Transp. in Dev. Econ. (2015) 1:33–39
DOI 10.1007/s40890-015-0005-2

ARTICLE

Technological and Socio-Economic Issues in the Global Automobile Industry

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Received: 17 February 2015 / Accepted: 29 July 2015 / Published online: 4 August 2015

Abstract For several economies the automotive industry has been a driver of economic growth. The automotive industry is evolving rapidly on multiple dimensions technological innovation, adoption of stricter government regulations and structural shifts with changing consumer preferences. More recently, amidst growing climate change and human health concerns, huge investments are being pumped into the industry to tackle the twin challenges of emissions and fuel efficiency. The problem is exacerbated in the developing countries because of the relatively inefficient public transportation system, lax emission norms and slow penetration of clean automotive technologies. With this backdrop, the article outlines the challenges faced by the global automotive industry and the strength of technology innovation in helping the industry adapt to some of these changes. The article also throws light on some recent technologies in this domain implemented in the face of tightening environmental regulations.

Keywords Emissions · Automobile industry · Regulation · Fuel consumption · Developing country

Introduction

For several developed economies the automobile industry has been a driver of economic growth, contributing significantly to GDP and to the exchequer. The past decade witnessed a big leap in the ICT industry where technological innovations in mobile phones and tablet computers completely changed the communication and computing landscape. With huge investments being pumped into the automobile sector, the focus is shifting yet again to low emission, high fuel efficiency automobiles.

The automobile industry has a relatively high capital-labour ratio compared to other industries in almost all countries that have big manufacturing base. Apart from being capital intensive, it exports a lot of its production to foreign countries making it partly reliant on external market conditions. The production is increasingly shifting to emerging markets such as China, India and Brazil. The financial crises may reinforce, and even accelerate, this shift in favour of the emerging economies. The five members of the BRICS group (Brazil, Russia, India, China and South Africa) were largely responsible for the (albeit modest) growth in world GDP in the aftermath of the 2008–09 global financial crises.

According to the 2013 World Economic Outlook Database compiled by the IMF, these five emerging economies accounted for little over 27 % of the world's share of GDP (at PPP) in 2012, a leap of 6 percentage points since 2006 [1]. Further, the BRICS were responsible for roughly 55 % of global growth since the end of 2009. In contrast, the developed economies (comprising of 23 high-income countries) contributed only 20 % to that growth. With the middle class expanding in China, India and Brazil, cars are becoming the new symbol of prosperity. In 2009 China surpassed US as the world's largest car producer. But, this remarkable growth is accompanied by formidable challenges, from health hazards and traffic congestion to fuel price fluctuations and global warming.

The performance of the medium and heavy commercial vehicle (MHCV) segment is taken as a crude indicator of

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aggregate economic growth. This is more so in the developing countries where the railways often find it difficult to keep pace with the growing demand for transportation of goods and passengers. Sales of passenger vehicles are often driven by financial factors such as fuel prices and interest rates. The passenger vehicle segment has huge potential in the threshold economies due to demand-side factors such as enormous demand for luxury or high-end cars despite steep import costs, rising income levels, improving infrastructure and an expanding middle class. The supply-side factors include relatively low cost of hiring labour, low cost of setting up plants and running low cost assembly lines which cater not just to the domestic market but also for export to the developed markets.

Currently, even with relatively smaller real incomes in these emerging economies, the average cost of purchasing and running a car is drastically higher than in industrialized economies. According to IMF data analysed by the Economist Intelligence Unit, Shanghai, Sao Paolo and New Delhi surpass London, Berlin, Tokyo and New York in terms of average cost of owning a car.[1] Nevertheless, car makers are flocking to emerging markets in an attempt to exploit the growing demand and to counter rising taxes on foreign made vehicles. It was recently reported that the German automobile giant Daimler plans to set up a new assembly plant in Brazil to roll out its new C Class from 2015.[2] Other German manufacturers such as BMW and Audi have also announced plans to set up or expand plants in the coming year to gain market share in Brazil which is dominated by Fiat, Volkswagen, GM and Ford. Similarly, in India, Daimler is investing more in its existing plant in Pune and, in order to attract less import duties, started assembling new E Class in this plant from 2013.The small and medium scale ancillary industrial units concomitantly move with the big manufacturers to new markets and collectively contribute to value addition, employment generation technology diffusion in the local economy of the host country. United States, Germany and Japan have been the technology pioneers in automobile engineering and sales for several decades now. Recently, between 2000 and 2007, the share of the US and Japan in global production fell from 40 to 30 %, while the share of the non-OECD countries increased from production of one in ten cars to one in five cars [2].

The growing demand in different geographical regions has led to an increase in the minimum efficient scale of production of most automobile manufacturers. One consequence is an increase in the number of mergers and acquisitions, as well as collaborations in the industry to take advantage of the economies of scale and scope. The financial crises during the last decade put enormous strain on the global transport industry because of plummeting car sales, tighter access to credit and higher input cost across countries for several successive periods. According to European Automobile Manufacturers' Association (ACEA), the decline in demand for new cars in 2012 in the EU was a historic low since 1990 [3]. Except for the UK, all major European markets posted negative growth figures with sales particularly weak in the most financially affected economies of Spain, France and Italy.[3] The American city of Detroit which witnessed a remarkable growth with the arrival of the automobile industry in the first half of the 20th century filed for bankruptcy in July 2013. Four years earlier General Motors filed for one of the largest bankruptcies in the history of corporate America. This led to an array of stimulus packages and corporate reorganizations putting additional financial stress on the global economy.

Therefore, the currently distressed global car manufacturers seem to be counting on the ongoing sales surge in Asian economies, as well as on America's automotive market which is now in a recovery mode. In order to maintain its competitive advantage in low-emissions engine technology, Europe has repeatedly given signals to car manufactures that they will have to adhere to fuel efficiency and emission targets by 2025. The European Parliament's Environment Committee confirmed the proposed limit of 95 g of carbon dioxide/km for 2020 which implies that the average car should require approximately 4 l of fuel for a driving range of 100 km. Further, it was decided that emissions should be brought down to 68–78 g/km at a mileage of 100 km in 3 l by 2025.

The rest of the article is structured in the following way. The next section describes the challenges—environmental and health-related—which the industry currently faces. Recent developments in developing countries such as China and India are also highlighted. Section three lays emphasis on the environmental regulations pertinent to the automotive industry and, lastly, section four explores in detail selected technological innovations in emission-reducing and fuel-saving automotive technologies.

[1] Of the two components of ownership cost purchase price and cost of running the vehicle the former was almost three times higher in the emerging economies and the average cost ranged from approximately $90,000 to $120,000. The cost is for buying a typical family car with a 1.8–2.5 l engine in 2010. The running cost includes road tax, registration-fee. service, insurance and petrol consumption for 10,000 miles (16,100 km) at 35 mpg (12.4 km/l) for 3 years.

[2] This was revealed by Reuters via the German weekly Der Spiegel in August 2013. It should be noted that Mercedes was manufacturing the A Class hatchback since 1999 at the Juiz de Fora plant but since the plant was retooled for production of commercial trucks, production of passenger car ended in 2010.

[3] ACEA Press Release on Feb 19, 2013.

Environmental and Health Challenges

Five months after the June 2012 Rio Summit on green economy and sustainable development an agreement was reached to extend the Kyoto Protocol. Originally signed in 1997 to impose binding restrictions on developed countries to reduce emissions, this Protocol was due to expire in 2012. This landmark agreement has two deadlines—(a) 2015 for the development of an extended Kyoto Protocol, and (b) 2020 for its implementation. Unfortunately, global emissions could not be curbed in the run up to 2012. Emissions picked up again after an initial decline during the economic downturn between 2008 and 2009. Greenhouse gas emissions in 2012 were found to be 20 % more than the level in 2000 which, in absolute terms, amount to an additional 50 gigatonnes of carbon equivalent [4]. The transport sector already consumes more than 50 % of the global oil supply with road transport accounting for 75 % of the share. This is despite the fact that transport fuel (at least in most industrialized economies) is taxed more than the fuel for electricity or heating.

Reducing demand for energy and curbing vehicular emissions have become major global challenges. Making improvements in fuel efficiency and emission reduction are therefore crucial to address these challenges. Increases in vehicle emissions, particularly in the big cities where cars have emerged as the main contributor to air pollution, are evident. The problem is exacerbated in the developing countries because of the inefficient public transportation system, lax emission norms and slow penetration of clean automotive technologies. Beijing's air quality has been reported as being one of the worst in all megacities globally. According to the Global Burden of Disease Study (2010), outdoor air pollution was responsible for 1.2 million premature deaths in China in 2010 which is approximately 40 % of the total number of premature deaths in the world [5]. The study also found that the ambient particulate matter (PM) in emission from vehicles was the fourth leading risk factor for deaths in China. Air pollution ranked seventh on the list of global risk factors according to the same study. The resulting alarm bells renewed efforts to deploy stricter environmental standards, to focus on cleaner transport technologies and to revitalize efforts to kick-start the electric car industry in China. Another developing country example is of India which had 620,000 premature deaths in 2010 because of the similar untenable levels of outdoor air pollution. Despite a higher tax on cars with large engine displacements, the preference of Chinese consumers is gradually shifting away from fuel sipping, midsize compact cars and sedans to fuel guzzling, large sport utility vehicles (SUVs) and hatchbacks. This is not only soaring China's import cost and contributing to air pollution, but also pushing regulators to adopt more stringent regulations. As expected, automobile companies are responding by committing to open new assembly plants and engine factories to satiate growing local demand in such a huge automobile market.

Use of biofuels is another contentious area. This is because of a lack of clarity on the exact amount of ethanol (a derivative of corn) which needs to be blended with gasoline to increase the octane rating of the fuel. Maize farmers in the US have been pushing hard to get the amount of ethanol (to be diluted in gasoline) to increase. Powertrain developers and fuel distillers claim that this will likely damage car engines. Manufacturers, therefore, continue to focus and invest in enhancing the efficiency of the conventional automotive technology—the internal combustion (IC) engine. In terms of performance, innovations in turbo-charging and direct fuel injection, for instance, have made gasoline powered engines a tough competitor for the hybrid and electric variants. The ushering green movement and environment legislations are certainly driving the car industry to become more environmentally responsible. European Union's biofuels policy which set a target of deriving 10 % of the transport fuel from biofuels by 2020 faces a different challenge. It is claimed that deploying incentive schemes for biofuels to help meet this strict target would result in inadequate land being available for growing food crops thereby threatening the right to food in parts of EU.

Environmental Regulation in the Automotive Industry

The automotive industry is evolving rapidly on multiple dimensions technological innovation, adoption of stricter government regulations and structural shifts with changing consumer preferences. Several countries have put in place policies to address transport issues including emission norms and fuel efficiency standards. Fuel economy programmes and emission targets (mandatory or voluntary) are one of the most cost-effective instruments to tackle oil demand and vehicular emissions [6]. The reduction in pollutant emissions emanating from vehicles achieved in the last 30 years have shown the effectiveness of environmental regulations targeted towards the road transport sector. These regulations have, directly and indirectly, directed advancements in environment friendly technologies (emission reducing and fuel saving) and novel non-conventional technologies particularly in the passenger and commercial vehicle segments.

The automotive industry is one of the fastest growing global economic sectors and faces big environmental

challenges. One side of the narrative is that road transport sector is responsible for almost 25 % of all global carbon emission from fossil fuels, accounts for approximately 50 % of world's oil consumption and its share of emissions have grown faster than the overall global emissions since 1990 [7]. Unger et al. [8] predicted that by year 2020 this sector is likely to have a particularly high impact on climate change. To add to these worries, the rising demand for oil and vehicles in developing countries will continue to fuel the growth of this sector over the next decade.[4] Emerging economies (particularly China, Brazil and India) have seen tremendous economic growth which can be witnessed from the expansion of their domestic automotive sectors. This has added more vehicles on roads than ever before. From 1999 to 2009, the share of global passenger car production in BRIC countries increased from 7.9 to 33.3 % [11]. The other side is that more than 80 % of environment friendly automobile technologies till 2007 were developed in US, Japan and Germany [12] and, till 2010, OECD countries accounted for only 30 % of global CO_2 emissions [13].

This highlights the technological and environmental imbalance witnessed in the world today and the critical role of policies concerning emissions and technology development.[5] These facts and trends draw attention to the relevance of environmental policies for reductions in emission and oil consumption which is an imperative for sustainable development now and in the future. There is a divergence in the consumption of gasoline fuel used for transport between developed and developing countries. While consumption is rising in developing countries like Brazil and China, the decline in developed countries could be due to reliance on cleaner fuels or slowing down of their economies.

Jaffe et al. in their 2005 study, suggested that the market failures (associated with environmental pollution, innovation and diffusion of new technologies) provides a strong rationale for environmental policies that foster emission reduction as well as the development and adoption of environmentally beneficial technology [14]. According to them, weak or non-existent environmental policies lead to lower than socially optimum investments in development and diffusion of environment-friendly technologies. Economic expansion and increased mobility has, among other reasons, increased fuel consumption in all countries. Nevertheless, United States, Japan and Europe are leaders in implementing strict but effective environmental regulations. They have shown the way for other countries which end up adopting the regulatory and technological path taken by Europe or US. The last decade witnessed a range of regulations proposed and adopted in these countries, many of which resulted in impressive decline in emission levels and increase in fuel economy standards. India, China and Brazil entered the international emission regulation stage much later but since then the gap has been converging rapidly.

Technological Innovation in the Automotive Industry

The 2009 UNFCCC meeting in Bonn brought the issue of role of (clean) technology in reducing emissions at the centre stage of intellectual property discussions. Since then the entire debate around patents imbedded in clean technologies and access has become more complex and contentious. The developing countries, led by the emerging cohort, argue that development and deployment of clean technologies is dependent on the ability to make substantial investments. The Rio summit held in June 2012 focused on two central themes—green economy and the institutional framework for sustainable development. For the first time there was a heated debate between two polarized environmental groups over intellectual property, and, specifically, on patent law and technology transfer. The argument put forth was that patents are primarily responsible for the high cost of such low-carbon technologies. The developed countries, on the other hand, argue that patents are a good way to incentivize innovation in clean technologies and weak intellectual property regimes are responsible for slow rate of transfer of such technologies [15].

The transformative process of technologies catering to a global audience is often a sluggish process. This is not only because of huge R&D and capital investments needed, but, in line with Schumpeterian theory, also due to the mammoth task of shifting reliance away from conventional technologies. However, the current internal combustion technology—building on the technological innovations of the past 100 years—is considered by many to be ahead of the electric propulsion technology. The gas-electric hybrids which are touted as the transition technology to the fully electric car also burn fuel in their engines. Consumer

[4] Recent studies have shown that the transport sector is expected to collectively grow at the same pace in the next decade with the total number of vehicles actually doubling by 2030 [9, 10].

[5] United Nations Framework Convention on Climate Change (UNFCCC) incorporates provisions for transfer of environmentally sound technologies from developed to developing countries and this clause has been one of the most contentious issues in recent climate negotiations. According to Article 4 of the UNFCCC Agreement, Parties shall take all needed steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties (…) the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties.

scepticism about the driving range of electric passenger cars (range anxiety) continues to prevail. Further, the existing fuel cell and battery technologies are unlikely to efficiently propel medium and heavy commercial vehicles (MHCVs) such as tractors and long-haul trailers, unless there is a revolutionary technological breakthrough in the near future.[6] This can partly explain why, despite all media hype, billions in government subsidies and increasing number of car models, the market for battery powered vehicles has not taken off. However, the shale gas boom in natural gas in US is expected to favour the commercial vehicle segment which is the backbone of the inter-state transport of several goods throughout the country.

Realizing the slow progress of battery technology for MHCVs, Cummins, a big automotive engine manufacturer, recently introduced heavy engines that run on liquefied natural gas which is an alternate fuel having a lower price and smaller carbon footprint.[7] Compressed natural gas, on the other hand, has a reduced energy density which limits range of vehicles and increases refuelling frequency. It is favourable to vehicles that travel shorter distances such as shuttle/transit buses, garbage haulers and small delivery vans. Government support in the form of federal and state tax concessions and grants for installation of natural gas stations has also helped with the transition to nonconventional fuels. Although the price of natural gas run vehicles is likely to decline once the installed capacity of these pumps increases, a lot more is expected from the administrators in this area. The Global Innovation Index 2013 states [16]:

> Despite the economic crisis, innovation is alive and well. R&D spending levels are surpassing 2008 levels in most countries and successful local hubs are thriving. A group of dynamic middle- and low-income countries including China, Costa Rica, India and Senegal—are outpacing their peers, but have not broken into the top of the rankings.

Patenting of Green Technologies in the Automotive Industry

On the intellectual property front, although the US Patent and Trademark Office (USPTO) closed its green technology fast track patent procedure in 2012, Brazil became the first BRIC country to embrace fast track procedures for green patents at its patent office the same year. Following in the footsteps, the Chinese Patent Office (SIPO) enacted a prioritized examination process for patent applications in selected technology classes later that year. This fast track process is open to patent applications directed to energy saving and new energy vehicles, among other green technologies. This is in sharp contrast to the recurring stand taken by these emerging economies in the international climate debates and negotiations where policies to weaken or eliminate green technology patent rights were proposed. Recently the number of clean energy patents has climbed rapidly, especially in the US. According to the Clean Energy Patent Growth Index, a record 798 clean energy patent applications were submitted in the USPTO in the third quarter of 2012, of which the Japanese auto giant Toyota was responsible for almost 10 %.[8] A recent report released by a consortium of transport sector stakeholders concluded that growth in Europe could be improved and approximately 1 million net additional jobs in 2030 can be created through innovation in the automobile industry. Technological improvements aimed at reducing foreign oil imports can deliver substantial fuel savings for the European economies in the next two decades.

Nowadays conventional engines are remarkably cleaner and powerful than their counterparts few decades ago. Several important technologies are responsible for this paradigm shift in internal combustion engine technology—from lowly carburettors to efficient fuel injectors to precise (gasoline) direct injectors, from heavy iron to lighter aluminium, from multi-valve to enhanced variable valve timing, from overhead valve to improved overhead cam shafts and finally the advancements in the embedded computer systems, engine controls units and on-board diagnostics to optimize overall performance. Perceptions about diesel in countries like US and India are still very different from that in Europe which has long preferred diesel to gasoline. With the recent advancement in engine technologies, diesel as a dirtier fuel than petrol is a foregone conclusion in most countries.

There is a virtual consensus among automotive engineers that a diesel turbo engine delivers a greater torque surge and better mileage relative to a comparable petrol counterpart in standard driving conditions.[9] But, a huge drawback is the difficulty in controlling smog-and acid

[6] The promising rechargeable non-aqueous lithium-air (battery, being further developed by researchers at the University of St. Andrews, is receiving a great deal of interest).

[7] The bulk of demand for such heavy commercial vehicles comes from big shippers in the FMCG and logistics industry (such as Procter & Gamble, United Parcel Services, FedEx, Walmart) that want to reduce reliance on transport fuel as well as earn green credentials.

[8] CEPGI Index is published quarterly by the Cleantech Group at Heslin Rothenberg Farley & Mesiti P.C, by tracking the granted US patents for solar, wind, hybrid/electric vehicles, fuel cells, hydroelectric, tidal, geothermal, biofuels and other clean renewable technological areas.

[9] Diesel is inherently a more combustible fuel at high pressures than gasoline which is a reason why diesel engines do not require spark plugs.

rain-causing nitrogen oxide (NOx) emissions in a diesel vehicle. Diesel engines are also relatively more expensive to develop due to the hardware (such as turbo-booster components and intricate injection systems) that runs the complex diesel combustion process. It should be noted that two factors make diesel more preferable than petrol in European countries—first, higher cetane rating which makes it relatively easier to curtail NOx emissions, and second, NOx limits are generally stricter in US than in Europe. In order to meet these stricter limits, manufacturers in US are compelled to incorporate expensive after-treatment equipment to decrease tailpipe (PM) emissions. Such after-treatment devices fitted on-board diesel vehicles make them even more expensive.

The negative perception about diesel prevailed in India for a long time. Overloaded public transport buses, aged passenger vehicles and under-maintained commercial vehicles—all running on diesel and emitted noxious fumes were the most visible on Indian roads and, consequently, became synonymous with the dirty fuel.[10] This perception has undergone a change in the last few years in which the advances in diesel engine technologies have made the diesel-run cars not only more fuel efficient and cheaper to run,[11] but also not more expensive to maintain than their petrol counterparts. After the introduction of stricter emission norms in India (such as BS III and IV) with reduced sulphur content to 50 ppm, diesel has indeed become a cleaner fuel.[12] China initially scheduled the nationwide implementation of China IV diesel standard (similar to Euro IV) in January 2011 but was later postponed until July 2013.

Given the extent of air pollution in Chinese cities, this move is contrary to the promise made to upgrade tighter emission norms. This regulation will force bus and truck manufacturers to install cleaner engines as well as require gas stations to supply higher-grade fuel with lower sulphur content. Similar to the Indian case, it is more difficult for the relatively weak environment ministry to impose the financial burden on the oil companies that have a bigger political and economic clout. Because fuel prices are not market determined but set by the Chinese government, it is difficult for the oil companies to pass on this additional cost to the consumers. Transport fuel is heavily subsidized in several countries including Brazil, China and India while it is undertaxed in others such as US and members of OPEC.[13]

According to 2013 Bloomberg Gas Price Ranking[14] the average pump price of gasoline in Germany ($7.96 per gallon) is more than double the price in the US. However, one quarter of Germany's total electricity is derived from renewable sources which will play a role in the future growth of the electric car segment. On the other hand, pump price for gasoline in the US ($3.29 per gallon) is one of the lowest in the non-OPEC countries due to a substantially low tax levied on it. Being the biggest consumer of gasoline with low fuel price, it is not surprising that US has the highest number of cars per thousand residents. China, the second biggest consumer of oil, tightly regulates retail pump price to curb inflation. China's pump price of $4.74 per gallon is approximately 20 percent less than the global average. China is expected to match the US vehicle fleet (more than 250 million) by 2020. Brazil is an emerging economy with abundant oil resources and is the largest user of ethanol in transport fuel. The pump price of gasoline in Brazil ($5.40) is close to the global average. Finally, India with a pump price of $5.0 per gallon suffers from widespread energy poverty due to low per capita income, limited access to electricity and a huge (potential) consumer base. Subsidies on fuel (particularly diesel) account for a big chuck of its annual budget. Subsidized diesel in India is used mainly in agriculture and commercial transport because of which there still exists an artificially created price differential between gasoline and diesel.

An indicator of car manufacturers' response to stricter fuel economy and emission standards is the changing trend of vehicular length and weight. Despite increasing fuel efficiency and tighter emissions standards, installation of safety devices and infotainment systems, long running car brands such as the Volkswagen Golf Series and Peugeot 20 Series were, for the first time, downsized in both length and weight. Despite the economic turbulence, manufacturers continued to focus on cars with reduced CO_2 emissions, higher fuel efficiency and newer engine technologies. Substantial progress has been made in hybrid and electric vehicle technologies in the last decade but the infrastructure required for these vehicles is still shaping up. Installation of sufficient number of charging stations is an

[10] A reason for such a negative view was the higher noise and vibration levels owing to the more explosive diesel combustion process.

[11] This is, in part, due to the subsidization of diesel, mainly for agricultural use, because of which there still exists an artificially created price differential between the two fuels in India.

[12] It should be noted that the allowed sulphur content internationally is 10 ppm.

[13] Heavy subsidization of fuel consumption is not considered to be efficient due to a number of reasons. (1) deteriorates budget and trade deficits, (2) misallocation of public funds to these subsidies instead of social sectors, (3) volatility of crude oil price affects fiscal planning, (4) subsidies encourage consumers to buy vehicles which further adds pressure on roads and contributes to air pollution, (5) discourages investment in clean vehicle technologies.

[14] Ranks 60 countries by average retail price and measures the percentage of average daily income needed to buy a gallon of fuel. Created using data compiled by Bloomberg, Associates for International Research Inc., Europe's Energy Portal, IMF, US Energy Information Administration, CIA World Factbook and OECD.

overwhelming task and solving the problem of range anxiety (how far the vehicle can go with one charge) require changes in consumer perception and driving habits. On the one hand, there is the success story of Tesla Motors but, on the other hand, there are the recent successive bankruptcy filings by American companies in the electric propulsion segment such as Fisker Automotive, Coda Automotive, Better Place and A123 Systems.

In Europe, the latest figures from ACEA for registrations in the first quarter of 2013 show that European car sales saw a positive growth for the first time in 19 months mainly due to increased consumer confidence in German markets. Daimler, Volkswagen and Renault saw the biggest increase of 11, 9.7 and 5 % respectively [3]. Toyota Motors which has sold 5 million hybrid vehicles since the first Prius rolled out in the US in July 2000 certainly stands out in the electric hybrid segment. With a global fleet of 20 hybrid vehicles and research collaboration with the US Department of Energy and National Renewable Energy Laboratory, Toyota now sells electric hybrid vehicles in 80 countries around the world. In Europe, the scuffle to implement stricter emission limits for 2020 is getting more political. Some have criticized the failure of the European Council to act on the emissions cap due to lobbying from Germany which is looking to protect its own luxury brands such as BMW and Daimler. The lobbyists claim that the cap would unfairly target their products and would also affect jobs in the industry. Other significant European car makers in France and Italy (Renault and Fiat) which make smaller cars have objected to this. The recent media report of France banning imports of some models of Mercedes is considered as a rebuke to German tactics. The French government claims that these cars use fluids in their air conditioning that fail to meet the European technical standards for emissions of harmful gases. Although the ban imposed early August 2013 is being reconsidered, it suggests the growing dissatisfaction within the European single market regarding tighter rules on exhaust emissions which are in the pipeline.

Conclusion

The automobile industry touches every segment of any society. The automotive industry is evolving rapidly on multiple dimensions technological innovation, adoption of stricter government regulations and structural shifts with changing consumer preferences. Several countries have put in place policies to address transport issues including emission norms and fuel efficiency standards. The industry is undergoing changes at an extremely fast pace, from product variety, fuel consumption, emissions to safety, comfort and pricing. Innovation and adoption of new technologies is vital and has to go in parallel with stricter government regulations, structural changes in the industry and changing consumer preferences. Innovation and adoption of new technologies is vital and has to go in parallel with stricter government regulations, structural changes in the industry and changing consumer preferences. The reduction in emissions emanating from vehicles achieved in the last 30 years have shown the effectiveness of environmental regulations targeted towards the road transport sector. These regulations have, directly and indirectly, directed advancements in environment friendly technologies (emission reducing and fuel saving) and novel non-conventional technologies particularly in the passenger and commercial vehicle segments.

Acknowledgments I would like to thank the German Max-Planck-Gesellschaft for the grant awarded to me for conducting doctoral research at the Max Planck Institute for Innovation and Competition in Munich on environmental regulations, innovation and patenting in green technologies in the transport sector. This paper largely draws from the introductory chapter of my dissertation. All errors are mine.

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