Ohio | Department of Development

Policy Research and Strategic Planning Office
A State Affiliate of the U.S. Census Bureau

THE OHIO MOTOR VEHICLE INDUSTRY

February 2009

Ted Strickland, Governor of Ohio
Lee Fisher, Lt. Governor of Ohio
Director, Ohio Department of Development

Ohio | Department of Development

Ted Strickland, Governor
Lee Fisher, Lt. Governor

Mark Barbash, Interim Director

Dear Fellow Ohioan:

The Motor Vehicle Industry is facing an unprecedented global transition -- and Ohio, second in the nation for vehicle production, is directly impacted by these changes. From assembly plants to plastic fasteners, Ohio's manufacturers serve the motor vehicle industry, and a wide variety of business sectors depend upon the industry for their revenues.

This report outlines the size, location, and trends of the motor vehicle facilities located in our state. Three-year trends are provided whenever possible. There are detailed profiles on Honda, General Motors, Ford, and Chrysler, as well as an analysis of national trends that will be impacting the big assemblers and the hundreds of Ohio-based suppliers. An Input-Output model of Ohio's economy suggests that more than 370,000 people depend upon the motor vehicle cluster for their jobs and income.

Ohio's diverse industry base makes our state a global market leader. This diversity is complemented by a business environment that facilitates professional success and a high quality of life that allows for personal fulfillment. Ohio's unique combination of life and work amenities makes our state a place where you can achieve true professional and personal balance.

I invite you to review the attached report to further your understanding of Ohio's large and diverse economy. We welcome your input. If you have any questions or comments, please contact John Magill, our Department's Chief Strategic Officer at (614) 466-2116.

Sincerely,

Mark Barbash
Interim Director
Ohio Department of Development

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FEBRUARY 2009

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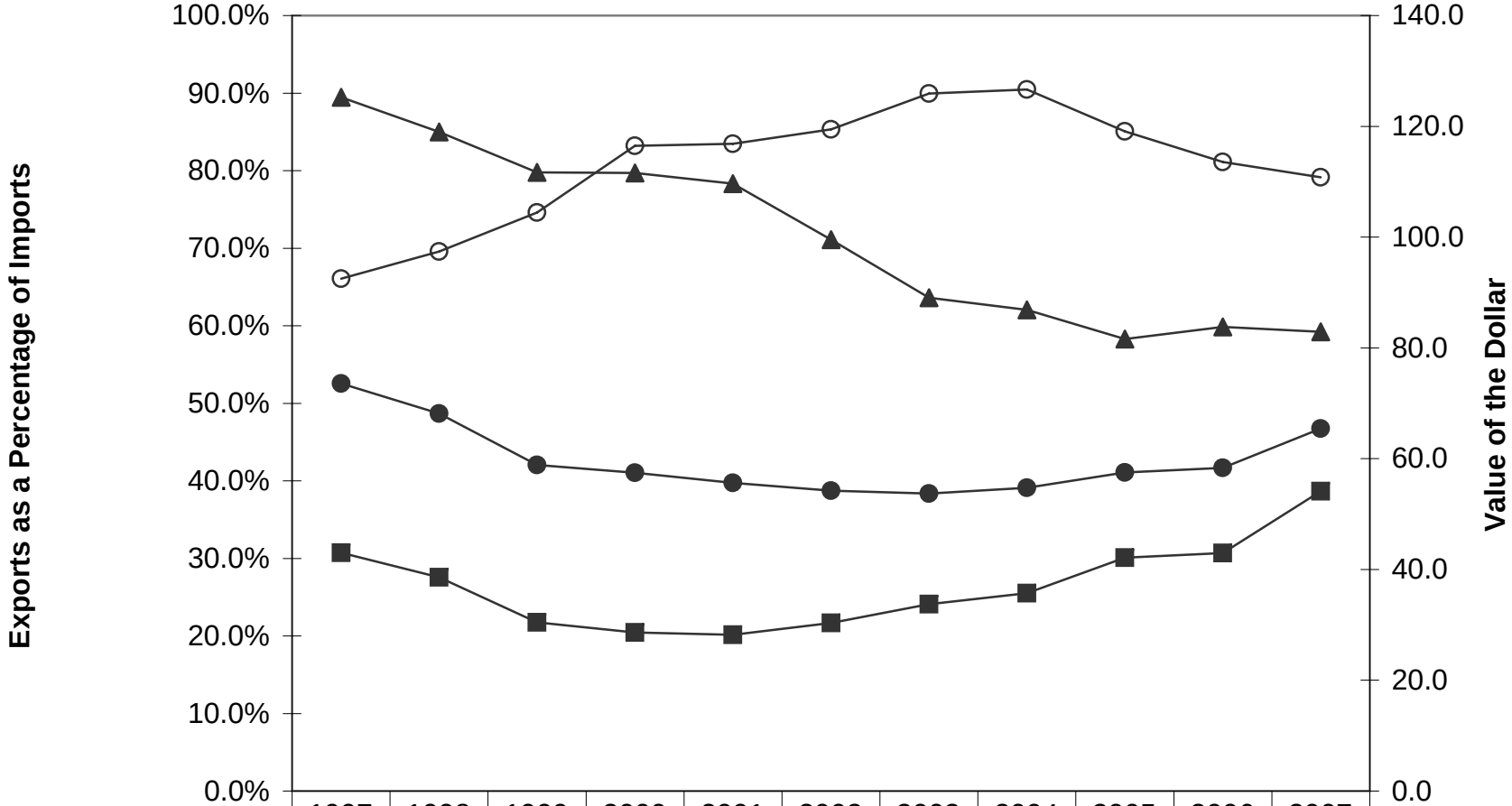
U.S. INDUSTRY ANALYSIS AND OUTLOOK

Exports of Motor Vehicles and Parts and Accessories as a Percentage of Imports and the Value of the Dollar, 1997-2007



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total	52.5%	48.7%	42.1%	41.0%	39.7%	38.7%	38.4%	39.1%	41.1%	41.7%	46.7%
Motor Vehicles	30.7%	27.5%	21.7%	20.4%	20.2%	21.7%	24.1%	25.5%	30.1%	30.7%	38.7%
Parts and Accessories	89.5%	85.0%	79.8%	79.7%	78.3%	71.1%	63.6%	62.0%	58.3%	59.8%	59.2%
Index Value of the Dollar	92.52	97.40	104.44	116.48	116.87	119.45	125.91	126.66	119.09	113.59	110.81

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

BALANCE OF TRADE TRENDS

The broadest trade measures include parts and accessories as well as motor vehicles (new and used). The common base for comparing (and combining) the two groups is their dollar value. The chart above shows the changes in the U.S. trade deficit in motor vehicles, parts-and-accessories, and the combination of the two ("Total") for 1997 through 2007.[16] Relatively speaking, the Total trade deficit increased 1997 to 2003, indicated by the falling value of exports-as-a-percent-age-of-imports from 52.5 to 38.4 percent. The deficit in motor vehicles has been relatively greater than the deficit in parts and accessories. This is indicated by the much lower ratio of exports-to-imports in vehicles – from 30.7 percent in 1997 to 21.7 percent in 2002. The same ratio for parts and accessories was much higher – up to 89.5 percent in 1997.

One explanation for the changes in trade deficits is the changing value of the dollar. A lower value of the dollar makes American-made goods relatively less expensive for foreigners to buy and foreign goods more expensive for people and companies in American to buy. A higher value has the opposite effects. The substantial increase in the index value of the dollar from 1997 to 2003 appears to have increased the relative Total deficit in exactly in this way. Conversely, the dol-lar's slighter decline since 2004 accompanied a smaller decrease the relative Total deficit. The relationship also is seen in the two components – motor vehicles and parts-and-accessories, although it does not match-up every year.[17]

It should be noted that the effect of currency fluctuations on U.S.-based companies can be complex. The devaluation of Asian currencies aided U.S.-based tire manufacturers by making their principal raw material – natural rubber – less ex-pensive (Prat, 1998). One U.S.-based tire manufacturer even increased production at its Asian plants. The devaluation of Asian currencies made its own products inexpensive imports, thereby decreasing its costs.

Trade agreements can affect levels of trade independently of the dollar's value. The North American Free Trade Agree-ment (NAFTA) has boosted motor vehicle trade among the member countries. It permitted manufacturers to rationalize production, improving productivity and profitability. The effect of NAFTA on U.S.-Canadian trade has been less dramatic than on U.S.-Mexican trade because Canada and the U.S. already had small or no tariffs (Gott, et.al., 1999). However, Mexico's membership in both NAFTA and MERCOSUR links the N. and S. American trade blocks, and its lower costs make it an attractive location for exports to other Latin America nations, not just to the U.S. and Canada (Levy, 1999).

The implementation of NAFTA may also help explain the relative increase in the U.S. industry's trade deficit. While Amer-ican exports to Canada and Mexico increased, imports from those countries increased even more. The most notable in-dustry effect was that more vehicles were imported from Mexico. Levy (2001) argues that the impact of the strong dollar is greater than the effect of NAFTA.

Government policy may have unintended consequences on trade. 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). This shows up in the U.S.-Canadian trade statistics. Most of the bi-lateral industry trade with Canada consists of intra-company shipments (Gott, et.al., 1999). The U.S. exports more en-gines and other parts to Canada than it imports from Canada. However, many of those engines and parts come back to the U.S. in vehicles; the U.S. trade deficit with Canada in vehicles more than offsets the surplus in engines, parts and accessories (U.S. Bureau of Economic Analysis, 2008b).

Finally, the growth of industry in a developing country may also affect the balance of trade. Levy (2001) cites China's parts industry as an example. At least some suppliers in China can provide parts at volumes and prices sufficient to at-tract the attention of other parts suppliers (e.g., tier-1 companies), assemblers, or parts distributors in the replacement market.

See Table A14

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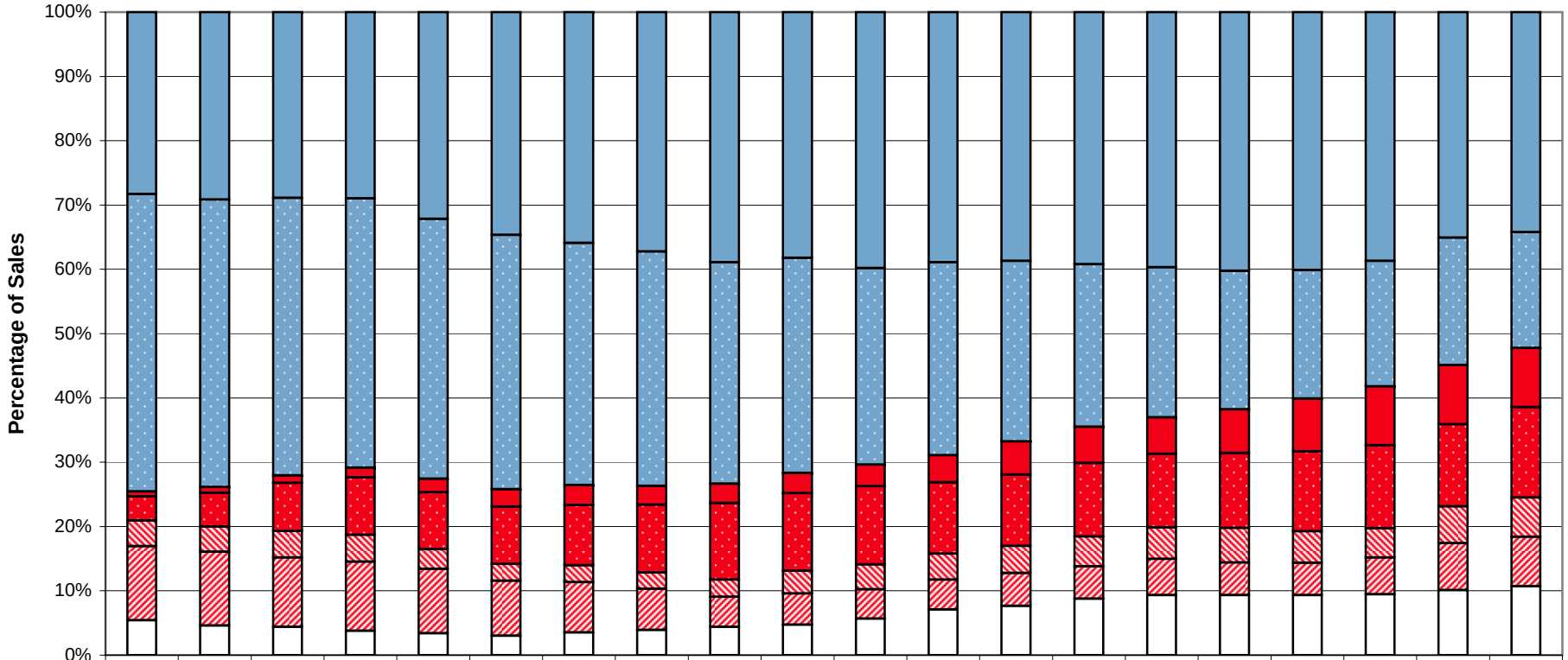
U.S. Market Share Sales Trends in Light Vehicles by Brand & Import Status: 1988 - 2007



	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997*	1998*	1999*	2000*	2001*	2002*	2003*	2004*	2005*	2006*	2007*
U.S.B.T.	28.3%	29.2%	28.9%	29.0%	32.1%	34.6%	35.9%	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%
U.S.B.C.	46.3%	44.7%	43.2%	41.9%	40.4%	39.6%	37.7%	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%
J.B.D.T.	0.7%	0.9%	1.1%	1.5%	2.1%	2.7%	3.1%	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%
J.B.D.C.	3.7%	5.2%	7.5%	9.0%	8.9%	8.9%	9.4%	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%
J.B.I.T.	4.0%	3.9%	4.1%	4.2%	3.1%	2.6%	2.6%	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%
J.B.I.C.	11.5%	11.5%	10.8%	10.8%	10.0%	8.6%	7.8%	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%
Others	5.4%	4.6%	4.4%	3.8%	3.4%	3.0%	3.5%	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%

Source: Ward's. Note: * - 1997 and later years not entirely comparable with earlier years.
Abbreviations used: B - Brand; C - Car; D - Domestic; I - Import; J - Japanese; T - Light Truck; U.S. - United States.

MARKET SHARE TRENDS

Market share trends are important because sooner or later "Capacity follows market share" (Harbour Consulting, 2006: 11). Starting with the energy crisis in 1973, the U.S. light vehicle market was transformed from a stable oligopoly into the most competitive market in the world as Japanese-brand assemblers captured a significant portion of sales. They did so by offering higher quality products better matching shifting consumer demand. Competition compelled U.S.-brand assem-blers to address both quality and organizational problems. The latter (and their suppliers) restructured their organizations and re-engineered their vehicles (and parts), improving design and quality while reducing costs. Design and quality is-sues are now much less distinguishing. The intensely competitive market limits the pricing power of assemblers. In some cases, new models are priced the same or lower than earlier models even though the former may have more features than the latter (Levy, 2008: 14).[18]

Never-the-less, the struggle for market share continues. The chart above illustrates a number of market share trends in U.S. light vehicle sales during the last 20 years. After fluctuating between 70 percent and 75 percent from 1988 through 1998, the combined share of U.S. brand cars and light trucks (U.S.B.C. and U.S.B.T.) fell below 70 percent of all sales in 1999, and continued to fall each year through 2007, when it was 52.2 percent. The net loss of market share for U.S. brands is the combination of two countervailing trends. Sales of U.S.B.T.s rose from 28.3 percent in 1988 to 40.2 percent in 2003. (U.S.-brand assemblers adapted faster than the competition to changing consumer tastes in this segment, but foreign-brand assemblers are now targeting this market.) However, this was not enough to counter-balance the declining market share of U.S.B.C.s, which fell from 46.3 percent in 1988 to 21.5 percent in 2003. Things took a turn for the worse for U.S.-based assemblers in 2004 when U.S.B.T.s started losing market share – down 6.9 percent, and U.S.B.C.s con-tinued losing market share – down 2 percent. Foreign car brands, whether imported or domestically assembled, have combined for the majority of car sales in America since 2002 (Ward's, 1993-2008).

Some of the market share loss of U.S. brands may be attributed to the changing value of the dollar. Statistics from the Federal Reserve Board (1990, 1993, 1996, 1999, 2004, 2006, 2008) show a net decline in the value of the dollar from 1988 to 1995, after which it steadily rose until 2002, and declined since then. The chart above shows that imports' share of motor vehicle sales (essentially the bottom three blocks of each stacked bar in the chart) fell from 20.9 percent in 1988 to 12.8 percent in 1995, and then grew to 19.8 percent in 2002, with little change until 2006.[19] However, the 7 percent rise in imports' market share does not account for all of the 10.7 percent decline in market share of U.S. brands from 1995 to 2002. Part of the difference is the increased share – 3.6 percent – of Japanese-brand light trucks and cars assembled in N. America (J.B.D.T. and J.B.D.C.) from 1995 to 2002. Appendix table A15b shows the details. Furthermore, the decline in the value of the dollar since 2002 is inconsistent with the increasing share of imports in the same period.

The chart also illustrates the continuing shift of production of Japanese brand vehicles to N. America. In 1988, 4.5 percent of sales in America were of Japanese brand cars and trucks made here, while 15.5 percent belonged to Japanese imports. By 1996, the share of Japanese imports had dropped to 7.4 percent of U.S. sales, while the share of domes-tically made Japanese-brand vehicles had risen to 14.9 percent. Shifting production from Japan to N. America achieved what was intended: circumvent the import quotas of the 1980s and insulate sales from the effects of changing currency values. (The rising value of the yen at the time made imported Japanese vehicles relatively more expensive when com-pared with vehicles produced in the U.S.) Since 1996, though, Japanese imports have risen with the more or less higher value of the dollar to claim 13.8 percent of U.S. sales, while domestically made Japanese vehicles had 23.3 percent of the market in 2007. The total – 37.1 percent – is the largest Japanese-brand share. The corresponding decline in market share of U.S. brands – now 52.2 percent – appears to be concentrated at GM and Ford (Levy, 2008: 3).[20]

Other vehicle makers individually have only toe-holds in the American market – their combined share of sales never sur-passed 7 percent until 1999. The improved design and quality of U.S. vehicles, as well as the declining value of the dol-lar, probably were factors in the decisions by European producers such as Peugeot, Renault, and Fiat to leave the U.S. market (Gott, et.al., 1999: 36-39).[21] Their increasing market share since 1993 is largely consistent with the rising value of the dollar. However, the recent strong value of the Euro hurt sales of European brands in the early part of this decade (Levy, 2004). Under these circumstances, the recent rise of other vehicle makers reflects the growing shares of South Korean producers Daewoo, Hyundai, and Kia. The South Koreans' success was initially based on low prices and extend-ed warranties (Levy, 2001).

The continuing competition for market share has led to much more frequent use of rebates and discounts by dealers and assemblers. "When one manufacturer offers incentives,… the others generally follow suit or risk losing market share" (Levy, 2008: 11). While per-unit costs of vehicles can be lowered by maintaining high demand – which rebates and dis-counts are intended to stimulate, failure to lower costs at the same time simply reduces profit. These practices are less likely with models for which demand is higher (Levy, 2008: 14).[22]

Finally, it has been noted that foreign-based makers of heavy-duty trucks have not threatened their American counterparts with imports for two reasons. First, heavy-duty trucks are not manufactured in many foreign countries because there is little need for such trucks – distances traveled are shorter, and few roads could accommodate them. Second, the few such assemblers have preferred to buy U.S.-based assets rather than establish their own manufacturing facilities. On the other hand, some foreign medium-duty truck makers have made some inroads into the American market with their exports (Wang, 2008: 10-11).

See Tables A15a & A15b

INDUSTRY OPERATIONS AND RECENT TRENDS

Companies making light vehicles (NAICS 33611) and companies assembling medium- and heavy-duty trucks (NAICS 33612) have a number of characteristics in common despite serving different markets. (The former serve mostly families and individuals, the latter usually serve organizations looking for capital goods.) Both produce their own components or purchase them from independent suppliers. The modules and parts – mostly metal, plastic, rubber and/or glass – are shipped to plants where workers assemble them into vehicles. Companies in both industries engage in the more profit-able – and riskier – activities of leasing and financing. Medium- and heavy-duty truck makers also offer maintenance and repair services (Levy, 2004; Wang, 2008: 8).

Price competition in both industries is intense (Levy, 2008; Wang, 2008: 10), continuing regardless of how well the econ-omy is doing. While both may offer rebates or discounts, the practice is much more frequent among light vehicle assem-blers. This is due to the reduction of trade barriers, the ready availability of information – especially price comparisons, and, in some instances, excess capacity (Levy, 2008: 14). The shear number of light vehicle assemblers operating in N. America probably also is a factor. As mentioned in the preceding section, the light vehicle market has not been an oli-gopoly in decades. Although there are now just four heavy-duty truck assemblers in N. America, the size, knowledge of market choices and the financial soundness of customers counter-balances that concentration (Wang, 2008: 10-11).[23]

Both industries are cyclical, albeit for different reasons. Purchasing a new light vehicle usually is the second largest ex-penditure 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 fall dramatically when the economy contracts and the unemployment rate is high (Levy, 2008: 15). Medium- and heavy-duty trucks are capital goods, and as such, purchases lag the economy. Purchases are made to add capacity as well as re-place aging equipment. During times of economic weakness, orders fall or are cancelled. Owners may choose to repair trucks, and fleet operators have even cannibalized idle trucks for spare parts (Wang, 2008: 11).

In other ways, the two industries differ. Heavy-duty trucks usually are customized to suit the buyer's needs.[24] Buyers select engines, transmissions, axles, suspensions, wheels, tires, brake systems, seating and other features based on considerations such as distance per trip, geography, and cargo type. More recent optional features that improve safety and efficiency include GPS-based tracking and communications systems, antilock brakes, and crash-avoidance warning systems. 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. Parts

suppliers may make interim improvements, and they work with assemblers to meet safety and emissions regulations (Wang, 2008: 10-11).

By contrast, light vehicle makers have sought to shorten model life times to five years. They bring new models to market in about three years, and aim to reduce this to two years. The accelerated pace may be due in part to changing consum-er tastes and regulatory requirements, but the practice also keeps a company's line-up fresh. It has been accomplished by having product designers work with engineers, thereby minimizing redesign work in later development stages (Levy, 2008: 12); work with industrial process designers also minimizes assembly time (Harbour Consulting, 2004).

The motor vehicle industry seems to change daily, perhaps the consequence of the two most important, interrelated in-dustry trends: competition and globalization. Competition increases when companies enter markets around the globe (again, as noted in the preceding section), and emerging markets such as Brazil, Russia and India present opportunities for higher-growth rates for established companies, with the attendant competition for market share. Such markets also are characterized by lower manufacturing costs, which certainly help U.S.-based companies' overall bottom lines. Some companies have closed plants in N. America while opening plants in the high-growth locales to better serve their cus-tomers (Levy, 2008: 7-8).[25]

The industrial process has changed over the years as companies have entered new territories and now compete in mar-kets around the world. The intensified competition compelled companies not only to improve quality, but also to 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. Fewer parts mean lower production costs, and less likelihood of assembly errors. Simplification also means that the number of stampings required for sheet metal parts such as hoods, trunks, fenders and doors has been reduced (Levy, 2008: 12; Wang, 2008: 10).

Perhaps the most far-reaching change for motor vehicle assemblers (NAICS 33611) has been the shift of work from as-semblers to tier-1 suppliers. Two examples illustrate these changes. In the past, seats were made at the assembly plant from the inventory of components. Now, assemblers order seats from an off-site facility, and have them delivered just-in-time for incorporation into the vehicle. (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 even hourly (Levy, 2008: 12). Similarly, the pistons, cylinder liners, connecting rods, and related bearings were made by dif-ferent 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 (which it at least helped design) at less cost than before (Gaines, 1999; Levy, 1999).

The first example is simply shifting the work off-site. The second represents the reorganization of the supplier base and its relationship with assemblers. Suppliers are now involved with assemblers in designing, developing, and engineering components and systems (Levy, 2008: 12). They also may 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 productivity targets offsetting inflation and lowering per-unit costs for the assemblers. In turn, assemblers agree to share the savings they achieve with suppliers. Suppliers are left to decide how to meet assemblers' goals on costs, quality, performance, timing, and features. They can choose their own tier-2 and tier-3 suppliers. These activities are riskier for suppliers, but the rewards may be greater (Levy, 2008: 16). Conversely, failure to meet assemblers' expectations can cost suppliers business. For example, Chrysler withdrew from a deal with Collins & Aikman over price and quality concerns regarding a bumper for its Jeep Liberty (Levy, 2004).

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 (Levy 2008: 15). Delphi received help from GM a couple of years ago (Karush, 2006), and currently is helping some of its tier-2 and tier-3 suppliers (Levy, 2008: 15).

While the relationship between assemblers and tier-1 suppliers may be closer, it is not cozy. Parts suppliers face financial pressures from both customers (who demand lower prices) and suppliers (in the form of higher prices for raw materials) (Levy, 2008: 2).[26] Assemblers also have asked suppliers to share in warranty repair costs (Harbour Consulting, 2004; Levy, 2004). Being squeezed from both ends may force some – particularly smaller ones – into bankruptcy or to other-wise leave the business, especially if they do not receive assistance from assemblers (Levy, 2008: 2).

On the other hand, large parts suppliers also have opportunities overseas with emerging markets. There are two appeal-ing facets: 1) low cost labor for manufacturing and engineering, and 2) rapidly growing local demand. Overseas expan-sion also supports assemblers' efforts to consolidate designs across international markets as well as supplying assem-blers (Levy, 2008: 2).

Assemblers and tier-1 suppliers around the world would like to reduce the number of suppliers with whom they deal to further trim costs and increase efficiency.[27] Indeed, the supplier base is becoming smaller as companies merge or leave the business. Mergers and acquisitions among/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. Tier-1 suppliers, in turn, are trying to reduce the

number of their (tier-2) suppliers in order to reduce their own costs and improve efficiency. The result is that the number of suppliers is shrinking as companies either merge or leave the business. Mergers between large firms are not occurring at present, but companies further down the supply chain are being acquired (Levy, 2004).

The downside of the mergers and acquisitions has been the accumulation of large debt loads. The large debt loads, perhaps in combination with other financial obligations and big customers pushing them for reduced prices, lead Delphi, Collins & Aikman, Dana, and Tower Automotive to file for bankruptcy protection. Others may follow because they find themselves in the same situation (Bennett and Assaad, 2006). Still other companies tried to overhaul themselves; for example, Lear obtained bank loans, suspended its dividend, and sold an interior products division to improve its financial position (Staff, 2006).

One 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, standar-dizing the process saves money (Harbour Consulting, 2004). Conversely, the commonality of parts and the standardi-zation of assembly processes enable companies to assemble more models on one line. The 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 them out.)

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 be-tween 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 se-quences are standardized, and the same equipment can be used for either model with little or no change.

TECHNOLOGIES IN PRODUCTION PROCESSES AND VEHICLES

Innovative technologies have been an important part of improving productivity at the plant. Examples include computer-aided design, engineering, and manufacturing (CAD/CAE/CAM), the adoption of progressive die presses ("progs") at stamping plants, and the use of the Internet. Computer technology has revolutionized the design process. It used to take 12 workers 12 weeks to produce a clay model of a proposed new vehicle. Today, one designer with CAD equipment and software can produce an animated video in three weeks, and an individual part may be designed in as little as one hour (Levy, 2008: 12). Progs are faster, form multiple parts with one stroke, take less space, and cost less (Harbour & Asso-ciates, 2001). Assemblers and suppliers can use the Internet to communicate more quickly and easily; consolidating supply chain transactions and logistics to a single location can reduce companies' costs.

However, technical innovations are not always panaceas; there may be tradeoffs that come with their adoption. For ex-ample, aluminum wheels may weigh less and work better with rubber than steel, but aluminum costs more per pound than steel. Similarly, progs work better with coiled steel than with steel blanks, and are less effective with aluminum. Prog die changes may take longer than die changes with the tandem presses they replace, and require more training for workers. The Internet website Covinsint, started by GM, Ford and Chrysler as a one-stop bidding shop for suppliers, was sold to Compuware because it did not work as well as envisioned. Compuware kept the name and tried to improve on the com-pany's successes as it competed with other electronic commerce exchanges for business (Harbour & Associates, 2001; Harbour Consulting, 2004). Furthermore, the price transparency of online competitive bidding has put downward pressure on prices and profits for suppliers of commodity items. On the other hand, suppliers of items that are highly engineered or customized have been less affected (Levy, 2008: 12).

Innovative technologies also have been an important part of creating higher quality vehicles. Technical advances have been spurred by consumer demand and/or new government regulations. One notable recent example of this has been the move by the National Highway Traffic Safety Administration (NHTSA) to require electronic stability controls on all new vehicles by 2010. Such devices could save over 10,000 lives per year, and currently are either standard or optional equipment on many vehicles. One NHTSA official said it "could be the greatest safety innovation since the safety belt" (quoted in Thomas, 2006b: D2).[28] Other recent innovations include knee and side air-bags, inflatable curtains, antilock braking systems and tire pressure monitors (Levy, 2008: 10-11).[29] Also noteworthy are the six-speed transmissions re-placing conventional four- and five-speed transmissions; they have fewer parts, weigh less, modestly improve fuel effi-ciency, and perform better when accelerating and moving through traffic (Harbour Consulting, 2006: 170-171).

However, vehicle makers have been caught between conflicting demands from government regulators and consumers. They must comply with standards for safety, fuel consumption and pollution control, each of which impacts vehicle performance. For example,

the easiest way to improve fuel economy is to reduce vehicle weight, but *ceteris paribus*, that reduces safety in a collision, and adding pollution control equipment adds weight to a vehicle. Finally, consumers' desires for larger vehicles (and their larger engines) – only recently diminished – conflict with the government's goal of reducing fuel consumption. The efforts to satisfy conflicting demands force manufacturers to adopt complex solutions[30] that add to a vehicle's cost (Levy, 2008: 13).

Efforts to improve fuel economy and meet emissions requirements have gone beyond improving components to include alternative power sources. Long before the recent rise in gasoline prices, people and organizations inside and outside of the industry have been investigating diesel, ethanol, natural gas[31] and electricity as supplements to, or replacements of, gasoline. Diesel engines are more fuel-efficient than gasoline engines, able to go 25-30 percent farther per gallon be-cause 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, these advantages must be weighed against their disadvantages. Diesels cost more for a number of reasons: they have to be sturdier and heavier because they operate at higher pressures, and their fuel injection system is more complex. Diesel fuel is more expensive, and the number of fuel stations is limited. Both engines and fuel must also meet stricter emission standards in America. However, this last problem may be diminishing with the shift to low-sulfur fuel and Honda's recently-patented method of reducing nitrous oxide (Harbour Consulting, 2006: 144-145; Kiley, 2008). Biological (i.e., renewable) sources of diesel fuel are also being investigated (Wikipedia, 2008). Clean-burning diesel engines also are a cheaper option than engines running on natural gas (Heywood, 2006: 62).[32]

The use of ethanol (a.k.a. grain alcohol) as a fuel has a long history (Wikipedia, 2008), even though it becomes a viable supplement-to/replacement-for gasoline on an industrial scale only when the price of oil is greater than $30 per barrel (Rohter, 2006).[33] Ethanol has a higher octane content than gasoline (Green, 2006),[34] and is a renewable energy source (Rohter, 2006; Wikipedia, 2008).[35] Unlike diesels, engines using ethanol are not substantially different from those using gasoline (Green, 2006). In fact, engines running on either gasoline or ethanol – so-called flexible fuel engines – are man-ufactured by the hundreds of thousands (Green, 2006), and the gasohol used in gasoline engines is 10 percent ethanol (Fischetti, 2006). The only technical disadvantages of ethanol are that it is more corrosive than gasoline – which is easily remedied, and that engines running on ethanol are hard to start when cold – which is why it is blended with gasoline. E85 fuel is 85 percent ethanol and 15 percent gasoline.[36]

Alternative fuels have other problems and limits. Choi (2006) cited a University of Minnesota study comparing energy gains and environmental impacts of ethanol and biodiesel that concluded that 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. However, Choi notes 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). This statistic is consistent with fact that roughly 20 percent of the current U.S. corn crop is converted to ethanol, and that ethanol comprises about 2 percent of U.S. transportation fuel (Heywood, 2006: 62). Heywood adds that ethanol made from residues and waste of plants seldom used as food could be more efficient and produce fewer greenhouse gases. Kammen (2006) comes to a similar conclusion.

The push for renewable fuels has had some unexpected and undesired consequences. "Rising global food prices and shortages have spurred calls in Congress to roll back the federal mandate to blend more ethanol and other biofuels with the gasoline supply. Critics say so much corn is being used for ethanol that there's less available for people and animals to eat, raising prices of everything from tortillas to meat." There are other reasons for increases in food prices, and any roll back is unlikely to occur this year (Mercer, 2008).

Battery-powered vehicles date to the early 20th century. Their initial advantages of fewer moving parts – and, therefore, fewer breakdowns – were 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, 2008e). The disadvantages re-mained significant even in times of expensive gasoline and concerns about pollution (battery-powered vehicles emit no pollutants) and despite battery improvements.

However, things may be changing. Neil (2006) described the changes by comparing GM's EV1, the most advanced bat-tery-powered car from the mid-1990s, with the Tesla 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 claims that the Roadster can accelerate from 0 to 60 miles per hour in four seconds, and has a top speed of 130 mile per hour. However, the sporty Roadster remains relative-ly expensive at $85,000-$100,000, although a sedan for less than $50,000 was anticipated in 2008.

Other companies around the world also are manufacturing battery-powered cars. One example from Ohio is the ZAP Alias. The car had three wheels with two seats side-by-side. Power is provided by rechargeable lithium-ion batteries, with a range exceeding 100 miles and speeds up to 100 miles per hour. The car initially is intended as a second car – the one usually driven less than 30 miles per day (Vellequette, 2008e).[37]

The Detroit Three also are working on battery-powered vehicles. One example is the Chevy Volt; it is an electric vehicle that can go 40 miles under normal driving conditions before the battery pack needs to be recharged. It takes about six hours to recharge the

lithiumion battery pack from a standard 110-volt electrical outlet. The on-board flexible-fuel engine serves only to recharge the batteries; it does not provide power to turn the wheels via a transmission and driveshaft. GM still faces technical challenges and affordability issues in bringing it to market by 2010, and the Volt is expected to face competition from Nissan's electric vehicle (Levy, 2008: 9-10). Chrysler has developed a prototype electric Jeep that gets the equivalent of 50 mpg and has a range of 400 miles (Chavez, 2008).

While battery technology has improved, other issues need to be resolved before battery-powered vehicles are widely adopted. The U.S. lacks the manufacturing capacity for batteries, drive motors and electronic control according to one industry insider cited by Schoenberger (2008b). Other problems that manufacturers and utilities need to address include electric grid capacity, standardizing plugs, safety measures, and locations for recharging stations – public garages, curb-side meters, and workplace parking lots. Public policy supports for electric vehicles are also needed (Business Courier of Cincinnati, 2008).

Fuel cells are the other power source for electric vehicles. They produce electricity as a result of a chemical reaction. They run longer than battery-powered vehicles, and can be quickly refueled. Those using hydrogen emit only heat and water vapor as by products, while those using other fuels produce few emissions. Given equivalent units of fuel, hydro-gen-based fuel cell vehicles are about twice as efficient as those powered by internal combustion engines (Harbour & Associates, 2001; Wald, 2004). For example, GM's model delivers the gasoline equivalent of 43 mpg with a range of 200 miles (Thomas, 2008b), and Honda's model gets the equivalent of 68 mpg (Business First, 2008) with a range of 270 (Thomas, 2008b) or 280 miles (Jones, 2008a).

GM and Honda are field testing hydrogen-based fuel cell-powered light vehicles, and favorable reactions have been re-ported. One driver of Honda's model commented that there was no sacrifice – he did not feel he was "puttering around in an underpowered, cramped little soapbox" (Thomas, 2008b). Indeed, Honda's most recent model can go from 0 to 60 mph in 10 seconds (Jones, 2008a), has a top speed of 99 mph, and seats four people. Its 148-pound fuel cell stack is 30 percent lighter than the previous model, and one-third the size of the 1999 model (Kageyama, 2008).

Fuel cells are appealing, but obstacles to widespread use remain. Fuel cells are heavy, difficult to make and not com-pletely 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 water, wind and the sun. 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 costs the equivalent of $3 per gallon (Thomas, 2008b). Once produced, hydrogen must be moved to a point where it is stored is stored before being distributed to vehicles.[38] However, there are very few hydrogen filling stations in the

country right now (Jones, 2008a), and building a distribution system may take decades (Ogden, 2006). Problems with storing hydrogen on the vehicle are now seen as less of a problem because storage tanks have been design to diffuse hydrogen into the air in non-flammable concentrations if punctured or leaking (Thomas, 2008b).

A last alternative has received a lot of attention in the press as it has become increasingly popular. Hybrid vehicles com-bine battery-powered electric motors with internal combustion engines to turn the wheels while reducing fuel consumption in the latter. It needs to be emphasized that battery-powered electric motors can be combined with *any* type of internal combustion engine using *any* type of fuel – gasoline, gasoline-ethanol blends, natural gas, diesel – to create a hybrid system (Levy, 2008: 13). More recently, hybrid vehicles using rechargeable batteries have been introduced (Romm and Frank, 2006: 78).[39]

There are a variety of hybrid systems. Those using all techniques may improve fuel economy by up to 60 percent, while those simply shutting off the internal combustion engine during stops improve fuel economy about 10 percent. The tech-niques include reducing engine size which, *ceteris paribus*, reduces fuel consumption; replacing the familiar Otto (four-stroke) cycle internal combustion engine with the less powerful but more fuel efficient Atkinson (two-stroke) cycle en-gine;[40] running the vehicle's electrical components from the batteries instead of the internal combustion engine;[41] and capturing via regenerative braking[42] energy that would otherwise be lost (Romm and Frank, 2006: 75). In the same vein of recapturing-otherwise-lost energy, more efficient thermocouples converting heat from engines and exhaust systems into electricity have been developed recently (Mayhood, 2008). Although a number of assemblers offer hybrid vehicles, Toyota has the most advanced hybrid system and the majority of the sales in America. It has registered over 650 patents, and licenses the technology to other companies (Harbour Consulting, 2006: 144).

Incorporating hybrid technologies can add thousand of dollars to a vehicle's cost, and batteries are significant part of the extra cost. The choice is between incorporating more techniques with the attendant complexity achieving greater fuel economy at higher cost vs. fewer techniques with less complexity, achieving some fuel saving at a lower cost. Japanese-based companies have tended to choose the former, and U.S.-based companies have tended to choose the latter (Jones, 2008b). As mentioned earlier, battery technology has improved; as production volumes rise, the premium prices paid for hybrids are expected to drop. Nevertheless, owners must operate their vehicles for a while before recouping the extra cost in lower fuel expenditures, and for any one vehicle, the length of time depends on how many miles a vehicle is driven per year as well as the price of fuel (Romm and Frank, 2006).[43]

Heywood (2006: 62) estimates that it will take years – even decades – before any or all of the fuel efficiency technologies discussed are competitive and widely diffused in motor vehicles.

THE NEAR AND LONGER TERM OUTLOOKS

While many of the trends identified earlier are expected to continue into the foreseeable future, analysts may differ in the details, and new developments will emerge. Topics about which they prognosticate include sales volumes, market shares, the direction of technologies and fuel prices, and the number of jobs.

The near-term outlook for sales is poor. Levy's mid-2008 forecasts of 15 million vehicles for 2008 and 15.4 million in 2009 were overly optimistic given that overall sales in recent months have been around 30 percent or more below the same months from one year earlier. The severity of the drop varied by company, but none of the major assemblers was exempt (for example, see Krisher and Fowler, 2008). It is due to a weak economy, the housing squeeze, higher credit costs, and upside-down loans.[44] Production at factories will follow sales (Levy, 2008: 1, 2, 5). The difference between the three largest Japanese-based assemblers – Honda, Nissan, and Toyota – and the Detroit Three is that the former are expected to surpass their 2007 production levels in a few years, while the latter are not. (Levy (2008: 12) notes that European-bas-ed assemblers as well as those based in Asia plan to add capacity in America.) At the time of publication in the middle of 2008, Levy (2008: 9) expected the Detroit Three's collective loss of N. American market share not to change company market share ranks; GM was still expected to be top-ranked here, followed by Toyota, Ford, Chrysler, Honda and Nissan – just as they ranked in 2007. More recent commentators might add "assuming they survive."

Meanwhile, medium- and heavy-duty truck sales could improve by the end of 2008 and in 2009 – despite the economic slow-down – due to buying ahead of stricter emission standards scheduled to start in 2010. This is similar to what hap-pened in 2006 and 2007 (Wang, 2008: 1-3, 11).

Similarly, the outlook for parts suppliers in 2008 also is negative. Most notably, light vehicle tire production in 2008 is ex-pected to be lower than 2007 due to cutbacks in vehicle production as well as fewer miles driven (Levy, 2008: 16). The demand for heavy-duty truck tires probably will remain soft due to a weak economy (Levy, 2008: 6). Like some assem-blers, tire manufacturers in N. America have more capacity than needed and face competition from manufacturers in low cost areas. In addition, the costs of raw materials have risen in recent years (Levy, 2008: 4).

Analysts differ in their assessment of long-term prospects for the industry. Levy (2004) describes the N. American and Western European light vehicle markets are mature and saturated, and predicts long-term sales growth therein will be relatively slow and cyclical. However, Figueroa and Woods (2007) forecast output from U.S. assembly plants (NAICS 3361) to grow at a faster-than-average rate of 3.3 percent for the 2006-2016 decade. Output from bodies and trailers (3362) is expected to match the growth rate for the economy as a whole: 2.9 percent. On the other hand, they expect output from the parts group (3363) to lag at only .7 percent per year. Wang believes that medium- and heavy-duty "truck

and engine sales [will] continue to show dramatic swings, with underlying growth averaging 4% to 5% annually over the long term" (2008: 8).

The longer-term potential for higher growth rates exists in the still-smaller markets of Latin America, Eastern Europe, and Asia – notably Brazil, Russia, India and China. In fact, the Chinese market is projected to replace the U.S. market within a decade as the world's largest for new vehicles (Levy, 2008: 7). However, exports of motor vehicles are unlikely to grow significantly for several reasons. Some countries – China, India, Indonesia, and Malaysia – are trying to develop their own industries or restrict the access of U.S. manufacturers. Others are subject to risks such as currency crises. Even if trade barriers did not exist, the typical U.S.-made product is over-equipped and far too expensive for emerging markets. Production costs (labor, energy, regulatory requirements, etc.) make this so. To a limited extent, this is true even of Canada. Canadians are much wealthier than typical consumers in emerging markets, but they generally are not as wealthy as Americans, and Canada's population is one-ninth that of the U.S. Consequently, the best-selling American-made models are the less expensive ones (Levy, 1999). Instead of trying to export to areas outside of N. America, U.S.-based assemblers may circumvent trade barriers by doing what they have done in the past: (1) set up operations in the markets in which they want to sell, even if the governments require using some locally produced parts, (2) buy a signifi-cant stake in a local company, and/or (3) form a joint venture with a local company (Gaines, 1999; Gott, et.al., 1999; Nielsen, 2000).

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). Over the long term, oil prices are expected to trend higher, with reduced demand in the West offset by increased demand in Asia and the Middle East (Levy, 2008: 9).[45] Consequently, consumers are expected to purchase vehicles that are more fuel efficient, regardless of whether they are cars or light trucks. Levy (2008: 1, 10) specifically predicts a shift away SUVs and luxury vehicles to CUVs and less expensive models (the latter reflecting the current economic malaise). U.S.-based assemblers cannot immediately meet the new demand in America for small cars by simply importing them as-is from one of their factories overseas because the cars have been built and tested to meet overseas government regulations – not American regulations. Consequently, such vehicles first must be changed to meet American standards before they are sold here (Durbin, 2008).

Any shift away from light trucks to cars will have a negative impact on light truck suppliers in Ohio. One example is axle-maker Dana, which announced company-wide job cuts of 3,000 (Vellequette, 2008b). Another is seat-maker Johnson Controls, which laid-off people since GM closed its SUV plant in Moraine (Gnau, 2008).

High gasoline prices make alternative fuels and the associated technologies more practical. The demand for renewable fuels such as ethanol and biodiesel are expected to grow in the near future so long as the price of crude oil remains high (Wang, 2008: 4).

A number of motor vehicle company officials and industry analysts believe ethanol usage by light vehicles could increase if the federal government acted to encourage its use beyond simply mandating that renewable fuel usage increase.[46] They suggest incentives for service stations to install more pumps offering E85 (a mixture of 85 percent ethanol and 15 percent gasoline) and/or subsidies to lower its costs. It's also noteworthy that assemblers plan to sell more vehicles with flexible fuel engines – those using either gasoline or ethanol (Thomas, 2006a).

Sales of hybrids are expected to increase, as more companies offer more models with the option of hybrid drives. Annual sales for hybrid are forecast to exceed 1,000,000 (or 6.1 percent of the total) by 2012 (Levy, 2008: 10). It is possible that most new car models will offer hybrid power sources as an option by 2020 (Romm and Frank, 2006). In the future, more sophisticated systems will recapture more of the braking energy (Romm and Frank, 2006: 75).

More plant closures are expected, and the remaining assembly plants must become flexible if more models are to be made for slow-growing markets. Even as they are closing plants, the Detroit Three are expected to lose market share. Sales of light trucks are of special concern. While they still dominate this sector, foreign-based assemblers collectively continue to take market share. This, combined with a shift toward more fuel-efficient vehicles, puts pressure on prices in what has been the profit center for the Detroit Three. Furthermore, the reduced sales by the Detroit Three will impact their suppliers, in turn, with reduced demand for parts. Given the lower margins and higher capital requirements of suppliers, suppliers will have will have a hard time earning enough cash to pay off debts. Consequently, more bankruptcy filings are possible. On the other hand, loss of business here may be at least partially offset by gains from operations in foreign markets. Meanwhile, foreign-based assemblers – particularly those based in Asia – continue to add plants here to further insulate their operations from detrimental currency fluctuations (Levy, 2008: 2-3).

Figueroa and Woods (2007) project employment declines from 2006 through 2016 for the overall U.S. motor vehicle industry. They predict that most of the losses will occur in the parts group (NAICS 3363): 138,300, or 21.1 percent, while the bodies and trailers group (3362) may have the smallest numbers: 4,100, or 2.3 percent. Losses in the assembly group (3361) are expected to fall between the two: 10,300, or 4.4 percent. Similarly, the Ohio Dept. of Jobs and Family Services/Labor Market Information (ODJFS/LMI, 2008) expected employment in the parts group to fall by 24,400, or 27 percent. ODJFS/LMI also forecast a loss of 4,300 jobs – 15.3 percent – in assembly operations, and 1,400 jobs – 16.5 percent – in the bodies and trailers group. Overall, it projects that 30,100 motor vehicle industry jobs in Ohio will disappear, a decline of 23.7 percent. Not all of the job reductions will be due to lay-offs. Some of the job reductions will occur through attrition, others will be the result of buy-outs or early retirements.

See Table A16