Roki Holdings Co., Ltd.	Japan	Roki America Co., Ltd.	Parts Only	355
S&T Motiv Co., Ltd.	S. Korea	S&T Automotive America	Parts Only	80
Sankei Giken Co., Ltd.	Japan	Newman Technology, Inc.	Parts Only	820
Sankyo Kogyo Co., Ltd.	Japan	SK Tech, Inc.	Parts Only	100
Sanoh Industrial Co., Ltd.	Japan	Sanoh America, Inc.	Parts Only	570
Schaeffler Technologies GmbH & Co. KG	Germany	LuK-Schaeffler Group USA, Inc.	Parts Only	1,770
Showa Corp.	Japan	American Showa, Inc.	Parts Only	1,125
Stanley Electric Co., Ltd.	Japan	Stanley Electric US Co., Inc.	Parts Only	1,270
Tachi-S Co., Ltd.-Johnson Controls, Inc.* (JV)	Japan-U.S.	Setex, Inc.	Parts Only	450
Taiho Kogyo Co., Ltd.	Japan	Taiho Corp. of America	Parts Only	120
Temasek Holdings Ltd.	Singapore	Kidron Metal Products	Parts Only	200
TFO Corp.	Japan	TFO Tech Co., Ltd.	Parts Only	140
ThyssenKrupp AG*	Germany	ThyssenKrupp Bilstein of America, Inc.	Parts Only	210
Tokai Kogyo Co., Ltd.	Japan	Green Tokai Co., Ltd.	Parts Only	570
Tokai Rubber Industries Ltd.	Japan	DTR Industries, Inc.	Parts Only	610
Toyobo Co., Ltd.	Japan	Toyobo Kureha America Ltd.	Parts Only	40
Tremcar Technologies, Inc.	Canada	Tremcar USA, Inc.	Parts Only	140
USUI Kokusai Sangyo Kaisha Ltd.	Japan	USUI Intl. Corp.	Parts Only	270
Valeo SA	France	Valeo Thermal Systems	Parts Only	325
Windsor Mold, Inc.	Canada	(total)		390
		Autoplas, Inc.	Parts Only	200
		Precision Automotive Plastics	Parts Only	190

Foreign Parents	Country	Ohio Subsidiaries ^	Assembly-plus or Parts Only	Total Jobs~
Wanxiang Group Corp.	China	Powers & Sons LLC	Parts Only	230
Yanagawa Seiki Co., Ltd.	Japan	YSK Corp.	Parts Only	180

Abbreviations, notes and sources: aka – also known as; JV – a joint venture between at least two companies; Intl. – International; Mfg. – Manufacturing; ^ – some subsidiaries are included because a most their output is used by the motor vehicle industry even though their NAICS codes indicate otherwise; ~ – with few exceptions, job figures are from the Office of Research, ODSA (2016a); * – a Fortune Global 500 company; Fiat Chrysler Automobiles (originally an Italian company now incorporated in the Netherlands with official headquarters in the United Kingdom) is not actually on Fortune's list, but it has sufficient revenue to be included; General Motors and Johnson Controls are on Fortune's U.S.-1,000 list, as is Autoliv, a Swedish-headquartered company incorporated in the state of Delaware; 1 – Honda's in-house supplier of equipment used in its assembly plants; 2 – integrated with the FCA US LLC Toledo assembly complex; 3 – jobs figure from Sakakibara (2016),

The companies listed above collectively may be credited with approximately 58,200 employees in Ohio.[8] Honda is the largest foreign-based company in the state's motor vehicle industry with nearly 12,300 its manufacturing facilities, with a collective 6,100-plus at its affiliates. (Additional people are employed at Honda's non-manufacturing facilities.) Fiat Chrysler Automobiles (FCA) is the second largest foreign-based employer with 6,200 at its Toledo assembly Perrysburg machining plants combined. Other foreign-based companies with at least 1,000 workers in Ohio include the Autoliv-Nissan Kogyo joint venture, Fuyao Glass, the International Automotive Components Group, KTH Parts, Magna International, Mahle, Nihon Plast, Schaeffler Technologies, Showa, Stanley Electric and TS Tech. Except for Honda and FCA, the companies listed above manufacture only parts or components. None manufactures trailers, etc. (NAICS code 3362) or tires (32621) for mass-market vehicles, although Bridgestone employs about 70 making racing tires in Akron (Mackinnon, 2016); one produces batteries (335911) and one, a Pacific Industrial subsidiary, makes tire values.

The foreign parent companies have headquarters in 16 nations. Fifty-two are located in Japan, 13 in Germany, five each in Canada and China (incorporating Hong Kong and Taiwan), four in Switzerland, three in the United Kingdom (U.K.), two each in France, India, Luxembourg and South Korea, and one each in Austria, Ireland, New Zealand, Norway, Singapore and Sweden. Although exact numbers are difficult to ascertain[9], it appears that Japanese-based companies account for around 33,300 jobs – 57.2 percent of all foreign-based company employment related to Ohio's motor vehicle industry. The U.K. collection, which includes FCA, accounts for 7,000, or 12.1 percent; German companies account for 5,400-plus, or 9.3 percent; and Canadian companies account for about 3,000, or 5.2 percent.

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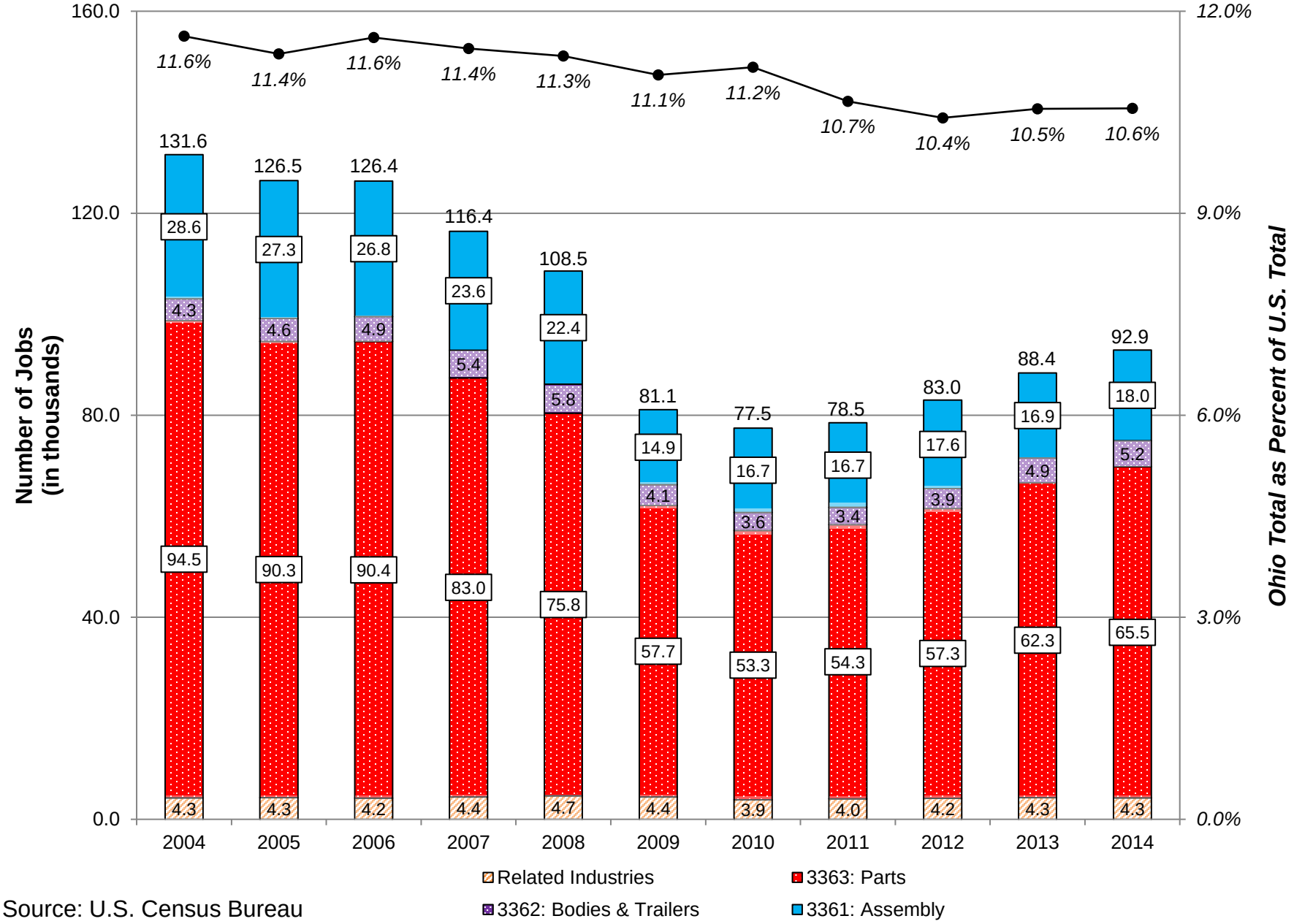
TRENDS

Employment Trends in Ohio's Motor Vehicle Industry: 2004-2014



Source: U.S. Census Bureau

EMPLOYMENT

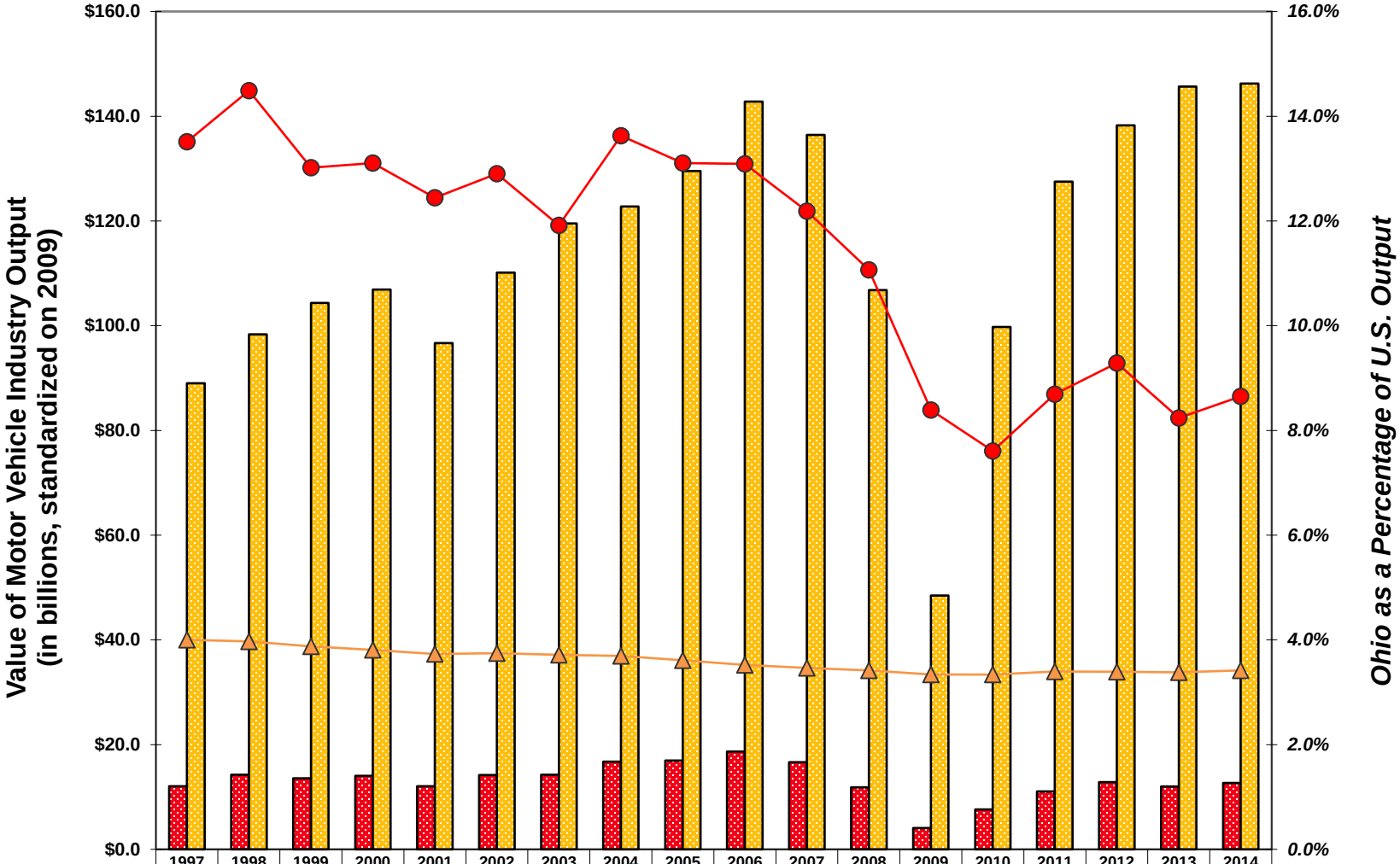
The chart above shows employment in Ohio's motor vehicle industry fell 41.1 percent from 131,600 in 2004 to 77,500 in 2010. The biggest drop occurred from 2008 to 2009 when 27,400 jobs were lost. Employment has since risen 18.8 percent from the depth of the recession to 92,900 in 2014.[10] However, the net loss of 38,700 jobs in 10 years is a 29.4 percent decrease. This overall loss reflects declines in the two largest groups: 29,000 in parts (3363) and 10,600 in assemblies (3361) – decreases of 30.7 and 37.1 percent, respectively. This contrasts with the related industries of tire and battery production, which showed no aggregate net change, and bodies and trailers (3362), which saw a net gain of 900 jobs. Detailed data in Appendix table A8 show job losses occurred in light vehicle assembly (33611), but not medium- and heavy-duty truck assembly (33612), and in six of the eight parts industries, with electrical and electronic equipment (33632) and seating and interior trim (33636) the exceptions.[11] One reason industry employment has not returned to pre-recession levels in most industries is operators have improved productivity through automation and streamlined production processes (Miles, 2016).

The chart above also illustrates Ohio's overall industry employment figures as percentages of the corresponding national totals. The 131,600 employees in 2004 were 11.6 percent of the U.S. total, and the 77,500 in 2010 were 11.2 percent. The nearly constant percentages while employment changed so dramatically mean that what happened in Ohio was generally part of what happened across the country.

Employment in Ohio's motor vehicle industry in 2015 grew by approximately 3.8 percent from 2014 according to preliminary data from the U.S. Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages. Additions in the parts and bodies and trailers groups more than offset a slight decrease at assembly plants, while employment in the tire industry was virtually unchanged. Motor vehicle industry employment also increased across the country at about the same rate.

See Table A8

Motor Vehicle Industry (NAICS 3361-3363) Output and Its Concentration in Ohio, 1997-2014



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Ohio MV Output	$12.0	$14.3	$13.6	$14.0	$12.0	$14.2	$14.2	$16.7	$17.0	$18.7	$16.6	$11.8	$4.1	$7.6	$11.1	$12.8	$12.0	$12.6
U.S. MV Output	$89.0	$98.4	$104.4	$106.9	$96.7	$110.1	$119.5	$122.8	$129.6	$142.8	$136.4	$106.8	$48.4	$99.8	$127.5	$138.3	$145.7	$146.3
Ohio MV as Pct. of U.S.	13.5%	14.5%	13.0%	13.1%	12.4%	12.9%	11.9%	13.6%	13.1%	13.1%	12.2%	11.1%	8.4%	7.6%	8.7%	9.3%	8.2%	8.6%
Ohio Total as Pct. of U.S.	4.0%	4.0%	3.9%	3.8%	3.7%	3.7%	3.7%	3.7%	3.6%	3.5%	3.5%	3.4%	3.3%	3.3%	3.4%	3.4%	3.4%	3.4%

Source: U.S. Bureau of Economic Analysis

GROSS DOMESTIC PRODUCT

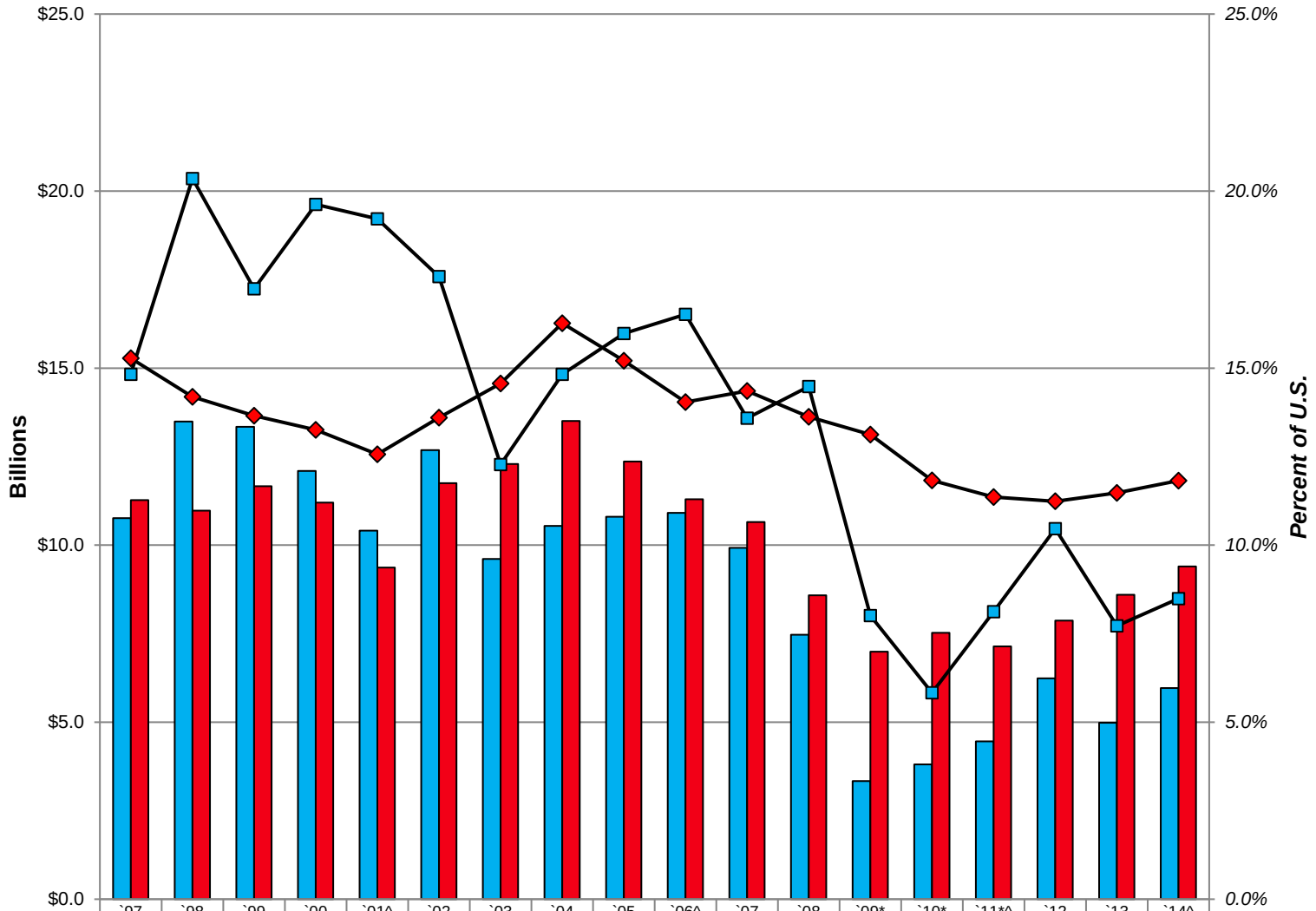
Gross Domestic Product (GDP) figures represent the net values of goods and services, expressed in dollars, produced during a year. The U.S. Bureau of Economic Analysis (BEA) calculates these values for each industry in every state, including the motor vehicle industry (NAICS 3361-3) in Ohio. The cyclical nature of motor vehicle industry output is evident after adjusting for inflation. It is easier to see in the chart above where U.S. motor vehicle industry output (yellow columns) rose 20.1 percent from 1997 through 2000 before falling in 2001. Output more-than-recovered in 2002, and continued growing through 2006 – an increase of 47.7 percent – and was still very high in 2007 before plummeting 66.1 percent from 2006 to the recession nadir in 2009. Beginning in 2009, output rose almost as dramatically as it fell, surpassing in 2013 the pre-recession peak of 2006 and growing a bit more in 2014. Output from Ohio (red columns) closely corresponds with the national trends: 16.5 percent growth in 1997-2000, 55.4 percent growth in 2001-2006, and a 78.6 percent plunge in 2006-2009. Although output from Ohio rose 216 percent from 2009 through 2012, it has since fluctuated and remains below the pre-recession peak of 2006. With the *partial* exception of the latest two years, production trends in Ohio's motor vehicle industry largely reflect what has happened throughout the nation.

Normally such swings in output are principally due to consumers' desires to feel comfortable before spending so much money. Sales and production typically rise during periods of sustained economic growth because jobs are plentiful and customers feel sufficiently confident making large expenditures. Conversely, sales and production fall when the economy contracts and the unemployment rate is high. Sales and production also are affected by secondary factors such as the cost of operation (insurance, gasoline, etc.), engineering and style changes, safety and other qualitative improvements (which make older models obsolete) and low interest rates (Levy, 2014: 26). Analysts have linked the severity of the downturn in the 2008-2009 recession with the chaotic near collapse of the financial system and its constriction of credit for businesses as well as consumers. They also credit the federal government's loans to GM and Chrysler (which were quickly repaid after a whirlwind trip through bankruptcy court) and its ultra-low interest rate environment in aiding the industry's recovery (Haider, 2016; Miles, 2016).

The chart above also illustrates the reduced concentration of the industry in the state. While economic activity in Ohio ranged between 3.3 and 4.0 percent of total domestic output (orange triangles), typically 12 to 14 percent of U.S. motor vehicle industry goods (red dots) originated here before the recession. Only with the onset of the recession in late-2007 does the industry concentration in Ohio start to fall. The drop in concentration incorporates the permanent closure of GM's Moraine plant in January, 2009, its closure of the Mansfield stamping plant and Ford's closure of a Cleveland engine plant. Ohio was second only to Michigan in motor vehicle industry output from 1997 through 2008, slipping to third – after Indiana – thereafter (U.S. BEA, 2016a).

See Table A9

Value-Added in Ohio's Motor Vehicle Industry
(NAICS 3361 & 3363) 1997-2014



	`97	`98	`99	`00	`01^	`02	`03	`04	`05	`06^	`07	`08	`09*	`10*	`11*^	`12	`13	`14^
3361: Assembly Value	$10.8	$13.5	$13.3	$12.1	$10.4	$12.7	$9.6	$10.5	$10.8	$10.9	$9.9	$7.5	$3.3	$3.8	$4.5	$6.2	$5.0	$6.0
3363: Parts Value	$11.3	$11.0	$11.7	$11.2	$9.4	$11.8	$12.3	$13.5	$12.4	$11.3	$10.6	$8.6	$7.0	$7.5	$7.1	$7.9	$8.6	$9.4
3361: Assembly Pct. of U.S.	14.8%	20.4%	17.2%	19.6%	19.2%	17.6%	12.3%	14.8%	16.0%	16.5%	13.6%	14.5%	8.0%	5.8%	8.1%	10.5%	7.7%	8.5%
3363: Parts Pct. of U.S.	15.3%	14.2%	13.7%	13.3%	12.6%	13.6%	14.6%	16.3%	15.2%	14.0%	14.4%	13.6%	13.1%	11.8%	11.4%	11.2%	11.5%	11.8%

Source: U.S. Census Bureau

* - Less reliable data; ^ - Unrevised estimate

VALUE-ADDED BY OHIO'S MOTOR VEHICLE INDUSTRY

Value-added data provide additional insight because they are available at the group level.[12] The chart and data table above illustrate a number of characteristics of, and changes in, the industry in Ohio:

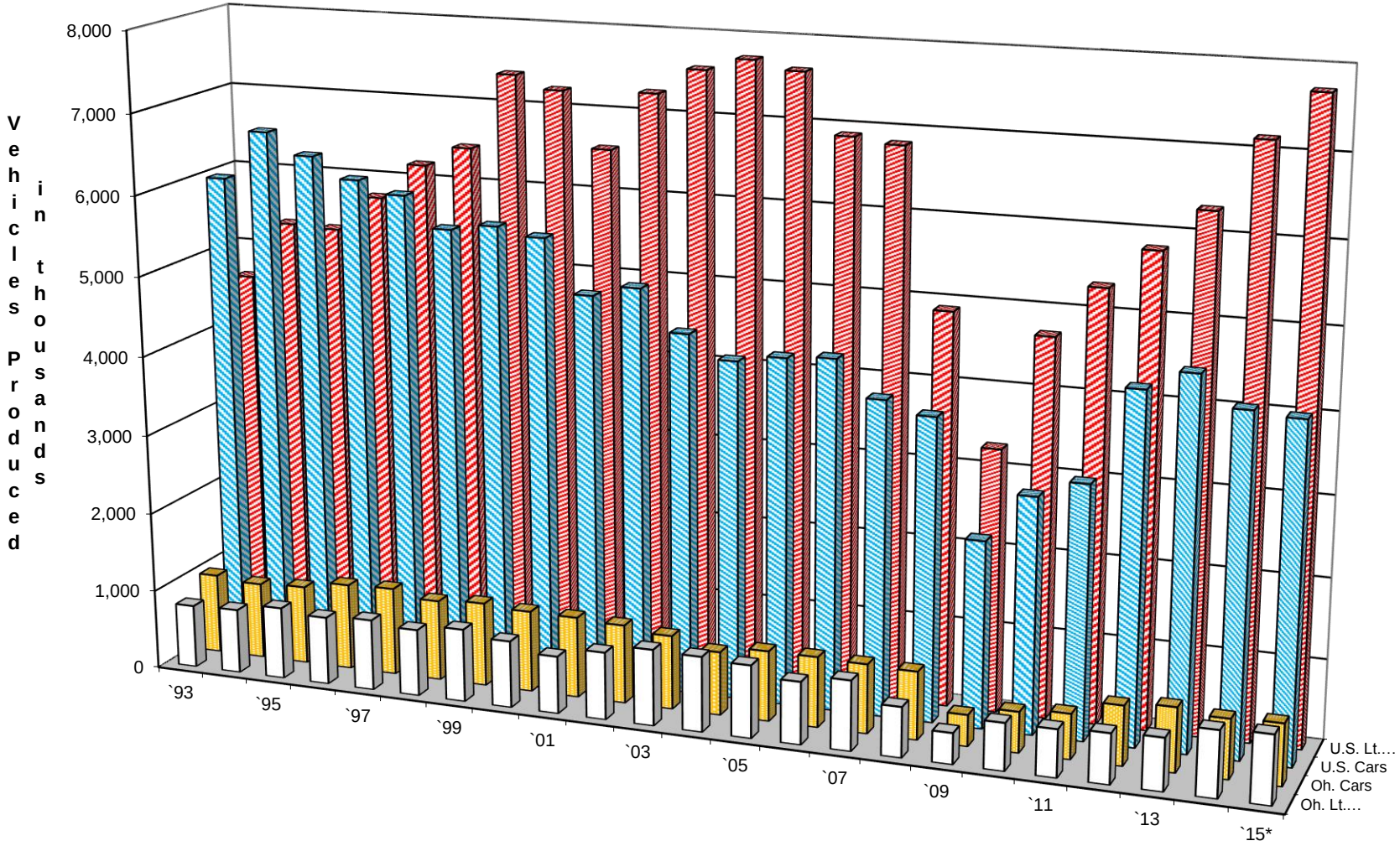
- The industry in Ohio is overwhelmingly comprised motor vehicle assembly and parts operations; both are multi-billion-dollar industries. Values-added in assembly and parts operations (NAICS 3361 and 3363, blue and red columns) were $6.0 and $9.4 billion, respectively, in 2014. These amounts contrast with the smaller industrial role of the bodies and trailers group (3362, see Appendix table A10), where value-added is usually less than $.5 billion in any year here.[13] During the 18-year period shown, value-added by assembly plants contributed an average of 45.8 percent of industry output from Ohio, parts plants added 51.9 percent, and bodies and trailers plants chipped in 2.3 percent. Value-added by the parts group has been greater than value-added by the assembly group every year beginning in 2003.

- Assembly and parts operations are directly dependent on one another, but they do not necessarily change in the same direction from one year to the next. This reflects the facts that parts made here are used in vehicles assembled here and elsewhere, and parts made outside of Ohio may be used by assembly plants here. Parts also are made for the replacement (i.e., repair) market as well as for new vehicles.

- The overall concentration of the motor vehicle industry in Ohio is due to the concentration of assembly and parts operations (blue squares and red diamonds, respectively). From 1997 through 2014, the percentage of value-added by assembly operations in Ohio ranged from 5.8 to 20.4 percent of the national total, averaging 13.8 percent; parts operations ranged from 11.4 to 15.3 percent of the corresponding total and average 13.0 percent. The steeper plunge from 2006 to 2009 in value-added at assembly plants – nearly $7.6 billion, or 69.4 percent (no adjustment for inflation) – reduced Ohio's portion of the corresponding national value-added to the single digits, except in 2012. This reflects the closure of GM's Moraine plant by 2009 as well as the impact of the recession. While value-added by the parts group also fell, the drop was not as severe – $4.3 billion, or 38.1 percent (again, unadjusted) – and the portion of such value-added from Ohio remained above 11.0 percent.[14] This comparatively milder drop in value-added for parts may be the result of consumers' tendencies to repair vehicles in hard times and postpone replacement. Values-added in both the assembly and parts groups have risen in the current economic expansion, but their portions of the national totals have been below their long-term averages. The portion of value-added by the bodies and trailers group in Ohio is only slightly greater than Ohio's total portion of U.S. GDP, and, with the exception of 2004-2006, has varied little.

See Tables A9 & A10

Light Vehicle Production in Ohio and the U.S., 1993-2015



	`93	`94	`95	`96	`97	`98	`99	`00	`01	`02	`03	`04	`05	`06	`07	`08	`09	`10	`11	`12	`13	`14	`15*
Oh. Lt. Trucks	796	813	907	855	893	840	918	842	723	848	957	944	912	785	878	630	389	592	596	627	654	825	854
Oh. Cars	1,006	960	989	1,085	1,105	1,016	1,056	1,022	1,016	990	928	797	882	885	870	854	394	511	566	745	802	742	765
U.S. Cars	5,982	6,601	6,340	6,083	5,934	5,554	5,638	5,542	4,879	5,019	4,510	4,230	4,321	4,367	3,924	3,777	2,331	2,934	3,149	4,326	4,566	4,196	4,149
U.S. Lt. Trucks	4,608	5,332	5,306	5,749	6,197	6,448	7,387	7,228	6,546	7,261	7,577	7,731	7,625	6,893	6,828	4,896	3,280	4,695	5,322	5,804	6,307	7,156	7,722

Sources: Automotive News & Ward's.

* - Initial estimate, subject to revision

LIGHT VEHICLE PRODUCTION IN OHIO AND THE U.S.

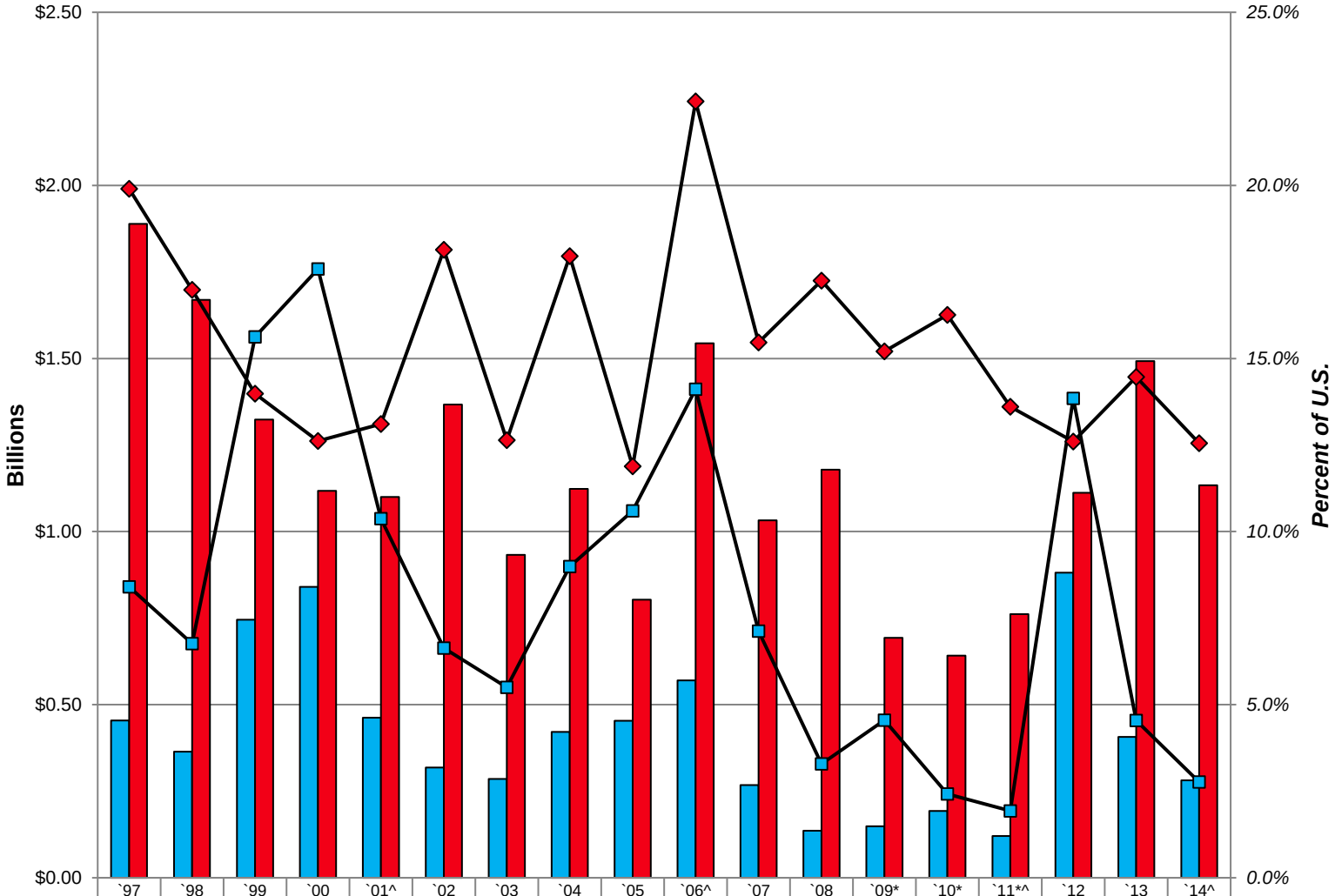
Light vehicle production is the core of the motor vehicle industry, comprising the vast majority of all motor vehicles made. The chart above illustrates the ups and downs of production in Ohio and the U.S. from 1993 through 2015. These fluctuations reflect various influences, including economic expansion and contraction, the opening and closing of plants, and changes in companies' product-mixes. In Ohio, the majority of production shifted from light trucks to cars during the mid-1980s as Honda increased production in first Marysville and then in E. Liberty. Cars were the majority of light vehicles produced in Ohio from 1993 through 2002. 2003 was the first year since 1988 in which more light trucks than cars rolled off assembly lines in Ohio. Neither car nor light truck production has consistently dominated since then, although light truck production has dropped with the closure of Ford's Lorain plant in 2005 and GM's Moraine plant in 2008-9. However, it rebounded in 2010 as Honda's E. Liberty plant changed to emphasize sport-utility vehicles. Car assemblies were again the majority in 2012 and 2013 after Honda recovered from the effects of floods in E. Asia, but light trucks dominated in 2014 and 2015 after Toledo North had re-opened and was producing year-round.

This differs from the national trend. Data in table A11, as well as the chart above, show production shifting from cars to light trucks. Car production still comprised 56.5 percent of U.S. light vehicle production in 1993. By 1997, car production was 48.9 percent of the same, and fell to 35.4 percent in 2004. It rose above 40 percent during the high-gas-price-and-recession years of 2008-9, but dropped below that level in 2010.[15] It rose again to 42.7 percent in 2012-13, but fell to 35.0 percent in 2015 after oil prices collapsed. Several explanations have been offered for these shifts: 1) using car platforms and adding car-like amenities and handling characteristics made light trucks substitutes for large cars and station wagons over the long term (Levy, 2010: 9); 2) higher profit margins and the lower corporate average fuel economy (CAFE) requirements of the time led assemblers to emphasize light truck production (Gott, et.al., 1999); nevertheless 3) light truck sales (and hence production) drop when fuel prices rise and/or the economy falters (Levy, 2014: 4, 8, 13).[16]

These contrasting shifts of production-mixes mean that Ohio has become a relatively more important source for cars, rising from 16.8 percent of U.S. output in 1993 to a peak of 22.6 percent in 2008; it has been around 17 or 18 percent for the last few years. At the same time, the state became a relatively less important source for light trucks. Factories in Ohio produced 17.3 percent of the nation's light trucks in 1993, but less than 13 percent after 1998. Ohio moved up from third to second rank in car production (after Michigan), but fell from first and second rankings in light truck production to second and third (after Michigan and occasionally Missouri). Throughout this transition, Ohio has typically been the source of one-seventh to one-sixth of light vehicles made in the U.S. The combined high numbers of cars and light trucks almost always make Ohio the second-ranked source for light vehicles despite generally lower production numbers.

See Table A11

Capital Expenditures in Ohio's Motor Vehicle Industry
(NAICS 3361 & 3363) 1997-2014



	`97	`98	`99	`00	`01^	`02	`03	`04	`05	`06^	`07	`08	`09*	`10*	`11*^	`12	`13	`14^
3361: Assembly Expndtrs.	$0.45	$0.36	$0.75	$0.84	$0.46	$0.32	$0.29	$0.42	$0.45	$0.57	$0.27	$0.14	$0.15	$0.19	$0.12	$0.88	$0.41	$0.28
3363: Parts Expndtrs.	$1.89	$1.67	$1.32	$1.12	$1.10	$1.37	$0.93	$1.12	$0.80	$1.54	$1.03	$1.18	$0.69	$0.64	$0.76	$1.11	$1.49	$1.13
3361: Assembly Pct. of U.S.	8.4%	6.8%	15.6%	17.6%	10.4%	6.6%	5.5%	9.0%	10.6%	14.1%	7.1%	3.3%	4.5%	2.4%	1.9%	13.8%	4.5%	2.8%
3363: Parts Pct. of U.S.	19.9%	17.0%	14.0%	12.6%	13.1%	18.1%	12.6%	18.0%	11.9%	22.4%	15.5%	17.2%	15.2%	16.3%	13.6%	12.6%	14.5%	12.5%

Source: U.S. Census Bureau

* - Less reliable data; ^ Unrevised estimate

CAPITAL EXPENDITURES FOR OHIO'S MOTOR VEHICLE INDUSTRY

The motor vehicle industry is almost uniformly a capital-intensive business (Haider, 2016; Miles, 2016; Peters, 2016; Petrillo, 2016). The chart above shows how much money companies have spent on land, buildings and equipment for production in Ohio, both in dollars (columns) and as a percentage of all such industry expenditures in the nation (squares and diamonds). It focuses on expenditures at assembly (NAICS 3361, blue) and parts plants (3363, red). It is evident that annual capital expenditures at parts plants typically ranged between $1-2 billion – although the recession and early recovery years of 2009-11 were less than $1 billion per year – and varied from 11.9 to 22.4 percent of the U.S. totals, averaging 15.3 percent. Expenditures at assembly plants usually were less than $500 million, but widely varied between 1.9 and 17.6 percent of national totals, averaging 7.5 percent. Capital expenditures for body and trailer production in Ohio also vary widely, but seldom exceeded $20 million a year and averaged 2.8 percent the national total. Total expenditures fluctuated during the years shown, ranging between $842 million and $2.37 billion (2010 and 1997). Figures within this range were 7.0 to 18.8 percent of the industry's annual investments (2010 and 2006). The 18-year average was 11.7 percent.

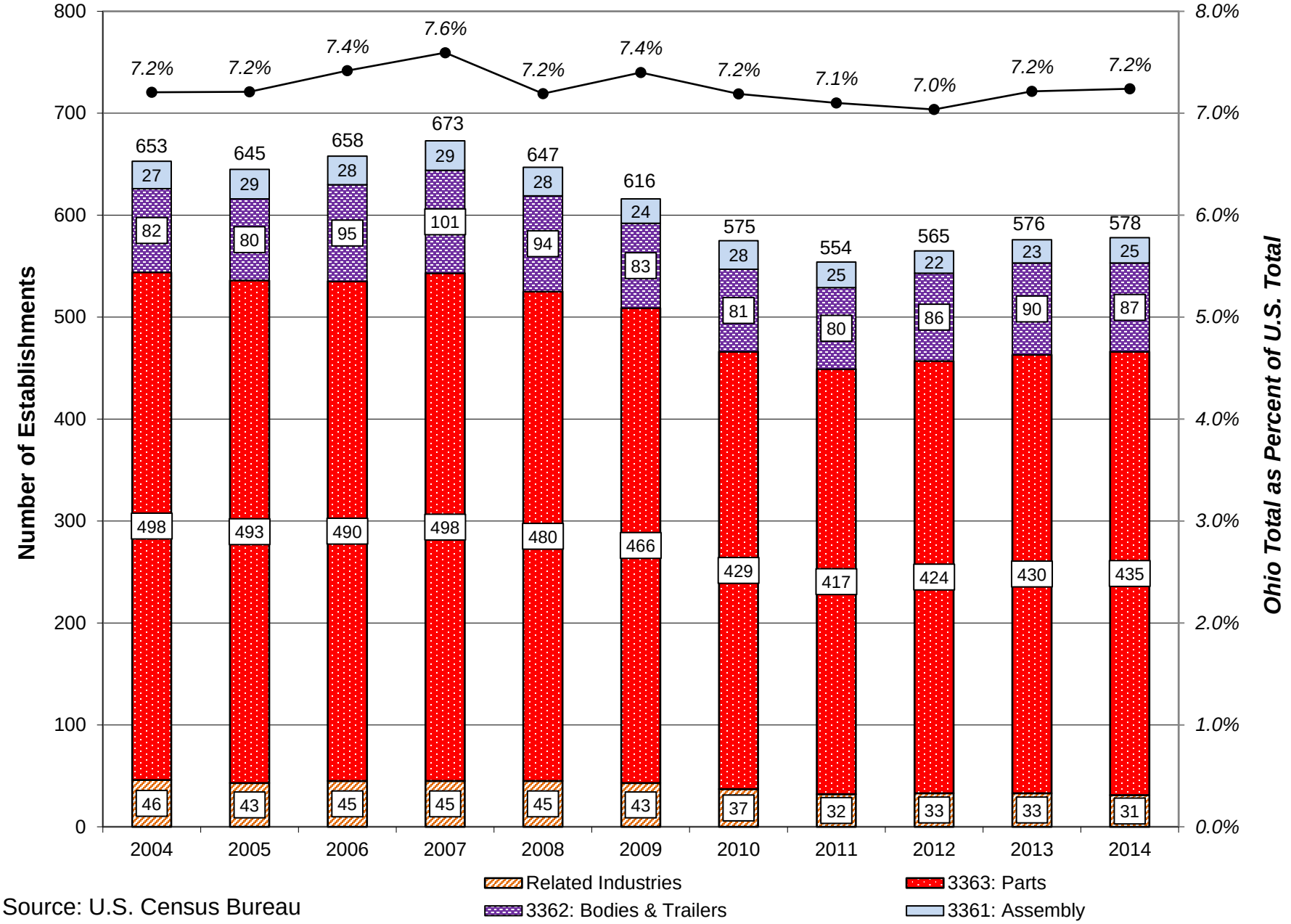
Levy (2004) offers an explanation of the up-and-down character of industry investment at the local level. He notes that large capital expenditures are required for product development and launching new models. While companies do this all the time, individual models typically are made at just one plant, with the consequence that capital expenditures at the local level may be highly variable over the course of the years, and a major changeover could require extensive changes costing billions (Levy, 2014: 31). This also may be true of engine, transmission and the larger stamping plants. Based on the chart above, this certainly appears true for Ohio.[17]

Most capital expenditures in Ohio are made for parts production: the average over the latest 18 years is about $734 of every $1,000 spent. An additional $258 or so went into assembly operations, with the remaining $7 for bodies and trailers. These proportions vary widely from year to year. Haider (2016) and Peters (2016) explicitly note the automation of production processes; that could be a major goal of capital expenditures and an implicit contrast with, say, new locations.

Despite some notable exceptions, it is hard to argue that companies are abandoning their facilities in Ohio – at least in a relative sense. Short time periods make it difficult to distinguish fluctuations and volatility from genuine trends. Consequently, longer-term averages may be more useful. In this regard, the figures are fairly close. On average, 13.0 percent of the industry's value-added from 1997-2014 originated in Ohio, while industry establishments in Ohio absorbed a comparable 11.7 percent of capital expenditures, and had 10.9 percent of comparable employment in 2014. These varied by group: the figures for assembly plants were 13.8 percent of value-added, 7.5 percent of capital expenditures, and 10.5 percent of jobs, but the corresponding figures for parts plants were 13.5 percent, 15.3 percent, and 12.8 percent.

See Tables A5, A10 & A12

Establishments Trends in Ohio's Motor Vehicle Industry: 2004-2014



Source: U.S. Census Bureau

ESTABLISHMENTS

Further evidence that the motor vehicle industry has not abandoned production in Ohio is seen in above chart showing the number of establishments by industry group – and the industry total – from 2004 to 2014. Although the total number of industry establishments in 2014 is less than the pre-recession peak – 578 vs. 673 – it appears to rise and fall with the industry expansion – from 653 in 2004 – and contraction – to 554 in 2011 (lagging the start of recovery by two years).

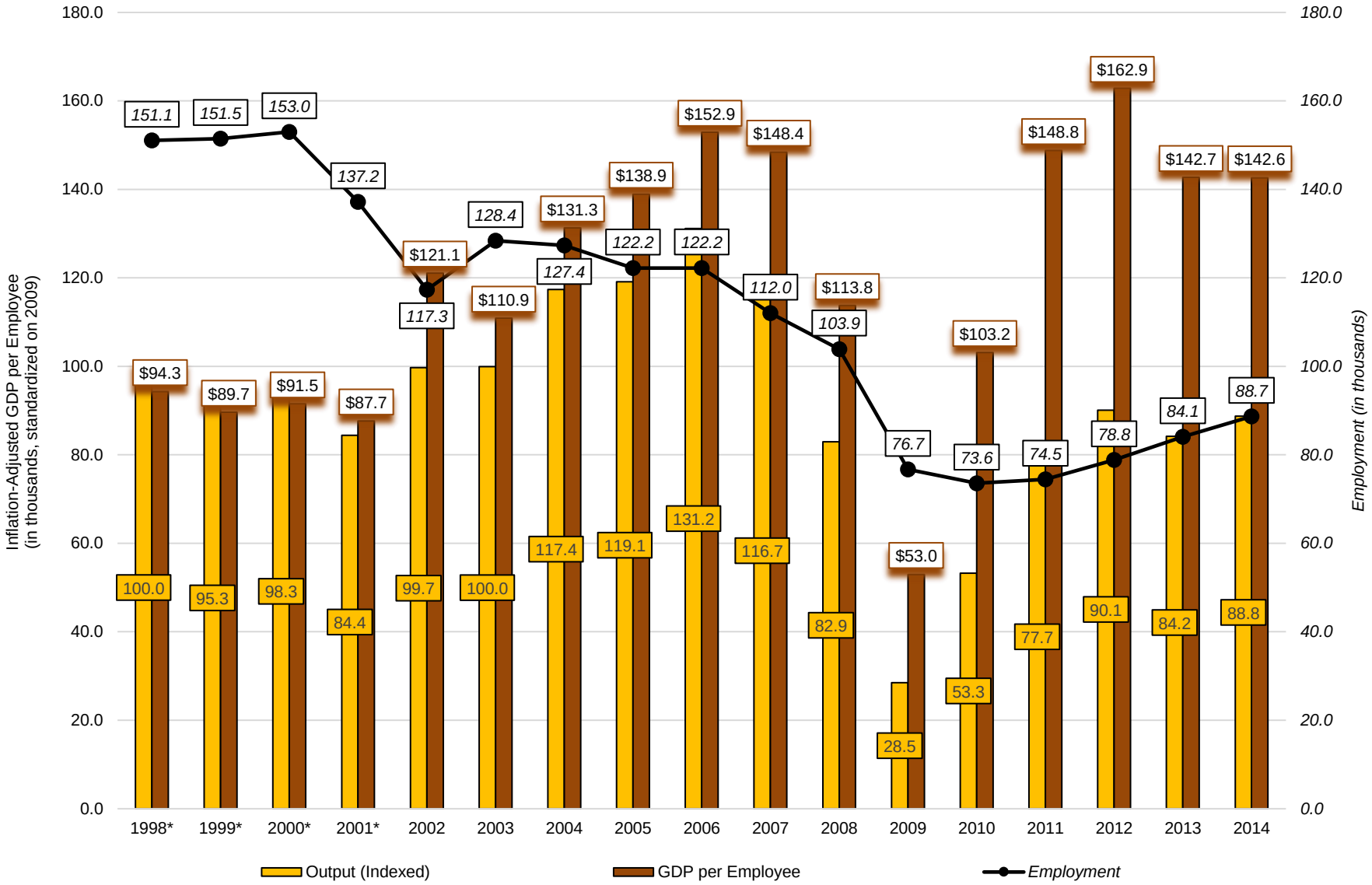
Changes in total numbers are due to changes in the constituent industries, and most of the changes are seen in the parts group (NAICS 3363), which fell from 498 in 2007 to 417 in 2011 before rising to 435 in 2014, and the related industries, which fell from 46 to 31. Detailed figures in Appendix table A13 show notable net decreases in most specific parts industries; steering and suspension (33633) and seating and interior trim (33636) are the two exceptions. Most of the reduction in related industries are seen in tire retreading (326212). Variations in these two clusters contrast with those seen among assemblers (3361) and bodies and trailers manufacturers. Variations in the assembly group (3361), from 22 to 29, seem less noticeable because of the relatively small number of such plants. This is misleading because the closure of GM's Moraine plant and Ford's Lorain plant had large and negative impacts on Ohio's economy, much more than the fluctuating numbers of a few much smaller light vehicle plants (33611) could. On the other hand, bodies and trailers establishments are smaller, and their numbers appear to change with the economy's expansion and contraction.

There are number of possible explanations for these changes. Analysts such as Levy (2014) and Peters (2016) have noted the consolidation of parts manufacturers as well as the desires of assemblers to deal with fewer suppliers, either of which could result in plant closures or repurposing for another industry. Some suppliers could have gone out of business with the recession while others opened new plants. It also is possible that some suppliers were reclassified one or more times during this time. In good years for the motor vehicle industry, a supply plant may be classified as part of the industry because that is where it makes the plurality of its revenue. In bad years for the motor vehicle industry, the same plant may be classified outside of the industry because the plurality of its revenue is made outside of the industry.

Despite the number of industry establishment varying between 554 and 673 (the latter is 121.5 percent of the former), Ohio's portion of the national total varied between 7.0 and 7.6 percent. This little-varying portion is consistent with the idea that what has happened in Ohio is more or less part of what was happening in the national industry.

See Table A13

Selected Trends in Ohio's Motor Vehicle Industry, 1998-2014
Output, Employment and Productivity (NAICS 3361-3)



Sources: U.S. Bureaus of the Census and Economic Analysis

* - Employment and GDP/Employee estimated

OUTPUT, EMPLOYMENT AND PRODUCTIVITY

The chart above traces changes in three aspects of Ohio's motor vehicle industry (NAICS 3361-3): output (gold columns, with industry Gross Domestic Product set to 100 in 1998), employment (black dots), and productivity (brown columns). Productivity is measured by inflation-adjusted GDP per industry employee. Changes are seen across four time periods:

- From 1998 through 2000, output fluctuated from 100 to 98.3 and employment ranged between 151,000 and 153,000, with productivity at $89,700 to $94,300 per employee. Industry output fell more than employment during the 2001 recession, which meant productivity decreased to $87,700 per employee that year.
- Output returned to pre-recession levels in 2002 and 2003 (consistent with economists' conclusion that that recession was short and relatively mild), but employment fell and additional 19,900 in 2002 before rising 11,100 in 2003. Output in 2003 was back to 1998, but employment was still 24,600 less than in 2000, which meant productivity had jumped to more than $110,000 per employee. Output expanded until 2006 while employment gradually declined to 122,200, meaning productivity rose to $152,900 per employee.
- Output in 2007, while still high, may be seen as sliding into recession; employment also declined by 10,200 from 2006. However, productivity in 2008 – the first full year of the recession – was $113,800 per employee, exceeding the productivity levels seen in normal times of 1998 to 2000. It was only in 2009 – the depth of the recession – that productivity fell (well) below $100,000 per employee.
- Output turned around in 2010 – the first full year of recovery – with employment following in 2011; both continued in 2012, with output fluctuating in 2013 and 2014 – but employment growing. Productivity had returned to the high levels seen in 2006 and 2007.

One way to characterize the net change from 1998 to 2014 would be to say 88.8 percent of 1998's output was achieved with only 58.7 percent of 1998's workforce, which could only be obtained with a 51.2 percent increase in productivity. Data show in Appendix table A14 document a very similar transition to greater productivity across the nation. Industry GDP per employee rose from $84,400 in 1998 to $144,900 in 2007. Productivity plummeted to $73,200 per employee in 2009 and rose to $191,100 by 2011 and remained above $180,300 for subsequent years.

It should also be noted that employment in Ohio and for the nation as a whole fell with reduced output volumes in 2001 and 2008-2009, and continued falling even as output grew in the corresponding following years of 2002 and 2010. However, employment grew in the subsequent years of 2003 and 2011. These patterns of change indicate employment lags output at least early in expansions. This is understandable, as employers add hours for existing employees before adding new employees to reduce overtime and associated expenses. The long-term net rise in productivity was facilitated by capital expenditures increasing automation; there are limits to how long people can work.

See Tables A8, A9 & A14

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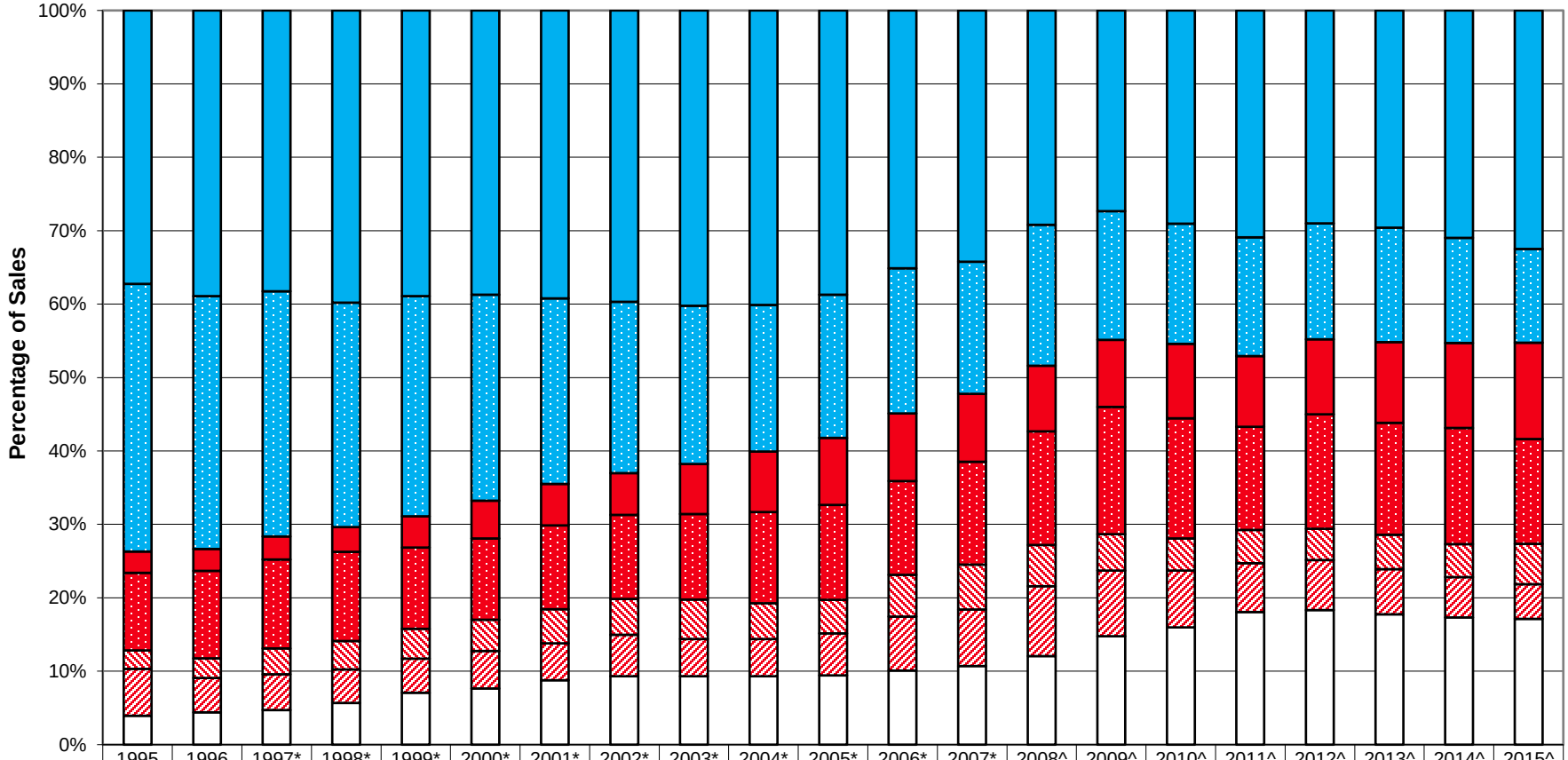
U.S. INDUSTRY ANALYSIS AND OUTLOOK

U.S. Market Share Sales Trends in Light Vehicles by Brand & Import Status: 1995 - 2015



	1995	1996	1997*	1998*	1999*	2000*	2001*	2002*	2003*	2004*	2005*	2006*	2007*	2008^	2009^	2010^	2011^	2012^	2013^	2014^	2015^
U.S.B.T.	37.2%	38.9%	38.2%	39.8%	38.9%	38.7%	39.2%	39.7%	40.2%	40.1%	38.7%	35.1%	34.2%	29.2%	27.3%	29.1%	30.9%	29.0%	29.6%	31.0%	32.5%
U.S.B.C.	36.4%	34.5%	33.4%	30.6%	30.0%	28.1%	25.3%	23.3%	21.5%	20.0%	19.5%	19.8%	18.0%	19.2%	17.5%	16.3%	16.2%	15.8%	15.6%	14.3%	12.8%
J.B.D.T.	2.9%	3.0%	3.1%	3.3%	4.2%	5.2%	5.7%	5.7%	6.8%	8.2%	9.1%	9.2%	9.2%	8.9%	9.1%	10.2%	9.6%	10.2%	11.0%	11.6%	13.1%
J.B.D.C.	10.5%	11.9%	12.1%	12.2%	11.1%	11.1%	11.4%	11.5%	11.7%	12.4%	12.9%	12.8%	14.0%	15.5%	17.3%	16.3%	14.0%	15.6%	15.3%	15.8%	14.3%
J.B.I.T.	2.5%	2.7%	3.5%	3.9%	4.1%	4.3%	4.6%	4.9%	5.4%	4.9%	4.6%	5.7%	6.1%	5.6%	4.9%	4.4%	4.5%	4.3%	4.7%	4.5%	5.5%
J.B.I.C.	6.4%	4.7%	4.9%	4.5%	4.6%	5.1%	5.1%	5.7%	5.1%	5.1%	5.7%	7.3%	7.7%	9.5%	8.9%	7.7%	6.7%	6.8%	6.2%	5.5%	4.7%
Others	3.9%	4.4%	4.7%	5.7%	7.1%	7.6%	8.8%	9.3%	9.3%	9.3%	9.4%	10.1%	10.7%	12.1%	14.8%	16.0%	18.0%	18.3%	17.7%	17.3%	17.1%

Sources: Automotive News, Ward's. Note: * - 1997 and later years not entirely comparable with earlier years; ^ - Automotive News data. Abbreviations used: B - Brand; C - Car; D - Domestic; I - Import; J - Japanese; T - Light Truck; U.S. - United States. Chrysler is treated as U.S.B. for the sake of continuity even though Fiat gained control of it in July, 2011.

MARKET SHARE TRENDS

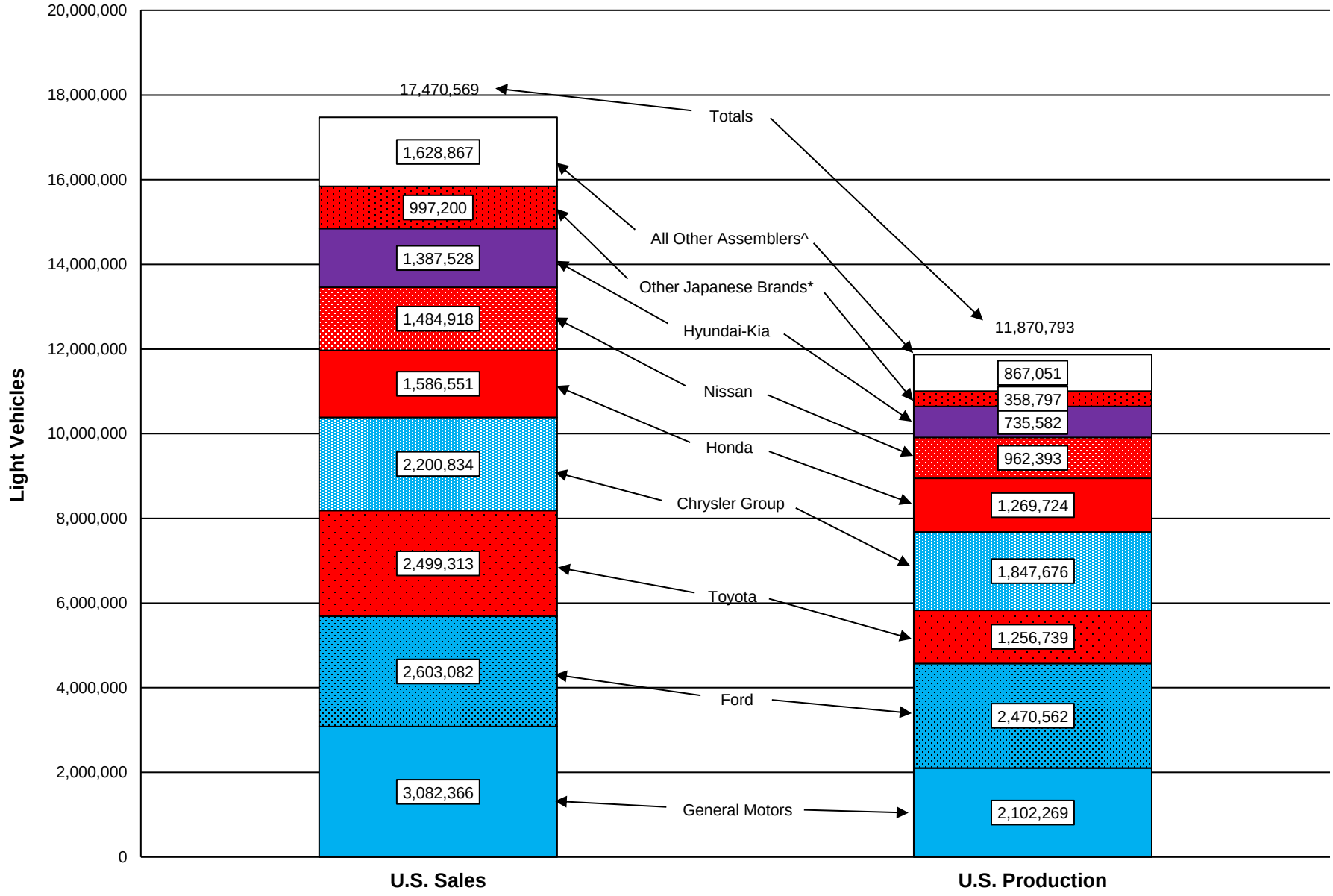
Market share trends are important because sooner or later "capacity follows market share" (Harbour Consulting, 2006: 11; capacity refers to companies' plants, shifts and workers). This section focuses on assemblers. Beginning in the early 1970s, the U.S. light vehicle market was transformed from a stable oligopoly dominated by *the Detroit Three* (GM, Ford and what is now FCA's Chrysler Group) since the 1950s into the most competitive market in the world. Foreign-based assemblers – those from Japan were first and have been the most successful – captured significant shares of the U.S. market by offering higher quality products better matching consumer demand. Competition compelled the Detroit Three to address both quality and organizational problems in the 1990s. They (and their suppliers) restructured their organizations and re-engineered their vehicles (and parts), improving design and quality while reducing costs. Design and quality issues are now much less distinguishing (Levy, 2014: 25).[18]

The chart above illustrates a number of market share trends in U.S. light vehicle sales from 1995 through 2015. After a relatively stable period in the early and mid-1990s, the combined share of U.S. brand cars and light trucks (USBC and USBT, blue, from the Detroit Three) fell below 70 percent of all sales in 1999, and continued to fall each year through 2009, when it was 44.9 percent. The net loss of market share for U.S. brands is the combination of two trends. Most notably, sales of USBC fell from 36.4 to 17.5 percent. While USBTs sales usually ranged between 38 and 40 percent for most of 1995 through 2005, they fell to 27.3 percent in 2009. Most of the market share lost by USBs was gained by Japanese brands (JBs, red), which collectively rose from 22.4 percent in 1995 to peak at 40.3 percent in 2009; all Others (European and S. Korean firms, white) saw their collective share rise from 3.9 to 14.8 percent. The Detroit Three reduced their capacity because of their long-term slide in market share. This was felt in Ohio first with Ford's closure of its Lorain plant in 2005 after a co-production agreement with Nissan ended and second with the closure of GM's Moraine assembly plant during the last recession. (Ford and GM also closed three parts plants during the recession.)

Since 2009, USBs collective market share usually remained between 45 and 46 percent as a 5 percent gain by USBTs offset a similar decline of USBCs. JBs' loss of 3 percent was gained by Others. The dip in JBs share to 34.9 percent in 2011 probably was due to floods in East Asia temporarily constraining parts production and, therefore, the availability of light vehicles. (Levy, (2014: 20-21) comes to the same conclusion.)

The chart also illustrates the shift to N. American production for JB sales: from 13.5 percent in 1995 to 27.4 percent in 2015. By comparison, JB imports share 8.9 in 1995 to 15.1 percent in 2008, but dropped to 10.2 in 2015. Shifting production from Japan to N. America achieved intended goals: circumvent the import quotas seen in the 1980s, insulate sales from the effects of changing currency values (higher yen values make imported Japanese vehicles relatively more expensive when compared with vehicles produced in N. America), and facilitate adaptation to local tastes.

2015 U.S. Sales and Production
of Light Vehicles by Company



Source: Automotive News

Notes: * - 3 Sellers, 2 Producers; ^ - 9 Sellers, 7 Producers

Finally, it should be noted that the long term growth in market share by Others from 3.9 to 17.1 percent reflects the success of Hyundai-Kia, now at 7.9 percent, more than any other single company. Hyundai-Kia has followed the Japanese strategy and derives most of its U.S. sales from domestically produced vehicles. By comparison, the remaining eight Other companies are mostly reliant on imports.

The left column in the chart above illustrates current market shares by company, identifying those whose U.S. light vehicles sales exceeded 1,000,000 in 2015. GM tops the list with close to 3.1 million, followed by Ford with 2.6 million, Toyota with nearly 2.5 million, and FCA's Chrysler Group at 2.2 million. Honda, Nissan and Hyundai-Kia each had sales ranging between 1.3 and 1.6 million. These seven companies held 85.0 percent of the market, individually ranging from 17.6 to 7.9 percent (GM to Hyundai-Kia). Three other Japanese assemblers combined for 997,200, amounting to 5.0 percent of the market. The remaining nine – mostly European brands – sold more than 1.6 million light vehicles for a 9.3 percent share.[19] The Detroit Three (blue) held the plurality of sales at 45.1 percent, while the three largest Japanese brands (red) had 31.9 percent and all other Japanese brands had 5.7 percent (Automotive News, 2016).

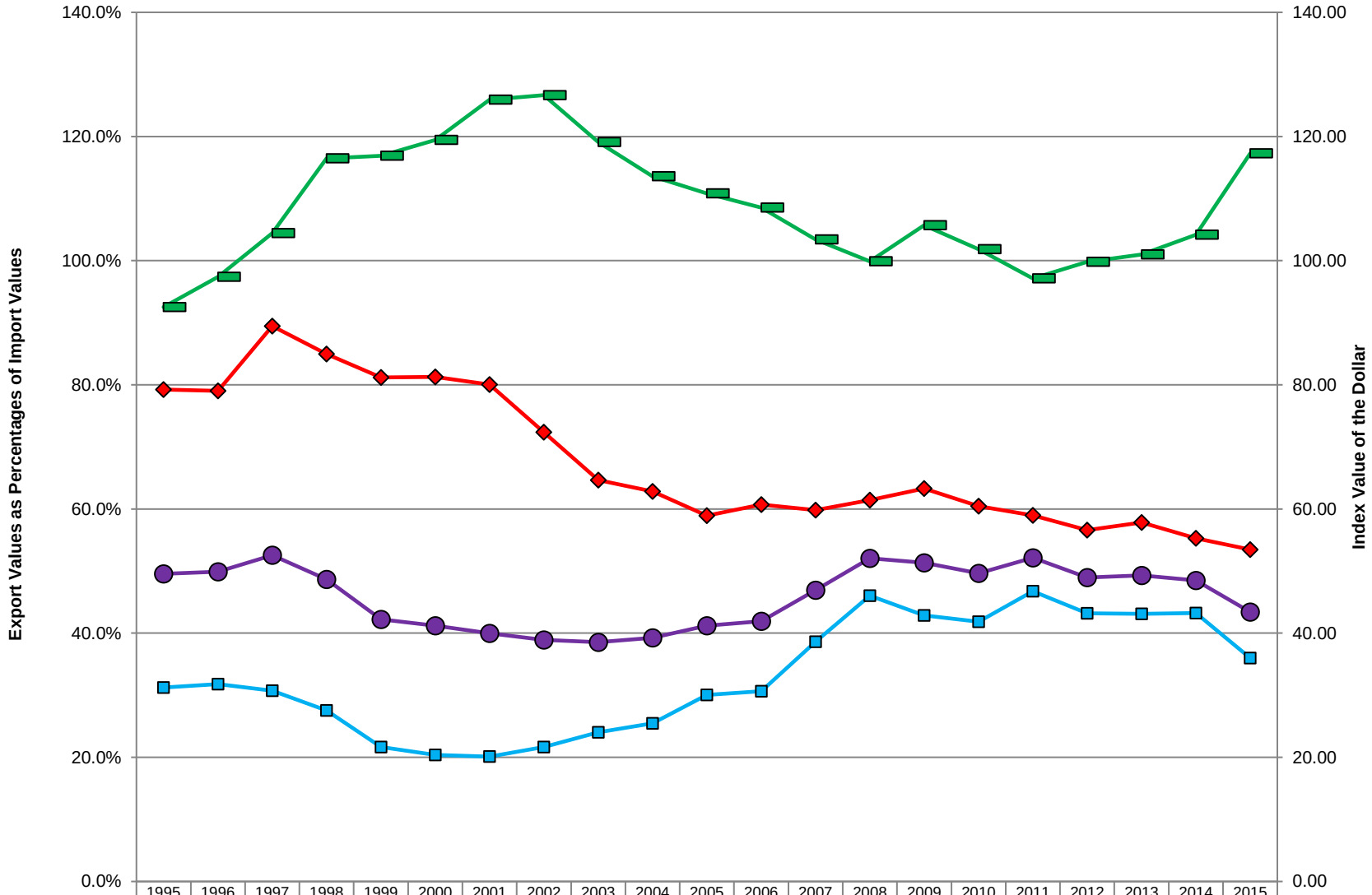
The right column in the chart above shows 2015 U.S. production by the same seven companies as well as summaries for other assemblers. The same seven companies made 89.7 percent of the light vehicles. Individual production shares ranged from 20.8 to 6.2 percent (Ford to Hyundai-Kia). The Detroit 3 combined for 54.1 percent, while the three largest Japanese-based assemblers produced 29.4 percent and two more combined for 3.0 percent. Five other assemblers combined for 7.3 percent (Automotive News, 2016).[20]

The fact that company sales numbers are greater than corresponding production numbers for all high-volume assemblers means that not one meets its U.S. demand solely with vehicles assembled in the U.S.; all must import vehicles (their assembly plants in Japan and NAFTA partners Canada and Mexico are the most likely sources).[21] This production deficit is probably more pronounced than the numbers suggest, as some U.S. production is exported (Canada probably is the most frequent destination).

The U.S. heavy-duty truck market is a different story for two reasons: (1) few heavy-duty trucks are manufactured outside of N. America because distances travelled are shorter and few roads could accommodate them, and (2) the few foreign-based assemblers in the U.S. market have preferred buying U.S.-based assets rather than establishing their own manufacturing facilities.[22] However, some foreign medium-duty truck makers have made some inroads into the U.S. market with their exports (Corridore, 2014: 17).

See Tables A15a & A15b

Motor Vehicle Imports, Exports and the Value of the Dollar, 1995-2015



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Industry Total	49.6%	49.9%	52.5%	48.7%	42.2%	41.2%	40.0%	38.9%	38.5%	39.2%	41.2%	41.9%	46.9%	52.1%	51.3%	49.6%	52.1%	49.0%	49.3%	48.5%	43.4%
Motor Vehicles	31.2%	31.8%	30.7%	27.5%	21.7%	20.4%	20.1%	21.6%	24.1%	25.5%	30.1%	30.7%	38.6%	46.1%	42.9%	41.9%	46.7%	43.2%	43.1%	43.3%	36.0%
Parts & Accessories	79.3%	79.0%	89.5%	85.0%	81.2%	81.3%	80.1%	72.3%	64.7%	62.8%	58.9%	60.7%	59.8%	61.4%	63.3%	60.5%	59.0%	56.6%	57.8%	55.3%	53.5%
Dollar 's Indexed Value	92.52	97.40	104.44	116.48	116.87	119.45	125.91	126.66	119.09	113.59	110.81	108.52	103.40	99.90	105.69	101.82	97.15	99.82	100.98	104.16	117.28

Sources: U.S. Bureau of Economic Analysis, Federal Reserve Board

TRADE BALANCES

The broadest measure of motor vehicle industry trade includes new and used vehicles as well as parts and accessories, and the common base for comparison is their dollar values. The chart above illustrates changes in the U.S. balance of trade by calculating export values as a percent of import values, removing any effects of inflation. The fact that all of the export-to-import ratios – Motor Vehicles (blue squares), Parts and Accessories (red diamonds) and the Industry Total combination of the two (purple circles) – are less than 100 percent (see the left vertical axis) indicates a U.S. trade deficit for each part and the industry-as-a-whole during the 1995-2015 period. Unlike the preceding Market Share Trends section (which considers only new vehicles), goods shipped to and from Canada and Mexico count as exports and imports.

A frequently-cited explanation for the changes in the ratios is the changing Index Value of the Dollar (green rectangles, the right vertical axis).[23] A lower value of the dollar makes American-made goods relatively less expensive for foreigners to buy and foreign-made goods more expensive for people and companies in the U.S. Higher values have the opposite effects. As the value of the dollar rose from 1995 through 2002, U.S. motor vehicles became more expensive, and the Motor Vehicles export-to-import ratio fell; as the value of the dollar fell from 2002 through 2008, U.S. motor vehicles became more affordable and the Motor Vehicle exports-to-imports ratio rose. The slightly elevated dollar values in 2009-2010 and the jump from 2015 to 2014 were accompanied by proportional drops in the Motor Vehicles exports-to-imports ratio. The Index Value of the Dollar works well in explaining variations of the Motor Vehicle exports-to-imports ratio because vehicles are *finished products* that come from and are sent to a variety of countries. Most *light* vehicle imports come from Canada, Japan, Germany and Mexico; most exports of the same go to Canada, China, Germany and Saudi Arabia (Peters, 2016). (The vast majority of imports of *heavier* vehicles come from Mexico, and the vast majority of exports go to Canada – as opposed to overseas – due to the great expense of shipping such products long distances.) The similar relationship between the Index Value and the Total ratio largely reflects the Index Value-Motor Vehicle ratio relationship because the value of motor vehicles is most of the Total, as measured by dollars.

On the other hand, changes in the Parts and Accessories ratio appear to have a little relationship with the changing value of the dollar; this ratio generally has *not* moved in opposite directions as has the Motor Vehicles ratio. This means the value of the dollar is a limited explanation of fluctuating trade levels, despite invocation by many analysts (e.g., Haider, 2016; Levy, 2014; Miles, 2016; O'Hollaren, 2016; Peters, 2016; Petrillo, 2016). Possible explanations for this divergence must include other factors. While light vehicle imports and exports come from and go to overseas nations (after Canada), most trade in Parts and Accessories is within NAFTA, the N. American Free Trade Agreement between Canada, Mexico and the U.S. (Haider, 2016; Miles, 2016; Peters, 2016; Petrillo, 2016). Most of the industry trade with Canada consists of intra-company shipments (Gott, et.al., 1999). This reflects the fact significant parts operations – especially engines, transmissions and large stampings – are subsidiaries of assemblers. Miles (2016) also notes "High fixed costs associated with

building [and operating engine plants in the U.S. and Canada] make it difficult for producers to quickly shift production [between countries] based on currency trends." Complicating matters are the facts that specific engines and transmissions may be used in several vehicle models *regardless of where they are assembled*; conversely, some models may use more than one type of engine (see Ward's, 2009).[24] Along these same lines, foreign-based assemblers operating in the U.S. must import engines – among other parts – regardless of currency exchange rates, relying on the greater value-added at assembly plants to compensate for any higher costs until they establish relationships with local suppliers – or until suppliers from the home country set up U.S. operations. (Levy, 2014: 9, has similar sentiments). Such corporate ties and requirements may be why the U.S. has an overall trade deficit in engines and many other parts (stampings are the exception (Peters, 2016)), but has a trade surplus in engines with Canada. (Many of those engines and parts come back to the U.S. in complete vehicles, giving Canada a surplus in that regard (U.S. BEA, 2016b).) Engines are just one example of the close ties assemblers and tier-1 suppliers and the dedicated use of many parts to specific models.[25] The situation is even more complicated because parts may cross the U.S. border more than once before a vehicle is completed (Althaus and Rodgers, 2016). It also is worth noting that trade policies may have unintended consequences: U.S.-based companies shifted the assembly of some larger (and more expensive) cars to Canada in order to meet the Corporate Average Fuel Economy (CAFE) requirements for vehicles assembled in the U.S. (Adams, 1998).

A comprehensive look at the impact of currency fluctuations on trade would focus on specific currencies instead of the generalized Index Value. For example, an under-valued yuan, among other factors, contributed to the rapid growth of tire imports from China during the last few years (Levy, 2014: 8). (The U.S. International Trade Administration has imposed anti-dumping duties to counter government subsidies that allowed some tires to be sold below cost (O'Hollaren, 2016).) It should be noted that U.S.-based companies have taken advantage of currency fluctuations too; the devaluation of Asian currencies aided them by making natural rubber, their principal raw material, less expensive (Prat, 1998). One of them even increased production at its Asian plants because the devaluation of the local currency made its own products inexpensive imports, thereby decreasing its costs.

This last example is part of a broader change, which helps explain why the U.S. has a persistent trade deficit despite fluctuating currency values: a shift of parts production from the U.S., sometimes by U.S.-based companies, to lower wage countries as part of a cost reduction strategy. This is particularly true of low value-added or commodity parts as well as low-skilled, labor intensive production (drawn from Miles, 2016; Peters, 2016; Petrillo, 2016). It is facilitated by the lower shipping costs of many smaller parts (Haider, 2016) as well as reduced trade barriers and propinquity. From the perspective of companies, this is rational in a highly competitive industry.[26] (Lower shipping costs and propinquity also facilitate exports from the U.S., and to be even-handed, NAFTA boosted *export and import* trade with Mexico more than with Canada because the U.S. and Canada had few trade barriers (Gott, et.al., 1999)).[27] Conversely, U.S. production and exports have shifted to higher value-added parts, goods requiring close collaboration with assemblers' designers and engineers,

more complex interconnected systems, and/or goods that emerging market countries lack the technological infrastructure to produce. What commodity production remains in the U.S. for export is distinguished by higher quality and benefits from growing global demand (again drawn from Haider, 2016; Miles, 2016; Peters, 2016; Petrillo, 2016). Tire makers also have shifted their commodity tires to low-cost countries while emphasizing higher-margin premium tire production here (Levy, 2014: 8; O'Hollaren, 2016).

Some of the trends and themes mentioned above are evident in the Ohio Exports Report, notably:

- The majority of motor vehicle industry exports from Ohio go Canada, with Mexico a distant second;
- Such exports from Ohio declined with the Great Recession and grew with economic recovery;
- Such exports from Ohio declined from 2014 to 2015 as the Index Value of the dollar rose (Office of Research, ODSA, 2016c).

See Table A16

INDUSTRY OPERATIONS AND RECENT TRENDS

Companies making light vehicles (NAICS 33611) and companies assembling medium- and heavy-duty trucks (33612) have a number of characteristics in common despite serving different markets. (The former serve mostly families and individuals, the latter supply capital goods to organizations and individual operators.) Both produce some of their vehicle components as well as purchasing other parts from independent suppliers. The modules and parts – mostly comprised of metals, plastics, rubber or glass – are shipped to plants where workers assemble them into vehicles. Both engage in the more-profitable-but-riskier activities of leasing and financing.[28] Medium- and heavy-duty truck makers also offer logistical, maintenance and repair services (Levy, 2014; Corridore, 2014: 11).

Price competition in both industries is intense and continuous regardless of how well the economy is doing, but for different reasons. Light vehicle companies are competing in a market that has not been an oligopoly for decades, which limits their pricing power (Levy, 2010: 22). On the other hand, heavy-duty truck buyers have the size, financial-soundness and knowledge of market choices to counter-balance the oligopoly of Daimler, Navistar, Paccar and Volvo (Corridore, 2014: 17; Peters, 2016). (Ford and GM have smaller shares.) Companies in both industries have used rebates and discounts as a competitive strategy more or less frequently.[29] In the same vein, sales in both industries also are affected by the availability of credit and costs of ownership (Corridore, 2014: 7-8; Levy, 2014: 26); sales of medium- and heavy-duty trucks also will spike higher ahead of new government regulations aimed at reducing pollution *if* buyers believe the new vehicles will be more expensive to own and/or operate, and, given such behavior, sales will drop in the year following implementation (Corridore, 2014: 7-8). As mentioned before, engineering, safety and quality improvements as well as changes in style affect light vehicle sales (Levy, 2014: 26).

Both industries are cyclical, but for different reasons. Purchasing a new light vehicle usually is the second largest expenditure a person or family makes, and people need to feel confident that they can afford it. As previously noted, new light vehicle sales take-off when the economy is expanding and people feel secure in their employment prospects, but can plunge when the economy contracts, jobs are scarce and people are less secure (Levy, 2014: 26). Medium- and heavy-duty trucks are capital goods, and as such, purchases may lag the economy; fleet operators order new trucks only after considering their financial strength and the outlook for their services. Purchases are made to add capacity as well as to replace aging equipment. During times of economic weakness, orders fall, or may be cancelled or deferred. Owners may choose to repair trucks, and fleet operators have even cannibalized idle trucks for spare parts (Corridore, 2014: 18).[30] Purchases of school buses, fire engines and other emergency service vehicles by governmental agencies are a small segment of this industry, but provide a bit of stability to the industry (Peter, 2016).

In other ways, the two industries differ. Light vehicle assemblers almost always use their own engines, transmissions and

large size stampings (NAICS 33631,5,7) (Miles, 2016; Peters, 2016). They are at least somewhat more likely to purchase other parts – tires, electrical and electronic equipment, steering and suspension components, brakes, seating, small size stampings, air-conditioning, etc. (32621, 33632-4,6-9) – from independent suppliers (Haider, 2016; Miles, 2016; O'Hollaren, 2016; Peters, 2016; Petrillo, 2016). Nevertheless, vehicle options are limited. This contrasts with medium- and heavy-duty trucks, which usually are customized to suit buyers' needs. While assemblers offer their own engines and transmissions, buyers may select those and other parts from independent companies based on considerations such as distance per trip, geography, and cargo type. Because trucks are so customized, assemblers concentrate on the design of platforms and rely on suppliers to design the various mechanical and electrical systems that they assemble into a complete vehicle. This lets assemblers maintain the lowest possible fixed-cost base and maximizes flexibility for customers. Basic vehicle redesigns may not be made for 10 years. New designs result from breakthroughs such as improved aerodynamics or weight reductions. Suppliers may make interim improvements – notably in engines, transmissions and axles, and they work with assemblers to meet safety and emissions regulations (Corridore, 2014: 17).[31]

By contrast, light vehicle makers have sought to shorten model life times to five years. They can move from sketch to prototype in less than a year and, if well-received in test marketing and cost-effective to make, to actual production in about two more years. (Prototypes failing either of those criteria are terminated.) The accelerated pace may be due in part to changing consumer tastes and regulatory requirements, but the practice also keeps a company's line-up fresh. The shorter time required to bring a new model to production is facilitated by product designers and engineers collaborating to minimize redesign work in later development stages (Levy, 2010: 20; 2014: 23); subsequent work with industrial process designers minimizes assembly time (Harbour Consulting, 2004).

The industrial process has changed over the years as companies responded to competitive pressures – either from imports or from rivals setting up operations in national markets around the world. Companies had to improve quality and cut costs wherever possible. (Better quality means, among other things, that products last longer, and that less time is needed for routine maintenance.) A number of organizational and technical changes have been made pursuing these goals. The assembly process has been simplified in a number of ways. Vehicles today contain fewer parts than in the past, and fewer parts mean lower production costs as well as less chance of assembly errors. Similarly, the number of stampings required for sheet metal parts such as hoods, trunks, fenders and doors has been reduced (Levy, 2014: 23; also see Corridore, 2014: 12). A more recent change has been for assembly plants faced with high demand for a model to change from a two-shift-assembly-third-shift-resupply schedule to a three-shift-24-hour operation with each shift independently resupplied (Peters, 2016).

Perhaps the most far-reaching organizational change has been the shift of some work from assemblers to tier-1 suppliers. Two examples illustrate these changes. In the past, seats were made at the assembly plant from the inventory of com-

ponents. Now, assemblers order seats from an off-site facility, and have them delivered just-in-time for installation. (Suppliers delivering goods in reusable containers reduce waste and pollution costs.) Meeting these demands is easier if suppliers locate close to their customers, as orders are placed daily or for specific amounts (Levy, 2014: 23). Similarly, the pistons, cylinder liners, connecting rods, and related bearings were made by different companies at different locations and shipped to a plant for assembly. Now, a single company has combined the operations, delivering a tested, more reliable system at less cost than before (Gaines, 1999; Levy, 1999).

These examples represent more than shifting subassembly work off the site of final assembly. They are part of a broader reorganization of the supplier base and its relationship with assemblers. Suppliers now work with assemblers in designing, developing, and engineering components.[32] They frequently assemble the components into modules, and do quality control testing. There are advantages and risks for both with this approach. Pooling organizational resources facilitated and shortened R&D cycles as well as actual production. Shifting these activities to suppliers reduces some investment risks and costs for assemblers while drawing both closer. Under these circumstances, contracts are no longer done annually, but for the life of the model. The contracts stipulate supplier targets for quality, costs and timeliness. In turn, assemblers agree to share profits and savings with suppliers. Tier-1 suppliers are left to decide how to meet the goals, and they can choose their own tier-2 and tier-3 suppliers (Levy, 2014: 23, 27). The risks are (1) failure to meet expectations will cost a supplier a lot of business, which could lead to its demise, and (2) suppliers may be subject warranty claims when parts fail, and product liability claims if the failure resulted in bodily injury or property damage (Peters, 2016). An example of the first was Chrysler's termination of a deal with Collins & Aikman over price and quality concerns regarding a bumper for its Ohio-made Jeep Liberty (Levy, 2004).

Another far-reaching consequence of suppliers assuming subassembly work has been the standardization of final assembly procedures for different model vehicles. In other words, when the same modules are used in different models, it is easier if those modules are assembled in the same order regardless of what model is being assembled. Given the tight schedules and close coordination between assemblers and tier-1 and tier-2 suppliers that just-in-time manufacturing requires, standardizing the process saves money (Harbour Consulting, 2004). Conversely, the commonality of parts and the standardization of assembly processes enable companies to assemble more models on one line. A key for an assembler's efficient operation, then, is rapidly and inexpensively making the necessary changes for different models. (An example might be re-programming welding machines instead of swapping one type for another.)

Harbour Consulting (2004) believes that this results in the more efficient use of facilities. For example, greater demand for one model produced by one plant and little demand for another made at a second plant could lead to overtime at the former and underutilization of labor and equipment at the latter. If the second plant could quickly and easily switch between production setups for the two models, then overtime could be reduced at the first plant and the second plant's fa-

cilities would be better utilized. (This also means it is easier to fill niche markets – Durbin, 2006). This can only happen if there is a just-in-time supply system, sufficient commonalities between the two vehicles' components, the assembly sequences are standardized, and the same equipment can be used for either model with little or no change.

While relationships among assemblers and suppliers may be closer and more extensive, they are not cozy. Assemblers want lower prices from tier-1 suppliers regardless of their own demand levels (and the subsequent impact on per-unit costs of suppliers) and any increased costs faced by suppliers (Levy, 2012: 20).[33] Furthermore, assemblers want to continue reducing the number of suppliers with whom they deal to trim further their own costs and increase efficiency.[34] Indeed, the number of supplier *companies* has fallen as companies merge or leave the business. Mergers and acquisitions among and by suppliers are done for a number of reasons. A larger size enables the new company to offer more products and/or integrate components into a module, thereby spreading overhead costs and reducing per unit costs. Larger companies also are better able to follow and service their clients around the world, making themselves more valuable to clients and more likely to get contracts. A recent example of these is ZF Friedrichshafen's purchase of TRW (Associated Press, 2014). (TRW has operations in Ohio.) Tier-1 suppliers, in turn, are trying to reduce the number of their suppliers in order to reduce their own costs and improve efficiency (Levy, 2004; 2014: 14).

Yet, with more invested in suppliers, assemblers and even tier-1 companies have been known to aid their crucial suppliers with staff or loans to avoid costly delays in production.[35] The recession's impact on suppliers was not as bad it could have been precisely for those reasons (Levy, 2012: 25), despite the plant closures, visits to bankruptcy courts, and/or sales of unprofitable divisions. Ironically, some of the remaining suppliers are in a better bargaining position vis-a-vis assemblers because there are fewer of them producing fewer products, and they are stretched to the limit despite lots of overtime, the addition of third shifts, and/or increasing capacity to meet demands (Levy, 2014: 14; also Sedgwick, 2012b).

Despite closer ties with assemblers, suppliers have found more clients both inside and outside the industry as they have sought stability in the wake of the Great Recession. Within the industry, U.S.-based suppliers now make parts for foreign-based assemblers operating here, and foreign-based suppliers with operations here make parts for the Detroit Three (drawn from Haider, 2016; Peters, 2016). These changes represent a weakening of the *keiretsu* ties that had been advantageous for Japanese-based assemblers in the past.

TECHNOLOGIES FOR PRODUCTION PROCESSES AND VEHICLES

Innovative technologies have been an important part of creating new parts, modules and vehicles as well as improving productivity at the plant. Computer-aided design (CAD) software and equipment, which dramatically reduced the time and people required to design parts and model a proposed new vehicle, has become well established (Levy, 2010: 20). More recently, it has been used in 3D printing, a process that adds material layer by layer at various areas within a spatial frame to create almost any shape in a matter of minutes, further reducing the time, cost and tools required by the industry to create prototypes (Levy, 2014: 25). This is just one example of broader computer use in production processes, including continuing automation to improve productivity (Haider, 2016; Peters, 2016). Assemblers and suppliers use the Internet to communicate quickly and easily; Petrillo (2016) notes "web-based industry exchanges have dramatically affected inventory management; component suppliers can now publish their production schedules online, allowing assemblers and retailers [i.e., original equipment and replacement market customers, respectively] to accurately plan purchases."[36]

Many innovations have made vehicles safer. Petrillo (2016) mentions the improved stopping distances, heat dissipation, durability and reduced dust and noise of ceramic-lined brakes compared with semi-metallic ones. Other examples include tire pressure monitors, inflatable curtains, knee and side air-bags, rear view mirrors with expanded fields of vision, rear view cameras linked to dashboard monitors, and anti-lock brakes (Levy, 2010: 19; 2012: 17). Adding such safety features has been credited with saving thousands of lives (Levy, 2014: 13, 18).[37] Others, such as catalytic converters and low-sulfur diesel fuel, have reduced air pollution. Some simply are better; for example, carburetors have virtually disappeared due to the superior air-fuel mixture control of modern fuel injectors (Miles, 2016). Improving fuel efficiency, driven by increasing CAFE standards, has been achieved by making vehicles lighter, notably with various lighter materials – aluminum, plastics, magnesium, carbon-fiber composites, and the adhesives to bond them – replacing heavier materials (Hagerty and Ramsey, 2014).[38]

However, improvements may have a price or come with a trade-off. Complying with pollution, safety and CAFE standards impacts vehicle performance: the better brakes and new, stronger-but-lighter-weight steels are more expensive (Petrillo, 2016; Gearino, 2016b, respectively); aluminum wheels weigh less and work better with rubber than steel wheels, but cost more per pound than does steel; reduced vehicle weight has improved fuel economy – but, *ceteris paribus*, that reduces safety in collisions, and adding pollution control equipment adds weight to a vehicle. Achieving these goals forced manufacturers to adopt complex solutions that increased vehicles' costs (Levy, 2014: 18).[39]

Other innovations beyond weight reduction have improved fuel economy and reduced pollution. Gasoline and diesel engines have become cleaner and more fuel efficient, with the former extracting nearly twice as much power from a gallon of gas as they did in the mid-1980s (Eisenstein, 2012; Whoriskey, 2011).[40] Adding turbochargers helps meet CAFE stan-

dards and may lower the number of cylinders needed without sacrificing performance (Miles, 2016).[41]

Technical innovations aimed at improving fuel efficiency are not limited to engines, but have occurred and are happening throughout the powertrain and other vehicle systems. Transmissions with more forward gears than the conventional four- and five-speeds have fewer parts, weigh less and perform better when accelerating or maneuvering in traffic (Harbour Consulting, 2006: 170-171). More recently, "automated manual" transmissions and dual clutch systems have appeared (Peters, 2016), and continuously variable transmissions (CVTs) have been reintroduced.[42] Tires have been designed for reduced rolling resistance (O'Hollaren, 2016), and vehicles long ago became more aerodynamic.

Perhaps the least-publicized but most extensive set of changes improving vehicle performance one way or another has been the implementation of "drive-by-wire" systems. Analogous to aircraft "fly-by-wire" systems, manual, mechanical, hydraulic and pneumatic control systems in motor vehicles have been and are being replaced by lighter-weight, more reliable electronic control units (ECUs, colloquially referred to as computers). Movements of controls – steering wheels, accelerator and brake pedals, etc. – are converted to electronic signals transmitted to ECUs, which receive data from sensors, perform complex calculations to determine how actuators move parts within safety limits – all done through electric wires (drawn from Wikipedia, 2016). Familiar applications include braking (including anti-lock braking and collision avoidance) and various aspects of engine and transmission operations; among the less familiar are new suspension components (drawn from Haider, 2016; Peters, 2016).[43]

Increasing CAFE requirements, the highly variable price of gasoline and concerns about greenhouse gas (GHG) emissions have lead people and organizations inside and outside of the industry to investigate alternative energy sources for powering vehicles. These include diesel fuel (including biodiesel), natural gas, ethanol and electricity.[44] Each has its advantages and drawbacks. Diesel engines are more fuel efficient than gasoline engines, able to go 25-30 percent farther per gallon because they run on a leaner mixture of fuel and air. That also means, *ceteris paribus*, they emit less CO_2 than gasoline engines and accelerate faster. However, diesel engines cost more for a number of reasons: they must be sturdier and heavier because they operate at higher pressures, and their fuel injection system is more complex; diesel fuel is more expensive, and both face stricter emission standards in the U.S. than in Europe.[45] In contrast to diesel engines and fuel, engines using natural gas emit fewer pollutants than gasoline, but such vehicles have had limited ranges (Heywood, 2006: 62) and natural gas isn't always price-competitive with gasoline (Peters, 2016).

Unlike natural gas and petroleum-derived fuels, ethanol is a renewable energy source because it is derived from crops (Rohter, 2006; Wikipedia, 2016).[46] It has a long history as a fuel, and has a higher octane content than gasoline (Green, 2006).[47] Engines using ethanol are not substantially different from those using gasoline (Green, 2006). In fact, millions of flexible fuel engines, running on either gasoline or an 85::15 ethanol-gasoline blend (known as E85), have been made.

However, other gasoline engines may be limited to a blend with as little as 10 percent ethanol (E10) (Wikipedia, 2016). Ethanol is less volatile than gasoline, making cold engines are harder – and explaining why it is blended with gasoline. It also is more corrosive than gasoline, but that disadvantage has been easy to remedy.

Despite their advantages, alternative fuels such as natural gas, ethanol and biodiesel face limitations: (1) even if produced on an industrial scale, they become viable supplements or replacements only when the price of oil is sufficiently high; (2) there currently is no distribution network comparable to that for gasoline; and (3) it is questionable whether any can be produced in sufficient volume to replace petroleum-derived fuels. Ethanol and biodiesel production also faces questions regarding environmental impact. Choi (2006) cited a University of Minnesota study comparing the two that concluded biodiesel was the better choice. Soybean-based biodiesel fuel returned more energy and produced less greenhouse gases when compared with corn-based ethanol production. It also entailed less nitrogen, phosphorus and pesticide pollution. Still, Choi noted one limitation found by the scientists: "*Dedicating all current U.S. corn and soybean production to biofuels, however, would meet only 12 percent of gasoline demand and 6 percent of diesel demand*. Prairie grass may provide larger biofuel supplies with greater environmental benefits" (2006: 38, emphasis added).[48] Corn, ethanol and biodiesel production have since risen, but the point remains that they are still far from replacing petroleum-derived fuels, which, along with natural gas, ultimately remain finite.

Hence the interest in electrically powered vehicles – that and meeting CAFE requirements of 42 miles per gallon in 2020 and 54-plus in 2025 (Krisher and Durbin, 2016; Mitchell, 2016).[49] Battery-powered vehicles date to the early 20th century. Their initial advantage of fewer moving parts – which meant fewer breakdowns – was out-weighed by their bulk, limited range, lengthy recharge times and slower acceleration rates. In addition, gasoline was cheap, readily available, and easy to transport (Vellequette, 2008). The advantages of gasoline remained significant for years even as batteries improved, gasoline prices would spike, and concerns about pollution grew (battery-powered vehicles emit no pollutants).

Recent technical advances have companies seriously pursuing battery power. Neil (2006) described the changes by comparing GM's EV [Electric Vehicle] 1, the most advanced solely battery-powered car from the mid-1990s, with Tesla's Roadster. The EV1 used nickel metal hydride batteries that, under ideal conditions, would last about 150 miles, with a full charge taking eight hours. The Roadster uses lithium-ion batteries that last for 250 miles, with a full charge taking 3.5 hours; and it comes with a portable charging pack so that it does not exclusively rely on its home charging station. The company also claimed the Roadster can accelerate from 0 to 60 miles per hour in four seconds, and has a top speed of 130 miles per hour. While the Roadster represents a significant technical advance, it remains an exotic, sporty vehicle priced far above the range of most consumers. Economies of scale and continuing advances have reduced battery production costs by 65 percent in the last five years, while improved technology has doubled the single-charge range from 100 to 200 miles – both important practical considerations for mass market vehicles (Mitchell, 2016) such as GM's Bolt

(which can go from 0 to 60 in 6.5 seconds) or Tesla's Model 3 (Krisher, 2016). Many car makers also followed the trail-blazing Toyota Prius by also developing hybrid vehicles.[50] The U.S. government has purchased thousands of hybrid vehicles in support of the market (Keane and Green, 2010).

Hybrids are very fuel efficient, coming close to or even exceeding the CAFE goals, but they and all-electric vehicles remain relatively expensive even after factoring-in any tax credits (Peters, 2016). Incorporating hybrid technologies adds to a vehicle's cost,[51] with owners usually operating vehicles for years before recouping the extra costs by saving on gas.[52] The fact that only 35 percent of hybrid owners in one survey bought another hybrid in 2011 was interpreted as indicating most owners had not recouped the higher prices when matched with comparable non-hybrid models. Hybrids also compete with fuel-efficient non-hybrid subcompact and mini models. Automotive News (2015: 14 & 17) recorded U.S. sales of models "sold exclusively with electrified powertrains" of 336,130 in 2014, down from 359,295 in 2013. Corresponding sales of subcompact and mini models totaled 828,742 and 784,681. These figures are 4.2, 4.6, 10.5 and 10.0 percent of U.S. car sales, respectively.[53] While hybrid technologies also are used in light trucks (see Boudette, 2016), it may be difficult to apply them to medium- and heavy-duty trucks because they need more power (Peters, 2016).

As with alternative fuels, systemic issues need to be resolved before EVs are widely adopted. Organizations – particularly governments, manufacturers and utilities – must address the issues of electric grid capacity and reliability,[54] safety, standardization and recharging station locations – public garages, curbside meters and parking facilities. Some progress on these issues is evident. General Electric developed a charging station years ago; more recently, Lear has developed a high-voltage home charging station (Haider, 2016). Delphi, among others, was developing a wireless charging system in which pads underneath parked vehicles transmit 3,300-plus watts to the vehicles' receivers; it worked as fast as most residential plug-in chargers (Colias, 2010). American Electric Power has proposed installing "1,275 [EV] charging stations over several years, including 250 available to the public" (Gearino, 2016c: C1). Currently, though, Tesla has seven charging stations in Ohio (Gearino, 2016d).

Fuel cells are the other power source for EVs, producing electricity as a result of a chemical reaction. Although not as efficient as batteries, they have three advantages: they can be adapted to any size vehicle without loss of efficiency (Chang, 2014; Webb, 2012), can be quickly refueled and range over 300 miles (Irwin, 2016). The cost of fuel cells also has fallen by 95 percent (Chang, 2014). Those using hydrogen emit only heat and water vapor as by products, while those using other fuels produce few emissions. Hydrogen storage is less of a problem because tanks have been designed to diffuse hydrogen into the air in non-flammable concentrations if punctured or leaking (Thomas, 2008). Given equivalent units of fuel, hydrogen-based fuel cell vehicles are about twice as efficient as those powered by internal combustion engines (Harbour & Associates, 2001; Wald, 2004). Indeed, Honda's current model is rated at the equivalent of 68 miles per gallon (Irwin, 2016). Hydrogen-based fuel cell-powered buses have recently joined the Stark Area Regional Transit Authority fleet (Shingler, 2016a).

Yet systemic obstacles to widespread use remain. Although progress has been made in reducing the size and weight of fuel cells (Kageyama, 2008), they have been difficult to make and not completely reliable in freezing weather (Jones, 2008a). Hydrogen does not freely exist on Earth, and producing it depends on current energy sources. The sources are either expensive or the technology for using them is not widely available – and that includes electrolysis powered by the sun, wind and water. The current practice of extracting hydrogen from natural gas (coal is another source of hydrogen) produces about one-half of the greenhouse gases that a gasoline engine does, but cost the equivalent of $3 per gallon in 2008 (Thomas, 2008). Once produced, hydrogen must be transported to a storage location before being distributed to vehicles. Although the network of hydrogen refueling stations is expanding (Irwin, 2016), a distribution system equal to that of gasoline will take years. Nevertheless, hydrogen vehicles are headed to a few showrooms (Chang, 2014; Irwin, 2016).

Self-driving vehicles currently are the most widely discussed innovation in popular media. Cursory readings often leave readers with the impression the mass-market debut of fully autonomous vehicles carry passengers and freight without human intervention is just around the corner, but experts list a number of daunting technical problems:

- sensing equipment – cameras, radar, lidar (a portmanteau of laser light and radar), etc. – must become more effective, especially in inclement weather;
- the software linking sensors to vehicle controls has to anticipate *every* possible scenario including police officers' hand signals and pedestrians in traffic;
- vehicle-to-vehicle and vehicle-to-infrastructure (lane markings, traffic signals, bridges, etc.) links must be established, maintained and seamless transferred.

All of this is at least a decade in the future, if at all feasible. What may be closer to realization – maybe five years away – are nearly autonomous vehicles that run over restricted courses; i.e., such vehicles cannot get out of the area, and most human-driven vehicles cannot get into the area. Testing vehicles in these isolated and controlled circumstances is part of ongoing research (drawn from Truett, 2016).[55]

THE TRANSPORTATION RESEARCH CENTER

The Transportation Research Center is a 4,500-acre proving ground and testing facility principally used for evaluating ground transportation equipment and components. Located on the northeast side of U.S. Route 33 halfway between Marysville and Bellefontaine (or about 40 miles northwest of Columbus), its office address is 10820 OH-347, East Liberty, Ohio. It is one of about 50 such facilities in the world, and employs well over 400 people – including at least 100 drivers.

The Center has 15 outdoor test tracks. An endurance track is used to study the stress of typical highway use, and usually more than one vehicle is on the track at any given time. Others – a bumpy incline, various tracks with less-than-ideal characteristics, off-road and rocky obstacle courses, water hazards, etc. – test vehicles under conditions that can be extraordinary; a 7.5-mile oval is used for tests conducted at 140 or 150 miles per hour. The Center also has facilities for conducting bio-mechanical research, and evaluating crash-worthiness, crash-avoidance systems, thermal extremes, emission controls, and – most recently – self-driving vehicles.

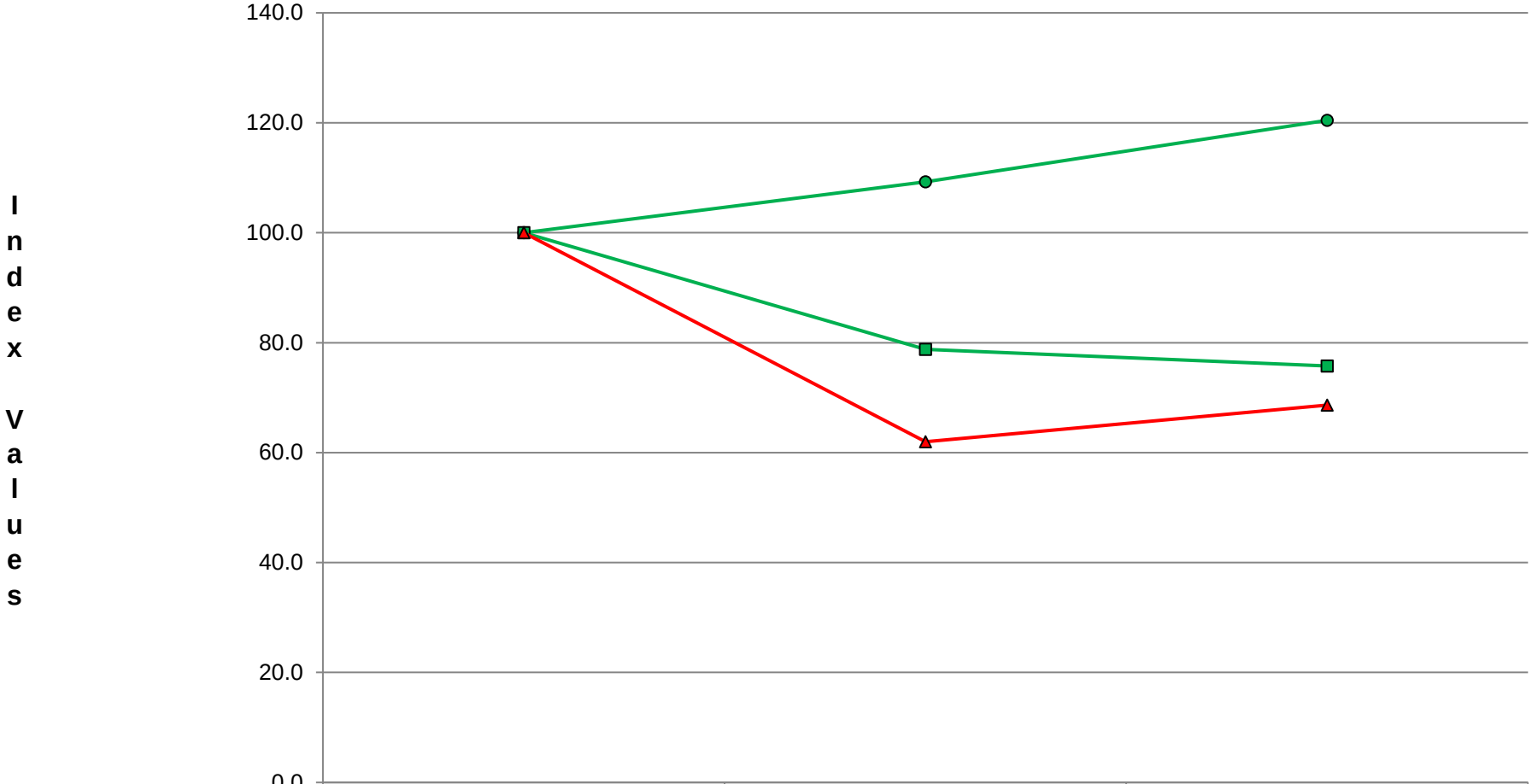
The Center is used by various clients – car, truck and bus assemblers, parts makers, lubricant producers, and ATV and motorcycle manufacturers – and assures the confidentiality of results. Smaller companies have may use it in lieu of establishing their own test facilities. However, the National Highway Traffic Safety Administration may be the single most frequent client; it maintains an office there.

The Center opened in 1974, and was a key factor in Honda's decision to located manufacturing facilities in that area of the state. While Honda now owns the land, the Center has retained ownership of the buildings and other assets; it ultimately is controlled by the Ohio State University (OSU). Consequently, it is a non-profit organization with revenues in excess of costs designated to fund vehicle research grants through OSU's College of Engineering (drawn from Gearino, 2016a; Wikipedia, 2016). (OSU also has its Center for Automotive Research on Kinnear Rd. in Columbus.)

The latest project involving the Center and OSU is testing autonomous and connected self-driving trucks on a stretch of State Route 33 that will use embedded high-capacity fiber optic cable and wireless sensors (Ludlow, 2016).

History and Projections: 2002/4--2022/4

Motor Vehicle Industry Output and Jobs



	2002/4	2012/4	2022/4
U.S. MV GDO 04-14-24	100.0	109.3	120.4
U.S. MV Jobs 04-14-24	100.0	78.8	75.8
Ohio MV Jobs 02-12-22	100.0	62.0	68.6

Sources: Henderson, ODJFS/LMI

THE NEAR AND LONGER TERM OUTLOOKS

Many of the trends identified earlier are expected to continue into the foreseeable future, but analysts may differ on the details, and new developments will emerge. Trends about which they prognosticate include employment, sales volumes, industry growth, exports, fuel prices and the possibilities for new technology.

The chart above indexes the history and projections for three industry subjects: U.S. motor vehicle industry gross duplicated output (GDO for NAICS 3361-3, green circles) and employment (green squares), plus industry employment for Ohio (red triangles). The chart shows U.S. motor vehicle industry GDO rose 9.3 percent (109.3 minus 100.0) from 2004 to 2014. The U.S. Bureau of Labor Statistics (BLS, 2015) predicts industry output will increase 10.2 percent from 2014 to 2024. The net change in output from 2004 to 2024 is expected to be 20.4 percent (120.4 minus 100). By comparison, data in Appendix table A17 project total U.S. GDO to be 38.3 percent larger in 2024 than in 2004. In essence, the motor vehicle industry is expected continue its cyclical, slower-than-average long-term growth, and may become a smaller part of the economy. Figures in Appendix table A17 show most of the industry growth is expected at assembly plants (3361).

The chart above also illustrates roughly comparable changes in industry employment seen in the past and forecast for the future. U.S. industry employment fell a net 21.2 percent from 2004 to 2014 (100 minus 78.8), and the U.S. BLS (2015) projects a net decline of 3.8 percent in the following decade (the index equals 75.8 in 2024). More detailed figures in Appendix table A17 present a similar history for each industry group: jobs in assembly and parts operations (3361 and 3363) fell 22.1 and 22.5 percent, respectively, from 2004 to 2014, while bodies and trailers jobs (3362) fell 14.6 percent. Employment in all three groups is projected to decline a bit more from 2014 to 2024, ranging from 2.8 percent in bodies and trailers to 4.2 percent in parts. In short, real industry economic growth (GDO) is not expected create industry jobs over the long term. Analysts credit this divergence to further automation at assembly and parts plants; an expected overall increase of imports, due to a continuing or increasing value of the dollar, also may be a factor (Haider, 2016; Miles, 2016; Peters, 2016; Petrillo, 2016). Further automation also may mean remaining workers will be more highly skilled than in the past (Miles, 2016).

Data from the Ohio Dept. of Job and Family Service's Labor Market Information division (ODFJS/LMI, 2014) show industry employment in Ohio (red triangles) fell 38.0 percent from 2002 to 2012 (100 minus 62); LMI projects only a slight increase by 2020 (from 62.0 to 68.6). Figures in Appendix table A17 show group job losses ranging from 20.2 to 41.8 percent during the 2002-2012 decade. Gains ranging from 5.4 to 12.8 percent are expected in 2012-2022 decade. The difference between the forecasts – positive gains expected by ODFJS/LMI vs. losses expected by the U.S. BLS – may be due in part to the differing time frames: 2012-2022 vs. 2014-2024. Figures in Appendix table A8 show the industry in Ohio and across the nation gained jobs from 2012 to 2014. Nevertheless, the gains expected in Ohio will not be enough to off-

set losses in the preceding decade. Net 2002-2022 losses for all three groups are expected to range from 13.2 percent in bodies and trailers to 38.7 percent in assembly, with parts and the industry total around 31 percent. In short, some jobs have been and may be regained, but most are not expected to come back.

The long-term prospects for the industry differ from shorter-term prospects. In the near term, Steven Szakaly, chief economist of the National Automobile Dealers Association, predicts sales of 17.1 million new light vehicles in 2017, less than the anticipated 17.4 million for 2016 and the record 17.47 million of 2015. He expects the market to be "stable… not growing [because] The industry has achieved record sales and pent-up demand is effectively spent" (quoted by Snyder, 2016). (By comparison, sales were 16.1 million in 2007, the last year before the 2008-2009 recession.) Szakaly predicts growth in light truck sales will offset a decline in car sales. 2017 sales are contingent on an expected 2.6 percent increase in overall economic growth, the addition 150,000 to 180,000 jobs per month, and gasoline prices remaining around $2.00 per gallon. Sales could go as high as 17.3 to 17.4 million under more favorable economic conditions (drawn from Snyder, 2016). *IBIS World* analysts vary a bit in their mid-term forecasts to 2021: Peters (2016) predicts slow growth; Miles (2016) forecasts sales declining an average of less than 1.0 percent per year; and Haider (2016) expects slow growth *or* a decline in vehicle sales. No one expects sales and production growth to continue at the high rates seen coming out of the Great Recession. They cite a variety of factors: pent-up demand has been satiated; rising interest rates, input expenses and the value of the dollar will make vehicle more expensive here and abroad; the economy is expected to grow and disposable income may rise, but consumers may "tighten" consumption; and consumer confidence may decline, rise or be uncertain – depending on who you read.

FTR, an organization following the freight transportation industry, expects U.S. class-8 truck production to end 2016 at about 230,000, down from 320,000 in 2015; 2017 and 2018 production is forecast to be 231,000 and 264,000 units, respectively. Medium-duty truck production (classes 4-7 in FTR's analysis) is expected to be about 210,500 in 2016, up from 188,100 in 2015; 2017 and 2018 production is predicted to be 201,800 and 206,000 units, respectively. These are supported by expectations of 2.0 percent annual growth in GDP (drawn from Kilcarr, 2016). Similarly, Peters (2016) anticipates aggregate sales and production in 2016 will be lower than in 2015 because pent-up demand has been met and freight traffic has declined a bit. She expects a recovery beginning in 2017 with generally slow growth to 2021 driven by the need to replace an aging fleet as well as an improving global economy despite a high value of the dollar; industry employment is expected to follow.

Sales and production of parts are expected to closely follow sales and production of new motor vehicles principally because the latter are almost always the market for the former (Haider, 2016; Miles, 2016; Peters, 2016; Petrillo, 2016).[56] Even in the tire industry, where replacement sales are far larger than original equipment sales, output is expected to be flat or growing at a rate less than predicted for the economy as a whole due to slower growth in the total number of ve-

hicles on the road – of which new vehicle sales are a part. Employment is expected to decline slightly. Increasing imports, despite duties – and more than off-setting any increase in exports, may play a role in this slower-than-average growth (O'Hollaren, 2016).

Within the overall sales forecast are a number of trends. The high oil prices of 2008 hurt consumers in many parts of the world (Charlton, 2008). The Great Recession sharply reduced oil prices from that peak. Prices are volatile, and shifts between larger and smaller light vehicles will occur as prices rise and fall, but prices are expected to trend higher over the long term.[57] A belief that any dip in oil prices is temporary, rising CAFE standards, efforts to reduce U.S. dependence on foreign oil and the negative effects of fossil fuels (Levy, 2014: 13) could shift the spectrum towards smaller, fuel efficient vehicles.[58] Any added vehicle costs may be offset by money save in reduced fuel consumption. Similar programs to increase fuel efficiency and reduce greenhouse gas emissions (CO_2, HFCs, N_2O and CH_4) from medium- and heavy-duty trucks and buses by 2027 are in place. Regarding the latter, increased costs of $12,000 per vehicle should be recouped in two years through fuel savings (Vlasic, 2016).

Predicting technological changes is an iffy endeavor because no one can be sure beforehand how or whether things will work at an industrial scale. Nevertheless, *IBIS World* analysts commonly point to increasing CAFE requirements, in place since 2011, as a force impacting all segments of the industry. Miles (2016) expects established diesel, electric vehicle (EV) and hybrid technologies will increase their market shares in the next five years as they become more competitive – and also reflecting values favoring frugality and reduced emissions (also see Peters, 2016, in that regard). In particular, a substantial increase in EV production would mean fewer internal combustion (IC) engines will be produced – and consequently, fewer transmissions would be produced.[59] EVs currently are more expensive than IC-powered vehicles due to the high cost of lithium batteries. However, the price of batteries is expected to fall during the next five years, and Tesla's silicon anodes may help (Peters, 2016). On the other hand, more efficient IC engines, lower oil prices or high alternative power prices could counter any move toward EVs. Despite possible growth of EVs, Miles (2016) expects gasoline engines to remain the overwhelming power source for motor vehicles. At this point, it is fair to say companies, whether independent or assemblers' subsidiaries, will continue research and development activities for all types. Analysts expect the wider use of innovations beyond vehicle power sources. Haider (2016) foresees increased use of electrical and electronic systems in many parts of vehicles: dashboards, entertainment, start-and-stop systems to save fuel, and as part of drive-by-wire re-placements of heavier and less reliable manual, mechanical or hydraulic systems used in steering, suspension and braking systems. Steering columns and shafts, and the hoses, fluids and belts associated with power steering would be eliminated; actuators and controllers could replace conventional dampers and roll bars in suspension systems (Peters, 2016); electronic park brakes would not require cables or drums (Petrillo, 2016). In sum, implementing drive-by-wire technologies will make for lighter, more reliable and better performing vehicles that are less complex and easier to assemble (Peters, 2016). Alternative materials – particularly aluminum and carbon fiber – might further displace

steel if advanced manufacturing processes lower costs. Beyond CAFE requirements, heated seats and automatic seat belts are expected to become more common, driven by consumer demand and more stringent safety regulations (Peters, 2016). Self-driving cars remain problematic due to technical limitations (White, 2014).

Automation at assembly and parts plants is expected to continue as companies, facing domestic and international competition, seek to reduce costs. This will require capital investments, which may focus more on upgrading existing plants as opposed to establishing new ones (Peters, 2016). No one has ventured any guesses how the ranks of assemblers may change, but Peters (2016) expects previously noted changes among tier-1 suppliers (see Levy, 2014) to continue. These include acquisitions providing synergies with existing product lines, divestitures of under-performing assets, or simply leaving the industry for other business ventures. Imports of vehicles and parts generally are expected to grow faster than exports – if exports grow at all; consequently, the deficit in the balance of trade is predicted to grow in either case (Haider, 2016; Miles, 2016; Peters, 2016).

See Tables A8 and A17

ABOUT THE BODIES-AND-TRAILERS GROUP

Products from the four industries in this group (NAICS 3362) are used by individuals and organizations. In that sense, the group mirrors a basic division of the larger industry groups (3361, 3363 and related industries): *consumer accessories or leisure items* such as motor homes, pickup trucks caps, or towed equipment – campers, horse and boat trailers, etc. – in one segment, and *capital goods components* such as truck cabs, bus bodies and trailers for hauling freight or job-related equipment and supplies in the other. Consequently, industry output is highly cyclical for the same reasons cited earlier: motor home sales and production rise when jobs are plentiful and consumers are financially confident; and shipping more freight in an expanding economy eventually requires more trucks and trailers.[60] Sales revenue for the group is nearly equally split between the two segments (Peters, 2016).

This group is mature, like most other motor vehicle industries, in the sense that the fundamental products are well established is the market place, as are the companies producing them, long-term growth parallels the overall economy, and competition is based price and features. The industry is somewhat globalized; companies making large products set up manufacturing facilities in the regions they serve because it generally is less expensive then shipping such items great distances. Consequently, most imports and exports are smaller items; most exports go to Canada, and most imports come from Mexico and Canada. Import values exceed export values by a ratio of about 8 to 7 (Peters, 2016). As previously mentioned, global locations also allow companies to circumvent trade barriers.

On the other hand, the industry differs from other motor vehicle industries in a number of ways:

- production is not concentrated; the two largest companies, Thor Industries (whose Airstreams are made in Ohio) and Berkshire-Hathaway (the ultimate parent company), have single-digit percentage portions of total industry group revenue;
- it is labor-intensive, not capital-intensive;
- except for motor homes, most goods are accessories made in low volumes, not subject to much automation;
- hybrid electric vehicles – perhaps the coming thing for light vehicles (33611) – are prohibitively expensive because motor homes need much more power than light vehicles;
- most other new technologies are incorporated from third-party vendors;
- the industry receives little in the way of government assistance (Peters, 2016).

Long-term industry growth may be slightly greater than for the economy as a whole due to the increasing portion of the population age 50 and over, the prime demographic for this group. Industry employment numbers may rise as a consequence. Imports and exports also are forecast to increase at about the same rate, with the balance of trade deficit remaining slight but steady (Peters, 2016).

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ASSEMBLER PROFILES

There are six high-volume motor vehicle assemblers with at least one such establishment in Ohio. They are Fiat Chrysler Automobiles (FCA), Ford, General Motors (GM), Honda, Navistar and Paccar. All share a number of characteristics:

- they make some of their own parts;
- they are publicly held companies;
- they have more than one brand;
- they are researching and/or developing alternative and supplemental power sources for their vehicles;
- they have subsidiaries; often these are secondary businesses (with NAICS codes outside of the motor vehicle industry) supporting their principal business, but also offering goods and/or services that may be unrelated to the industry;
- they have multi-continental operations, which means they have revenue sources as well as employment outside the state of Ohio and N. America.[61]

Given the size and complexity of these companies as well as space limitations on this report, the individual profiles focus on recent news and planned changes to company operations in Ohio after selected highlights.

Ohio

Fiat Chrysler Automobiles in Ohio

FCA
FIAT CHRYSLER AUTOMOBILES

Prepared by: Office of Research
Ohio Development Services Agency
December 2016

R082316A

Fiat Chrysler Automobiles NV

Website: www.fcagroup.com
2015 Revenue: €110,595,000,000 (approximately $122,730,000,000, which would have ranked 35th overall in the world if included in Fortune's Global 500).
Profit: €632,000,000 (approximately $701,300,000) – 2.2 percent of revenue (Usforex, 2016; Wikipedia, 2016).
2015 Light Vehicle Production for its Chrysler Group:
in N. America: 2,900,834 – ranked 3rd with 16.5 percent of all N. American light vehicle production;
in Ohio: 564,934 – ranked 2nd in the state, with 19.5 percent of its N. American light vehicle production here (Automotive News, 2016).

Fiat Chrysler Automobiles (FCA) is headquartered in London, the United Kingdom, although it is incorporated under Dutch law and still has management and other facilities in Turin, Italy. Its principal business is manufacturing motor vehicles; its 2015 revenue would rank it 6th in the world among comparable companies. The two main divisions are *FCA US* (aka the Chrysler Group – still part of the Detroit Three, with headquarters in Auburn Hills) whose brands also include Dodge, Jeep and Ram; and *FCA Italy* (aka the Fiat Group – part of Others in the market share section) with other brands Abarth, Alfa Romeo, Lancia (for now) and Maserati. (Ferrari became an independent company in January, 2016.) Other marques are Automotive Lighting, Magneti Marelli, Mopar (all components), VM Motori (engines), Comau (automation) and Teksid (its foundry). Sergio Marchionne is the CEO, and John Elkann is Chairman of the Board; Michael Manley is President and CEO of the Jeep brand. FCA's latest worldwide employment figure is 225,587 (FCA, 2016; Wikipedia, 2016).

The Chrysler Group was the top-ranked light truck assembler in Ohio during 2015, and 2nd-ranked in overall light vehicle output; the Jeep Cherokee the highest volume light truck produced here. FCA US has the lightest footprint of all high-volume light vehicle assemblers. Its three manufacturing plants here – two assembly plants in Toledo and a powertrain operation in Perrysburg – currently employ about 6,200, with another 750 directly employed by Mobis and Kuka, but working under its aegis at the Toledo complex (Automotive News, 2016; Office of Research, ODSA, 2016a).

Current plans call for moving Jeep Cherokee production, which started at Toledo North in June, 2013, out of state after March, 2017. Wrangler production will replace it in March, 2018. A new Jeep pickup probably will be added at Supplier Park (fka Toledo South or Stickney), and diesel engines may become available for U.S. consumption (Linkhorn, 2015).

Ohio

Ford Motor Company in Ohio

Prepared by: Office of Research
Ohio Development Services Agency
December 2016

R082316A

Ford Motor Co.

Websites: www.ford.com, www.media.ford.com, www.corporate.ford.com.
2015 Revenue: $149,558,000,000 – ranked 9th overall in the U.S. and 21st overall in the world;
Profit: $7,373,000,000 – 4.9 percent of revenue (Fortune, 2016).
2015 Light Vehicle Production:
in N. America: 3,105,003 – ranked 2nd with 17.6 percent of all N. American light vehicle production;
in Ohio: 52,847 – ranked 4th in the state, with 1.7 percent of its N. American light vehicle production here (Automotive News, 2016).

Ford was the 5th-ranked motor vehicle assembler in the world, as judged by 2015 revenue, and the only one of the Detroit Three not to file bankruptcy in 2009.[62] The company's principal business is assembling vehicles of all sizes as well as producing powertrains and major stampings, among other components. Its other brands are Lincoln and Motorcraft. (The latter sells AM parts, but much of Ford's parts production was spun off to Visteon years ago.) Ford has manufacturing operations on every continent as well as interests in, or joint ventures with, smaller industry manufacturers around the world. It also owns Ford Credit, which principally finances motor vehicle sales. The company's world headquarters is in Dearborn, Michigan, where William Clay Ford Jr. is Executive Chairman, Mark Fields is President and CEO, and Bruce Hettle is Group Vice President for Manufacturing and Labor Affairs (Ford, 2016; Wikipedia, 2016). Its latest worldwide employment figure is 199,000 (Fortune, 2016).

While the Ohio Assembly plant at Avon Lake began medium-duty (F650/F750) truck production in January, 2015, its highest volume product continues to be Econoline chassis for specialized vans, and it recently added F350/F450/F550 cab production as part of a $200 million investment announced earlier this year (McCafferty, 2016); well over 1,400 work there. Engine Plant No. 1 at Brook Park makes 3.5L EcoBoost and 3.7L Duratech engines, while the Lima plant makes the V-6 versions of the same; 1,600 work at the former, and 1,200 at the latter. 1,600-plus work at the Sharonville plant, which makes 5- and 6-speed transmissions (Ford, 2016). Ford's total manufacturing employment in Ohio is about 5,900.

85.6 percent of Ford's planned $2.01 billion in investments in Ohio during the last four years was intended for its three parts plants (Office of Research, 2016b; Priddle and Snavely, 2015).

Ohio

General Motors in Ohio

Prepared by: Office of Research
Ohio Development Services Agency
December 2016

R082316A

General Motors Co.

Websites: www.gm.com
2015 Revenue: $152,356,000,000 – ranked 8th overall in the U.S. and 20th overall in the world;
Profit: $9,687,000,000 – 6.4 percent of revenue (Fortune, 2016).
2015 Light Vehicle Production:
in N. America: 3,390,370 – ranked 1st with 19.2 percent of all N. American light vehicle production;
in Ohio: 299,227 – ranked 3rd in the state, with 8.8 percent of its N. American light vehicle production here (Automotive News, 2016).

General Motors (GM) is the 4th-ranked motor vehicle assembler in the world, as judged by 2015 revenue. The principal business of the company is assembling light vehicles and medium-duty trucks as well as producing powertrains and major stampings, among other components. (Other parts operations were spun off to Delphi Automotive, which became a British firm also serving non-automotive industries, and non-motor vehicle subsidiaries were divested – all years ago.) The current company brands familiar to N. Americans are Buick, Cadillac, Chevrolet and GMC; others in various markets around the world include Baojun, Holden, Jie Fang, Opel, UzDaewoo (sic), Vauxhall and Wuling – either as subsidiaries or as joint venture partners. It also owns GM Financial, which has loan and lease programs for customers and dealers. GM's world headquarters is in Detroit, Michigan, where Mary Barra is Chairwoman and CEO, Dan Ammann is President, Alan Batey is Executive Vice President and President, N. America, and Alicia Boler-Davis is Executive Vice President, Global Manufacturing (GM, 2016; Wikipedia, 2016). Its latest worldwide employment figure is 215,000 (Fortune, 2016).

GM's Cruze is the second most popular car to come out of Ohio in recent history; a turbo-charged diesel version was added in 2016, and hatchback version is due in 2017. The 4,500 workers at the Lordstown assembly plant (including stamping and painting operations) comprise the plurality of the 9,600 employees at manufacturing establishments here.[63] There also are 2,000 making 6-speed front- and rear-wheel drive transmissions in Toledo, well over 1,300 at its Parma stamping plant, 1,100-plus at its Defiance foundry producing aluminum and iron engine-related products, and well over 500 making 6.6 L V8 diesel truck engines at DMAX (a joint venture with Isuzu) in Moraine. It also has a parts distribution center in Cincinnati (GM, 2016; Wikipedia, 2016).

The parts plants collectively have garnered 60.5 percent of the $506 million GM has planned to invest in Ohio during the last four years (Office of Research, 2016b). GM added to those figures in 2016 with its announcement of plans to invest $218 million at its Parma stamping plant (Shingler, 2016b).

Ohio

Honda Motor Company in Ohio

Prepared by: Office of Research
Ohio Development Services Agency
December 2016

R082316A

Honda Motor Co.

Websites: world.honda.com and ohio.honda.com
2015 Revenue: $121,624,000,000 – ranked 36th overall in the world;
Profit: $2,870,000,000 – 2.4 percent of revenue (Fortune, 2016).
2015 Light Vehicle Production:
in N. America: 1,862,491 – ranked 5th with 10.6 percent of all N. American light vehicle production;
in Ohio: 701,819 – ranked 1st in the state, with 37.7 percent of its N. American light vehicle production here (Automotive News, 2016).

Honda would be the 7th-ranked motor vehicle assembler in the world, judging by 2015 revenue and incorporating FCA within Fortune's Global 500 list.[64] The company's principal business is manufacturing light vehicles and powertrains as well as some additional parts. (Motorcycles, aircraft – including a joint jet engine venture with General Electric, marine engines and personal watercraft, power generators and lawn and garden equipment are other major products.) Its only other light vehicle brand is Acura. Even though headquartered in Tokyo and with operations on every continent, the plurality of revenue comes from N. America (SEC, 2016). Fumihiko Ike is Chairman of the Board, Takahiro Hachigo is President and CEO, Toshiaki Mikoshiba is, among other titles, President and CEO of American Honda Motor Co. (Torrance, Ca.), and Tomomi Kosaka is President and CEO of Honda of America Manufacturing (Marysville, Oh.) (Honda, 2016; Wikipedia, 2016). The latest world-wide employment figure is 208,399 (Fortune, 2016).

Honda currently assembles four car and two SUV models at its Marysville and E. Liberty locations, making it the top car producer, the 2nd-ranked light truck maker, and overall leader in light vehicle production in Ohio. Its Accord is the highest-volume model light vehicle made here. The latest news: Road and Track named the new Acura NSX – the only luxury sports car made in N. America – 2017 Performance Car of the Year (Gearino, 2016b); the new CR-V is turbo charged; and current plans call for adding Acura MDX production at E. Liberty in 2017. (There are no plans at this time to end MDX production in Alabama or end RDX production in E. Liberty.) 12,200-plus work in its manufacturing facilities, including 4,350 at the Marysville complex, 2,850 at the Anna engine plant, 2,250 at E. Liberty and 1,150 at the Russells Point transmission plant. At least 1,600 more make parts at subsidiaries known by other names. An additional 3,200-plus Honda employees are engaged in wholesale, logistical, research, development and other professional and technical services. Honda's *keiretsu* parts makers collectively employ well over 5,900 (Automotive News, 2016; Gearino, 2016a; Honda, 2016; Office of Research, 2016a).

Honda announced plans to invest $1.27 billion in its manufacturing facilities during the last four years, with 65.8 percent intended for powertrain operations and 26.8 percent intended for assembly plants. 530 new jobs were anticipated upon the completion of all projects (Office of Research, 2016b).

Ohio

Navistar International and PACCAR/Kenworth in Ohio

Prepared by: Office of Research
Ohio Development Services Agency
December 2016

R082316A

Navistar International Corp.

Website: www.navistar.com
2015 Revenue: $10,140,000,000 – ranked 281st overall in the U.S., not in the top 500 in the world;
Profits: -$184,000,000 – -1.8 percent of revenue (Fortune, 2016).

Technically a holding company, Navistar's world headquarters is in Lisle, Illinois, where Troy Clarke is President and CEO. It has manufacturing establishments in N. and S. America with additional facilities elsewhere. The company's principal business is assembling medium- and heavy-duty trucks and buses. It also manufactures military vehicles, truck and bus bodies and chassis, diesel engines and other OE and AM parts. (Customers may choose Cummins diesel engines.) It offers financial services through a partnership with GE Capital, and maintains a sales and service network. Prominent brands are IC buses, International trucks and defense vehicles, and N-series engines (Navistar, 2016). Worldwide employment is 13,800 (Fortune, 2016). Volkswagen has taken a 16.6 percent equity stake in the company; a full merger is possible (Taylor, 2016). Approximately 1,500 people are employed at the Springfield plant, with 600 more jobs anticipated as contracts with GM for vans and medium-duty trucks are implemented in 2018. At least 75 trucks are assembled each work day; the principal models currently made are the DuraStar and the WorkStar (Sanctis, 2016).

Paccar, Inc.

Website: www.Paccar.com
2015 Revenue: $19,115,000,000 – ranked 147th overall in the U.S., not in the top 500 in the world;
Profits: $1,604,000,000 – 8.4 percent of revenue (Fortune, 2016).

Paccar's world headquarters is in Bellevue, Washington, where Mark C. Pigott is Executive Chairman and Ronald E. Armstrong is the CEO. Its principal business is assembling medium- and heavy-duty trucks under various brands: DAF (Brazil and Europe), Leyland (United Kingdom), Kenworth (N. America and Australia) and Peterbilt (N. America). It also makes off-road trucks, powertrains and other parts (including Dynacraft batteries), winches and hoists, and has related leasing, sales, financing and repair operations (Paccar, 2016). 23,000 are employed worldwide (Fortune, 2016). Approximately 1,850 are work at its Kenworth plant in Chillicothe, which has the capacity to assemble 160 class-8 T680 or T880 trucks per day. The plant recently announced a $17 million investment for storage and retrieval (Balusik, 2016; Paccar, 2016).

APPENDICES

NAICS CODES: INDUSTRY DEFINITION AND EXAMPLES

Beginning with the 1997 Economic Censuses, the nation's industry statistics have been collected under the North American Industry Classification System (NAICS) (Office of Management and Budget, 1998). Establishments producing goods or providing services sufficiently alike are classified in the same *industry*. A six-digit NAICS code is assigned to each industry. Closely related industries formed an *industry group*. The first four digits of the code indicate the group to which the industries belong. (A five-digit code defines a subgroup when it subsumes more than one six-digit code; otherwise, it serves as an industry code.) Industry groups with common elements and shared characteristics comprise a *major industry* or *sub-sector*, and are indicated by the first three digits of the code. Most of the data from government sources used in this report have been collected under that system. (Slight revisions are available at <http://www.ntis.gov/naics>.)

Three groups from the *transportation equipment* sub-sector (NAICS 336) combine to form the core of the motor vehicle industry in this report. They are *motor vehicles* (3361, also referred to as assembly operations), *motor vehicle bodies and trailers* (3362), and *motor vehicle parts* (3363). The *tires* subgroup (32621) and *storage batteries* (335911) are included – when information is available – because most of the goods produced in those industries are original equipment or replacement parts for motor vehicles. Industries wherein most of the goods produced are not used in motor vehicles are excluded from this report, although some exceptions may be made for establishments at least mostly dedicated to motor vehicle parts. Diesel engine and automotive glass production (333618 and 327215, respectively) are examples of this.

The defining concept for the motor vehicle industry is manufacturing equipment for transporting people and goods over a network of roads. This definition excludes establishments producing ships, boats, railroad and aerospace vehicles and equipment. Also excluded for various reasons are establishments producing motorcycles, bicycles, military armored vehicles and tanks, all-terrain vehicles, go-carts, golf carts, racecars, snowmobiles, animal-drawn vehicles, children's vehicles and components thereof. After the discussion of the industry's impact on Ohio's economy, industries dependent on motor vehicles – suppliers of materials to the industry, makers of equipment used to manufacture motor vehicles-bodies-trailers-and-parts, wholesalers, retailers, gas stations, and repair services – are not included.

Motor vehicle establishments use production processes similar to machinery manufacturers (333): bending, forming, welding, machining and assembling metal, glass, rubber and/or plastic parts into components and finished products. However, some machinery is used to produce other goods, and the goods-moving machinery – agricultural, construction, and material-handling equipment – is not intended for highway use. Other people-moving machinery – elevators, escalators, moving sidewalks, etc. – is also classified in the machinery industry.

Examples of products made in various motor vehicle industries follow the NAICS codes and industry titles below.

The transportation equipment industries:

3361	Motor Vehicles.
33611	Automobiles and Light Duty Motor Vehicles.
336111	Automobiles. Establishments assemble complete cars (both uni-body or body-and-chassis) or produce car chassis alone. Manufacturing only car bodies, or assembling vehicles on a purchased chassis, is classified in 336211.
336112	Light Trucks and Utility Vehicles. Establishments assemble complete light trucks (body and chassis) or produce light truck chassis alone. Light duty trucks (class-1 through class-3) include minivans, pick-ups and sport-utility vehicles. Manufacturing only truck and bus bodies, or assembling vehicles on a purchased chassis, is classified in 336211.
33612	Heavy Duty Trucks. "Heavy-duty trucks" includes the medium- and heavy-duty (class-4 through class-8) trucks as well as buses, heavy-duty motor homes and other special-purpose, heavy-duty motor vehicles for highway use. Establishments assemble complete trucks (body and chassis) or chassis alone.
3362	Motor Vehicle Bodies and Trailers.
336211	Motor Vehicle Bodies. Establishments produce truck cabs as well as car, truck and bus bodies. These may be sold separately or assembled on a purchased chassis and sold as complete vehicles. Dump truck lifting mechanisms and fifth wheels are included.
336212	Truck Trailers. Examples also include truck trailer chassis, cargo container chassis, detachable trailer bodies, and detachable trailer chassis sold separately.
336213	Motor Homes. The defining element is the integration of the motor and the living quarters in the same unit. Whether or not the chassis is purchased is irrelevant. Car and van conversion is included if the work is done on an assembly line. Mobile homes are classified in 321991; customized cars and trailers not produced on an assembly line are classified in 811121.
336214	Travel Trailers and Campers. Examples include transport trailers for cars, camping trailers, horse and utility trailers.
3363	Motor Vehicle Parts.
33631	Motor Vehicle Gasoline Engines and Engine Parts. Examples of parts include carburetors, pistons, piston rings and valves – all of which are no longer broken-out into a 6-digit industry – as well as crankshafts, flywheels, ring gears, fuel injection systems and parts, manifolds, positive crankcase ventilation (PCV) valves, mechanical pumps, and timing gears and chains. Both original and rebuilt equipment are included. Other gasoline engine equipment such as belts are classified outside of the industry, as are stationary gasoline

engines and parts of the same nature but not for use in motor vehicles. All diesel engines, including those used in motor vehicles, are classified in 333618.

33632 Motor Vehicle Electrical and Electronic Equipment. Vehicular lighting fixtures are no longer broken out into a 6-digit industry, and bulbs are classified elsewhere. Older products include windshield washer pumps, alternators, generators, coils, distributors, ignition cable sets, wiring harnesses, instrument control panels, spark plugs, starters, and block and battery heaters. (Motor vehicle batteries are classified in 335911.) Newer products include electronic sensors and control units (the latter are colloquially referred to as computers), actuators, and information and entertainment systems. Similar equipment not used with motor vehicles is classified elsewhere, as are car alarms, car stereos and electric motors – even those for electric vehicles.

33633 Motor Vehicle Steering and Suspension Components. Examples include steering wheels, columns and gear boxes, power steering components, idler and control arms, drag links, rack and pinion steering assemblies, ball joints, struts, tie rod ends and shock absorbers. Springs, though, are fabricated metal products (332).

33634 Motor Vehicle Brake Systems. Parts include cylinders, drums, hose assemblies, calipers, pads, linings and shoes. Rubber and plastic hose and belting without fittings are classified in 326.

33635 Motor Vehicle Transmissions and Parts. Examples include various clutches; automatic and manual transmissions; automated manual transmissions; axles, axle bearings, and their assemblies; differentials; torque converters; constant velocity and universal joints; and transaxles – the last combines axle, differential and transmission functions in front-engine-front-wheel-drive and rear-engine-rear-wheel-drive vehicles. Both original and rebuilt equipment are included. Non-motor vehicle power transmission equipment is classified elsewhere.

33636 Motor Vehicle Seating and Interior Trim. Seat belts, and seat and tire covers also are included.

33637 Motor Vehicle Metal Stampings. Examples include bumpers, fenders, hard tops and other body parts – even metal hub caps – as well as moldings and exterior trim. Convertible tops are classified in 33639.

33639 Other Motor Vehicle Parts. Examples include, but are not limited to, air bags, catalytic converters and exhaust systems, convertible tops, fuel tanks, various filters, luggage and utility racks, framed mirrors, mufflers, resonators, radiators and cores, sunroofs, trailer hitches and tow bars, transmission coolers, wheel rims and windshield wipers. Heating-ventilation-air-conditioning (HVAC) systems are included, but are no longer a separate 6-digit industry. Both original and rebuilt equipment are included. Non-motor vehicle HVAC systems are classified elsewhere.

The related industries:

32621	Tires.
326211	Tire Manufacturing, except retreading. Includes pneumatic, semi-pneumatic and solid tires, inner tubes, and repair materials. Most new tires are produced for motor vehicles.
326212	Tire retreading. The feature distinguishing this industry from tire repair service is the reliance on assembly line operations. Retreads are used by school buses and commercial trucks (Rubber Manufacturers Association, 2006). These markets are much smaller than the markets for passenger cars and non-commercial light trucks.
335911	Storage Batteries. In particular, lead-acid batteries smaller than 1.5 cubic feet.

GLOSSARY

A number of terms used in this report have fairly specific meanings. *Motor vehicles* includes a variety of products: cars, vans, sport-utility vehicles (SUVs), crossover-utility vehicles (CUVs), buses, trucks of all sizes and motor homes. The basic industry division is between cars and light trucks, which are mass-market *light vehicles* overwhelmingly purchased by families and individuals (NAICS code 33611), and commercial trucks, etc., which are capital equipment mostly for organizations (33612). Detailed discussions of the industry, though, divide trucks and buses into eight classes based on *gross vehicle weight* (GVW - the combined weight of the vehicle and its rated maximum payload), and then regroup the classes into the categories of *light*-, *medium*- and *heavy-duty* for presentations. The U.S. Dept. of Transportation's Federal Highway Administration uses the following groupings:

- Light-duty – classes 1-3, with GVWs of 14,000 lbs. or less; the vast majority of these pickups, SUVs and minivans;
- Medium-duty – classes 4-6, with GVWs ranging from 14,001 to 26,000 lbs.;
- Heavy-duty – classes 7 and 8, with GVWs over 26,000 lbs. (Wikipedia, 2016).

Yet these groupings are somewhat arbitrary, as different analysts focus on market segments. Levy (2014) focused on cars and class 1-2 trucks (GVWs of 10,000 lbs. or less) as consumer goods; annual sales of the latter are in the millions, while class-3 trucks sales (more likely to organizations) are less than 300,000 – much closer to medium-duty numbers. Corridore (2014) limited his discussion of medium-duty trucks to classes 5-7 (GVWs of 16,001-33,000 lbs.), counting only class-8 trucks (GVWs greater than 33,000 lbs.) as heavy-duty. Ward's (1991-2009) counts classes 4-7 as medium-duty and class-8 as heavy-duty. Medium-duty trucks are more likely to be specialized (fire trucks, school buses, etc.) or dedicated to hauling specific types of freight (beverages, packages, etc.) (Peters, 2016), while heavy-duty trucks are more likely to haul a wide variety of freight. Finally, *IBIS World* analysts considers CUVs light trucks, perhaps because they are assembled on the same lines as light trucks, while Automotive News (2016) counts them as cars because they use car chassis. This report counts CUVs as cars.

Assembler distinguishes motor vehicle manufacturers such as Ford, GM, Honda, or Kenworth from other companies making only the parts and modules comprising a vehicle. The latter are *parts manufacturers* or *suppliers*. Suppliers produce goods and modules for use either as *original equipment (OE)* or to be sold as *replacement parts* in the *aftermarket (AM)*. Many do both to varying degrees. Parts makers also are grouped depending on their position in the supply chain. *Tier-1* refers to those directly selling parts and sub-assemblies to assemblers. *Tier-2* companies make parts or components for tier-1 companies, and *tier-3* companies supply the raw materials to tier-1 and -2 companies. *Powertrain* is a generic term grouping engines, transmissions and other drive-train components. *Accessories* may be added to vehicles but are not necessary for operating vehicles.

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DETAILED TABLES

Table A1: Leading and Notable Motor Vehicle Industry Employers in Ohio, 2016

Parent/Co. Name/Subsidiary or Division	NAICS#	City	Jobs~ Total	Jobs~ At Site
Ahresty Corp./Ahresty Wilmington Corp.[1]	33152	Wilmington		898
Aisin Seiki Co., Ltd.*/Advics Mfg. Ohio, Inc.^	33634	Lebanon		700
ArcelorMittal*/ArcelorMittal Tailored Blanks^	33637	Pioneer		110
Asahi Glass Co., Ltd.^			600	
AGC Automotive N. America, Inc.	32721	Bellefontaine		485
Belletech Corp.	32721	Bellefontaine		115
Berkshire Hathaway, Inc.*/Scott Fetzer Co./Stahl Co.	336212	Wooster		115
Cooper Tire & Rubber Co. (includes HQ)*[2]	326211	Findlay		1,800
Cooper-Standard Holdings, Inc.*			494	
Cooper-Standard Automotive, Inc.	33634	New Lexington		352
Cooper-Standard Automotive, Inc.[3]	33639	Bowling Green		142
Daimler AG*/Detroit Diesel Remanufacturing East^	333618	Byesville		490
Dana, Inc.*			1,121	
Dana Driveshaft Mfg. LLC[4]	33639	Lima		621
Dana, Inc. (HQ)	551114	Maumee		500
Delphi Automotive plc[5]			620	
Delphi Automotive Systems LLC^	33632	Warren		500
Delphi Automotive Systems LLC^	33632	Vienna		120
Dover Corp.*/Wiseco Piston Co., Inc.[6]	33631	Mentor		315
Fiat Chrysler Automobiles NV*-plus^			6,950	
FCA US LLC			6,200	
FCA US LLC (North & South assembly plants combined)	336112	Toledo		5,160
FCA US LLC (power train parts)	33635	Perrysburg		1,040
Hyundai Mobis Co., Ltd.*/Mobis NA LLC (integrated with the assembly plants)	336111	Toledo		500
Kuka AG/Kuka Toledo Production Operations LLC (integrated with the assembly plants)	336211	Toledo		250
EG Industries, Inc.[28]			953	
FPE (fka Florida Production Engineering)	32619	Circleville		200
Marion Industries, Inc.	32619	Marion		753
Flex-N-Gate Corp./Ventra Sandusky LLC (fka Ford's Automotive Components Holdings)	33639	Sandusky		1,344
Ford Motor Co.*[1]			5,908	
Ford Motor Co. (aka Ohio Assembly)	336112	Avon Lake		1,469
Ford Motor Co. (Engine Plant #1)	33631	Brookpark		1,607
Ford Motor Co.	33631	Lima		1,204
Ford Motor Co.	33635	Sharonville		1,628
F-Tech, Inc./F&P America Mfg., Inc.^	33633	Troy		690

Table A1: Leading and Notable Motor Vehicle Industry Employers in Ohio, 2016

Parent/Co. Name/Subsidiary or Division	NAICS#	City	Jobs~ Total	Jobs~ At Site
Fuyao Glass Industry Group Co., Ltd./Fuyao Glass America, Inc.^	32721	Dayton		1,400
General Motors Co.*[1]			9,599	
General Motors Co. (iron and aluminum foundry products)	33151/2	Defiance		1,128
DMAX (JV, Isuzu Motors Ltd. owns 40 percent)	333618	Dayton		576
General Motors Co. (jobs include a small adjacent stamping plant)[26]	336111/7	Lordstown		4,500
General Motors Co.	33635	Toledo		2,028
General Motors Co.	33637	Parma		1,367
Goodyear Tire & Rubber Co. (mostly HQ)*[7]	551114	Akron		3,000
G-TEKT Corp./Jefferson Industries Corp.^	33637	W. Jefferson		750
Hitachi, Ltd.*/AAP St. Mary's Corp.^	33639	Saint Marys		525
Honda Motor Co., Ltd.*^			12,290	
AY Mfg., Ltd.	33639	Columbus		175
Cardington Yutaka Technologies, Inc.	33639	Cardington		725
Celina Aluminum Precision Technology, Inc.	33152	Celina		550
Honda Engineering N. America, Inc. (in-house metal working facility)	3335	Marysville		350
Honda of America Mfg., Inc.	336111	Marysville		4,000
Honda of America Mfg., Inc. (Performance Mfg. Center)[27]	336111	Marysville		70
Honda of America Mfg., Inc.	336112	E. Liberty		2,250
Honda of America Mfg., Inc.	33631	Anna		2,850
Honda Transmission Mfg. of America, Inc.	33635	Russells Point		1,150
US Yachiyo, Inc.	33639	Marion		170
Honda affiliates:^			5,960	
Autoliv, Inc.*-Nissin Kogyo Co., Ltd. (JV, 51 & 49 percent)			1,020	
Autoliv Nissin Brake Systems	33634	Findlay		455
Nissin Brake Ohio, Inc.	33634	Findlay		565
KTH Parts Industries, Inc.			1,650	
Kalida Mfg. Inc.	33639	Kalida		500
KTH Parts Industries, Inc.	33639	Saint Paris		1,150
Nihon Plast Co., Ltd./Neaton Auto Parts Mfg., Inc.	33636	Eaton		1,100
Tanaka Seimitsu Kogyo Co., Ltd./FT Precision, Inc.	33639	Fredericktown		400
TS Tech Co., Ltd.			1,190	
Trim Industries, Inc.	33636	Canal Winchester		600
Tri-Mold LLC	32619	Circleville		230
TS Tech USA Corp.	33636	Reynoldsburg		360
Yamada Mfg. Co., Ltd./Yamada N. America, Inc.	33633	S. Charleston		600

Table A1: Leading and Notable Motor Vehicle Industry Employers in Ohio, 2016

Parent/Co. Name/Subsidiary or Division	NAICS#	City	Jobs~ Total	Jobs~ At Site
Intl. Automotive Components (IAC) Group SA^			2,225	
IAC Group N. America, Inc.	32622	Canton		10
IAC Group N. America, Inc.	32619	Fremont		315
IAC Group N. America, Inc.	32622	Holmesville		300
IAC Group N. America, Inc.	33639	Huron		600
IAC Group N. America, Inc.	33636	Sidney		350
IAC Group N. America, Inc.	33639	Wauseon		650
Johnson Controls, Inc.*[8]			1,880	
Johnson Controls Battery Group, Inc.	335911	Holland		600
Johnson Controls, Inc.-Tachi-S Co. Ltd. (JV)	33636	St. Mary's		450
Johnson Controls Interiors Mfg.	33636	Bryan		250
Johnson Controls Interiors LLC	33639	Northwood		580
Kasai Kogyo Co./Kasai N. America, Inc. (fka M-Tek, Inc.)^	33637	Upper Sandusky		540
Kirchhoff Holding GmbH & Co. KG/Kirchoff Van-Rob, Inc. (aka VR)	33639	Waverly		580
MAC Trailer, Inc.[9]			964	
MAC LTT	336212	Kent		224
MAC Mfg., Inc.	336212	Salem		165
MAC Trailer Mfg., Inc.	336212	Alliance		475
MAC Refuse, Inc.	336212	Alliance		100
Magna Intl., Inc.*^			2,130	
Magna Decoma Intl.	33639	Toledo		200
Norplas Industries, Inc. (aka Magna Exteriors)	33637	Northwood		1,100
Magna Cosma Intl. (aka Vehtek)	33637	Bowling Green		420
Gramag Truck Interior Systems LLC (JV with Grammar AG)	33636	London		30
Magna Seating of America, Inc.[26]	33636	Warren		320
Magna Seating of America, Inc.	33636	Strongsville		60
Mahle Behr GmbH & Co. KG^			1,415	
Mahle Dayton LLC	33631	Dayton		1,300
Mahle Engine Components USA, Inc.	33631	McConnelsville		115
Midway Products Group, Inc.			534	
Findlay Products Corp.[2]	33637	Findlay		179
P & A Industries, Inc.[2]	33637	Findlay		140
Progressive Stamping, Inc.[10]	33637	Ottoville		215
Mitsubishi Electric Corp.*/Mitsubishi Electric Automotive America, Inc.^	33632	Mason		550
Moriroku Holdings Co./Greenville Technology, Inc.^	33639	Greenville		770

Table A1: Leading and Notable Motor Vehicle Industry Employers in Ohio, 2016

Parent/Co. Name/Subsidiary or Division	NAICS#	City	Jobs~ Total	Jobs~ At Site
MTD Holdings, Inc.			799	
Shiloh Industries, Inc.[11]	33637	Wellington		220
Shiloh Industries, Inc. (aka Welded Blank or 3D Metals)	33637	Valley City		n.a.
Shiloh Industries, Inc. (aka Medina Blanking)	33637	Valley City		50
Shiloh Industries, Inc. (includes HQ)	33637	Valley City		n.a.
Navistar International Corp.* (aka International Truck & Engine)[12]	33612	Springfield		1,500
Paccar, Inc.*/Kenworth Truck Co.[13]	33612	Chillicothe		1,850
Pacific Industrial Co., Ltd./Pacific Mfg. Ohio, Inc. & Pacific Industries USA, Inc.^	33639	Fairfield		542
Parker-Hannifin Corp.*/Hose Products Division	33639	Wickliffe		271
Peugeot SA*			1,070	
Faurecia Exhaust Systems, Inc.^	33639	Franklin		390
Faurecia Exhaust Systems, Inc.^	33639	Northwood		50
Faurecia Exhaust Systems, Inc.[14]	33639	Toledo		200
Faurecia Exhaust Systems, Inc.^	33639	Toledo		130
Faurecia Exhaust Systems, Inc.^	33639	Troy		300
Robert Bosch GmbH*/Robert Bosch Battery Systems[25]	335991	Springboro		56
Sankei Giken Co., Ltd./Newman Technology, Inc.^	33639	Mansfield		820
Sanoh Industrial Co., Ltd.^			570	
Sanoh America, Inc.	3329	Archbold		70
Sanoh America, Inc.	3329	Findlay		280
Sanoh America, Inc.	3329	Mt. Vernon		220
Schaeffler Technologies GmbH & Co. KG/LuK-Schaeffler Group USA, Inc.^	33639	Wooster		1,770
Showa Corp.^			1,125	
American Showa, Inc.	33633	Blanchester		575
American Showa, Inc.	33633	Sunbury		550
Stanley Electric Co., Inc./Stanley Electric US Co., Inc.^	33632	London		1,270
Stoneridge, Inc.[15]	33632	Lexington		760
Tenneco, Inc.*			928	
Tenneco, Inc.[16]	33639	Kettering		478
Tenneco, Inc.[17]	33639	Napoleon		450
Thor Industries, Inc.*/Airstream, Inc.[18]	336213	Jackson Center		670
ThyssenKrupp AG*/Bilstein of America, Inc.^	33633	Hamilton		210
Tokai Kogyo Co., Ltd./Green Tokai Co., Ltd.^	33639	Brookville		570
Tokai Rubber Industries Ltd./DTR Industries, Inc.^	32621	Bluffton		610

Table A1: Leading and Notable Motor Vehicle Industry Employers in Ohio, 2016

Parent/Co. Name/Subsidiary or Division	NAICS#	City	Jobs~ Total	Jobs~ At Site
Toledo Molding and Die, Inc.[19]			1,126	
Toledo Molding and Die, Inc. (3 sites: HQ, test lab & plant)	32619	Toledo		n.a.
Toledo Molding and Die, Inc.	32619	Bowling Green		n.a.
Toledo Molding and Die, Inc.	32619	Delphos		n.a.
Toledo Molding and Die, Inc.	32619	Tiffin		n.a.
WEK	32619	Jefferson		n.a.
Tower Intl., Inc.*			423	
Tower Automotive Operations USA I LLC[20]	33637	Bluffton		189
Tower Automotive Operations USA I LLC[21]	33639	Bellevue		234
Truck Hero, Inc.[22]			750	
ARE, Inc.	336211	Massillon		475
ARE, Inc.	336211	Mt. Eaton		275
Worthington Industries, Inc.*/Artiflex Mfg., LLC (aka Gerstenslager)[23]	33637	Wooster		750
ZF Friedrichshafen AG/TRW[24]	33634	Fayette		215

Abbreviations, notes and sources: aka/fka - also/formerly known as; HQ - headquarters; Intl. - International; JV - Joint Venture; Mfg. - Manufacturing; n.a. - not available; NAICS - North American Industry Classification System; # - non-industry NAICS codes are included if production is principally for motor vehicles; ~ - Jobs figures are the latest available from either (1) privates sector sources - Hoovers (2016), frequently excepted as noted - or (2) Office of Research (2016a); the latter estimates are noted by "6" after the name; * - A Fortune U.S.-1,000 or Global-500 company or parent; 1 - Jobs figure from a company website (2016); 2 - Jobs figure from The Alliance (2015); 3 - Jobs estimated from Rockwell (2015); 4 - Jobs figure from the Lima News (2016); 5 - Layoffs may occur in the near future (McCoy, 2016); 6 - Jobs figure from Scott (2014); an additional 100 were planned at the time; 7 - Jobs figure the City of Akron (2016); 8 - Johnson Controls keeps battery business but spin-offs automotive part to a new company called Adient and/or a joint venture with Yanfeng, a Chinese company (Linkhorn, 2015; Snavely, 2016); Bryan employment the class minimum from Manta (2016); Northwood employment from Linkhorn (2015); 9 - Alliance job estimates from company website and Hall (2015); Kent figure from Tank Transport Trader (2014); Salem figure from Shields (2011); sources expected more manufacturing jobs; 10 - Jobs figure from the Better Business Bureau, Lima (2016); 11 - Jobs figure from Muncey (2014); 12 - Jobs figure from Sanctis (2016); 600 more jobs are anticipated by 2018 as contracts with GM are implemented; 13 - Based on Balusik (2016); 14 - Estimate based on Linkhorn (2014): 100+100 out of 150 anticipated; more jobs may be added; 15 - Jobs figure from Caudill (2015); 16 - Jobs figure from Navera (2016); more may be added; 17 - Jobs figure from CIC of Henry County (2014); 18 - Jobs figure from RV Pro Staff (2016); additional jobs are anticipated; 19 - Total Ohio employment is 1,126; 20 - Jobs figure from 4-Traders.com (2016); 21 - Jobs figure from Sandusky Co. Economic Development Corp. (2016); 22 - Jobs figure from Pritchard (2014); 23 - Jobs figure from Wayne Co. Economic Development Corp. (2015); 24 - Jobs figure from Fulton Co. Economic Development Corp. (2016); 25 - Jobs figure from Bloomberg (2015); 26 - 1,200-plus will be furloughed from GM and 83 from Magna in the near future due to reduced demand (Staff, 2016); 27 - Jobs fiigure from Sakakibara (2016); 28 - Jobs figure from ODSA (2016).

Table A2: Expansion and Attraction Announcements in Ohio's Motor Vehicle Industry, 2012-2015

Year	Parent/Co./Division	County	NAICS Code*	Product	Intended Investments	And Jobs
2012	Ada Technologies, Inc.	Hardin	336399	Miscellaneous parts	$5,200,000	52
2012	ArcelorMittal/Powerlasers	Williams	33637	Metal blanks	$5,000,000	30
2012	Creative Extruded Products, Inc.	Montgomery	326199	Plastic auto parts		
2012	Dia Seiko Co., Ltd./ABC INOAC Exterior Systems LLC	Sandusky	326121	Plastic auto parts	$14,000,000	100
2012	Ernie Green Industries, Inc./Florida Production Engineering, Inc.	Pickaway	336399	Miscellaneous parts	$2,500,000	32
2012	Fehrer Enterprise Corp./NC Works, Inc.	Warren	31323	Automotive fabrics	$3,800,000	16
2012	Findlay Products Corp.	Hancock	33637	Stampings	$1,000,000	
2012	Fuserashi Co., Ltd./Fuserashi International Technology, Inc.	Medina	33637	Forged auto parts	$4,400,000	17
2012	Gebr. Rochling KG/Roechling Automotive Corp. USA LLP	Summit	326199	Plastic auto parts	$4,000,000	
2012	General Motors Co.	Trumbull	336111	Cars, related assembly activity	$200,000,000	
2012	General Motors Co.	Cuyahoga	33637	Stampings	$20,000,000	
2012	Honda Motor Co., Ltd./Honda of America Mfg.	Shelby	336312	Engines, related activity	$170,000,000	200
2012	Honda Motor Co., Ltd./Honda of America Mfg.	Shelby	336312	CVT pulley parts	$98,000,000	20
2012	Honda Motor Co., Ltd./Honda of America Mfg.	Logan	33635	Transmissions	$50,000,000	120
2012	Honda Motor Co., Ltd./Honda of America Mfg.	Logan	336112	SUVs, related assembly activity	$16,000,000	
2012	Honda Motor Co., Ltd./Honda of America Mfg.	Union	336111	Cars, related assembly activity	$7,100,000	
2012	Honda Motor Co., Ltd./US Yachiyo, Inc.	Marion	336399	Fuel tanks	$20,000,000	40
2012	Imasen Electric Industrial Co., Ltd./Imasen Bucyrus Technology, Inc.	Crawford	336399	Motor vehicle parts		250
2012	Industry Products Co.	Miami	336399	Auto trunk floors	$3,400,000	50
2012	International Automotive Components Group/Huron LLC	Erie	33636	Interior trim	$5,000,000	143
2012	Johnson Controls, Inc./Hoover Universal	Wood	336399	Miscellaneous parts	$10,000,000	86
2012	KTH Parts Industries, Inc. (Honda affiliate)	Champaign	336399	Miscellaneous parts	$4,700,000	100
2012	KTH Parts Industries, Inc. (Honda affiliate)/Kalida Mfg., Inc.	Putnam	336399	Miscellaneous parts		41
2012	L&W Cleveland	Lorain	33637	Stampings	$16,500,000	60
2012	Marengo Fabricated Steel Ltd.	Morrow	336211	Tank truck bodies	$1,500,000	15
2012	Molten Corp./Molten North America Corp.	Hancock	326199	Plastic auto parts	$1,200,000	60
2012	Nissin Kogyo Co., Ltd./Nissin Brake Ohio, Inc.	Hancock	33634	Brakes	$20,000,000	125
2012	Oerlikon/Sulzer Friction Systems	Montgomery	33635	Transmission parts	$4,000,000	
2012	Ohashi Technica, Inc./Ohashi Technica USA, Inc.	Delaware	336399	Miscellaneous parts	$2,000,000	
2012	Piston Automotive LLC	Lucas	336399	Miscellaneous parts	$6,900,000	84
2012	Sanoh Industrial Co., Ltd./Sanoh America, Inc.	Fulton	33634	Brake parts	$7,000,000	40
2012	Schaeffler Technologies GmbH & Co. KG/LuK USA LLC	Wayne	336399	Miscellaneous parts	$46,500,000	100
2012	Stanley Electric Co., Inc./Stanley Electric US Co.	Madison	336321	Motor vehicle lighting	$56,700,000	
2012	Stripmatic Products	Cuyahoga	33637	Stampings	$1,600,000	
2012	Taiho Kogyo Co., Ltd./Taiho Corp. of America	Seneca	336399	Miscellaneous parts	$13,000,000	35
2012	Toledo Molding & Die, Inc.	Seneca	336399	Miscellaneous parts	$8,400,000	64
2012	Toledo Molding & Die, Inc.	Van Wert	336399	Miscellaneous parts	$5,400,000	45
2012	Toledo Molding & Die, Inc.	Lucas	336399	Miscellaneous parts	$3,000,000	41
2012	TS Tech Co., Ltd./TS Tech Americas, Inc.	Franklin	33637	Stamped trim parts	$7,000,000	
2012	Westport Axle Corp.	Lorain	336399	Axles	$3,500,000	10
2012	Wiseco Piston Co., Inc.	Lake	336311	Forged aluminum pistons	$1,500,000	100
2012 Subtotals					$849,800,000	2,076

Table A2: Expansion and Attraction Announcements in Ohio's Motor Vehicle Industry, 2012-2015

Year	Parent/Co./Division	County	NAICS Code*	Product	Intended Investments	And Jobs
2013	Ada Technologies, Inc.	Hardin	336399	Miscellaneous parts	$1,000,000	
2013	Ahresty Corp./Ahresty Wilmington Corp.	Clinton	331523	Die-cast aluminum auto parts		107
2013	AMG Industries, Inc.	Knox	33637	Stampings	$100,000	10
2013	Behr GmbH & Co. KG/Behr Dayton Thermal Products	Montgomery	336391	Air-conditioning parts	$4,000,000	
2013	Bridgestone Corp./Bridgestone APM Co.	Wyandot	326291	Motor vehicle rubber products	$3,200,000	25
2013	Clark Fixture Technology Mexico S. de RL de CV/Clark Fixture Technologies	Wood	336399	Exhaust system	$1,000,000	5
2013	Eberhard Mfg. Co.	Cuyahoga	336399	Miscellaneous parts	$1,200,000	
2013	FCA, Inc.	Wood	336399	Miscellaneous parts	$20,000,000	
2013	Ford Motor Co.	Allen	336312	Engines, related activity	$420,000,000	
2013	General Motors Co.	Lucas	33635	Transmissions	$55,700,000	
2013	General Motors Co.	Lucas	33635	Transmissions	$30,000,000	
2013	G-Tekt Ltd./G-Tekt N. America Corp.	Madison	33637	Stampings	$28,000,000	23
2013	Hendrickson USA LLC	Stark	33633	Truck suspensions	$2,000,000	30
2013	Hitachi, Ltd./AAP St. Marys Corp.	Auglaize	336399	Auto wheels		
2013	Honda Motor Co., Ltd./Honda of America Mfg.	Shelby	336312	Engine parts	$180,000,000	
2013	Honda Motor Co., Ltd./Honda of America Mfg.	Union	336111	Cars, related assembly activity	$70,000,000	100
2013	Honda Motor Co., Ltd./Honda of America Mfg.	Union	336111	Cars, related assembly activity	$23,000,000	50
2013	Howa Textile Industry Co., Ltd./American Howa Kentucky, Inc.	Delaware	336399	Miscellaneous parts	$4,300,000	60
2013	Ikeda Mfg. Co., Ltd./Sunfield, Inc.	Licking	336399	Miscellaneous parts		
2013	International Automotive Components Group	Shelby	336399	Miscellaneous parts	$1,200,000	42
2013	ISS America, Inc.	Logan	336311	Auto engine parts	$3,000,000	20
2013	KTH Parts Industries, Inc. (Honda affiliate)	Champaign	336399	Miscellaneous parts	$28,000,000	60
2013	Matcor Automotive, Inc./Matsu Ohio, Inc.	Williams	33637	Stampings	$4,000,000	46
2013	Miba AG/Miba Sinter USA LLC	Morgan	336399	Sintered auto parts	$34,000,000	110
2013	Millat Industries	Montgomery	336399	Motor vehicle parts	$2,800,000	13
2013	Minth N. America, Inc.	Warren	336399	Miscellaneous parts	$86,000,000	418
2013	Mitec Automotive AG/Mitec Powertrain, Inc.	Hancock	336399	Miscellaneous parts	$1,500,000	
2013	Muro Corp./Murotech Ohio Corp.	Auglaize	33637	Stampings	$1,300,000	
2013	Nippon Sheet Glass Co., Ltd./Pilkington N. America, Inc.	Wood	327211	Motor vehicle glass	$250,000	100
2013	Ohio Valley Mfg.	Richland	33637	Stampings	$4,500,000	30
2013	Proform Industries Ltd.	Franklin	336399	Fuel tanks	$1,200,000	120
2013	Riffle Machine Works	Ross	336399	Truck part subassemblies	$3,000,000	40
2013	Stanley Electric Co., Inc./Stanley Electric US Co.	Madison	336321	Motor vehicle lighting	$15,000,000	150
2013	Tachi-S Co., Ltd./Setex, Inc.	Auglaize	33636	Seats		85
2013	Takagi Mfg. Co., Ltd./Takumi Stamping, Inc.	Butler	33637	Stampings	$3,600,000	13
2013	ThyssenKrupp AG/Bilstein of America	Butler	33633	Suspension components	$5,400,000	100
2013	Trilogy Engineered Solutions LLC	Summit	336312	Engine parts for CNG	$1,100,000	25
2013	Valeo SA/Valeo Climate Control Corp.	Butler	336391	Air-conditioning parts	$14,400,000	105
2013	Xperion E & E USA LLC	Licking	336312	Cylinders for natural gas	$6,400,000	59
2013 Subtotals					$1,060,150,000	1,946
2014	ADVICS Manufacturing Ohio, Inc.	Warren	3363	Auto brakes	$100,000,000	100
2014	Airstream, Inc.	Shelby	3362	Recreational vehicle	$5,900,000	125

Table A2: Expansion and Attraction Announcements in Ohio's Motor Vehicle Industry, 2012-2015

Year	Parent/Co./Division	County	NAICS Code*	Product	Intended Investments	And Jobs
2014	Amanda Manufacturing	Hocking	3326	Auto stampings and rods	$5,000,000	20
2014	Anchor Industries	Cuyahoga	3321	Engine mounts	$4,000,000	
2014	Artiflex Manufacturing LLC	Wayne	3363	Stampings	$10,000,000	
2014	Autoneum North America, Inc	Lucas	3363	Auto insulation	$2,000,000	100
2014	Borgers USA Corp.	Huron	3363	Auto insulation	$60,000,000	230
2014	Braun Industries, Inc.	Van Wert	3361	Emergency vehicles	$1,000,000	30
2014	Brown Industrial, Inc.	Shelby	3362	Truck bodies	$2,000,000	3
2014	Camaco Lorain Manufacturing	Lorain	3363	Motor vehicle seats		100
2014	Clarke Fire Protection Products, Inc.	Hamilton	3336	Diesel engines	$3,500,000	50
2014	Consolidated Metco, Inc.	Ross	33152	Cast metal truck parts	$1,300,000	55
2014	Continental Structural Plastics, Inc.	Wood	3261	Plastic products for trucks	$2,900,000	56
2014	Crown Battery Manufacturing Co.	Sandusky	3359	Batteries	$4,000,000	
2014	Dana Holding Corp.	Lucas	3363	Motor vehicle parts	$28,600,000	50
2014	Dayton Molded Urethanes LLC	Montgomery	3261	Auto products	$1,500,000	80
2014	F&P America Ltd.	Miami	3363	Auto parts	$2,500,000	
2014	Faurecia SA/Faurecia Emissions Control Technologies	Lucas	3363	Exhaust systems	$20,000,000	150
2014	Faurecia SA/Faurecia Emissions Control Technologies	Warren	3363	Auto exhaust systems		120
2014	Ford Motor Co.	Lorain	3362	Motor vehicles	$40,000,000	
2014	Freudenberg-NOK Sealing Technologies	Hancock	3361	Automotive O rings	$8,600,000	50
2014	Fuyao Glass America, Inc.	Montgomery	3272	Automotive glass	$230,000,000	800
2014	General Motors Co.	Lucas	3363	Auto transmissions - 6 speed	$30,600,000	
2014	General Motors Co.	Cuyahoga	3363	Motor vehicle stampings	$14,000,000	
2014	General Motors Co.-Isuzu Motors Ltd./DMAX, Ltd.	Montgomery	3336	Truck diesel engines	$60,000,000	
2014	Honda Motor Co., Ltd./Honda of America Mfg.	Union	3361	Motor vehicles	$3,500,000	
2014	Johnson Welded Products, Inc.	Champaign	3363	Truck brake parts	$1,000,000	
2014	Keihin Thermal Technology of America , Inc.	Madison	3363	HVAC auto parts	$2,500,000	90
2014	Kimble Manufacturing Co.	Tuscarawas	3362	Auto parts	$400,000	20
2014	M.H. Eby Corp.	Madison	3362	Trailers	$1,000,000	12
2014	Mac Trailer Enterprises, Inc.	Stark	3362	Truck trailers	$2,000,000	
2014	Maca Plastics, Inc.	Adams	3363	Auto parts	$400,000	22
2014	Manufacturing Business Development Solutions	Wyandot	3363	Auto parts	$1,000,000	40
2014	Mitsubishi Electric Automotive America, Inc.	Warren	3363	Motor vehicle parts	$32,100,000	
2014	Mobis North America LLC	Lucas	3361	Auto chassis systems	$1,200,000	
2014	Navistar International Corp.	Clark	3361	Trucks	$28,000,000	
2014	Newman Technology, Inc.	Richland	3363	Auto parts	$3,000,000	10
2014	Ohio Metal Technologies, Inc.	Licking	3321	Auto forgings	$7,000,000	11
2014	Pleasant Valley Trailer	Tuscarawas	3362	Trailers	$1,900,000	
2014	S&T Automotive America LLC	Franklin	3363	Shock absorbers	$6,500,000	80
2014	Sekisui Plastics USA, Inc.	Hardin	3363	Plastic auto parts	$7,800,000	50
2014	SK Tech, Inc.	Montgomery	3363	Motor vehicle electrical equipment	$2,500,000	
2014	ThyssenKrupp AG/Bilstein of America	Butler	3363	Auto parts	$26,000,000	214
2014	Toledo Molding & Die, Inc.	Wood	3261	Auto parts	$8,000,000	28
2014	Tremcar USA, Inc.	Tuscarawas	3362	Tank truck bodies		50
2014	Tremcar USA, Inc.	Tuscarawas	3362	Tank truck bodies		25
2014	TS Tech Co., Ltd./TS Tech Americas, Inc.	Franklin	3363	Auto parts	$6,600,000	68

Table A2: Expansion and Attraction Announcements in Ohio's Motor Vehicle Industry, 2012-2015

Year	Parent/Co./Division	County	NAICS Code*	Product	Intended Investments	And Jobs
2014	UGN, Inc.	Warren	3363	Auto parts	$27,000,000	148
2014	Unique-Chardan, Inc.	Williams	3363	Auto parts	$400,000	30
2014	USUI International Corp.	Hamilton	3363	Auto parts		150
2014	Wilbert Plastic Services	Sandusky	3261	Auto plastic parts	$6,600,000	70
2014	Yamada North America Inc	Clark	3363	Auto parts		40
2014	ZF Group AG/TRW Automotive, Inc.	Fulton	3363	Auto brake parts		20
2014 Subtotals					$813,800,000	3,297
2015	A-Brite LP	Cuyahoga	3328	Auto part plating	$18,000,000	104
2015	Ada Technologies, Inc.	Hardin	3363	Auto parts	$7,000,000	20
2015	ADVICS Manufacturing Ohio, Inc.	Warren	3363	Auto parts	$150,000,000	260
2015	Airstream, Inc.	Shelby	3362	Recreational vehicles		150
2015	Akron Paint & Varnish	Summit	3255	Paint & coatings		30
2015	Alex Products, Inc.	Paulding	3363	Auto seat frames	$2,400,000	30
2015	BASF Corp.	Darke	3251	Automotive coatings	$4,000,000	50
2015	Bendix Commercial Vehicle Systems LLC	Lorain	3363	Truck parts	$50,000,000	45
2015	Core Molding Technologies, Inc.	Franklin	3261	Plastic auto products	$2,000,000	
2015	Corvac Composites LLC	Highland	3262	Plastic auto parts	$12,500,000	175
2015	Ford Motor Co.^	Lorain	3361	Motor vehicles	$250,000,000	
2015	Ford Motor Co.^	Cuyahoga	33631	Engines, related activity	$150,000,000	
2015	Ford Motor Co.^	Allen	33631	Engines, related activity	$250,000,000	
2015	Ford Motor Co.^	Hamilton	33635	Transmissions	$900,000,000	
2015	F&P America Ltd.	Miami	3363	Auto parts	$3,000,000	
2015	FRAM Group Operations, LLC	Darke	3363	Oil filters	$5,400,000	30
2015	Fuyao Glass America, Inc. phase 2	Montgomery	3272	Automotive windshields	$130,000,000	750
2015	G.S.W. Manufacturing, Inc.	Hancock	3363	Wiring harness sets		28
2015	Galion-Godwin Truck Body, Co.Galion-Godwin Truck Body, Co	Holmes	3362	Dump truck bodies	$3,700,000	40
2015	General Motors Co.-Isuzu Motors Ltd./DMAX, Ltd.	Montgomery	3363	Diesel engines	$96,000,000	150
2015	Green Tokai Co., Ltd.	Montgomery	3363	Auto parts	$9,400,000	15
2015	Green Tokai Co., Ltd.	Montgomery	3363	Auto parts	$3,700,000	
2015	GT Technologies, Inc.	Lucas	3363	Valve train engine parts	$22,200,000	24
2015	GT Technologies, Inc.	Defiance	3363	Valve train engine parts	$7,000,000	19
2015	Hanon Systems/Halla Visteon Climate Control	Wyandot	3363	Auto parts	$16,000,000	139
2015	Hirschvogel, Inc.	Franklin	3363	Forged auto parts	$50,400,000	37
2015	Honda Motor Co., Ltd./Honda of America Mfg.	Shelby	3363	Auto engines - VTEC	$340,000,000	
2015	Honda Motor Co., Ltd./Honda of America Mfg.	Union	3361	Motor vehicles	$210,000,000	
2015	Honda Motor Co., Ltd./Honda of America Mfg.	Logan	3361	Motor vehicles - MDX	$85,000,000	
2015	J.R. Manufacturing, Inc.	Mercer	3363	Auto parts	$2,800,000	30
2015	Mac Trailer Enterprises, Inc.	Stark	3362	Specialty trailers	$850,000	150
2015	Mancor Ohio, Inc.	Ross	3362	Truck parts	$80,000	21
2015	Midwest Acoust-a-Fiber, Inc.	Delaware	3363	Auto insulation products	$20,500,000	14
2015	Mitsubishi Electric Automotive America, Inc.	Warren	3363	Auto parts	$80,800,000	100
2015	Molten Corp./Molten North America Corp.	Hancock	3261	Plastic auto parts	$3,500,000	14

Table A2: Expansion and Attraction Announcements in Ohio's Motor Vehicle Industry, 2012-2015

Year	Parent/Co./Division	County	NAICS Code*	Product	Intended Investments	And Jobs
2015	Navistar International Corp.	Clark	3361	Truck assembly	$12,900,000	300
2015	Nissin Brake Ohio, Inc.	Hancock	3363	Auto brake systems	$37,000,000	
2015	Nitto Denko Automotive Ohio, Inc.	Miami	3363	Auto parts	$1,200,000	
2015	NPA Coatings, Inc.	Cuyahoga	3255	Automotive coatings	$8,500,000	25
2015	Pentaflex, Inc.	Clark	3321	Truck stampings	$4,100,000	40
2015	Roki America Co., Ltd.	Hancock	3363	Auto parts	$4,000,000	
2015	Schaeffler Technologies GmbH & Co. KG/LuK USA LLC	Wayne	3363	Auto transmission parts	$38,500,000	100
2015	Taiho Kogyo Co., Ltd./Taiho Corp. of America	Seneca	3363	Auto parts	$8,000,000	50
2015	Tekfor, Inc.	Wayne	3321	Automotive forgings	$1,500,000	
2015	Tigerpoly Manufacturing, Inc.	Franklin	3261	Plastic auto parts	$5,000,000	
2015	Tower Automotive Operations USA LLC	Sandusky	3363	Auto stampings	$32,000,000	138
2015	Tramec Sloan LLC	Crawford	3363	Brake assemblies	$2,000,000	90
2015	Valeo North America, Inc	Logan	3363	Auto parts	$14,000,000	85
2015	VisTech Manufacturing Solutions	Butler	3363	Auto parts assembly, sewing	$240,000	19
2015	Vitatoe Industries, Inc.	Ross	3362	Auto and truck parts	$1,100,000	25
2015	Yamada North America, Inc.	Clark	3363	Auto parts	$15,200,000	100
2015	YSK Corp.	Ross	3363	Auto parts	$12,500,000	
2015 Subtotals					$3,083,970,000	3,397
Grand Totals 2012-2015:					$5,807,720,000	10,716

Notes: * - Establishments with NAICS codes outside of the industry definition are included here when their products are made for motor vehicles; ^ - from Priddle and Snavely (2015). Abbreviations Used: Mfg. - manufacturing.

Sources: Office of Research, ODSA (2013b-2016b); Priddle and Snavely (2015).

Prepared by: Office of Research, Ohio Development Services Agency (ODSA) (DL, JK, 12/16).

Table A3: Motor Vehicle Industry Concentration in Ohio

Year, Subject & NAICS Codes	Industry Title[1]	From Ohio: Amount (millions)	From Ohio: Distribution in Ohio	U.S. Totals (millions)	Ohio as Percent of U.S.
2014 GDP :	Total	$588,827		$17,233,139	3.4%
3361-3[2]	Motor Vehicle Industry (part)	$12,128		$140,240	8.6%
2014 Value-Added: 3361-3[2]	Motor Vehicle Industry (part)	$15,842	100.0%	$163,404	9.7%
3361	MV Assembly	$5,964	37.6%	$70,245	8.5%
3362	MV Bodies & Trailers	$479	3.0%	$13,664	3.5%
3363	MV Parts	$9,399	59.3%	$79,496	11.8%
2012 Value-Added:	Motor Vehicle Industry (summary)	$15,179	100.0%	$151,220	10.0%
3361-3	Motor Vehicle Industry (part)	$14,475	95.4%	$140,427	10.3%
3361	MV Assembly	$6,237	41.1%	$59,589	10.5%
33611[3]	Automobile & Light Duty MV	$5,138	33.9%	$54,348	9.5%
33612	Heavy Duty Trucks	$1,099	7.2%	$5,240	21.0%
3362[3]	MV Bodies & Trailers	$371	2.4%	$10,826	3.4%
3363	MV Parts	$7,867	51.8%	$70,012	11.2%
33631	MV Gas Engines & Engine Parts	$568	3.7%	$9,011	6.3%
33632	MV Electrical & Electronic Eqpt.	$712	4.7%	$6,396	11.1%
33633	MV Steering & Suspension Parts	$301	2.0%	$3,909	7.7%
33634	MV Brake Systems	$475	3.1%	$4,010	11.8%
33635	MV Transmission & Power Train Parts	$1,543	10.2%	$11,356	13.6%
33636	MV Seating & Interior Trim	$687	4.5%	$5,378	12.8%
33637	MV Metal Stamping	$1,860	12.3%	$10,868	17.1%
33639	Other MV Parts	$1,721	11.3%	$19,084	9.0%
32621 & 335911	Related Non-transportation Industries	$704	4.6%	$10,792	6.5%
32621	Tires	$579	3.8%	$7,748	7.5%
326211	Tire Mfg. (Exc. Retreading)	$552	3.6%	$7,265	7.6%
326212	Tire Retreading	$27	0.2%	$484	5.6%
335911	Storage Batteries[4]	$125	0.8%	$3,044	4.1%

Notes: 1 - Abbreviations: Eqpt. - equipment; Exc. - except; GDP - gross domestic product; Mfg. - manufacturing; MV -motor vehicle(s); 2 - Value-added figures are greater than GDP figures because the latter excludes costs of purchased services; 3 - Six-digit industry data for Ohio suppressed to maintain confidentiality; 4 - Five-digit value-added figure for Ohio was used as proxy for the suppressed six-digit figure; given that the two primary battery plants (NAICS 335912) in Ohio employed 46 people (or 4.0 percent) out of a total of 1,162 for all battery production, the $125 million figure is a slight over-statement. Sources: U.S. Bureau of the Census (2015c, 2016a), U.S. Bureau of Economic Analysis (2016a). Prepared by: Office of Research, Ohio Development Services Agency (ODSA) (DL, 8/16).

Table A4a: Detailed Light Vehicle Production in Ohio, 2012-2016

Company: Assembly Type City Nameplate and Model	2016 (YTD)* Vehicles Produced	2016 (YTD)* Percent of Production	2015 (YTD) Vehicles Produced	2015 (YTD) Percent of Production	2015* Vehicles Produced	2015* Percent of Production	2014 Vehicles Produced	2014 Percent of Production	2013 Vehicles Produced	2013 Percent of Production	2012 Vehicles Produced	2012 Percent of Production	Notes
Total Light Vehicles	1,455,710	100.0%	1,509,804	100.0%	1,618,827	100.0%	1,566,751	100.0%	1,456,118	100.0%	1,372,608	100.0%	The lingering effects of East Asian floods and
Total Cars	728,228	50.0%	706,455	46.8%	765,018	47.3%	741,588	47.3%	802,292	55.1%	745,381	54.3%	a model change-over meant 2012 and 2013
Total Light Trucks	727,482	50.0%	803,349	53.2%	853,809	52.7%	825,163	52.7%	653,826	44.9%	627,227	45.7%	output was less than normal.
FCA: Light Trucks	455,473	31.3%	535,402	35.5%	564,934	34.9%	511,466	32.6%	295,997	20.3%	275,003	20.0%	Two adjacent SUV plants.
Toledo North:	228,356	15.7%	286,371	19.0%	302,257	18.7%	275,518	17.6%	72,958	5.0%	78,695	5.7%	Retooled during plant closure.
Jeep Cherokee	228,356	15.7%	286,371	19.0%	302,257	18.7%	275,518	17.6%	72,958	5.0%	0	0.0%	Production started June, 2013.
Jeep Liberty	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	78,695	5.7%	Production ended in August, 2012.
Toledo Supplier Park:	227,117	15.6%	249,031	16.5%	262,677	16.2%	235,948	15.1%	223,039	15.3%	196,308	14.3%	
Jeep Wrangler	59,249	4.1%	63,558	4.2%	67,081	4.1%	60,861	3.9%	67,431	4.6%	72,472	5.3%	
Jeep Wrangler Unlimited	167,868	11.5%	185,473	12.3%	195,596	12.1%	175,087	11.2%	155,608	10.7%	123,836	9.0%	
Ford: Light Trucks	53,905	3.7%	49,422	3.3%	52,847	3.3%	105,487	6.7%	132,390	9.1%	135,231	9.9%	Most van production moved out-of-state after
Avon Lake (aka Ohio Assembly):	53,905	3.7%	49,422	3.3%	52,847	3.3%	105,487	6.7%	132,390	9.1%	135,231	9.9%	June, 2014; medium-duty truck production
Econoline vans & chassis	51,168	3.5%	49,422	3.3%	52,847	3.3%	105,487	6.7%	132,390	9.1%	135,231	9.9%	added in 2015, but not included here.
F350/F450/F550 chassis cabs	2,737	0.2%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	F-series added 1st quarter, 2016
GM: Cars	319,536	22.0%	267,503	17.7%	299,227	18.5%	286,306	18.3%	292,959	20.1%	279,382	20.4%	A sub-compact; a turbo diesel version was
Lordstown:	319,536	22.0%	267,503	17.7%	299,227	18.5%	286,306	18.3%	292,959	20.1%	279,382	20.4%	added in 2016.
Chevrolet Cruze	319,536	22.0%	267,503	17.7%	299,227	18.5%	286,306	18.3%	292,959	20.1%	279,382	20.4%	
Honda: Light Vehicles	626,796	43.1%	657,477	43.5%	701,819	43.4%	663,492	42.3%	734,772	50.5%	682,992	49.8%	East Asian floods, beginning in March, 2011,
Car Subtotal	408,692	28.1%	438,952	29.1%	465,791	28.8%	455,282	29.1%	509,333	35.0%	465,999	33.9%	disrupted parts production and constrained
Light Truck Subtotal	218,104	15.0%	218,525	14.5%	236,028	14.6%	208,210	13.3%	225,439	15.5%	216,993	15.8%	assemblies into the first few months of 2012.
E. Liberty--Light Vehicles:	218,104	15.0%	223,690	14.8%	241,193	14.9%	221,289	14.1%	242,363	16.6%	243,346	17.7%	The MDX will be added in the near future.
Acura RDX--Light Truck	63,269	4.3%	54,700	3.6%	60,044	3.7%	60,026	3.8%	57,007	3.9%	37,504	2.7%	A CUV; moved from Marysville, March, 2012.
Crosstour--Car	0	0.0%	5,165	0.3%	5,165	0.3%	13,079	0.8%	16,924	1.2%	26,435	1.9%	Crosstour production ended summer, 2015.
CR-V--Light Truck	154,835	10.6%	163,825	10.9%	175,984	10.9%	148,184	9.5%	168,432	11.6%	179,407	13.1%	The new model is turbo charged.
Marysville--Light Vehicles:	408,104	28.0%	433,787	28.7%	460,626	28.5%	442,203	28.2%	492,409	33.8%	439,646	32.0%	
Accord--Car	353,304	24.3%	357,202	23.7%	379,385	23.4%	401,423	25.6%	466,695	32.1%	400,143	29.2%	
Acura ILX--Car	14,580	1.0%	26,475	1.8%	28,017	1.7%	68	0.0%	0	0.0%	0	0.0%	
Acura RDX--Light Truck	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	82	0.0%	Production moved to E. Liberty March, 2012.
Acura TL--Car	0	0.0%	0	0.0%	0	0.0%	3,765	0.2%	25,714	1.8%	39,421	2.9%	TL production ended March, 2014.
Acura TLX--Car	40,220	2.8%	50,110	3.3%	53,224	3.3%	36,947	2.4%	0	0.0%	0	0.0%	TLX production started July, 2014.
PMC (Marysville)--Car--Acura NS	588	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	"Super" car production started spring, 2016.

Notes and abbreviations: * - Initial, subject to revision; aka - also known as; CUV - crossover utility vehicle; SUV - sport utility vehicle; YTD - year to date (through November).

Source: Automotive News (2014-2016).

Prepared by: Office of Research, Ohio Development Services Agency (ODSA) (DL, 12/16).

Table A4b: Light Vehicle Production at Continuously Operating Plants in Ohio, 2007-2015

	Annual Production									Percentage Changes		
Company and Plant	2007	2008	2009	2010	2011	2012	2013	2014	2015'	2007-2009	2009-2015	2007-2015
Total Light Vehicles*	1,318,404	1,260,145	724,519	1,011,559	1,057,584	1,293,913	1,383,160	1,291,233	1,316,570	-45.0%	81.7%	-0.1%
FCA: Supplier Park	156,716	127,907	84,952	144,685	165,166	196,308	223,039	235,948	262,677	-45.8%	209.2%	67.6%
Ford: Avon Lake	179,918	126,640	88,054	121,471	133,850	135,231	132,390	105,487	52,847	-51.1%	-40.0%	-70.6%
GM: Lordstown	280,452	308,015	87,917	158,099	281,810	279,382	292,959	286,306	299,227	-68.7%	240.4%	6.7%
Honda*:	701,318	697,583	463,596	587,304	476,758	682,992	734,772	663,492	701,819	-33.9%	51.4%	0.1%
E. Liberty*:	242,475	237,883	161,601	246,743	192,179	243,346	242,363	221,289	241,193	-33.4%	49.3%	-0.5%
Marysville*:	458,843	459,700	301,995	340,561	284,579	439,646	492,409	442,203	460,626	-34.2%	52.5%	0.4%

Notes: * - production constrained by floods in Asia for most of 2011 and the first few months of 2012; i - initial, subject to revision.

Sources: Automotive News (2010-2016), Ward's (2009).

Prepared by: Office of Research, Ohio Development Services Agency (DL, 8/16).

Table A5: Motor Vehicle Industry Establishments and Employment, Ohio and the U.S., 2014

		Ohio			U.S.			Ohio as a Percentage of the U.S.	
2012 NAICS Codes	Shorter Industry Title	Establishments	Employment	Mean	Establishments	Employment	Mean	Establishments	Employment
11-81	Total (Private Sector, exc. Farm & Railroad)	250,535	4,636,844	18.5	7,563,085	121,079,879	16.0	3.3%	3.8%
32621-3363	Motor Vehicle (MV) Industry	578	92,931	160.8	7,983	880,194	110.3	7.2%	10.6%
3361-3	Transportation Eqpt. Subtotal	547	88,675	162.1	7,312	811,071	110.9	7.5%	10.9%
3361	MV Assembly	25	17,968	718.7	336	170,550	507.6	7.4%	10.5%
33611	Cars & Light Trucks	16	14,546	909.1	257	143,434	558.1	6.2%	10.1%
33612	Medium- & Heavy-Duty Trucks	9	3,422	380.2	79	27,116	343.2	11.4%	12.6%
3362	MV Bodies & Trailers	87	5,166	59.4	1,898	128,465	67.7	4.6%	4.0%
336211	MV Bodies	39	2,465	63.2	760	42,508	55.9	5.1%	5.8%
336212	Truck Trailers	24	1,257	52.4	408	29,981	73.5	5.9%	4.2%
336213-4	Motor Homes, Trailers & Campers^	24	1,444	60.2	730	55,976	76.7	3.3%	2.6%
3363	MV Parts	435	65,541	150.7	5,078	512,056	100.8	8.6%	12.8%
33631	MV Gas Engines & Engine Parts	52	5,079	97.7	858	53,655	62.5	6.1%	9.5%
33632	MV Electrical & Electronic Eqpt.	26	9,656	371.4	688	58,310	84.8	3.8%	16.6%
33633	MV Steering & Suspension Parts	21	2,584	123.0	253	31,681	125.2	8.3%	8.2%
33634	MV Brake Systems	24	3,083	128.5	186	21,923	117.9	12.9%	14.1%
33635	MV Transmission & Power Train Parts	31	10,080	325.2	491	65,767	133.9	6.3%	15.3%
33636	MV Seating & Interior Trim	32	8,197	256.2	394	57,697	146.4	8.1%	14.2%
33637	MV Metal Stamping	142	15,518	109.3	771	91,286	118.4	18.4%	17.0%
33639	Other MV Parts	107	11,344	106.0	1,437	131,737	91.7	7.4%	8.6%
32621-335911	Related Industries Subtotal	31	4,256	137.3	671	69,123	103.0	4.6%	6.2%
32621	Tires	27	3,185	118.0	528	49,920	94.5	5.1%	6.4%
326211	Tire Mfg. (Exc. Retreading)	9	2,930	325.6	118	43,557	369.1	7.6%	6.7%
326212	Tire Retreading	18	255	14.2	410	6,363	15.5	4.4%	4.0%
335911	Storage Batteries	4	1,071	267.8	143	19,203	134.3	2.8%	5.6%

Notes: Abbreviations: Eqpt. - equipment; Exc. - except; Mfg. - manufacturing; MV - motor vehicle. General Motor's (GM's) foundry in Defiance and its diesel engine plant in Dayton, as well as Daimler's diesel engine plant in Byesville, are excluded because their NAICS codes (3315 and 333618) are not part of the industry definition, and there is no ready comparison to the national summary of such dedicated plants. Conversely, a few non-motor vehicle tire and/or battery manufacturers are included to facilitate the Ohio-U.S. comparisons. ^ - The overwhelming majority of establishments and employment are in the 336214 - Trailers and Campers.

Sources: U.S. Bureau of the Census (2016b).

Prepared by: Office of Research, Ohio Development Services Agency (ODSA) (DL, 8/16).

Table A6: Motor Vehicle Industry Employment and Pay, Ohio and the U.S., 2014

2012 NAICS Codes	Shorter Industry Title	Ohio Employ-ment	Ohio Payroll in millions	Ohio Mean	U.S. Employ-ment	U.S. Payroll in millions	U.S. Mean	Ohio Means as a Percent of U.S. Means
11-81	Total (Private Sector, exc. Farm & Railroad)	4,636,844	$203,868.1	$43,967	121,079,879	$5,940,442.6	$49,062	89.6%
32621-3363	Motor Vehicle (MV) Industry	92,931	$5,717.8	$61,527	880,194	$49,776.4	$56,552	108.8%
3361-3	Transportation Eqpt. Subtotal	88,675	$5,473.0	$61,719	811,071	$45,851.1	$56,532	109.2%
3361	MV Assembly	17,968	$1,470.8	$81,854	170,550	$12,844.5	$75,312	108.7%
33611	Cars & Light Trucks	14,546	$1,245.1	$85,596	143,434	$11,110.0	$77,457	110.5%
33612	Medium- & Heavy-Duty Trucks	3,422	$225.7	$65,950	27,116	$1,734.5	$63,966	103.1%
3362	MV Bodies & Trailers	5,166	$268.1	$51,889	128,465	$5,869.2	$45,687	113.6%
336211	MV Bodies	2,465	$138.1	$56,038	42,508	$2,020.6	$47,534	117.9%
336212	Truck Trailers	1,257	$61.8	$49,132	29,981	$1,306.7	$43,583	112.7%
336213-4	Motor Homes, Trailers & Campers	1,444	$68.2	$47,206	55,976	$2,541.9	$45,411	104.0%
3363	MV Parts	65,541	$3,734.2	$56,974	512,056	$27,137.5	$52,997	107.5%
33631	MV Gas Engines & Engine Parts	5,079	$344.7	$67,875	53,655	$3,310.0	$61,690	110.0%
33632	MV Electrical & Electronic Eqpt.	9,656	$700.7	$72,571	58,310	$3,193.2	$54,763	132.5%
33633	MV Steering & Suspension Parts	2,584	$127.6	$49,364	31,681	$1,620.1	$51,137	96.5%
33634	MV Brake Systems	3,083	$148.5	$48,183	21,923	$1,087.2	$49,590	97.2%
33635	MV Transmission & Power Train Parts	10,080	$704.9	$69,928	65,767	$4,083.9	$62,096	112.6%
33636	MV Seating & Interior Trim	8,197	$337.0	$41,109	57,697	$2,530.3	$43,855	93.7%
33637	MV Metal Stamping	15,518	$837.7	$53,982	91,286	$4,925.8	$53,960	100.0%
33639	Other MV Parts	11,344	$533.0	$46,989	131,737	$6,387.1	$48,484	96.9%
32621-335911	Related Industries Subtotal	4,256	$244.8	$57,526	69,123	$3,925.2	$56,786	101.3%
32621	Tires	3,185	$184.8	$58,014	49,920	$2,832.0	$56,730	102.3%
326211	Tire Mfg. (Exc. Retreading)	2,930	$174.3	$59,495	43,557	$2,579.0	$59,209	100.5%
326212	Tire Retreading	255	$10.5	$40,996	6,363	$253.0	$39,760	103.1%
335911	Storage Batteries	1,071	$60.1	$56,077	19,203	$1,093.3	$56,932	98.5%

Notes: Abbreviations: Eqpt. - equipment; Exc. - except; Mfg. - manufacturing; MV - motor vehicle. General Motor's (GM's) foundry in Defiance and its diesel engine plant in Dayton, as well as Daimler's diesel engine plant in Byesville, are excluded because their NAICS codes (3315 and 333618) are not part of the industry definition, and there is no ready comparison to the national summary of such dedicated plants. Conversely, a few non-motor vehicle tire and/or battery manufacturers are included to facilitate the Ohio-U.S. comparisons. ^ - The overwhelming majority of establishments and employment are in the 336214 - Trailers and Campers.

Sources: U.S. Bureau of the Census (2016b).

Prepared by: Office of Research, Ohio Development Services Agency (ODSA) (DL, 8/16).

Table A7: Establishments and Estimated Employment in Ohio's Motor Vehicle Industry by County, 2014

Area Name	Establishments	Employment*	Area Name	Establishments	Employment*	Area Name	Establishments	Employment*
Ohio	580	94,844	Greene	1	333	Morrow	3	756
			Guernsey^	2	539	Muskingum	0	0
Adams	0	0	Hamilton	13	2,415	Noble	0	0
Allen	7	1,574	Hancock	16	4,867	Ottawa	2	30
Ashland	1	28	Hardin	2	400	Paulding	4	201
Ashtabula	7	77	Harrison	0	0	Perry	1	3
Athens	0	0	Henry	3	483	Pickaway	1	333
Auglaize	5	701	Highland	2	81	Pike	1	333
Belmont	2	145	Hocking	0	0	Portage	5	525
Brown	1	143	Holmes	4	75	Preble	4	826
Butler	9	1,314	Huron	2	150	Putnam	5	890
Carroll	1	3	Jackson	1	99	Richland	12	1,656
Champaign	5	1,429	Jefferson	2	22	Ross	4	2,516
Clark	13	1,901	Knox	5	734	Sandusky	8	1,024
Clermont	7	266	Lake	10	466	Scioto	1	3
Clinton	1	650	Lawrence	0	0	Seneca	5	605
Columbiana	8	608	Licking	8	1,331	Shelby	10	3,656
Coshocton	1	3	Logan	4	3,214	Stark	16	902
Crawford	6	1,025	Lorain	17	2,966	Summit	24	1,104
Cuyahoga	60	4,791	Lucas	26	7,365	Trumbull	15	7,850
Darke	5	458	Madison	6	1,854	Tuscarawas	7	303
Defiance^	5	2,192	Mahoning	8	114	Union	2	3,336
Delaware	6	618	Marion	7	733	Van Wert	4	367
Erie^	5	1,312	Medina	15	650	Vinton	0	0
Fairfield	6	155	Meigs	0	0	Warren	8	1,973
Fayette	1	143	Mercer	3	466	Washington	1	3
Franklin	28	2,245	Miami	6	795	Wayne	16	2,953
Fulton	7	1,236	Monroe	0	0	Williams~	11	652
Gallia	1	143	Montgomery^	33	4,045	Wood	10	2,675
Geauga	1	28	Morgan	2	400	Wyandot	3	697

Notes: * - All employment figures are estimates based on County Business Patterns; a few incorporate information from other sources; county employment figures sum to 93,952, less than the state total, and therefore tend to be slightly low.
^ - Figures include GM's Defiance foundry, Daimler's Guernsey diesel plant, and GM-Isuzu's D-MAX Montgomery diesel plant.
~ - Titan's off-road tire plant is excluded.

Sources: company websites, ODSA (2014), and U.S. Bureau of the Census (2016b).

Prepared by: Office of Research, Ohio Development Services Agency (ODSA) (DL, 8/16).

Table A8: Motor Vehicle Industry Employment Trends, 2004-2014 (in thousands, except percentages)

NAICS Code	Shorter Industry Title	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Changes: 2004-14 Number	Changes: 2004-14 Percent
32621-3363	***Ohio*** Motor Vehicle (MV) Industry	131.6	126.5	126.4	116.4	108.5	81.1	77.5	78.5	83.0	88.4	92.9	-38.7	-29.4%
3361-3	Transportation Eqpt. Subtotal	127.4	122.2	122.2	112.0	103.9	76.7	73.6	74.5	78.8	84.1	88.7	-38.7	-30.4%
3361	MV Assembly	28.6	27.3	26.8	23.6	22.4	14.9	16.7	16.7	17.6	16.9	18.0	-10.6	-37.1%
33611	Cars & Light Trucks	25.2	23.6	23.2	20.4	19.8	12.7	14.5	13.9	14.0	13.6	14.5	-10.7	-42.3%
33612	Medium- & Heavy-Duty Trucks	3.4	3.7	3.7	3.1	2.6	2.2	2.2	2.9	3.6	3.3	3.4	0.1	2.0%
3362	MV Bodies & Trailers	4.3	4.6	4.9	5.4	5.8	4.1	3.6	3.4	3.9	4.9	5.2	0.9	21.2%
336211	MV Bodies	2.1	2.3	2.5	3.2	3.4	2.2	1.8	1.7	1.6	2.4	2.5	0.3	15.3%
336212	Truck Trailers	1.2	1.2	1.5	1.3	1.1	0.9	0.8	0.7	1.0	1.2	1.3	0.0	2.9%
336213-4	Motor Homes, Trailers & Campers^	0.9	1.0	1.0	0.9	1.3	1.0	0.9	1.0	1.3	1.3	1.4	0.5	59.6%
3363	MV Parts*	94.5	90.3	90.4	83.0	75.8	57.7	53.3	54.3	57.3	62.3	65.5	-29.0	-30.7%
33631	MV Gas Engines & Engine Parts	9.5	8.6	8.5	8.1	7.2	6.5	3.2	4.6	4.9	5.1	5.1	-4.4	-46.3%
33632	MV Electrical & Electronic Eqpt.	9.1	8.5	9.7	9.1	8.2	6.8	8.5	8.0	8.0	9.2	9.7	0.6	6.7%
33633	MV Steering & Suspension Parts	5.6	4.9	4.9	5.1	5.4	4.2	3.5	3.2	2.6	2.6	2.6	-3.1	-54.2%
33634	MV Brake Systems	7.3	6.4	6.2	5.0	3.4	2.7	2.4	2.4	2.2	2.7	3.1	-4.2	-57.8%
33635	MV Transmission & Power Train Parts	13.8	13.3	13.1	11.6	11.4	7.5	7.1	7.3	8.8	9.4	10.1	-3.7	-26.7%
33636	MV Seating & Interior Trim	7.2	7.3	7.3	7.3	6.4	5.3	5.2	5.8	6.8	7.7	8.2	1.0	14.2%
33637	MV Metal Stamping	25.1	24.0	24.3	21.7	20.3	14.4	13.9	13.4	14.2	14.6	15.5	-9.6	-38.1%
33639	Other MV Parts	17.0	17.2	16.6	15.1	13.5	10.4	9.5	9.6	9.8	11.1	11.3	-5.7	-33.4%
32621-335911	Related Industries Subtotal*	4.3	4.3	4.2	4.4	4.7	4.4	3.9	4.0	4.2	4.3	4.3	0.0	0.0%
32621	Tires	3.2	3.3	3.1	3.3	3.5	3.3	2.7	2.9	3.0	3.3	3.2	0.0	0.2%
326211	Tire Mfg. (Exc. Retreading)	2.7	2.7	2.7	2.9	3.0	2.9	2.4	2.5	2.6	2.9	2.9	0.2	7.6%
326212	Tire Retreading	0.5	0.5	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.3	-0.2	-44.2%
335911	Storage Batteries	1.1	1.0	1.0	1.1	1.2	1.2	1.2	1.1	1.1	1.0	1.1	0.0	-0.4%
32621-3363	***U.S.*** Motor Vehicle (MV) Industry	1,131.8	1,112.9	1,088.7	1,017.3	957.5	733.7	693.5	736.2	796.9	837.7	880.2	-251.6	-22.2%
3361-3	Transportation Eqpt. Subtotal	1,049.7	1,033.2	1,007.9	941.7	879.4	662.1	627.6	667.3	727.1	769.7	811.1	-238.7	-22.7%
3361	MV Assembly	216.8	214.5	211.2	196.5	182.1	134.4	130.4	136.7	150.0	161.4	170.6	-46.2	-21.3%
33611	Cars & Light Trucks	187.2	182.2	179.0	165.9	153.4	111.7	109.5	109.1	119.2	133.4	143.4	-43.8	-23.4%
33612	Medium- & Heavy-Duty Trucks	29.6	32.3	32.1	30.6	28.6	22.7	20.9	27.5	30.8	28.0	27.1	-2.5	-8.3%
3362	MV Bodies & Trailers	143.9	147.6	155.6	151.6	136.4	96.0	94.2	102.8	115.5	119.0	128.5	-15.4	-10.7%
336211	MV Bodies	45.0	46.2	47.6	50.4	47.5	39.5	38.6	38.3	40.5	39.4	42.5	-2.5	-5.5%
336212	Truck Trailers	25.7	29.0	32.3	32.9	25.9	18.8	17.9	23.1	28.3	29.3	30.0	4.3	16.7%
336213-4	Motor Homes, Trailers & Campers^	73.2	72.4	75.8	68.3	63.0	37.7	37.7	41.4	46.7	50.3	56.0	-17.2	-23.6%
3363	MV Parts	689.1	671.0	641.1	593.6	560.9	431.8	402.9	427.9	461.6	489.3	512.1	-177.0	-25.7%
33631	MV Gas Engines & Engine Parts	91.8	80.9	76.6	71.9	60.6	48.3	44.3	51.4	52.8	53.4	53.7	-38.2	-41.6%
33632	MV Electrical & Electronic Eqpt.	87.0	85.3	77.6	69.3	66.1	52.4	47.7	45.7	50.0	55.3	58.3	-28.7	-33.0%
33633	MV Steering & Suspension Parts	37.3	37.8	39.4	36.0	37.4	31.7	26.1	27.2	28.7	29.8	31.7	-5.6	-15.0%
33634	MV Brake Systems	40.9	39.4	33.8	30.9	27.4	21.7	20.2	21.7	21.9	23.1	21.9	-19.0	-46.4%
33635	MV Transmission & Power Train Parts	94.6	90.8	83.8	78.0	75.3	52.1	51.2	53.4	58.2	63.0	65.8	-28.9	-30.5%
33636	MV Seating & Interior Trim	56.9	57.4	52.8	52.2	50.0	40.9	39.8	41.8	47.0	54.9	57.7	0.8	1.4%
33637	MV Metal Stamping	114.7	111.2	110.6	100.0	94.3	66.9	67.0	72.1	81.0	85.6	91.3	-23.4	-20.4%
33639	Other MV Parts	165.9	168.3	166.5	155.4	150.0	117.7	106.6	114.6	122.0	124.1	131.7	-34.1	-20.6%
32621-335911	Related Industries Subtotal	82.0	79.7	80.8	75.6	78.1	71.6	66.0	68.9	69.8	67.9	69.1	-12.9	-15.7%
32621	Tires	64.0	62.6	62.5	58.0	58.2	53.4	48.1	50.0	50.5	49.1	49.9	-14.1	-22.0%
326211	Tire Mfg. (Exc. Retreading)	55.1	54.3	54.0	49.8	50.2	46.4	41.8	43.8	43.8	42.8	43.6	-11.5	-20.9%
326212	Tire Retreading	8.9	8.3	8.5	8.2	8.0	7.0	6.3	6.2	6.7	6.3	6.4	-2.6	-28.8%
335911	Storage Batteries	18.0	17.1	18.3	17.7	19.8	18.1	17.8	18.9	19.3	18.9	19.2	1.2	6.6%

Notes: ^ - The vast majority are Trailers and Campers (336214); * - some constituent Ohio figures may be estimates; abbreviations used: Eqpt. - equipment; Exc. - except; Mfg. - manufacturing; MV - motor vehicle.
Sources: U.S. Bureau of the Census (2006b-2016b).
Prepared by: Office of Research, Ohio Development Services Agency (ODSA) (DL, 8/16).

Table A9: Total and Motor Vehicle Industry Gross Domestic Product for Ohio and the U.S., 1997-2014
(in billions of chained dollars standardized on 2009)

	Motor Vehicles, Bodies, Trailers & Parts (NAICS 3361-3363) GDP						Total GDP						
	Ohio			U.S.			Ohio		U.S.		Ohio as a Percent of the U.S.		
Year	Dollar Value (billions)	Percent Change from Prior Yr.	As Percent of Total	Dollar Value (billions)	Percent Change from Prior Yr.	As Percent of Total	Dollar Value (billions)	Percent Change from Prior Yr.	Dollar Value (billions)	Percent Change from Prior Yr.	NAICS 3361-3363	Total	Ohio::U.S. Concentration Ratio
1997	$12.0		2.7%	$89.0		0.8%	$445.4		$11,128.9		13.5%	4.0%	3.38
1998	$14.3	18.5%	3.1%	$98.4	10.5%	0.8%	$460.9	3.5%	$11,607.6	4.3%	14.5%	4.0%	3.65
1999	$13.6	-4.7%	2.9%	$104.4	6.1%	0.9%	$471.1	2.2%	$12,150.9	4.7%	13.0%	3.9%	3.36
2000	$14.0	3.1%	2.9%	$106.9	2.4%	0.8%	$480.9	2.1%	$12,625.3	3.9%	13.1%	3.8%	3.44
2001	$12.0	-14.1%	2.5%	$96.7	-9.6%	0.8%	$475.1	-1.2%	$12,743.6	0.9%	12.4%	3.7%	3.34
2002	$14.2	18.1%	2.9%	$110.1	13.9%	0.8%	$486.1	2.3%	$12,970.9	1.8%	12.9%	3.7%	3.44
2003	$14.2	0.2%	2.9%	$119.5	8.5%	0.9%	$494.3	1.7%	$13,303.9	2.6%	11.9%	3.7%	3.21
2004	$16.7	17.4%	3.3%	$122.8	2.7%	0.9%	$508.6	2.9%	$13,772.8	3.5%	13.6%	3.7%	3.69
2005	$17.0	1.5%	3.3%	$129.6	5.5%	0.9%	$513.2	0.9%	$14,211.4	3.2%	13.1%	3.6%	3.63
2006	$18.7	10.1%	3.6%	$142.8	10.2%	1.0%	$513.6	0.1%	$14,593.5	2.7%	13.1%	3.5%	3.72
2007	$16.6	-11.1%	3.2%	$136.4	-4.5%	0.9%	$512.7	-0.2%	$14,798.4	1.4%	12.2%	3.5%	3.52
2008	$11.8	-28.9%	2.4%	$106.8	-21.7%	0.7%	$502.6	-2.0%	$14,718.3	-0.5%	11.1%	3.4%	3.24
2009	$4.1	-65.6%	0.9%	$48.4	-54.6%	0.3%	$477.9	-4.9%	$14,320.1	-2.7%	8.4%	3.3%	2.51
2010	$7.6	86.8%	1.6%	$99.8	105.9%	0.7%	$488.1	2.1%	$14,628.2	2.2%	7.6%	3.3%	2.28
2011	$11.1	46.0%	2.2%	$127.5	27.8%	0.9%	$503.5	3.1%	$14,833.7	1.4%	8.7%	3.4%	2.56
2012	$12.8	15.9%	2.5%	$138.3	8.4%	0.9%	$512.8	1.9%	$15,126.3	2.0%	9.3%	3.4%	2.74
2013	$12.0	-6.6%	2.3%	$145.7	5.4%	1.0%	$517.7	1.0%	$15,317.2	1.3%	8.2%	3.4%	2.44
2014	$12.6	14.2%	2.4%	$146.3	14.7%	0.9%	$534.9	6.2%	$15,653.0	5.5%	8.6%	3.4%	2.53
Net Changes, 1997-2014													
Numeric	$0.6		-0.3%	$57.3		0.1%	$89.5		$4,524.2		-4.9%	-0.6%	-0.85
Percent	5.2%			64.3%			20.1%		40.7%				

Notes: State GDP is analogous to national GDP, but not identical with it due to minor technical differences. Chained dollars adjusts for inflation, allowing comparisons of the volume of goods produced from year to year.

Source: U.S. Bureau of Economic Analysis (2016a).

Prepared by: Office of Research, Ohio Development Services Agency (DL, 8/16).

Table A10: Trends in Value-Added by Group for Ohio and the U.S., 1997-2014
(in millions of dollars)

	Ohio				U.S.				Ohio as a Percentage of the U.S.			
Year	3361: Assembly	3362: Bodies & Trailers	3363: Parts	Summary	3361: Assembly	3362: Bodies & Trailers	3363: Parts	Summary	3361: As-sembly	3362: Bodies & Trailers	3363: Parts	Sum-mary
1997	$10,760.0	$281.9	$11,275.6	$22,317.5	$72,575.0	$7,693.7	$73,797.9	$154,066.6	14.8%	3.7%	15.3%	14.5%
1998	$13,493.2	$331.0	$10,977.3	$24,801.4	$66,288.7	$8,474.4	$77,370.5	$152,133.6	20.4%	3.9%	14.2%	16.3%
1999	$13,344.9	$331.2	$11,665.1	$25,341.2	$77,424.7	$10,158.9	$85,426.3	$173,009.9	17.2%	3.3%	13.7%	14.6%
2000	$12,092.3	$339.9	$11,197.9	$23,630.2	$61,627.7	$9,871.3	$84,481.3	$155,980.3	19.6%	3.4%	13.3%	15.1%
2001^	$10,408.9	$273.1	$9,362.9	$20,044.9	$54,172.8	$8,417.3	$74,532.3	$137,122.4	19.2%	3.2%	12.6%	14.6%
2002	$12,686.7	$244.0	$11,753.1	$24,683.9	$72,157.1	$8,741.7	$86,428.2	$167,327.0	17.6%	2.8%	13.6%	14.8%
2003	$9,606.0	$272.5	$12,292.3	$22,170.8	$78,239.9	$9,475.8	$84,401.2	$172,117.0	12.3%	2.9%	14.6%	12.9%
2004	$10,541.7	$703.1	$13,504.4	$24,749.2	$71,100.6	$11,186.5	$83,006.0	$165,293.2	14.8%	6.3%	16.3%	15.0%
2005	$10,800.6	$945.8	$12,361.1	$24,107.5	$67,605.8	$12,292.5	$81,289.8	$161,188.0	16.0%	7.7%	15.2%	15.0%
2006^	$10,908.5	$1,122.4	$11,298.8	$23,329.8	$66,035.3	$13,482.8	$80,497.4	$160,015.6	16.5%	8.3%	14.0%	14.6%
2007	$9,920.1	$470.4	$10,649.2	$21,039.7	$73,039.6	$12,806.0	$74,178.3	$160,023.9	13.6%	3.7%	14.4%	13.1%
2008	$7,469.2	$253.7	$8,581.8	$16,304.8	$51,590.4	$10,021.2	$63,002.7	$124,614.3	14.5%	2.5%	13.6%	13.1%
2009*	$3,337.8	$307.2	$6,994.3	$10,639.2	$41,665.0	$7,012.0	$53,305.1	$101,982.1	8.0%	4.4%	13.1%	10.4%
2010*	$3,805.3	$362.6	$7,522.4	$11,690.3	$65,275.0	$8,200.8	$63,575.7	$137,051.5	5.8%	4.4%	11.8%	8.5%
2011*^	$4,458.9	$411.5	$7,138.5	$12,009.0	$54,916.5	$8,980.1	$62,854.6	$126,751.2	8.1%	4.6%	11.4%	9.5%
2012	$6,237.1	$371.0	$7,867.2	$14,475.3	$59,588.6	$10,826.4	$70,012.3	$140,427.4	10.5%	3.4%	11.2%	10.3%
2013	$4,981.4	$452.8	$8,596.4	$14,030.6	$64,512.7	$12,398.4	$74,916.0	$151,827.1	7.7%	3.7%	11.5%	9.2%
2014^	$5,963.6	$479.2	$9,399.1	$15,841.9	$70,244.5	$13,664.0	$79,496.0	$163,404.5	8.5%	3.5%	11.8%	9.7%
Average percentages for the 18-year period:									13.8%	4.3%	13.5%	13.0%

Notes: * - Some data for Ohio are less reliable, as indicated by the relatively large standard errors of the estimates (not shown).
^ - Initial figures, but not subject to revision because they precede an Economic Census year.

Sources: U.S. Bureau of the Census (2000c, 2001a-2003a, 2005c, 2006a-2008a, 2010c, 2011a-2016a, 2015c).

Prepared by: Office of Research, Ohio Development Services Agency (DL, 8/16).

Table A11: Light Vehicle Production in Ohio and the U.S., 1993-2015

	Ohio				U.S.				Ohio as Percent of U.S.		
Year	Cars	Light Trucks	Light Vehicles	Cars as Percent of Light Vehicles	Cars	Light Trucks	Light Vehicles	Cars as Percent of Light Vehicles	Cars	Light Trucks	Light Vehicles
1993	1,005,870	795,541	1,801,411	55.8%	5,982,120	4,608,017	10,590,137	56.5%	16.8%	17.3%	17.0%
1994	959,856	812,660	1,772,516	54.2%	6,601,223	5,332,048	11,933,271	55.3%	14.5%	15.2%	14.9%
1995	988,869	907,288	1,896,157	52.2%	6,339,892	5,306,197	11,646,089	54.4%	15.6%	17.1%	16.3%
1996	1,084,599	855,430	1,940,029	55.9%	6,082,835	5,749,418	11,832,253	51.4%	17.8%	14.9%	16.4%
1997	1,105,007	893,447	1,998,454	55.3%	5,933,921	6,196,565	12,130,486	48.9%	18.6%	14.4%	16.5%
1998	1,016,129	840,416	1,856,545	54.7%	5,554,373	6,448,290	12,002,663	46.3%	18.3%	13.0%	15.5%
1999	1,055,762	918,210	1,973,972	53.5%	5,637,949	7,387,029	13,024,978	43.3%	18.7%	12.4%	15.2%
2000	1,022,393	841,636	1,864,029	54.8%	5,542,217	7,228,497	12,770,714	43.4%	18.4%	11.6%	14.6%
2001	1,016,218	722,869	1,739,087	58.4%	4,879,119	6,545,570	11,424,689	42.7%	20.8%	11.0%	15.2%
2002	989,509	847,787	1,837,296	53.9%	5,018,777	7,260,805	12,279,582	40.9%	19.7%	11.7%	15.0%
2003	927,925	956,952	1,884,877	49.2%	4,510,469	7,576,559	12,087,028	37.3%	20.6%	12.6%	15.6%
2004	797,009	943,622	1,740,631	45.8%	4,229,625	7,730,729	11,960,354	35.4%	18.8%	12.2%	14.6%
2005	882,222	912,367	1,794,589	49.2%	4,321,272	7,625,381	11,946,653	36.2%	20.4%	12.0%	15.0%
2006	884,734	785,007	1,669,741	53.0%	4,366,996	6,893,281	11,260,277	38.8%	20.3%	11.4%	14.8%
2007	870,008	878,327	1,748,335	49.8%	3,924,268	6,828,042	10,752,310	36.5%	22.2%	12.9%	16.3%
2008	854,209	629,877	1,484,086	57.6%	3,776,641	4,896,450	8,673,091	43.5%	22.6%	12.9%	17.1%
2009	394,333	389,129	783,462	50.3%	2,331,435	3,280,365	5,611,800	41.5%	16.9%	11.9%	14.0%
2010	511,310	592,222	1,103,532	46.3%	2,934,267	4,694,826	7,629,093	38.5%	17.4%	12.6%	14.5%
2011	565,851	595,698	1,161,549	48.7%	3,148,601	5,322,261	8,470,862	37.2%	18.0%	11.2%	13.7%
2012	745,381	627,227	1,372,608	54.3%	4,325,546	5,803,973	10,129,519	42.7%	17.2%	10.8%	13.6%
2013	802,292	653,826	1,456,118	55.1%	4,566,010	6,307,444	10,873,454	42.0%	17.6%	10.4%	13.4%
2014	741,588	825,163	1,566,751	47.3%	4,195,914	7,156,434	11,352,348	37.0%	17.7%	11.5%	13.8%
2015*	765,018	853,809	1,618,827	47.3%	4,148,984	7,721,989	11,870,973	35.0%	18.4%	11.1%	13.6%

Notes: * - Initial, subject to revision.

Sources: Automotive News (2010-2016), Ward's (1994-2009).

Prepared by: Office of Research, Ohio Development Services Agency (DL, 8/16).

Table A12: Trends in Capital Expenditures by Group for Ohio and the U.S., 1997-2014
(in millions of dollars)

	Ohio				U.S.				Ohio as a Percentage of the U.S.			
Year	3361: Assembly	3362: Bodies & Trailers	3363: Parts	Summary	3361: Assembly	3362: Bodies & Trailers	3363: Parts	Summary	3361: As-sembly	3362: Bodies & Trailers	3363: Parts	Sum-mary
1997	$454.1	$26.6	$1,888.5	$2,369.3	$5,406.6	$441.1	$9,489.4	$15,337.1	8.4%	6.0%	19.9%	15.4%
1998	$364.1	$12.6	$1,669.7	$2,046.4	$5,383.8	$377.8	$9,830.8	$15,592.3	6.8%	3.3%	17.0%	13.1%
1999	$745.7	$16.6	$1,323.6	$2,086.0	$4,773.5	$463.7	$9,464.3	$14,701.4	15.6%	3.6%	14.0%	14.2%
2000	$840.2	$13.6	$1,118.0	$1,971.8	$4,777.8	$588.1	$8,863.0	$14,229.0	17.6%	2.3%	12.6%	13.9%
2001^	$462.6	$6.7	$1,099.9	$1,569.2	$4,461.3	$503.3	$8,390.4	$13,355.0	10.4%	1.3%	13.1%	11.8%
2002	$318.6	$8.3	$1,366.9	$1,693.8	$4,802.2	$328.0	$7,534.3	$12,664.5	6.6%	2.5%	18.1%	13.4%
2003	$285.3	$4.6	$932.7	$1,222.6	$5,186.7	$386.8	$7,377.3	$12,950.7	5.5%	1.2%	12.6%	9.4%
2004	$421.3	$14.6	$1,123.6	$1,559.5	$4,686.8	$441.5	$6,259.2	$11,387.5	9.0%	3.3%	18.0%	13.7%
2005	$453.8	$22.7	$803.2	$1,279.7	$4,283.1	$391.2	$6,759.4	$11,433.6	10.6%	5.8%	11.9%	11.2%
2006^	$570.5	$11.1	$1,543.9	$2,125.4	$4,042.8	$393.5	$6,884.3	$11,320.6	14.1%	2.8%	22.4%	18.8%
2007	$268.2	$14.0	$1,032.4	$1,314.6	$3,765.1	$413.9	$6,675.5	$10,854.5	7.1%	3.4%	15.5%	12.1%
2008	$135.8	$12.0	$1,179.2	$1,327.0	$4,129.9	$332.2	$6,836.7	$11,298.7	3.3%	3.6%	17.2%	11.7%
2009*	$148.5	$4.2	$693.2	$845.9	$3,264.0	$431.9	$4,559.5	$8,255.4	4.5%	1.0%	15.2%	10.2%
2010*	$192.8	$8.0	$641.6	$842.5	$7,976.9	$187.6	$3,946.4	$12,110.8	2.4%	4.3%	16.3%	7.0%
2011*^	$120.3	$5.1	$761.2	$886.6	$6,221.4	$350.1	$5,595.5	$12,167.1	1.9%	1.5%	13.6%	7.3%
2012~	$881.2	D	$1,112.2	$1,993.4	$6,363.3	$563.6	$8,828.1	$15,755.0	13.8%	n.a.	12.6%	12.7%
2013	$406.8	$17.4	$1,492.2	$1,916.3	$8,952.3	$467.1	$10,313.9	$19,733.3	4.5%	3.7%	14.5%	9.7%
2014^	$281.3	$13.9	$1,133.4	$1,428.7	$10,166.7	$468.7	$9,032.6	$19,668.0	2.8%	3.0%	12.5%	7.3%
Average percentages for the 18-year period:									7.5%	2.8%	15.3%	11.7%

Notes: * - Some data for Ohio are less reliable, as indicated by the relatively large standard errors of the estimates (not shown).
^ - Initial figures, but not subject to revision because they precede an Economic Census year.
D - Data suppressed to maintain confidentiality; n.a. not available; ~ - summary percentage excludes Ohio 3362.

Sources: U.S. Bureau of the Census (2000c, 2001a-2003a, 2005c, 2006a-2008a, 2010c, 2011a-2016a, 2015c).

Prepared by: Office of Research, Ohio Development Services Agency (DL, 8/16).

Table A13: Motor Vehicle Industry Establishment Trends, 2004-2014

NAICS Codes	Shorter Industry Title	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Changes: 2004-14 Number	Changes: 2004-14 Percent
32621-3363	***Ohio*** Motor Vehicle (MV) Industry	653	645	658	673	647	616	575	554	565	576	578	-75	-11.5%
3361-3	Transportation Eqpt. Subtotal	607	602	613	628	602	573	538	522	532	543	547	-60	-9.9%
3361	MV Assembly	27	29	28	29	28	24	28	25	22	23	25	-2	-7.4%
33611	Cars & Light Trucks	18	19	19	19	17	14	18	15	13	14	16	-2	-11.1%
33612	Medium- & Heavy-Duty Trucks	9	10	9	10	11	10	10	10	9	9	9	0	0.0%
3362	MV Bodies & Trailers	82	80	95	101	94	83	81	80	86	90	87	5	6.1%
336211	MV Bodies	38	35	43	46	41	37	36	36	39	42	39	1	2.6%
336212	Truck Trailers	20	18	24	22	25	22	22	19	24	25	24	4	20.0%
336213-4	Motor Homes, Trailers & Campers^	24	27	28	33	28	24	23	25	23	23	24	0	0.0%
3363	MV Parts	498	493	490	498	480	466	429	417	424	430	435	-63	-12.7%
33631	MV Gas Engines & Engine Parts	55	49	54	61	58	58	48	49	49	52	52	-3	-5.5%
33632	MV Electrical & Electronic Eqpt.	41	38	39	38	37	33	31	30	28	24	26	-15	-36.6%
33633	MV Steering & Suspension Parts	22	23	24	26	23	22	22	20	19	19	21	-1	-4.5%
33634	MV Brake Systems	33	29	29	27	28	31	26	24	23	27	24	-9	-27.3%
33635	MV Transmission & Power Train Parts	38	35	35	35	27	27	28	27	31	31	31	-7	-18.4%
33636	MV Seating & Interior Trim	32	34	37	37	36	31	31	29	31	35	32	0	0.0%
33637	MV Metal Stamping	156	159	152	149	154	155	139	137	140	139	142	-14	-9.0%
33639	Other MV Parts	121	126	120	125	117	109	104	101	103	103	107	-14	-11.6%
32621-335911	Related Industries Subtotal	46	43	45	45	45	43	37	32	33	33	31	-15	-32.6%
32621	Tires	40	37	38	39	38	36	30	25	28	29	27	-13	-32.5%
326211	Tire Mfg. (Exc. Retreading)	12	10	9	9	9	9	7	6	7	9	9	-3	-25.0%
326212	Tire Retreading	28	27	29	30	29	27	23	19	21	20	18	-10	-35.7%
335911	Storage Batteries	6	6	7	6	7	7	7	7	5	4	4	-2	-33.3%
32621-3363	***U.S.*** Motor Vehicle (MV) Industry	9,061	8,945	8,871	8,862	8,996	8,324	7,997	7,801	8,029	7,983	7,983	-1,078	-11.9%
3361-3	Transportation Eqpt. Subtotal	8,240	8,168	8,083	8,091	8,237	7,632	7,339	7,161	7,372	7,347	7,312	-928	-11.3%
3361	MV Assembly	377	380	370	378	377	355	371	341	336	331	336	-41	-10.9%
33611	Cars & Light Trucks	275	281	275	280	277	265	277	250	251	249	257	-18	-6.5%
33612	Medium- & Heavy-Duty Trucks	102	99	95	98	100	90	94	91	85	82	79	-23	-22.5%
3362	MV Bodies & Trailers	2,195	2,164	2,157	2,187	2,156	2,007	1,898	1,835	1,887	1,870	1,898	-297	-13.5%
336211	MV Bodies	826	814	820	845	839	787	742	705	741	731	760	-66	-8.0%
336212	Truck Trailers	408	391	394	394	429	407	402	401	421	420	408	0	0.0%
336213-4	Motor Homes, Trailers & Campers^	961	959	943	948	888	813	754	729	725	719	730	-231	-24.0%
3363	MV Parts	5,668	5,624	5,556	5,526	5,704	5,270	5,070	4,985	5,149	5,146	5,078	-590	-10.4%
33631	MV Gas Engines & Engine Parts	1,021	1,005	992	1,010	949	890	851	851	849	850	858	-163	-16.0%
33632	MV Electrical & Electronic Eqpt.	854	828	799	800	792	754	729	712	678	684	688	-166	-19.4%
33633	MV Steering & Suspension Parts	229	246	257	253	261	258	246	248	245	244	253	24	10.5%
33634	MV Brake Systems	262	251	241	238	233	204	199	191	195	250	186	-76	-29.0%
33635	MV Transmission & Power Train Parts	534	533	535	526	524	490	476	466	503	496	491	-43	-8.1%
33636	MV Seating & Interior Trim	407	399	421	407	409	409	403	395	398	408	394	-13	-3.2%
33637	MV Metal Stamping	788	792	781	758	788	769	736	717	773	773	771	-17	-2.2%
33639	Other MV Parts	1,573	1,570	1,530	1,534	1,748	1,496	1,430	1,405	1,508	1,441	1,437	-136	-8.6%
32621-335911	Related Industries Subtotal	821	777	788	771	759	692	658	640	657	636	671	-150	-18.3%
32621	Tires	692	656	663	649	643	580	535	514	529	500	528	-164	-23.7%
326211	Tire Mfg. (Exc. Retreading)	145	138	138	129	134	120	115	111	111	108	118	-27	-18.6%
326212	Tire Retreading	547	518	525	520	509	460	420	403	418	392	410	-137	-25.0%
335911	Storage Batteries	129	121	125	122	116	112	123	126	128	136	143	14	10.9%

Notes: ^ - The vast majority are Trailers and Campers (336214); abbreviations used: Eqpt. - equipment; Exc. - except; Mfg. - manufacturing; MV - motor vehicle.
Sources: U.S. Bureau of the Census (2006b-2016b).
Prepared by: Office of Research, Ohio Development Services Agency (ODSA) (DL, 8/16).

Table A14: Selected Motor Vehicle Industry* Statistics for Ohio and the U.S., 1998-2014

	Ohio				U.S.			
Year	GDP (in millions, standardized on 2009)	Employ-ment (thousands)	Gross Domestic Product per Employee	Capital Expend-itures (millions)	GDP (in millions, standardized on 2009)	Employ-ment (thousands)	Gross Domestic Product per Employee	Capital Expend-itures (millions)
1998^	$14,251	151.1	$94,325	$2,046	$98,359	1,165.6	$84,383	$15,592
1999^	$13,582	151.5	$89,662	$2,086	$104,358	1,170.1	$89,191	$14,701
2000^	$14,006	153.0	$91,542	$1,972	$106,880	1,198.1	$89,211	$14,229
2001^	$12,028	137.2	$87,686	$1,569	$96,666	1,060.1	$91,182	$13,355
2002	$14,210	117.3	$121,113	$1,694	$110,147	988.4	$111,440	$12,665
2003	$14,244	128.4	$110,925	$1,223	$119,523	1,032.5	$115,765	$12,951
2004	$16,725	127.4	$131,323	$1,560	$122,752	1,049.7	$116,935	$11,387
2005	$16,977	122.2	$138,936	$1,280	$129,563	1,033.2	$125,399	$11,434
2006	$18,693	122.2	$152,943	$2,125	$142,791	1,007.9	$141,666	$11,321
2007	$16,626	112.0	$148,437	$1,315	$136,434	941.7	$144,879	$10,854
2008	$11,818	103.9	$113,759	$1,327	$106,799	879.4	$121,446	$11,299
2009	$4,063	76.7	$52,990	$846	$48,439	662.1	$73,156	$8,255
2010	$7,590	73.6	$103,154	$842	$99,759	627.6	$158,958	$12,111
2011	$11,080	74.5	$148,805	$887	$127,496	667.3	$191,054	$12,167
2012~	$12,841	78.8	$162,870	$1,993	$138,255	727.1	$190,150	$15,755
2013	$11,997	84.1	$142,721	$1,916	$145,680	769.7	$189,262	$19,733
2014	$12,648	88.7	$142,633	$1,429	$146,253	811.1	$180,321	$19,668

Notes: * - NAICS codes 3361-3 combined; ^ - Ohio employment and GDP per employee estimated; ~ - Ohio capital expenditures low.

Sources: U.S. Bureaus of the Census (2001a-2016a, 2000b-2016b, 2005c, 2010c, 2015c) and Economic Analysis (2016a).

Prepared by: Office of Research, Ohio Development Services Agency (DL, 8/16).

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Table A15a: U.S. Sales of Imported and Domestic Light Vehicles, 1995-2015

	Domestic Built				Imports				Totals			
Year & type	U.S. Brand	Japanese Brand	All Others	Total	U.S. Brand	Japanese Brand	All Others	Total	U.S. Brand	Japanese Brand	All Others	Total
1995: Cars	5,433,959	1,594,725	100,023	7,128,707	74,065	967,906	464,286	1,506,257	5,508,024	2,562,631	564,309	8,634,964
Trucks	5,622,090	441,007	0	6,063,097	7,840	380,923	29,501	418,264	5,629,930	821,930	29,501	6,481,361
Total	11,056,049	2,035,732	100,023	13,191,804	81,905	1,348,829	493,787	1,924,521	11,137,954	3,384,561	593,810	15,116,325
1996: Cars	5,283,829	1,840,015	129,738	7,253,582	43,727	722,403	506,042	1,272,172	5,327,556	2,562,418	635,780	8,525,754
Trucks	6,004,180	459,689	10,165	6,474,034	6,525	414,715	34,085	455,325	6,010,705	874,404	44,250	6,929,359
Total	11,288,009	2,299,704	139,903	13,727,616	50,252	1,137,118	540,127	1,727,497	11,338,261	3,436,822	680,030	15,455,113
1997*: Cars	4,947,704	1,827,257	141,808	6,916,769	106,608	737,506	511,191	1,355,305	5,054,312	2,564,763	652,999	8,272,074
Trucks	5,778,757	473,971	14,712	6,267,440	2,949	533,953	45,305	582,207	5,781,706	1,007,924	60,017	6,849,647
Total	10,726,461	2,301,228	156,520	13,184,209	109,557	1,271,459	556,496	1,937,512	10,836,018	3,572,687	713,016	15,121,721
1998*: Cars	4,671,055	1,891,048	199,278	6,761,381	83,370	706,939	587,789	1,378,098	4,754,425	2,597,987	787,067	8,139,479
Trucks	6,181,040	518,411	43,804	6,743,255	3,207	603,078	51,746	658,031	6,184,247	1,121,489	95,550	7,401,286
Total	10,852,095	2,409,459	243,082	13,504,636	86,577	1,310,017	639,535	2,036,129	10,938,672	3,719,476	882,617	15,540,765
1999*: Cars	4,863,463	1,870,805	245,089	6,979,357	206,340	783,597	728,990	1,718,927	5,069,803	2,654,402	974,079	8,698,284
Trucks	6,567,196	715,372	137,463	7,420,031	4,109	685,956	85,158	775,223	6,571,305	1,401,328	222,621	8,195,254
Total	11,430,659	2,586,177	382,552	14,399,388	210,449	1,469,553	814,148	2,494,150	11,641,108	4,055,730	1,196,700	16,893,538
2000*: Cars	4,651,346	1,922,657	256,502	6,830,505	216,786	885,094	914,240	2,016,120	4,868,132	2,807,751	1,170,742	8,846,625
Trucks	6,675,664	895,081	80,060	7,650,805	38,306	737,590	76,429	852,325	6,713,970	1,632,671	156,489	8,503,130
Total	11,327,010	2,817,738	336,562	14,481,310	255,092	1,622,684	990,669	2,868,445	11,582,102	4,440,422	1,327,231	17,349,755
2001*: Cars	4,132,495	1,953,838	238,663	6,324,996	193,241	865,424	1,038,964	2,097,629	4,325,736	2,819,262	1,277,627	8,422,625
Trucks	6,664,127	967,980	86,357	7,718,464	51,799	793,396	136,085	981,280	6,715,926	1,761,376	222,442	8,699,744
Total	10,796,622	2,921,818	325,020	14,043,460	245,040	1,658,820	1,175,049	3,078,909	11,041,662	4,580,638	1,500,069	17,122,369
2002*: Cars	3,736,251	1,927,076	214,318	5,877,645	185,726	952,315	1,087,543	2,225,584	3,921,977	2,879,391	1,301,861	8,103,229
Trucks	6,609,603	954,593	82,568	7,646,764	66,032	819,295	181,048	1,066,375	6,675,635	1,773,888	263,616	8,713,139
Total	10,345,854	2,881,669	296,886	13,524,409	251,758	1,771,610	1,268,591	3,291,959	10,597,612	4,653,279	1,565,477	16,816,368
2003*: Cars	3,391,080	1,941,147	195,203	5,527,430	194,047	844,482	1,044,522	2,083,051	3,585,127	2,785,629	1,239,725	7,610,481
Trucks	6,600,737	1,129,552	71,103	7,801,392	94,839	892,164	240,177	1,227,180	6,695,576	2,021,716	311,280	9,028,572
Total	9,991,817	3,070,699	266,306	13,328,822	288,886	1,736,646	1,284,699	3,310,231	10,280,703	4,807,345	1,551,005	16,639,053
2004*: Cars	3,114,964	2,094,307	147,602	5,356,873	253,039	852,346	1,043,674	2,149,059	3,368,003	2,946,653	1,191,276	7,505,932
Trucks	6,664,465	1,389,089	61,176	8,114,730	102,052	824,785	319,421	1,246,258	6,766,517	2,213,874	380,597	9,360,988
Total	9,779,429	3,483,396	208,778	13,471,603	355,091	1,677,131	1,363,095	3,395,317	10,134,520	5,160,527	1,571,873	16,866,920
2005*: Cars	3,075,058	2,189,281	216,194	5,480,533	234,455	969,341	982,737	2,186,533	3,309,513	3,158,622	1,198,931	7,667,066
Trucks	6,441,730	1,546,113	77,530	8,065,373	117,187	773,429	324,699	1,215,315	6,558,917	2,319,542	402,229	9,280,688
Total	9,516,788	3,735,394	293,724	13,545,906	351,642	1,742,770	1,307,436	3,401,848	9,868,430	5,478,164	1,601,160	16,947,754

Table A15a: U.S. Sales of Imported and Domestic Light Vehicles, 1995-2015

	Domestic Built				Imports				Totals			
Year & type	U.S. Brand	Japanese Brand	All Others	Total	U.S. Brand	Japanese Brand	All Others	Total	U.S. Brand	Japanese Brand	All Others	Total
2006*: Cars	3,068,116	2,107,786	300,188	5,476,090	198,446	1,207,354	938,964	2,344,764	3,266,562	3,315,140	1,239,152	7,820,854
Trucks	5,675,676	1,522,237	138,883	7,336,796	117,425	938,955	290,370	1,346,750	5,793,101	2,461,192	429,253	8,683,546
Total	8,743,792	3,630,023	439,071	12,812,886	315,871	2,146,309	1,229,334	3,691,514	9,059,663	5,776,332	1,668,405	16,504,400
2007*: Cars	2,708,404	2,259,309	285,637	5,253,350	185,388	1,240,663	939,012	2,365,063	2,893,792	3,499,972	1,224,649	7,618,413
Trucks	5,397,480	1,484,315	200,929	7,082,724	111,103	982,240	294,742	1,388,085	5,508,583	2,466,555	495,671	8,470,809
Total	8,105,884	3,743,624	486,566	12,336,074	296,491	2,222,903	1,233,754	3,753,148	8,402,375	5,966,527	1,720,320	16,089,222
2008^: Cars	2,379,316	2,049,953	247,174	4,676,443	163,254	1,258,793	943,619	2,365,666	2,542,570	3,308,746	1,190,793	7,042,109
Trucks	3,834,378	1,183,528	176,168	5,194,074	33,272	744,026	232,206	1,009,504	3,867,650	1,927,554	408,374	6,203,578
Total	6,213,694	3,233,481	423,342	9,870,517	196,526	2,002,819	1,175,825	3,375,170	6,410,220	5,236,300	1,599,167	13,245,687
2009^: Cars	1,706,252	1,809,047	242,665	3,757,964	122,571	932,504	879,388	1,934,463	1,828,823	2,741,551	1,122,053	5,692,427
Trucks	2,822,709	953,758	170,518	3,946,985	28,853	512,984	250,255	792,092	2,851,562	1,466,742	420,773	4,739,077
Total	4,528,961	2,762,805	413,183	7,704,949	151,424	1,445,488	1,129,643	2,726,555	4,680,385	4,208,293	1,542,826	10,431,504
2010^: Cars	1,811,256	1,893,685	336,373	4,041,314	82,475	895,404	968,338	1,946,217	1,893,731	2,789,089	1,304,711	5,987,531
Trucks	3,327,937	1,178,962	304,091	4,810,990	39,301	507,657	244,365	791,323	3,367,238	1,686,619	548,456	5,602,313
Total	5,139,193	3,072,647	640,464	8,852,304	121,776	1,403,061	1,212,703	2,737,540	5,260,969	4,475,708	1,853,167	11,589,844
2011^: Cars	2,019,659	1,795,074	617,268	4,432,001	47,936	854,619	1,004,333	1,906,888	2,067,595	2,649,693	1,621,601	6,338,889
Trucks	3,916,503	1,229,777	371,567	5,517,847	31,914	578,062	312,864	922,840	3,948,417	1,807,839	684,431	6,440,687
Total	5,936,162	3,024,851	988,835	9,949,848	79,850	1,432,681	1,317,197	2,829,728	6,016,012	4,457,532	2,306,032	12,779,576
2012^: Cars	2,273,434	2,259,331	901,659	5,434,424	16,186	984,396	1,038,898	2,039,480	2,289,620	3,243,727	1,940,557	7,473,904
Trucks	4,165,677	1,483,343	374,008	6,023,028	35,216	616,507	344,571	996,294	4,200,893	2,099,850	718,579	7,019,322
Total	6,439,111	3,742,674	1,275,667	11,457,452	51,402	1,600,903	1,383,469	3,035,774	6,490,513	5,343,577	2,659,136	14,493,226
2013^: Cars	2,391,449	2,381,161	959,866	5,732,476	38,449	962,629	1,074,431	2,075,509	2,429,898	3,343,790	2,034,297	7,807,985
Trucks	4,545,549	1,714,781	365,676	6,626,006	71,659	728,005	367,493	1,167,157	4,617,208	2,442,786	733,169	7,793,163
Total	6,936,998	4,095,942	1,325,542	12,358,482	110,108	1,690,634	1,441,924	3,242,666	7,047,106	5,786,576	2,767,466	15,601,148
2014^: Cars	2,315,231	2,608,064	918,391	5,841,686	45,365	907,731	1,131,625	2,084,721	2,360,596	3,515,795	2,050,016	7,926,407
Trucks	5,016,052	1,909,264	398,065	7,323,381	92,102	743,952	407,157	1,243,211	5,108,154	2,653,216	805,222	8,566,592
Total	7,331,283	4,517,328	1,316,456	13,165,067	137,467	1,651,683	1,538,782	3,327,932	7,468,750	6,169,011	2,855,238	16,492,999
2015^: Cars	2,195,075	2,495,100	972,522	5,662,697	37,593	826,807	1,045,565	1,909,965	2,232,668	3,321,907	2,018,087	7,572,662
Trucks	5,484,574	2,287,335	446,452	8,218,361	191,840	958,740	529,056	1,679,636	5,676,414	3,246,075	975,508	9,897,997
Total	7,679,649	4,782,435	1,418,974	13,881,058	229,433	1,785,547	1,574,621	3,589,601	7,909,082	6,567,982	2,993,595	17,470,659

Note: * - Wards changed how data are presented; therefore, figures for 1997 and after are not entirely comparable with earlier years; ^ - Automotive News data; not entirely comparable with Wards.

Sources: Automotive News (2009-2016), Ward's (1995-2008).

Prepared by: Office of Research, Ohio Development Services Agency. Telephone 614/466-2116 (DL, 10/16).

Table A15b: Percentages of U.S. Sales of Imported and Domestic Light Vehicles, 1995-2015

	Domestic Built				Imports				Totals			
Year & type	U.S. Brand	Japanese Brand	All Others	Total	U.S. Brand	Japanese Brand	All Others	Total	U.S. Brand	Japanese Brand	All Others	Total
1995: Cars	35.9%	10.5%	0.7%	47.2%	0.5%	6.4%	3.1%	10.0%	36.4%	17.0%	3.7%	57.1%
Trucks	37.2%	2.9%	0.0%	40.1%	0.1%	2.5%	0.2%	2.8%	37.2%	5.4%	0.2%	42.9%
Total	73.1%	13.5%	0.7%	87.3%	0.5%	8.9%	3.3%	12.7%	73.7%	22.4%	3.9%	100.0%
1996: Cars	34.2%	11.9%	0.8%	46.9%	0.3%	4.7%	3.3%	8.2%	34.5%	16.6%	4.1%	55.2%
Trucks	38.8%	3.0%	0.1%	41.9%	0.0%	2.7%	0.2%	2.9%	38.9%	5.7%	0.3%	44.8%
Total	73.0%	14.9%	0.9%	88.8%	0.3%	7.4%	3.5%	11.2%	73.4%	22.2%	4.4%	100.0%
1997*: Cars	32.7%	12.1%	0.9%	45.7%	0.7%	4.9%	3.4%	9.0%	33.4%	17.0%	4.3%	54.7%
Trucks	38.2%	3.1%	0.1%	41.4%	0.0%	3.5%	0.3%	3.9%	38.2%	6.7%	0.4%	45.3%
Total	70.9%	15.2%	1.0%	87.2%	0.7%	8.4%	3.7%	12.8%	71.7%	23.6%	4.7%	100.0%
1998*: Cars	30.1%	12.2%	1.3%	43.5%	0.5%	4.5%	3.8%	8.9%	30.6%	16.7%	5.1%	52.4%
Trucks	39.8%	3.3%	0.3%	43.4%	0.0%	3.9%	0.3%	4.2%	39.8%	7.2%	0.6%	47.6%
Total	69.8%	15.5%	1.6%	86.9%	0.6%	8.4%	4.1%	13.1%	70.4%	23.9%	5.7%	100.0%
1999*: Cars	28.8%	11.1%	1.5%	41.3%	1.2%	4.6%	4.3%	10.2%	30.0%	15.7%	5.8%	51.5%
Trucks	38.9%	4.2%	0.8%	43.9%	0.0%	4.1%	0.5%	4.6%	38.9%	8.3%	1.3%	48.5%
Total	67.7%	15.3%	2.3%	85.2%	1.2%	8.7%	4.8%	14.8%	68.9%	24.0%	7.1%	100.0%
2000*: Cars	26.8%	11.1%	1.5%	39.4%	1.2%	5.1%	5.3%	11.6%	28.1%	16.2%	6.7%	51.0%
Trucks	38.5%	5.2%	0.5%	44.1%	0.2%	4.3%	0.4%	4.9%	38.7%	9.4%	0.9%	49.0%
Total	65.3%	16.2%	1.9%	83.5%	1.5%	9.4%	5.7%	16.5%	66.8%	25.6%	7.6%	100.0%
2001*: Cars	24.1%	11.4%	1.4%	36.9%	1.1%	5.1%	6.1%	12.3%	25.3%	16.5%	7.5%	49.2%
Trucks	38.9%	5.7%	0.5%	45.1%	0.3%	4.6%	0.8%	5.7%	39.2%	10.3%	1.3%	50.8%
Total	63.1%	17.1%	1.9%	82.0%	1.4%	9.7%	6.9%	18.0%	64.5%	26.8%	8.8%	100.0%
2002*: Cars	22.2%	11.5%	1.3%	35.0%	1.1%	5.7%	6.5%	13.2%	23.3%	17.1%	7.7%	48.2%
Trucks	39.3%	5.7%	0.5%	45.5%	0.4%	4.9%	1.1%	6.3%	39.7%	10.5%	1.6%	51.8%
Total	61.5%	17.1%	1.8%	80.4%	1.5%	10.5%	7.5%	19.6%	63.0%	27.7%	9.3%	100.0%
2003*: Cars	20.4%	11.7%	1.2%	33.2%	1.2%	5.1%	6.3%	12.5%	21.5%	16.7%	7.5%	45.7%
Trucks	39.7%	6.8%	0.4%	46.9%	0.6%	5.4%	1.4%	7.4%	40.2%	12.2%	1.9%	54.3%
Total	60.1%	18.5%	1.6%	80.1%	1.7%	10.4%	7.7%	19.9%	61.8%	28.9%	9.3%	100.0%
2004*: Cars	18.5%	12.4%	0.9%	31.8%	1.5%	5.1%	6.2%	12.7%	20.0%	17.5%	7.1%	44.5%
Trucks	39.5%	8.2%	0.4%	48.1%	0.6%	4.9%	1.9%	7.4%	40.1%	13.1%	2.3%	55.5%
Total	58.0%	20.7%	1.2%	79.9%	2.1%	9.9%	8.1%	20.1%	60.1%	30.6%	9.3%	100.0%
2005*: Cars	18.1%	12.9%	1.3%	32.3%	1.4%	5.7%	5.8%	12.9%	19.5%	18.6%	7.1%	45.2%
Trucks	38.0%	9.1%	0.5%	47.6%	0.7%	4.6%	1.9%	7.2%	38.7%	13.7%	2.4%	54.8%
Total	56.2%	22.0%	1.7%	79.9%	2.1%	10.3%	7.7%	20.1%	58.2%	32.3%	9.4%	100.0%

Table A15b: Percentages of U.S. Sales of Imported and Domestic Light Vehicles, 1995-2015

	Domestic Built				Imports				Totals			
Year & type	U.S. Brand	Japanese Brand	All Others	Total	U.S. Brand	Japanese Brand	All Others	Total	U.S. Brand	Japanese Brand	All Others	Total
2006*: Cars	18.6%	12.8%	1.8%	33.2%	1.2%	7.3%	5.7%	14.2%	19.8%	20.1%	7.5%	47.4%
Trucks	34.4%	9.2%	0.8%	44.5%	0.7%	5.7%	1.8%	8.2%	35.1%	14.9%	2.6%	52.6%
Total	53.0%	22.0%	2.7%	77.6%	1.9%	13.0%	7.4%	22.4%	54.9%	35.0%	10.1%	100.0%
2007*: Cars	16.8%	14.0%	1.8%	32.7%	1.2%	7.7%	5.8%	14.7%	18.0%	21.8%	7.6%	47.4%
Trucks	33.5%	9.2%	1.2%	44.0%	0.7%	6.1%	1.8%	8.6%	34.2%	15.3%	3.1%	52.6%
Total	50.4%	23.3%	3.0%	76.7%	1.8%	13.8%	7.7%	23.3%	52.2%	37.1%	10.7%	100.0%
2008^: Cars	18.0%	15.5%	1.9%	35.3%	1.2%	9.5%	7.1%	17.9%	19.2%	25.0%	9.0%	53.2%
Trucks	28.9%	8.9%	1.3%	39.2%	0.3%	5.6%	1.8%	7.6%	29.2%	14.6%	3.1%	46.8%
Total	46.9%	24.4%	3.2%	74.5%	1.5%	15.1%	8.9%	25.5%	48.4%	39.5%	12.1%	100.0%
2009^: Cars	16.4%	17.3%	2.3%	36.0%	1.2%	8.9%	8.4%	18.5%	17.5%	26.3%	10.8%	54.6%
Trucks	27.1%	9.1%	1.6%	37.8%	0.3%	4.9%	2.4%	7.6%	27.3%	14.1%	4.0%	45.4%
Total	43.4%	26.5%	4.0%	73.9%	1.5%	13.9%	10.8%	26.1%	44.9%	40.3%	14.8%	100.0%
2010^: Cars	15.6%	16.3%	2.9%	34.9%	0.7%	7.7%	8.4%	16.8%	16.3%	24.1%	11.3%	51.7%
Trucks	28.7%	10.2%	2.6%	41.5%	0.3%	4.4%	2.1%	6.8%	29.1%	14.6%	4.7%	48.3%
Total	44.3%	26.5%	5.5%	76.4%	1.1%	12.1%	10.5%	23.6%	45.4%	38.6%	16.0%	100.0%
2011^: Cars	15.8%	14.0%	4.8%	34.7%	0.4%	6.7%	7.9%	14.9%	16.2%	20.7%	12.7%	49.6%
Trucks	30.6%	9.6%	2.9%	43.2%	0.2%	4.5%	2.4%	7.2%	30.9%	14.1%	5.4%	50.4%
Total	46.5%	23.7%	7.7%	77.9%	0.6%	11.2%	10.3%	22.1%	47.1%	34.9%	18.0%	100.0%
2012^: Cars	15.7%	15.6%	6.2%	37.5%	0.1%	6.8%	7.2%	14.1%	15.8%	22.4%	13.4%	51.6%
Trucks	28.7%	10.2%	2.6%	41.6%	0.2%	4.3%	2.4%	6.9%	29.0%	14.5%	5.0%	48.4%
Total	44.4%	25.8%	8.8%	79.1%	0.4%	11.0%	9.5%	20.9%	44.8%	36.9%	18.3%	100.0%
2013^: Cars	15.3%	15.3%	6.2%	36.7%	0.2%	6.2%	6.9%	13.3%	15.6%	21.4%	13.0%	50.0%
Trucks	29.1%	11.0%	2.3%	42.5%	0.5%	4.7%	2.4%	7.5%	29.6%	15.7%	4.7%	50.0%
Total	44.5%	26.3%	8.5%	79.2%	0.7%	10.8%	9.2%	20.8%	45.2%	37.1%	17.7%	100.0%
2014^: Cars	14.0%	15.8%	5.6%	35.4%	0.3%	5.5%	6.9%	12.6%	14.3%	21.3%	12.4%	48.1%
Trucks	30.4%	11.6%	2.4%	44.4%	0.6%	4.5%	2.5%	7.5%	31.0%	16.1%	4.9%	51.9%
Total	44.5%	27.4%	8.0%	79.8%	0.8%	10.0%	9.3%	20.2%	45.3%	37.4%	17.3%	100.0%
2015^: Cars	12.6%	14.3%	5.6%	32.4%	0.2%	4.7%	6.0%	10.9%	12.8%	19.0%	11.6%	43.3%
Trucks	31.4%	13.1%	2.6%	47.0%	1.1%	5.5%	3.0%	9.6%	32.5%	18.6%	5.6%	56.7%
Total	44.0%	27.4%	8.1%	79.5%	1.3%	10.2%	9.0%	20.5%	45.3%	37.6%	17.1%	100.0%

Note: * - Wards changed how data are presented; therefore, figures for 1997 and after are not entirely comparable with earlier years; ^ - Automotive News data; not entirely comparable with Wards.

Sources: Automotive News (2009-2016), Ward's (1995-2008).

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Table A16: Imports and Exports of Motor Vehicles, Parts and Accessories, and the Value of the Dollar, 1995-2015 (in millions of dollars, except index values)

		Exports			Imports			Balances of Trade		
Year	Index Value of the Dollar	Total	Motor Vehicles*	Parts & Accessories	Total	Motor Vehicles*	Parts & Accessories	Total	Motor Vehicles*	Parts & Accessories
1995	92.52	$61,261	$23,896	$37,365	$123,632	$76,488	$47,144	-$62,371	-$52,592	-$9,779
1996	97.40	$64,238	$25,192	$39,046	$128,691	$79,292	$49,399	-$64,453	-$54,100	-$10,353
1997	104.44	$73,302	$26,940	$46,362	$139,492	$87,669	$51,823	-$66,190	-$60,729	-$5,461
1998	116.48	$72,386	$25,884	$46,502	$148,680	$93,954	$54,726	-$76,294	-$68,070	-$8,224
1999	116.87	$75,256	$25,289	$49,967	$178,241	$116,696	$61,545	-$102,985	-$91,407	-$11,578
2000	119.45	$80,357	$26,126	$54,231	$194,952	$128,241	$66,711	-$114,595	-$102,115	-$12,480
2001	125.91	$75,437	$25,387	$50,050	$188,747	$126,234	$62,513	-$113,310	-$100,847	-$12,463
2002	126.66	$78,941	$28,915	$50,026	$202,777	$133,631	$69,146	-$123,836	-$104,716	-$19,120
2003	119.09	$80,633	$32,347	$48,286	$209,171	$134,484	$74,687	-$128,538	-$102,137	-$26,401
2004	113.59	$89,213	$36,538	$52,675	$227,331	$143,482	$83,849	-$138,118	-$106,944	-$31,174
2005	110.81	$98,408	$43,971	$54,437	$238,714	$146,312	$92,402	-$140,306	-$102,341	-$37,965
2006	108.52	$107,264	$49,083	$58,181	$255,962	$160,135	$95,827	-$148,698	-$111,052	-$37,646
2007	103.40	$121,264	$60,777	$60,487	$258,498	$157,410	$101,088	-$137,234	-$96,633	-$40,601
2008	99.90	$121,453	$65,323	$56,130	$233,204	$141,825	$91,379	-$111,751	-$76,502	-$35,249
2009	105.69	$81,715	$39,974	$41,741	$159,188	$93,236	$65,952	-$77,473	-$53,262	-$24,211
2010	101.82	$112,007	$54,981	$57,026	$225,641	$131,344	$94,297	-$113,634	-$76,363	-$37,271
2011	97.15	$133,037	$66,772	$66,265	$255,226	$142,831	$112,395	-$122,189	-$76,059	-$46,130
2012	99.82	$146,159	$73,571	$72,588	$298,498	$170,253	$128,245	-$152,339	-$96,682	-$55,657
2013	100.98	$152,659	$77,125	$75,534	$309,574	$178,972	$130,602	-$156,915	-$101,847	-$55,068
2014	104.16	$159,811	$80,503	$79,308	$329,501	$186,087	$143,414	-$169,690	-$105,584	-$64,106
2015^	117.28	$151,918	$72,514	$79,404	$350,053	$201,530	$148,523	-$198,135	-$129,016	-$69,119

Notes and abbreviations: * - new and used; ^ - initial estimates; earlier years may be revised.

Sources: Federal Reserve Board (1996-2016); U.S. Bureau of Economic Analysis (2016b).

Prepared by: Office of Research, Ohio Development Services Agency (DL, 10/16).

Table A17: History and Projections* for the U.S. Motor Vehicle Industry

					Changes					
		Actual			2004-2014		2014-2024		2004-2024	
NAICS Code	Shorter Industry Title	2004	2014	Projected 2024	Number	Percent	Number	Percent	Number	Percent
U.S. Gross Duplicated Output^ (in billions, standardized on 2009)										
	Total	$25,002.7	$27,723.5	$34,573.0	$2,720.8	10.9%	$6,849.5	24.7%	$9,570.3	38.3%
31-33	Manufacturing	$5,095.6	$5,446.3	$6,586.7	$350.7	6.9%	$1,140.4	20.9%	$1,491.1	29.3%
3361-3	Transportation Eqpt. (part)	$543.3	$593.6	$654.4	$50.3	9.3%	$60.8	10.2%	$111.1	20.4%
3361	Assembly	$277.0	$308.4	$346.3	$31.4	11.3%	$37.9	12.3%	$69.3	25.0%
3362	Bodies & Trailers	$35.7	$39.8	$44.5	$4.1	11.5%	$4.7	11.8%	$8.8	24.6%
3363	Parts	$230.6	$245.4	$263.6	$14.8	6.4%	$18.2	7.4%	$33.0	14.3%
Jobs (in thousands)		2004	2014	2024	2004-2014		2014-2024		2004-2024	
U.S.	Total	144,047.0	150,539.9	160,328.8	6,492.9	4.5%	9,788.9	6.5%	16,281.8	11.3%
31-33	Manufacturing	14,315.9	12,188.3	11,374.2	-2,127.6	-14.9%	-814.1	-6.7%	-2,941.7	-20.5%
3361-3	Transportation Eqpt. (part)	1,112.8	876.7	843.1	-236.1	-21.2%	-33.6	-3.8%	-269.7	-24.2%
3361	Assembly	255.9	199.3	192.3	-56.6	-22.1%	-7.0	-3.5%	-63.6	-24.9%
3362	Bodies & Trailers	164.8	140.8	136.8	-24.0	-14.6%	-4.0	-2.8%	-28.0	-17.0%
3363	Parts	692.1	536.6	514.0	-155.5	-22.5%	-22.6	-4.2%	-178.1	-25.7%
		2002	2012	2022	2002-2012		2012-2022		2002-2022	
Ohio	Total	5,332.89	5,502.10	5,957.10	169.21	3.2%	455.00	8.3%	624.2	11.7%
31-33	Manufacturing	884.07	656.04	635.36	-228.03	-25.8%	-20.68	-3.2%	-248.7	-28.1%
3361-3	Transportation Eqpt. (part)	141.51	87.71	97.13	-53.80	-38.0%	9.42	10.7%	-44.4	-31.4%
3361	Assembly	33.67	19.59	20.64	-14.08	-41.8%	1.05	5.4%	-13.0	-38.7%
3362	Bodies & Trailers	8.77	7.00	7.56	-1.77	-20.2%	0.56	8.0%	-1.2	-13.8%
3363	Parts	99.07	61.12	68.93	-37.95	-38.3%	7.81	12.8%	-30.1	-30.4%

Notes: * - Projections have not been made for tires (NAICS 32621) or storage batteries (335911).
^ - Gross Duplicated Output is greater than Gross Domestic Product because the latter is the final value of goods and services only, while the former also includes the value of intermediate goods and services.

Sources: ODJFS/LMI (2016); U.S. Bureau of Labor Statistics (2016).

Prepared by: Office of Research, Ohio Development Services Agency (DL, 10/16).

NOTES

1 Including corporate headquarters.

2 Total company employment figures for the motor vehicle industry exclude sites employing less than 50 people.

3 The differing portions of industry GDP and VA from Ohio may be partially explained by the fact that GDP excludes the cost of purchased services included in VA, costs which may not be proportional from one state to another, as well as the fact that 2011 GDP figures are revised, while 2011 VA figures are not.

4 Model changeovers usually don't cause severe disruption to assemblers because they're normally done in two to four week in the summer. However, a major changeover may require extensive changes at the plant, new equipment must be de-bugged and proven, and glitches in production processes resolved (Levy, 2014: 31). Assemblers also have been disrupted by material shortages, troubled suppliers and quality issues (Levy, 2014: 14). Any one or combination of these issues could have been a factor in the delayed launch of the Cherokee.

5 There are a number of caveats that must be noted. Parts plants include assemblers' parts plants and independent tier-1, -2, and -3 supplier plants – the latter regardless of their NAICS code. Only active suppliers are included; plants that are opening, closing or inactive are excluded. Also excluded are administrative and support establishments for sales, research and development, and other internal non-production services, as well as tooling companies (i.e., those selling machinery used by assemblers and suppliers to produce their goods), freight forwarders (i.e., independent transportation services), and trainers (i.e., educators). Finally, the ELM database is continually updated and revised, which means exact numbers may not be reproducible after awhile, and the information therein is volunteered by participating companies. For these reasons, there is no guarantee of accuracy beyond the aforementioned criteria.

6 Specifically, GM's Defiance foundry and its diesel engine plant in Dayton, plus Daimler's Detroit Diesel in Byesville. On the other hand, larger non-motor vehicle suppliers in the tires subgroup have been excluded.

7 Daimler's and GM's diesel engine plants, as well as the latter's foundry (NAICS code 3315) dedicated to the motor vehicle industry were excluded in the previous section so that consistent comparisons could be made with the U.S. industry. They are included in this section, and their employment is included in the next section. Conversely, larger non-motor vehicle industry tire establishments and employment are excluded.

8 The number would be larger if no employees were credited to U.S.-based joint venture parent companies.

9 The difficulty arises in allocating the jobs to joint venture partners with different home countries.

10 “92,900” as the 2014 employment figure in this section is less than the 94,800-plus given in preceding sections because the former *excludes* the GM and Daimler foundry and diesel engine plants included in the latter; the former also *includes* the Titan off-road tire plant excluded from the latter. These changes legitimate comparisons national trends.

11 Net changes are dependent on the beginning and ending points. Therefore, net changes are not necessarily indicative of long term trends, especially in smaller, more-specific industries.

12 Value-added and GDP figures are closely related. GDP computations begin with value-added (which is largely the difference between the value of shipments and the costs of labor and materials) and proceed by subtracting additional costs such as services purchased by the manufacturing establishment. This explains why GDP figures are less than value-added figures.

13 The percentage of value-added for bodies and trailers in Ohio during 2004-2006 are greater than the percent of U.S. GDP originating in Ohio, leading one to believe that the former is concentrated here. However, the percentages for value-added in bodies and trailers – and the totals on which they are based – are not reliable because the relative standard errors of the bodies and trailers estimates are way too high (see U.S. Census Bureau, 2008a). Caution also is warranted for the assembly and parts value-added figures for 2009 and 2010 due to relatively high standard errors (U.S. Bureau of the Census, 2012a).

14 Using value-added in Ohio as a percentage of the nation removes the effects of inflation, making comparisons of one year with any other more meaningful. It should also be noted that the decline in value added from 2002 to 2003 is inconsistent with the increases of GDP and light vehicle production for the same period (U.S. Bureau of the Census, 2005a; U.S. Bureau of Economic Analysis, 2016a; Ward’s, 2005).

15 Levy (2012: 23) gives partial credit to the “cash-for-clunkers” program for increasing light vehicle production in the first half of 2010.

16 These changes are evident to dealers and assemblers in as little as 60 days (Reuters, 2011).

17 Capital expenditures also vary with the size and degree of vertical integration of the company. GM and Ford generally spend more than the smaller and less vertically integrated Chrysler group (Levy, 2014: 25).

18 The Detroit Three have made substantial progress in matching the initial-quality and frequency-of-repair records of Japanese-brand assemblers. At the same time, though, assemblers' recalls have risen. This probably is due to the increased use of electronics, tougher standards, and better reporting (Harbour Consulting, 2004).

19 The three other Japanese brands *sold* here are Mazda, Mitsubishi and Subaru. The nine other assemblers *selling* here are Aston Martin, BMW, Daimler, FCA (its European marks are part of the Fiat Group), Jaguar-Land Rover, Lotus, Tesla (the only American), Volvo and Volkswagen.

20 Mitsubishi and Subaru are the two Japanese-based companies assembling vehicles here; the others are AM General, BMW, Daimler, Tesla and Volkswagen.

21 AM General and Tesla may meet U.S. demand with their lone assembly plants, but 2015 sales and production figures are less than 25,000 each.

22 Daimler's principal N. American subsidiary is Freightliner, but it also owns White Star and Sterling. Volvo bought Mack from Renault in 2001 (Levy, 2014: 11) when the Renault needed funds to take a veto-stake in Nissan.

23 The G5a index from the Federal Reserve Board summarizes the value of the dollar against the currencies of major trading partners; it is a broadly based general measure most appropriate for summarizing overall exports of goods.

24 Engine plants do not operate on a just-in-time basis to supply assemblers for these and other reasons; they use large storage facilities (Miles, 2016).

25 Most parts are intermediate goods produced as original equipment, not as final goods for the replacement market (Haider, 2016, Miles, 2016, Peters, 2016, and Petrillo, 2016); tires are the notable exception (O'Hollaren, 2016).

26 Some companies have left the industry here but stayed or expanded elsewhere in the world (Peters, 2016).

27 While reducing tariffs can increase trade, establishing tariffs does not always protect industries from foreign competition. Assemblers circumvented the infamous "chicken tax" (a 25 percent tariff on *complete* imported light trucks in retaliation a tariff on exports of chickens) by importing *nearly* complete light trucks, which faced a much lower tariff rate, and installing engines here (Miles, 2016).

28 The manufacturers or their subsidiaries are making loans as well as taking a chance on the price they can get for a used vehicle once a lease has expired (Corridore, 2014: 11-12).

29 Rebates, discounts, etc. are intended to stimulate demand; their use is less likely with models already in high demand. Maintaining high demand reduces *per-unit* costs for assemblers and may lead to increased market share, but failure to lower overall costs at the same time simply reduces profit. In the latter instance, incentives can be counterproductive. Usage of rebates and discounts by light vehicle assemblers and their associated dealers was greatest in 1997-2008, but abated with the recession as the Detroit Three reduced capacity (Levy, 2012: 24). However, they have returned with the intense competition in the largest market segment: mid-size cars (Levy, 2014: 5-6). Corridore (2014: 12) tells a similar tale of overproduction and using residual value guarantees at lease's end – an incentive – in the late 1990s, all in an attempt to increase market share. These actions had the unintended consequence of flooding the market with used trucks a few years later, reducing their prices, and forcing lessors to take substantial write-downs. This was an exception to truck-makers usual practice of using incentives to stimulate sales only when necessary (Jaffe, 2010: 17).

30 Medium- and heavy-duty truck production is the more highly cyclical of the two (Corridore, 2014:11). Production during 2003-2013 ranged from 462,000 (2006) to 132,000 (2009), with the latter just 28.6 percent of the former. The production numbers in this range represented between 1.9 and 4.1 percent (2010 and 2006, respectively) of all motor vehicle production in the U.S., according to Ward's statistics cited by Levy (2014: 10).

31 Assemblers also establish and support a network of independent dealers with wholesale financing, marketing strategies and materials, etc. Dealers, in turn, sell to independent truck operators – persons who typically buy just one vehicle from inventory (Corridore, 2014: 18).

32 This is not always true. Scheinin (2016) recounts insights gained during a dashboard programming session with an expert on designing for human-computer interaction. He learned teams working on electronic components such as steering controls, the instrument panel and the center console may not talk to one another, even if they do not work for different companies (i.e., competitors); furthermore, designs may not be adequately tested. The problem is exacerbated by conflicting goals of assemblers and smart phone makers. Assemblers do not want drivers on their phones while driving, so they have created super multi-functional dashboards in competition with smart phones – one was accompanied with a 135-page manual. Meanwhile smart phone makers have created applications for projecting smart phone functions on to dashboard screens. Even when accommodating one another, matters can be complicated by different product life cycles: light vehicles – about five years, after two or three years of design; this contrasts with 18 months for smart phones. The myriad possibilities, the time required to learn systems, the

unexpected results (or no results) to a series of commands, etc., can leave consumers befuddled.

33 Assemblers have faced challenges in dealing with higher costs for raw materials such as steel, copper, rubber and plastics due to increased demand for commodities. For both assemblers and suppliers, rapid growth in developing countries – particularly China – has been a significant factor in such demand.

34 On the other hand, the reliance on one source for a component risks slow-downs or even stoppages at assembly plants when production slows down or stops at the plant where the component is made. For example, operations at seven Chrysler and three GM assembly plants slowed for lack of a single part because of hurricane-induced floods at the supplier in North Carolina (Associated Press, 1999). Similarly, Japanese assembly operations in N. America also were curtailed by floods in Japan and Thailand during 2011, allowing the Detroit Three to briefly regain some U.S. market share.

35 For example, Delphi received help from GM when the former was in bankruptcy from 2005 to 2009 (Karush, 2006), and, after emerging from bankruptcy, in turn helped companies with purchasing and manufacturing shortly there-after (Levy, 2012: 25).

36 Parts makers were dismayed, though, that the transparency of on-line procurement put downward pressure on parts prices (more on commodity items, less on high value-added items (Levy, 2014: 26; also Corridore, 2014: 13).

37 In the U.S., new safety features usually are incorporated by regulation; in Europe, they typically originate with cus-tomer demand. Consequently, European parts makers have been leaders in this field (Levy, 2010: 19).

38 Using super strong adhesives in place of rivets and bolts permits using thinner metal pieces, which reduces vehicle weight (Boudette, 2016).

39 The fuel efficiency of vehicles is increasing and greenhouse gas (GHG) emissions per driver are declining. This at least partially due to actions taken by the EPA as well as higher CAFE standards (Krisher and Durbin, 2016).

40 During much of that time, though, some of the fuel efficiency gains went to meet consumers' preferences for more powerful engines instead of increasing miles per gallon (Levy, 2012: 16-17; Whoriskey, 2011). It also is fair to add that consumer preferences for more vs. less fuel efficient vehicles varies with the price of gasoline; "In addition, efforts to reduce US energy dependence and the negative impact of fossil fuels are forces driving regulatory de-mands for higher fuel efficiency" (Levy, 2014: 13). (Also see Levy, 2012: 11, 15.)

41 Turbochargers are a moderately-priced, off-the-shelf technology that has been around for years, but only recently have they become sufficiently reliable for widespread use in gasoline engines. Turbochargers work by using exhaust gases to turn a rotor that drives a compressor pumping more air into the combustion chamber, thus increasing power. Consequently, turbocharged engines may be made smaller, thereby improving fuel economy without sacrificing power; a modern turbocharged V-6 performs about like a V-8 without one. The Lordstown-made Cruze, the Cleveland-made engine for Ford's F-150, and any vehicle with a clean-diesel engine are examples of turbocharger use (Gearino, 2010; Levy, 2012: 15; Sedgwick and Roy, 2010). Other possibilities for improving engine fuel efficiency include valve timing (Miles, 2016), automatic engine stops and restarts at traffic lights (some hybrids do this), using booster batteries during acceleration to supplement engines designed for maintaining speed, getting gasoline engines to diesel, and operating on three or four cylinders in a fuel-saving mode – a V6 engine made in Anna could do the last (Phelan, 2008).

42 Ford's Sharonville plant makes six-speed transmissions (Ford, 2016) and GM's Toledo plant makes six- and eight-speed transmissions (GM, 2016). Dual clutch systems use one clutch for odd-numbered gears, the other for even numbered gears (Peters, 2016). CVTs were introduced to the U.S. mass market in 1987, but reliability problems lead to their discontinuation. Re-engineered CVTs have been reintroduced by Japanese-based companies as standard equipment on some high volume models. Honda started making CVTs and related items few years ago at its Russells Point and Anna plants; their CVTs became standard equipment for Accords with I4 engines (Chappell, 2012; Rechtin, 2012).

43 A new shock absorber has no electromechanical valves or small moving parts; it uses iron particles suspended in a synthetic hydro-carbon fluid. When fully magnetized, the fluid become nearly plastic. A sensor and ECU combine to vary the degree of resistance in the shock absorber by continually checking and adjusting the level of magnetization. The ability to rapidly vary resistance makes for a smoother ride, better control and even faster travel on irregular road surfaces (drawn from Peters, 2016; Wikipedia, 2016).

44 Diesel and gasoline are liquid hydro-carbons derived from crude petroleum by a variety of processes. Natural gas is a generic term for methane and ethane – the two most common types – as well as propane, butane and other paraffin hydrocarbons. All natural gases are subject to processing before use (Parker, 1984). Honda's Anna plant has made engines that use natural gas (Harbour Consulting, 2004), but Honda limited sales of vehicles with such engines to fleet operations. Ethanol is grain alcohol.

45 The shift to low-sulfur fuel and Honda's patented method of reducing N_2O have helped meet these standards (Harbour Consulting, 2006: 144-145; Kiley, 2008). Federal officials believe the increased costs truckers incur in meet-

ing requirements to improve efficiency and reduce GHG emissions by 23 percent by the end of 2018 will be more than offset by savings on fuels over the life of the vehicle (Levy, 2014: 19).

46 Ethanol can be fermented from a variety of plants; decades ago, farmers distilled it from corn for their own use. Sugarcane is another source. Brazilian officials claimed U.S. import duties of $.54 per gallon on sugarcane-based ethanol prevented the industry from developing even faster (Rohter, 2006; Wikipedia, 2014). Biological sources of diesel fuel have been developed and that fuel is being used, but it is not a significant part of the market and engine modification or restrictions on the amount used may be required. Furthermore, biodiesel production involves alcohols (Wikipedia, 2016).

47 Octane ratings of gasoline are based on the ratio of 2,2,4-trimethylpentane, which has eight carbon atoms, to heptane's seven carbon atoms. Gasoline rated at 87 octane has a ratio of the former to the latter of 87 to 13. The more complex the molecular chain, the more it can be compressed before spontaneously igniting, allowing the engine to operate at a higher compression ratio and producing greater power. The octane rating of ethanol is typically 108-110 (Fischetti, 2006).

48 This statement recognizes concerns that so much corn was being used for ethanol that was less available as food for people and animals, and that prices of other corn-based products had risen as a consequence (see Mercer, 2008). *Ceteris paribus*, increasing demand for corn-based ethanol increases prices for corn and other corn-based products. However, the relationship may not be so simple because other factors come into play. People may substitute other products to replace corn, more farmers may choose to plant more corn in response to higher corn prices, and the variations in weather will always play a role (Koff, 2010).

49 The CAFE standards have some flexibility based on the composition of light vehicle sales. The current light trucks to cars sales ratio would yield a 50.8 miles per gallon standard (Krisher and Durbin, 2016). The situation is further complicated by credits for things like reduced emissions from air-conditioners and electric vehicle sales, all of which may translate into a real-world target of 40 miles per gallon (Boudette, 2016).

50 Hybrid vehicles combine battery-powered electric motors with internal combustion (IC) engines to turn the wheels while reducing fuel consumption in the latter. Some hybrids turn the wheels only with battery-powered motors and use the IC engine to recharge the battery. Others use both power sources to turn the wheels. It needs to be emphasized that battery-powered electric motors can be combined with *any* type of IC engine using *any* type of fuel to create a hybrid system (Levy, 2010: 18). Hybrid vehicles may incorporate any number of innovations:

- using thermocouples to convert heat from IC engines and exhaust systems into electricity (Mayhood, 2008);

- running the vehicle's electrical components from the batteries instead of the engine;
- shutting off the IC engine when the vehicles is not moving;
- reducing engine size which, *ceteris paribus*, reduces fuel consumption;
- replacing the familiar four-stroke cycle IC engine with the less powerful but more fuel efficient two-stroke cycle engine; and
- capturing via regenerative braking energy that would otherwise be lost: "Just as a motor can transform electrical energy stored in a battery into torque (the force that produces wheel rotation and hauling power), the process can run in reverse so that the torque created by slowing a moving car generates electricity that can be accumulated in the battery" (Romm and Frank, 2006: 74-75).

Simply shutting off the IC engine during stops improves fuel economy about 10 percent; using all may improve fuel economy up to 60 percent, but entails greater complexity and cost. U.S.-based companies have favored the former, while Japanese-based companies have tended to the latter (Jones, 2008b).

51 Executives have complained that prices do not cover production costs (Tschampa, 2014; with the Prius a notable exception (Chang, 2014)). Eisenstein (2012) believed that high-volume assemblers persisted in making money-losing EVs because they do not want to be shut out of the California market, which is thought to set trends for other states and the nation, and whose Air Resources Board mandates a percentage of zero emissions vehicles.

52 The specific length of time varies from model to model, and also depends on how many miles are driven per year as well as the price of fuel (Romm and Frank, 2006). Edmunds estimated it takes an average of six years to recoup the greater initial cost of a hybrid, assuming gasoline costs $4.00 per gallon (cited by Levy, 2012:13). The time would be even longer once higher insurance rates and/or recharging equipment are included (Krisher, 2016).

53 Considering only models "sold exclusively with electrified powertrains" under estimated the EV sales numbers and market share because sales of models where buyers *opted* for the electrified powertrain have not been included.

54 Greater EV numbers would require a power grid capable of handling the increased load. This could include people charging vehicles in anticipation of power loss in a storm. A grid often takes days to completely recover from a disaster, while gas stations can quickly reopen if they have generators to power their pumps (Schnably, 2010).

55 While Truett (2016) focused on technical requirements and limitations, Carty (2016) pondered potential social and behavioral problems that could confound the most ardent proponents of fully autonomous vehicles. Her list of questions, compiled with the help of contributors, follows:

1. “Do autonomous cars become magnets for carjackers, who could pretty much just step out in front of a car to make it stop? Could you hijack an autonomous delivery truck the same way?”
2. “How does the car know whether the last passenger really exited? What if that person is a creepy criminal who hides in the back seat as the car heads off to get its next passenger?”
3. “Will the driverless car become the 1970s New York subway car of the future, decorated by taggers and vandals, inside and out?”
4. “What happens when you are heading to the airport and you get a mile from home and realize you left your passport on the kitchen table? What if it's your cellphone you left behind?”
5. “Won't these vehicles end up being the best drug couriers? What if you unwittingly get in a car that is carrying someone else's drugs? Will ‘I'm sorry, your Honor, but that's not my cocaine’ ever fly in court?”
6. “How many different ‘games’ can bored teens come up with? Will there be autonomous-vehicle surfing, with passengers climbing onto the roof while the car is driving? Will there be frat-house challenges to see how many pledges can jam into one car?”
7. “What happens if a drunken or carsick passenger throws up in a shared car? Who makes sure it doesn't just head out to pick up a new passenger? Who cleans up the mess? And honestly, can you ever really get rid of that smell?”
8. “How do these cars not end up being a hot spot for amorous teens?”
9. “What about when the flu or next big virus is sweeping through an area? Do shared autonomous vehicles become breeding grounds for germs?” (Carty, 2016).

56 These analysts often expect increasing imports of parts, which work against increasing domestic output. They occasionally see exports growing, but exports usually are a minor part of domestic output.

57 Oil and natural gas prices will rise over the very long term due to world-wide population growth and economic development, increasing costs in locating and extracting them, and because they are finite resources that eventually will be depleted. As previously noted in the text, it is probably impossible to produce ethanol and bio-diesel in sufficient volumes to replace oil and natural gas.

58 Achieving higher fuel efficiency is possible. A study by Lotus Engineering concluded that a gasoline-powered car could get 127 miles per gallon on the highway. The car would be a 1,150 pound three-seater, have an aluminum frame, use composite body panels, and place a 600 cc motorbike engine under the rear seats. It would be crashworthy and cost about $10,000. It would also incorporate the latest electronic technology such as voice command and a heads-up display (Sedgwick, 2012a).

59 Internal combustion (IC) engines produce variable amounts of torque; transmissions are needed to keep IC engines within a range of revolutions per minute (RPMs) producing near maximum torque. On the other hand, electric motors produce nearly the same amount of torque at all RPMs, substantially reducing or eliminating the need for transmissions (Peters, 2016).

60 Two bits of trivia: (1) interest on a loan to purchase a motor home is tax deductible as a second home mortgage, and (2) “reefer” is industry slang for a refrigerated trailer.

61 Comparisons to the state of Ohio in this regard are instructive: (1) net state-collected taxes for Ohio in fiscal year 2015 totaled $27,593,441,123 (Ohio Dept. of Taxation, 2016); and (2) there were 108,469 full-time and 76,720 part-time employees, which, when combined, amounted to the equivalent of 135,594 full-time jobs for Ohio’s state government in March, 2012 (U.S. Bureau of the Census, 2014d).

62 Alan Mulally, Ford’s president and CEO at the time, and one analyst believed that Ford would have failed along with GM and Chrysler without the governmental assistance provided to the latter two because it would not have been able to get parts. The analyst argued that the parts industry was in worse shape than the assemblers (Keane, 2012).

63 However at this writing, 1,200-plus may be furloughed from the Lordstown plant in the near future due to reduced demand for the Chevrolet Cruze (Krisher, 2016).

64 The total includes significant amounts from its other products: motorcycles, scooters, all-terrain vehicles, outboard motors, portable generators, lawn mowers, power tillers, snow blowers and general purpose engines. Honda has recently ventured in robotics and aircraft production.

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