

Ray, Saon; Miglani, Smita

Working Paper

Upgrading in the Indian automobile sector: The role of lead firms

Working Paper, No. 360

Provided in Cooperation with:

Indian Council for Research on International Economic Relations (ICRIER)

Suggested Citation: Ray, Saon; Miglani, Smita (2018) : Upgrading in the Indian automobile sector: The role of lead firms, Working Paper, No. 360, Indian Council for Research on International Economic Relations (ICRIER), New Delhi

This Version is available at:

<https://hdl.handle.net/10419/203694>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Working Paper No. 360

**Upgrading in the Indian automobile
sector: the role of lead firms**

**Saon Ray
Smita Miglani**

June 2018



INDIAN COUNCIL FOR RESEARCH ON INTERNATIONAL ECONOMIC RELATIONS

Table of Contents

Abstract.....	iii
1. Introduction.....	1
2. Literature Review	1
<i>a) Lead firms shape the upgrading prospects in a country</i>	<i>2</i>
<i>b) Lead firms in automobile GVCs</i>	<i>4</i>
<i>c) Upgrading in the context of automobile industry</i>	<i>5</i>
3. The Indian automobile industry	6
<i>Policy framework and its role in emergence of lead firms</i>	<i>8</i>
<i>Evidence of India's integration in automobile GVCs</i>	<i>10</i>
<i>Product lines and their role in emergence of lead firms</i>	<i>13</i>
4. Methodology	15
5. Case analysis.....	15
A) Process upgrading.....	16
<i>i) New production machinery purchased</i>	<i>16</i>
<i>ii) Workers training.....</i>	<i>17</i>
<i>iii) Reduction in delivery times</i>	<i>19</i>
<i>iv) Introduction or improvements in total quality programs</i>	<i>19</i>
<i>v) Introduction of new organizational/ management techniques</i>	<i>19</i>
<i>vi) Improvements in the production process</i>	<i>20</i>
<i>vii) Increased usage of computer programs and internet for business purposes.....</i>	<i>22</i>
B) Product upgrading	23
<i>i) Steps taken to improve product quality</i>	<i>23</i>
<i>ii) Introduction of new materials to enhance product range</i>	<i>25</i>
<i>iii) Reduction in reworking rates</i>	<i>27</i>
C) Functional upgrading	28
<i>i) Design.....</i>	<i>28</i>
<i>ii) Marketing</i>	<i>29</i>
<i>iii) Branding.....</i>	<i>29</i>
D) Inter-sectoral upgrading	30
<i>Electric vehicles</i>	<i>31</i>
6. Conclusion	31
References.....	33

List of Tables

Table 1: Automobile Export Trends	12
Table 2: Upgrading by Indian Automobile firms	16

Abstract

This paper has made an attempt to identify the role of lead firms in mapping the activities related to upgrading. Upgrading refers to the process through which firms may move up the value chain. The literature identifies different types of upgrading such as product, process, functional and inter-chain upgrading which form the essential dynamics of the growth of a manufacturing industry. The Indian automobile industry is one of the successful cases in this regard. Using a case analysis approach, this paper looks at upgrading efforts made by seven major OEMs, including the use of advanced modular platforms, new materials and platform sharing among firms. The role of policy in facilitating the emergence and growth of lead firms has also been assessed.

Keywords: *Global value chains, automobile industry, organization of production, R&D*

JEL Classification: *L2, F23, L62, O32*

Author's email: *sray@icrier.res.in, smiglani@icrier.res.in*

Disclaimer: *Opinions and recommendations in the report are exclusively of the author(s) and not of any other individual or institution including ICRIER. This report has been prepared in good faith on the basis of information available at the date of publication. All interactions and transactions with industry sponsors and their representatives have been transparent and conducted in an open, honest and independent manner as enshrined in ICRIER Memorandum of Association. ICRIER does not accept any corporate funding that comes with a mandated research area which is not in line with ICRIER's research agenda. The corporate funding of an ICRIER activity does not, in any way, imply ICRIER's endorsement of the views of the sponsoring organization or its products or policies. ICRIER does not conduct research that is focused on any specific product or service provided by the corporate sponsor.*

Upgrading in the Indian automobile sector: the role of lead firms

Saon Ray and Smita Miglani

1. Introduction^ξ

The process of globalization has thrown up many new facets of integration, one of which can be understood through Global Value Chains (GVCs). GVCs refer to the full range of activities involved in value creation of a product from its conception to end-use. The literature has examined ways in which firms can enter such value chains and also move up within them (Gereffi, 1999; Giuliani et al. 2005; Taglioni and Winkler, 2016).

The concept of upgrading is important in the GVC literature and refers to the capacity of firms to make better products, more efficiently and move into more skilled activities (Kaplinsky, 2000; Giuliani et al., 2005). Upgrading can be achieved in various ways but is neither automatic nor easy (Navas-Aleman, 2011).

This paper examines upgrading undertaken by the Indian automobile industry. While meeting the consumer demand and responding to the fast changing technologies, the success of this industry has been largely dependent on its ability to upgrade based on factors such as frugal innovations, new product development, integrated supply chain and focus on marketing distribution channels. A case study approach has been followed to identify the upgrading efforts of major lead firms in India.

The paper is organized as follows: the next section discusses the literature on this subject, section three discusses the Indian automobile industry. Section four presents the methodology and section five the case based analysis of upgrading in the Indian automobile industry. Lastly, Section six concludes.

2. Literature Review

The organization of production into networks or GVCs has changed the nature of world trade and production. GVCs refer to full range of activities involved in value creation of a product from its conception to end- use (Gereffi and Fernandez-Stark, 2011). The range of activities differs, depending on producer or buyer driven chains. Producer driven chains are most commonly found in industries such as automobiles, aircraft, semiconductors, heavy machinery etc. (Gereffi, 1999). Such chains are led by transnational firms that coordinate production and are usually found in capital and technology intensive sectors. Buyer driven chains are headed by large retailers, branded marketers, branded manufacturers who set up decentralized production in developing countries. These chains are usually found in more labour intensive industries such as garments, footwear, toys etc.

^ξ Acknowledgements: The authors would like to thank Prof. Dev Nathan and Prof. Biswajit Nag for comments on the earlier draft of the paper.

The coordination of GVCs is generally done by large multinational enterprises (MNEs). As mentioned before, these are usually called the “Lead firms” or “governor firms” that largely determine production parameters and wield power over other firms in the chain. Lead firms decide the location of high value activities and conditions under which firms participate in GVCs. They affect upgrading opportunities by GVC participation. In this section, we discuss a) how lead firms shape the upgrading prospects in the GVC framework, b) in the specific context of the automobile industry, what are the roles of lead firms in upgrading?, and c) upgrading in the context of the automobile industry.

a) Lead firms shape the upgrading prospects in a country

Gereffi and Sturgeon (2013) present a typology of industrial policies in emerging countries which has three components: first, horizontal which affect the entire national economies. Second, the vertical industrial policies that are targeted at particular sectors or industries and finally, GVC oriented policies. While the first two policies can be termed as traditional policies, the third set of policies is aimed at improving a country’s position in GVCs and includes possibilities of upgrading as well as improving the links across different segments of the value chain. UNCTAD (2018) notes that industrial policies worldwide are addressing new themes such as GVC integration and upgrading.

Countries can internationalize their domestic firms in two ways: first, countries (and firms) can export to international buyers, and second, firms can become domestic final producers that import intermediates. Emergence of lead multinational corporations (MNCs) and eventual GVC participation depends most importantly on factors such as creating conducive business environment, attracting foreign investment and internationalization of domestic firms. Foreign Direct Investment (FDI) inflows have played an important role in the success of the outward-oriented development strategy in the developing world. FDI helps bring in new (risk-sharing, non-debt creating) capital flows, foreign exchange, easy access to foreign markets and foreign sourcing and technology transfers (Prasad et al., 2006; Chia and Plummer, 2015).

The concept of upgrading is important in the GVC literature and refers to the capacity of firms to make better products, more efficiently and move into more skilled activities (Kaplinsky, 2000; Giuliani et al., 2005). Gereffi (1999) describes the process of upgrading as one where the firm is able to move to more profitable and technologically sophisticated capital and skill intensive niches.¹ Learning in GVCs is influenced by the governance of GVC and different mechanisms of learning and innovation are likely to dominate in different types of chains (Gereffi, et al. 2005, Pietrobelli and Rabellotti, 2009).

Chain governance is one of factors likely to influence a firm’s chances for upgrading (Bair, 2009; Schmitz, 2004). Governance of value chains is important for developing countries as it

¹ Upgrading may or may not imply innovation in the narrow sense (UNIDO, 2015). However, learning is involved. Learning refers to the process of accumulating intangible assets and can be done in two ways: the acquiring of knowledge and skills that enable a firm to operate plant and to raise quality and introduce new products (Bell, 2007).

defines their prospects for learning and earning (Schmitz, 2006). Also, some activities are better remunerated than others and it is in the interest of developing country firms to learn the skills to upgrade their positions in the GVCs. The ability to identify activities providing higher returns along value chains is the key to understanding the global appropriation of returns to production (Giuliani et al. 2005).

Giuliani et al. (2005) discuss how differences in learning across sectors foster the role of global buyers in each of the sectors and may help or hinder upgrading. Based on this argument, they develop a sectoral classification of upgrading in the context of Latin America. The categories studied are traditional manufacturing, natural resource based sectors, complex product industries and specialized suppliers. In complex products industries which are defined as “high cost, engineering-intensive products, subsystems, or constructs supplied by a unit of production” (Hobday, 1998), the local network is normally anchored to one “assembler” which operates as a leading firm. This firm is characterized by high design and technological capabilities and its relationships with local suppliers and these may be crucial to foster firms’ upgrading efforts through technology and skill transfers. Scale-intensive firms typically lead complex product sectors (Bell and Pavitt, 1993), where the process of technical change is realized within an architectural set (Henderson and Clark, 1990), and it is often incremental and modular.

The typology of governance² of GVCs proposed by Gereffi, Humphrey and Sturgeon (2005) discusses the conditions under which different patterns emerge: the complexity of the information involved in the transactions, the possibility of codifying information and the competence of the suppliers along the value chain. In modular value chains, complexity of transactions is high, there are capable potential suppliers, and the codification of transactions is high. Suppliers learn to produce components and modules to fully specified technical standards and the need to adhere to these standards induces learning. Lead firms put pressure on suppliers to innovate but do not become involved directly in the learning process. Hence lead firms exert external stimulus for learning and innovation among suppliers.

Giuliani et al. (2005) further examine the endogenous and exogenous factors that influence firm upgrading and note that the degree of cumulativeness of knowledge, codification and complexity of the knowledge base influence the capacity and way firms upgrade. Levy (2005) observes that offshoring requires the simplification of linkages with partners and codification of tacit and embedded information. Hence, Milberg (2004) and Pietrobelli and Staritz (2013) note that lead firms outsource activities that add little value but retain control over their intangible high value added activities.

Giuliani et al. (2017) classify the learning mechanisms within and outside GVCs into two types: mutual learning via face to face interactions and training of the local workforce by a lead firm. A third type occurs through knowledge transfer from GVC lead firms related to narrow range

² Modular, relational, hierarchical, captive, market and arms’ length are the different types of chains. Each chain has different levels of complexity of transactions, codification of transactions, and competence of suppliers. Hence the learning mechanism within each GVC chain is also different (Pietrobelli and Rabellotti, 2010).

of tasks. While the first type is common in the case of complex and not fully codified innovative processes, the second type is found in GVC operations of MNE affiliates. There are learning mechanisms outside the GVCs either through firm level learning efforts mainly through research and development (R&D) undertaken by the firm and collective learning at the local level through interactions with other firms and organizations. There are other channels of learning that are external to the firms - these include learning from partners not vertically related to firms and competitors.

While most of the studies have been conducted in the context of developed countries, fewer exist in case of developing countries (Blyde et al., 2014; Pietrobelli and Rabellotti, 2010, UNCTAD 2010). Navas-Aleman (2011) suggests that it is rare for developing country manufacturers to design their own exports even when operating in GVCs and even rarer for them to own exports brands. As Keesing and Lall (1992) also note, lack of design and marketing skills leaves firms from developing countries in a vulnerable situation in comparison with global buyers.

b) Lead firms in automobile GVCs

The most highly developed supply chain is that of the car industry (Sutton, 2004) and is the most global (Humphrey and Memedovic, 2003). Production is organized regionally or nationally with bulky, heavy and model specific parts production concentrated close to final assembly points, and lighter, more generic parts produced at a distance to take advantage of scale economies and low labour costs. Vehicle development is concentrated in a few design centres.

Sturgeon et al. (2008) note that the automobile industry is a set of linked, specialized clusters where global integration has proceeded at the level of design and vehicle development whereas as far as production is concerned regional integration has occurred since the mid 1980s for technical and political reasons. Global integration has proceeded farthest at the buyer-supplier relationship.

The organization of GVCs in the automotive industry differs from that in other industries in the following ways: one, lead firms in this industry are few (Humphrey and Memedovic, 2003) and have the strength to drive supplier co-location at the regional, national, and local levels for operational reasons (such as just-in-time production, and design collaboration).³ Paucity of robust, industry wide standards and codification schemes can limit the rise of true value chain modularity (Sturgeon et al., 2008). The reason for this is technical and structural. On the technical side, vehicle performance characteristics such as noise, vibration and handling are deeply interrelated and changes in one component has an impact on other components. Rising vehicle complexity can continued to thwart efforts to fully codify vehicle designs and design process. Information exchange between suppliers of complex parts and sub-systems and lead firms is necessarily intensive. On the structural side, the concentrated structure of the industry,

³ Linkages between lead firms and suppliers in the automotive industry require tight coordination, especially in the area of design, production and logistics (Humphrey, 2003).

gives the lead firms and extraordinary amount of market power, leading to a more captive relationship (Sturgeon et al., 2008).

There are thick linkages between lead firms and Tier 1 suppliers. First, the need for full co-location of parts with final assembly varies by type of component, or stage of production for a given process (Sturgeon et al., 2008). Second, the export of finished vehicles to large markets is often determined by political considerations. This motivates lead firms to locate production close to end markets and creates additional pressure for supplier co-location within regional-scale production systems (Sturgeon et al., 2008; Sturgeon and Biesebroeck, 2010). Also high transportation costs make shipping of complete cars or subsystems difficult (OECD, 2012).

There are strong agglomeration economies in the industry. Once automakers set up local technical centres, they tend to pressure ‘global’ suppliers to establish local engineering capabilities as well.⁴ When this happens, global suppliers can begin to source inputs locally, providing opportunities and support for local Tier two suppliers to develop. Over time, it is possible for local firms to start serving automakers directly, and international opportunities can grow from there.⁵ Thus, a virtuous cycle of development can only develop if the local domestic market is large enough to attract significant investment (Sturgeon and Biesebroeck, 2010).

Innovation and learning in the context of GVCs and developing countries in the automobile industry have been examined in Humphrey et al. (2000), Humphrey (2003), Humphrey and Memedovic (2003), Sturgeon and Biesebroeck (2011) and Gereffi (2015). Around seven percent of the top 2500 R&D investing companies in the world is from the automotive industry. Patenting activities in alternatives to traditional combustion engines, as well as safety measures have increased in the last decade. Toyota Motor Corporation has been a leader in the development of green cars, with the introduction of Toyota Prius in 2000. This hybrid car, sold four million units since its introduction till 2014 (McKinsey, 2015).

c) Upgrading in the context of automobile industry

Upgrading can be described through which firms move up the value chain to perform more profitable activities. Upgrading has been described in the literature as occurring through i) product ii) process iii) functional iv) chain or inter-sectoral upgrading. Kaplinsky et al. (2003)

⁴ Sturgeon (2002) looks at nation-specific models of industrial organization in which there are two broad categories: Captive Production Networks and Relational Production Networks. The former exist in the automobile industry of countries such as Japan and Korea where there is dependence on the lead firm for coordination. The latter are based more on trust and reputation as is observed in Italy and Germany. The Italian model is called the Egalitarian, Cooperative Network as it involves elaborate labour divisions while the German model the Self-Reliant model as they retain their strong end-product focus.

⁵ American firms have tended to develop market linkages and forge relational ties with their suppliers. However, they have also broken such ties after the necessary collaborative engineering work has been accomplished (Sturgeon et al., 2008). Japanese car makers on the other hand, developed captive ties with their suppliers, though the relationship has become more relational over time. These captive linkages with suppliers have been partly maintained especially when these relations were projected outside of Japan.

suggest that the path followed by countries in upgrading begins with process, followed by product, functional and finally inter-sectoral upgrading.

Product upgrading involves the making of more sophisticated products (Amador and Cabral, 2016). Process upgrading involves transforming inputs products more efficiently or through using superior technology. Functional upgrading involves performing new functions in the chain. Inter sectoral upgrading involves applying the knowledge acquired in a sector to move to a new sector (Giuliani, et al., 2005).

Navas-Aleman (2011) has discussed the steps through which each of these can be achieved. Process upgrading is achieved through the following steps i) new production machinery purchased ii) workers training iii) reduction in delivery times iv) introduction or improvements in total quality programmes v) introduction of new organizational/ management techniques vi) improvements in the production process vii) increased use of computer for business purposes. Product upgrading can be done through i) steps taken to increase product quality ii) introduction of new materials iii) reduction in reworking rates – this has to be understood in terms of lowering defects and in the case of the auto industry involves the recall of parts or models of cars. Functional upgrading can be done through i) design ii) marketing and iii) branding

Upgrading has to be viewed in line with the companies positioning as global entities. As lead firms have presence (upstream and downstream) in a number of countries when integrated in GVCs, often models are launched in a set of countries, imported as Completely Knocked Down (CKD) or Semi Knocked Down (SKDs) in others, assembled there and then supplied domestically or exported to another set of countries. Therefore, at times, upgrading may be a result of impetus provided in a single country, a small set of countries (example, demand for affordable cars in developing countries) or a push provided at the global level (example, demand for vehicles adhering to fuel efficient norms and safety standards).

3. The Indian automobile industry

India is among the top 20 world producers of vehicles and has continually increased its production over the period 2004-14 (OECD, 2016). The rise of consumption by the middle class in countries like China and India has been driving up vehicle production in these countries. India's case stands out where the value added of final demand of vehicles bought in the economy comes from domestic companies.

India's indigenous passenger car industry was launched in the 1940s with the establishment of Hindustan Motors (HM hereafter) and Premier Automobiles Limited (PAL hereafter). However, the industry saw a very slow paced growth from the 1940s till 1980s. In 1983, the government permitted Suzuki to enter the country in a joint venture with Maruti Udyog Limited, a state owned enterprise incorporated in 1981 to form a company called Maruti Suzuki India Limited (Maruti Suzuki hereafter).⁶ Till that time, the auto sector in India was protected

⁶ In the initial years, the cars produced by Maruti were nearly Japanese, with only tyres and batteries manufactured in India (Bhargava and Seetha, 2010).

by high import tariffs and production catered to the demands of local automobile manufacturers. As part of the broader move to liberalize the economy, India opened up the sector to (FDI) in the 1990s and also progressively relaxed import barriers (McKinsey, 2006). With the liberalization of the Indian economy and a relaxation of restrictions on FDI in the auto industry, leading multinational companies entered the market for the first time in the late 1990s. By 1997, ten companies had announced firm plans to begin production in India (Humphrey and Memedovic, 2003).

The largest carmaker is Maruti Suzuki India Limited (MSIL) with a market share close to 50 percent in the Indian market, followed by Hyundai Motor India Ltd. (HMIL), with a share of around 17 percent. Behind these are Mahindra & Mahindra Limited (M&M hereafter) (around seven percent), Renault India Pvt. Limited (Renault hereafter), and Toyota Kirloskar Motor Pvt. Limited (with approximately five percent share each). Tiwari and Kalogerakis (2017) reveal that while the gross turnover of the Indian automobile industry rose by about 77 percent in 2009-10 to 2014-15, while the R&D expenditure rose by 108 percent. Leading Indian auto manufacturers are in the process of transforming from local players to global companies. India's domestic carmakers, viz. Tata Motors Limited (Tata Motors hereafter),^{7,8} M&M and Ashok Leyland, have developed manufacturing facilities, significant R&D, technology development and testing centres and have ventured abroad.

Also important has been the role of foreign acquisitions and mergers.⁹ Indian firms' business models were focused on domestic markets and markets in other countries with similar characteristics such as Africa, Latin America and South Asia. Tata Motors and M&M had global aspirations and acquired firms overseas, establishing subsidiaries and forming new partnerships. In 2004, Tata Motors bought Daewoo Group's truck manufacturing unit, in South Korea. In 2007, this unit launched the heavy duty truck 'Novus' in Korea, proving it too be an important source of learning for its heavy commercial vehicles segment. In 2005, it acquired 21 percent share in Hispano Carrocera SA, a Spanish bus manufacturing firm. In 2006, the company formed a JV with a Brazilian firm, Marco Polo to manufacture and assemble fully built buses and coaches. In 2008, it acquired Jaguar and Rover for US\$2.3 billion, and established plants in Malaysia, Kenya, Bangladesh, Spain, Ukraine and Russia to assemble knocked down units exported to these countries. M&M also opened subsidiaries in Australia, South Africa, Italy and Uruguay to assemble knocked down units and supply auto components. In 2005, M&M acquired Stokes Group, a leading auto component manufacturer in the United Kingdom (UK) (Kale, 2012).

According to Kale (2012), an important role in the development of the industry was played by firm strategies, ownership and managerial vision of the diversified and big business groups

⁷ Design centre of Tata Engineering and Locomotive Company (TELCO) was set up in 1967 (Bowonder, 1998).

⁸ TELCO was renamed Tata Motors Limited and moved into the passenger segment by acquisition of assets and organizational learning (Brusche, et al. 2010).

⁹ See also Ray and Miglani (2016a)

such as the Tata Group¹⁰ and M&M in building technological capabilities of these firms. The ambition and vision of Ratan Tata to develop the first ‘Indian car’ and then ‘people’s car’ were driving forces behind the development of Tata Indica¹¹ and Tata Nano. Firms such as Hyundai, Maruti Suzuki and Tata Motors, have created a comparative advantage in the production and export of small and compact cars around the world. Though home-grown lead firms have played a key role in propelling growth, it can be said that this segment has also benefitted significantly from foreign collaboration (Ray and Miglani, 2018).¹²

Policy framework and its role in emergence of lead firms

According to the framework developed by Sturgeon et al. (2016), there have traditionally been four types of industrial policy strategies for upgrading in the automotive GVCs.¹³ Investment policy, particularly FDI policy is a key instrument of industrial policy (UNCTAD, 2018). India’s policy approach has included attracting FDI to serve the local market and instituting local content requirements to stimulate assembly and the local supply base. At the same time, the government has encouraged development of national brands and suppliers (Ray and Miglani, 2018). In the automobile industry, FDI in R&D and design in India has followed FDI in manufacturing (Ray and Miglani, 2018).

The Indian automobile sector allows foreign equity investment up to 100 percent with no minimum investment criteria.¹⁴ Manufacturing and imports in this sector are exempt from licensing and approvals. The government is encouraging R&D in this sector by offering rebates on R&D expenditure. The National Automotive Testing and R&D Infrastructure Project (NATRiP) project, initiated in the year 2005, was set up at a cost of USD 573 million to enable the industry to adopt and implement global performance standards. It focuses on providing

¹⁰ Tyabji (2014) discusses the process of upgrading followed by TELCO through improvement in product, worker training, and import of existing technology. The latter route was not preferred but was inevitable in some cases where indigenous technology did not exist. TELCO installed CNC machine sin for manufacture of light commercial vehicles and started manufacture of these CNC machines in 1986-87. Three robots were produced in 1994-95 in collaboration with Nachi-Fujikoshi – spot welding robot, sealant application robot and arc-welding robot. Similarly, Pathak et al. (2008) discusses the process of technology transfer and absorption for motorcycles and bikes in Hero in collaboration with Honda.

¹¹ Tata Indica was positioned to compete with Maruti 800. Bruche et al. (2010) discusses the development of the production facilities for the Indica project. The technology partnerships included I.D.E.A. (Italy) for exterior and interior design, Le Moteur Moderne (France) for power train and gasoline engine, Ogihara (Japan) for skin panels die design, Nachi Fukokishi (Japan) for design of robotics etc.

¹² As noted by Sturgeon and van Biesebroeck (2010), every aspect of vehicle development and production, including design and engineering, existed in local firms from the beginning, which allowed the Indian industry to surge forward. The improvement in the breadth and depth of local capabilities was aided, most notably, by joint ventures with foreign players and acquisitions abroad.

¹³ 1. Developing a fully vertical industry with national brands and suppliers is generally not feasible for many developing countries, 2. Attracting FDI to serve the local market and instituting local content rules to encourage employment and the local supply base (e.g. China, South Africa and Thailand), 3. Attracting FDI for assembly and/or parts manufacturing as a low cost portion of regional production systems, 4. Specializing in one or few parts and subsystems for export either for use in final assembly or for parts sold as replacement parts aftermarkets and to repair shops.

¹⁴ In this paper, we discuss only the recent policy formulations. For a discussion on earlier policies in the automobile industry, see Tiwari et al. (2011).

low-cost manufacturing and product development solutions. As a part of the program, seven test centers have been finalized to set up the test facilities.

The automobile manufacturing policy in India¹⁵ is governed by the Automotive Mission Plan 2016-26,¹⁶ which lays down the achievements and targets of the industry by 2026. Other initiatives include the Draft National Automotive Policy 2018, the National Electric Mobility Mission Plan (NEMMP) 2020, Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME), New Green Urban Transport Scheme (GUTS), 2017.

There are three major government initiatives with regard to electric vehicles and mobility. The National Electric Mobility Mission Plan 2020 (NEMMP) aims to encourage indigenous hybrid and electric vehicles production through government-industry collaboration. The aim is to put 6 million electric and hybrid vehicles per year on the road by 2020. It is estimated that a cumulative outlay of USD 2.15 billion is required for this initiative. The Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India aims at incentivizing the use of E-Vehicles across all vehicle segments ranging from two wheelers to light commercial vehicles and buses. The four focus areas of this scheme are technology development, demand development, pilot projects and charging infrastructure. Following this, Energy Efficiency Services Ltd. (EESL) has invited global bids for 10,000 electric sedans as a part of its phase one of the scheme. It has also floated tenders for 3000 alternating current (AC) charging points and 1000 direct current (DC) ones. The objective of the New Green Urban Transport Scheme (GUTS), 2017 is to promote low carbon sustainable public transport system in urban areas. The scheme will be executed with the help of private sector including assistance from the central and state governments under a seven-year mission with a total cost of USD 10.76 billion. For first phase, 103 cities have been identified. These cities are either capital cities or have a population of five lakh and above. The scheme will push for promotion of Non-Motorized Transport (NMT), public bike sharing, Bus Rapid Transit (BRT) systems, Intelligent Transport Systems (ITS), urban freight management etc.

The Draft National Automotive Policy 2018 formulated by the Department of Heavy Industries envisages increasing exports to 35-40 percent of the overall output and to make India one of the major automotive export hubs in the world. It also envisages long-term roadmap for

¹⁵ For details, see <http://www.makeinindia.com/sector/automobiles> (last accessed on May 14, 2018).

¹⁶ Automotive Mission Plan 2016-26; the salient points of this mission plan are:

- The automobile industry is poised to be the third largest in the world, contributing 12 percent to GDP.
- The sector has the potential to generate USD 300 billion revenue.
- The Indian Automotive industry to be a top job creator – 65 million additional jobs
- The Indian Automotive industry to be one of the prime movers of Manufacturing sector and “Make in India” initiative
- The Indian Automotive industry aims to increase exports of vehicles by five times.
- The growth of vehicles particularly the passenger vehicles is expected to triple to 9.4 million units per annum by 2026.
- The plan also envisions India to be the first in the world in production/sale of small cars, two-wheelers, three-wheelers, tractors and buses; and third in passenger vehicles and heavy trucks.
- Specific interventions are envisaged to sustain and improve manufacturing competitiveness and to address challenges of environment and safety.

emission standards beyond Bharat Stage VI and harmonization with the global standards by 2028. It proposes harmonization of Automobile Industry Standards (AIS) and Bureau of Indian Standards (BIS) standards on safety of critical parts in the next three years and the fast track adoption of Bharat New Vehicle Safety assessment Programme.

While these initiatives by the government have aimed to remove problems faced by auto manufacturers, in terms of Gereffi and Sturgeon's (2013) framework, none of these are specifically GVC oriented.

Evidence of India's integration in automobile GVCs

The integration of a country in the global economy is closely linked to their participation in GVCs (OECD, 2013).¹⁷ India's GVC participation has been estimated at 22 percent for backward and 19 percent for forward links in 2009. UNCTAD (2013) argues that emerging markets such as India, Brazil,¹⁸ Argentina and Turkey have low GVC participation rates. It also suggests that large economies such as Brazil and India have a lower import content of exports than smaller economies such as Singapore or Malaysia. This is because of lower participation levels, both upstream and downstream.¹⁹ The former is due to the nature of exports (either natural resources or services), and the fact that they are relatively larger economies with a greater degree of self sufficiency in production for exports. The latter is due to their focus on exports of final goods and services which are not used as intermediates in exports to third countries.

Athukorala (2013) explores the reasons for India's failure to fit into global production networks (particularly in the electronics sector),²⁰ by examining India's overall export share from the 1950s to 2011. He observes that India's contribution to world exports has been very small and suggests that the reason for this can be traced back to the import substitution policies adopted by the government till as late as 1991, by which time China and the Philippines exports had far surpassed India's. When network trade²¹ is compared, India again stands out in comparison to other East Asian countries. Network trade accounted for 22 percent for India, between 1990-91 and 2010-11, of the total increment in manufactured exports, compared to 70 percent for

¹⁷ The OECD (2013) calculates the GVC participation rate based on intermediates which are produced in one country and then included in another country's exports drawing on Koopman et al. (2011) and De Backer and Miroudot (2013).

¹⁸ Sturgeon et al. (2013) point out that while the share of primary goods in total exports was 32 percent for Brazil, it was 45 percent for Russia and 11 percent for India and only 3 percent for China in 2011. Brazil exported 37 percent resource based goods in 2011, while Russia exported 27 percent, India 39 percent and China 9 percent resource based goods as share in total exports.

¹⁹ Exported value added incorporated in third country exports

²⁰ The paper examines the export performance of India and East Asian countries in seven product categories: office machines and automatic data processing machines (SITCC 75), telecommunication and recording sound equipment (SITC 76), electrical machinery (SITC 77), road vehicles (SITC 78), professional and scientific equipment (SITC 87) and photographic apparatus (SITC 88). It also uses an econometric analysis to explore the determinants of difference in inter-country export using the gravity model to bilateral trade flows of total manufacturing trade and parts and components trade for the period 1996-2009.

²¹ Network trade or global production sharing trade

East Asia. For India, the exception was road vehicles and other transport equipment accounted for 28 percent of total network exports in 2010-11 (compared to an average of 13.2 percent for East Asia). As per OECD (2012), GVCs are very prominent in the automobile industry. The index of the length of GVCs helps ascertain the ‘number of production stages’ involved in the industry. This index was above 2.5 for India (in 2008), indicating fairly high level of vertical linkages including stages of production located abroad.

Since the late 1980s, MNCs started looking for emerging countries to set up their centres for production and other activities. This was due to a combination of factors including slow growth in home markets and lure of emerging markets (Sturgeon and Florida, 2004). Final assembly plants were set up in Brazil, India and China. In India, FDI in auto assembly was allowed in two waves: in 1983 and in 1993.²² Both waves were market seeking – India with two million households that could afford cars was seen as a large and untapped country (MCKinsey, 2003; Ray and Miglani, 2016a). The country’s FDI data provides evidence of several global manufacturers such as Suzuki Motor Corporation (Suzuki hereafter), Hyundai Motor Company (Hyundai hereafter), Honda Motor Company (Honda hereafter), Nissan Motor Company Limited (Nissan hereafter) and Ford Motor Company (Ford hereafter), which “decided to make India a global platform for small cars” in the 2000s (D’Costa, 2011). Technology acquisition through collaborations and alliances has been a preferred route followed by Indian firms. The joint venture model of operation for foreign firms which was popular in the 1990s has gradually given way to a 100 percent foreign ownership and management model in the last decade.

Global automobile and component firms have been putting up development centres in India, either on their own or in partnership with local players (e.g. General Motors Company, Daimler Chrysler AG, Johnson Controls International Plc, Delphi, Bosch). These have helped their partners acquire the global best technologies and standards in short periods of time. Several global original equipment manufacturers (OEMs) such as Ford, General Motors Company (GM hereafter), Hyundai, Toyota Motor Corporation (Toyota hereafter), and Volvo India Pvt. Limited (Volvo hereafter) have established technology centres in India for doing R&D in automobile design (TIFAC 2006, Tiwari and Herstatt, 2014).

GVC participation can be measured through exports and imports of intermediate goods which has been discussed earlier in this paper.²³ Typically, there are two reasons why companies resort to exporting cars from a country. The first case is when the companies first set up plants in anticipation of a growing domestic market, but their capacities far exceed what they can

²² Cumulative FDI Equity Flows (remittance-wise) received during January, 2000 – December, 2015 were 1,426,933.88 crores (US\$ 278.62 billion). Out of this, the amount of FDI inflows in the Automobile Industry during January, 2000 to December, 2015 is Rs. 77,036.56 crore (US\$ 14.48 billion) which is 5.20 percent of the total FDI equity inflows. For details, see <http://dipp.nic.in/sites/default/files/Chapter6.2.v.0.pdf> (last accessed on June 06, 2018)

²³ Ray and Miglani (2016b) documents parts those are imported by India. These include the crankshafts made in Japan and Thailand. Another example is the electronic brakes and electronic control systems (which have stringent specifications as well). Component imports are in two categories, one, high tech parts, which come mainly from Germany, Japan, Korea and Thailand; and aftermarket parts which usually originate in China. See also Amighini (2012).

eventually sell there. They then start using the spare capacity to service larger export markets. Exports help companies to offset deficit in domestic demand and break-even with combined volumes of domestic sales and exports. The second reason is related to the scale of operations. When the scale of operations for a company in a country becomes large enough to become a globally cost competitive producer of vehicles, it makes obvious sense to start focusing on exports.

Low cost of labor and economies of scale have made India an ideal country as an export hub for small cars. With the current annual production of about 29 million and export of four million vehicles (2017-18), the Indian auto industry is expected to be the world's third-largest automotive market by volume by 2026.²⁴ Apparently, the companies' focus on foreign markets (exports) not only helps them retain healthy profit margins, but also makes them continue with efforts on maintaining best standards in manufacturing and upgrading. Another way of looking at this is assessing the contribution of firms' engagement in GVCs (as discussed below). (Tiwari and Herstatt, 2014). Companies which had partnerships with foreign players or received FDI have benefited in a similar manner.

The automobile industry exports have been growing continually. In the 1990s, the average annual growth of exports was around 15 percent (Parhi, 2008). Between 2001 and 2017, the CAGR of export of vehicles from the country was approximately 20 percent.²⁵ The share of exports in total output has been approximately 14-15 percent in the last five years.

The industry is known for export of mini hatchbacks, and an evolving export base for mid-size cars and compact sport utility vehicles (SUVs).²⁶ The export trends of various categories of vehicles for the last few years are shown below. Currently, there are more than 30 international-quality models in the market, some of which are now being exported to MNCs' home markets.²⁷

Table 1: Automobile Export Trends

Category	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Passenger Vehicles	5,08,783	5,59,414	5,96,142	6,21,341	6,53,053	7,58,830
Commercial Vehicles	92,258	80,027	77,050	86,939	1,03,124	1,08,271
Three Wheelers	3,61,753	3,03,088	3,53,392	4,07,600	4,04,441	2,71,894
Two Wheelers	19,75,111	19,56,378	20,84,000	24,57,466	24,82,876	23,39,273
Grand Total	29,37,905	28,98,907	31,10,584	35,73,346	36,43,494	34,78,268

Source: Society of Indian Automobile Manufacturers (SIAM) Statistics

²⁴ For details, see <https://www.investindia.gov.in/sector/automobile> (last accessed on June 02, 2018)

²⁵ Computed using SIAM data.

²⁶ India is evolving into one of the top global export bases of certain car models. Examples are Volkswagen's Vento, Hyundai's SUV Creta, GM's Beat and Ford's EcoSport.

²⁷ 'Top 5 Popular Car Brands In India'. Ameya Naik, Auto NDTV, Ameya Naik, April 22, 2017 <https://auto.ndtv.com/news/best-car-brands-in-india-1684619> (last accessed on May 18, 2018).

Exports have been part of the business and country strategies for companies. Low cost of manufacturing and economies of scale as a result of catering to both Indian and overseas markets allow vehicle makers to utilize their capacities more effectively, become competitive and offset weak demand in the domestic market.²⁸ Moreover, joint venture arrangements enable learning from one country being taken to other countries.

In India, for companies like Renault-Nissan (partnership) and Hyundai, exporting to overseas markets has been their key strategic targets since the beginning of their operation. Renault-Nissan had initially set up massive capacities anticipating long term demand within the country, and decided to export simultaneously to mitigate capital costs in the short term. The strategy was similar for Hyundai. The company kept adding capacity for many years as it introduced new models of cars after its entry in India, but simultaneously also kept its focus on exports. It can be said that companies like Volkswagen, GM and Ford have followed a slightly different strategy, the difference being that the focus on exports came in many years of their entry and operation. Volkswagen had to keep its exports up as its target for capturing 10 percent of the domestic passenger vehicle market was not achieved after nearly a decade in India. Companies like Maruti Suzuki and Tata have largely followed the second business strategy, of focusing on exports only when their scale of their operations reached a certain threshold.

Product lines and their role in emergence of lead firms

The Indian automotive lead firms' current stature is a result of efforts and critical turning points crossed at various points in time. For instance, in the Maruti Suzuki's case, the government provided the initial fillip needed to start large scale production and establish a vendor and supplier network with the help of foreign collaboration. A number of well planned strategic moves enabled the company to acquire a majority of the market share almost 90 percent in the 1980s and has maintained around 50 percent share currently. The key success factors for this company's growth have been its constantly upgrading models with latest technologies, affordable pricing with a focus on the middle income consumer segment and establishment of a large distribution and supplier network. These moves led to this firm emerging as a lead firm propelling the industry's growth in domestic and export markets.

Among foreign firms, the role of Hyundai Motors India Limited (HMIL), the local subsidiary of Korea's parent Hyundai Motor Company (HMC) has been noteworthy as a lead firm. Product development has played an important role in its case. The push came with the launch of its small car launch called Santro. Having launched the model after studying the nature of the Indian market, the model was hugely successful and helped catapult the company's position in the initial years. Later, the company was the first to introduce many innovative concepts in

²⁸ 'Boost to Make in India: Hyundai plans to shift production of Verna from Korea to India', Economic Times, Ketan Thakkar, September 01, 2017, <https://economictimes.indiatimes.com/industry/auto/news/boost-to-make-in-india-hyundai-plans-to-shift-production-of-verna-from-korea-to-india/articleshow/60316013.cms> (last accessed on May 14, 2018)

India, including the *multi-point fuel injection (MPFI)* engine and *Common Rail Direct Injection (CRDI)* technologies, and the Fluidic Sculpture 2.0 design language to the country.

Some of the other companies which have played significant leading roles in the automobile market are the indigenous Tata Motors and Mahindra & Mahindra.²⁹ These companies though initially specialized in the manufacturing of commercial and utility vehicles, later on developed capabilities to serve the passenger car segment and emerged among market leaders in the same (Ray and Miglani, 2018). Mahindra & Mahindra (M&M) built its brand value around SUVs dominating the Indian market in the segment. In 2000, the company entered the segment by launching the Bolero and in 2002, Scorpio was launched which remains the most successful SUV of the company till date.³⁰ By focusing on product development,³¹ taking risks and analysis of the Indian market, M&M has managed to survive competition and rise up the value ladder and launch many products over the years in the domestic market as well as venture overseas.

Since entering India two decades ago, the Japanese automaker Honda primarily strengthened its roots riding on the success of its mid size sedan 'City'. In 1998, the Honda City was born in India which was the third generation of the Japanese model. Also called City VTEC, this petrol sedan was straight, simple in design, nothing too fancy; and was put up against the Maruti Suzuki Esteem, then the most popular luxury sedan made in India. The City as Honda's flagship product helped it immensely in establishing brand image in the Indian market. The City became the identity of Honda Cars India Limited over the years, becoming its biggest seller in India and continues to remain the first choice of many sedan-buyers with a budget of around Rs 10 lakh. It has also helped bring the premium tag to other models of the company like Mobilio and Brio.³²

For all these market leaders, what has enabled them to stay ahead of competition is constant focus on product development, incorporating customer feedback, adding more features, design cues into their products at different intervals to meet the requirements of a complex, diverse and dynamic market like India. Additionally, a supportive FDI policy enabled the entry of small and large sized firms to enter the market which took care of the technical details in products manufactured when the passenger car industry was still in its infancy.

²⁹ For details, see <https://howmuch.net/articles/most-valuable-brands-2017> (last accessed on August 28, 2017)

³⁰ While Scorpio gave the company, the maximum brand value and the Bolero the maximum volumes. The launch of these vehicles was undertaken after thorough consumer research on different usage segments of the category. Research studies suggested that competing brands such as Tata Sumo had a powerful equity in commercial segment but negligible presence as a personal vehicle. Thereafter, attempts were made to re-position and re-launch these models were taken over the years to posit them according to the needs of the Indian market.

³¹ '15 years and still counting: Scorpio most successful SUV of Mahindra & Mahindra', Economic Times, Lijee Philip, July 11, 2017, <https://economictimes.indiatimes.com/industry/auto/news/passenger-vehicle/uv/15-years-and-still-counting-scorpio-most-successful-suv-of-mahindra-mahindra/articleshow/59534523.cms> (last accessed on April 24, 2017).

³² For details, see <http://www.india.com/auto/car-news/honda-city-surpasses-7-lakh-unit-sales-milestone-in-india-36810/> (last accessed on March 06, 2018)

4. Methodology

The paper is based on a two step approach using qualitative methods. The first step involves the use of publicly available sources citing trends of the automotive industry. In the second step, a qualitative assessment has been made of the upgrading undertaken by the major automobile firms in India. This qualitative approach has been used since the objective is not to measure the upgrading process, but the nature of the process which can best be done through a qualitative approach. The methodology followed in this paper is the case study approach. The seven cases chosen for the paper include all the major passenger car manufacturers in India.³³ However, in order to present the broad trends emanating from the industry, the findings have been presented not for individual companies but grouped under the heading of the type of upgrading process followed.³⁴ The categorization of upgrading proposed by Humphrey and Schmitz (2002) has been followed and the adaptation of Navas-Aleman (2011)'s sub-categories of upgrading has been made to categorize upgrading in the specific context of the automobile industry.

To the best of our knowledge, this is the first paper in the Indian context to follow this approach. The analysis focuses on the passenger car segment. The segments of two wheelers, three wheelers, commercial and heavy vehicles, and auto-components have been excluded from the coverage of this paper.

5. Case analysis

The sources of data are secondary in nature and include journal articles and newspaper reports. Since no primary survey was conducted, names of the firms have been disclosed and the sources of all information on these firms are revealed in the paper. This section discusses the latest upgrading initiatives by these firms.³⁵

The role of lead firms in the industry has been in upgrading technology through innovations and acquisition of technology. Indian industrial policy has encouraged lead firms and capabilities in areas of design, product development and engineering (Sturgeon and Biesebroeck, 2010). For example, for the Tata Nano project, which according to Bruche (2010) can be described as 'reverse exploratory process', the development team were given three broad parameters: acceptable cost, acceptable performance and regulatory compliance. Palepu et al.

³³ We observe no systematic difference between foreign and domestic lead firms with respect to upgrading. This could be due to the approach of the paper which has reported specific instances of upgrading using the categorization of it by Humphreys and Schmitz (2002) and Navas-Aleman (2011). This is not to suggest that these differences do not exist. They may exist but is beyond the scope of analysis of this paper.

³⁴ Upgrading is a continuous process. In this paper, we have been able to capture upgrading undertaken by these 7 firms only for the latest couple of years, for reasons of non availability of data. For earlier studies on the issue of frugal innovation in Indian automobiles, please refer to Tiwari and Herstatt (2014).

³⁵ Readers can refer to Sutton (2006) and Tiwari and Herstatt (2014) for earlier discussions. Tiwari and Kalogerakis (2017) discuss the role of the auto component industry in the development of the frugal car 'Tata Nano' and other models of Tata, Mauti, Mahindra and Renault. The paper also identifies the innovation pathways that are useful in developing frugal innovations.

(2011) note that for this the engine was redesigned thrice, body twice, floor plan 10 times etc. The top automotive suppliers Bosch (engine management system and then diesel engine cooperation), Caparo, Denso, Johnson Controls, Saint-Gobain-Sekurit all supplied components.

The results of the paper have been laid out in this section. Table 2 lists the specific cases of upgrading discussed in the paper.³⁶

A) Process upgrading

Increases the efficiency of production either through better organization of the production process or the use of improved technology.³⁷ The channels through which process upgrading occurs include the seven categories listed in Table 2 and discussed below.

Table 2: Upgrading by Indian Automobile firms

	Hyundai	Maruti Suzuki	Tata Motors	Honda	Ford	Toyota	M&M
Process upgrading							
New production machinery purchased		X	X	X		X	X
Workers training	X	X	X			X	
Reduction in delivery times		X					
Introduction or improvements in total quality programs	X	X					
Introduction of new organizational/management techniques			X	X			
Improvements in the production process		X	X	X			
Increased usage of computer programs and internet for business purposes	X	X	X	X			X
Product upgrading							
Steps taken to increase product quality	X		X	X	X		X
Introduction of new materials and fabric to enhance the product range	X	X	X	X			X
Reduction in reworking rates							
Functional upgrading							
Design	X	X	X	X	X		X
Marketing	X		X	X			X
Branding	X			X			X
Inter-sectoral (chain) upgrading							

Source: Authors' compilation

i) New production machinery purchased

Purchase or investment in new production machinery (including components) is one of the most direct ways of process upgrading in an industry. In case of automobiles, the reduction or

³⁶ These are not exhaustive but list the most prominent upgrading undertaken by the firms.

³⁷ For details, see <https://microlinks.org/good-practice-center/value-chain-wiki/types-upgrading> (last accessed on June 04, 2018)

consolidation of platforms is one of the ways in which firms can churn out multiple products in short periods of time. In 2017, Tata Motors announced a plan to consolidate vehicle platforms from the current six to two in the next few years. Each of these platforms would have multiple top structures and the platform will be adaptable to various lengths, widths, suspension setups and even wheelbase differences. The first platform of the two will be called Advanced Modular Platform (AMP) and will be used for the next generation of hatchback and sedan applications along with new SUV applications. The first car based on the AMP platform will be launched in 2019 and will most likely be a larger premium hatchback. The AMP platform will adhere to future crash regulations and will also be equipped to handle both left hand drive and right hand drive layouts. The carmaker will launch its first product, a premium hatchback (X451), on the AMP platform in 2019 to take on the Maruti Baleno and Hyundai i20. The cost-competitive AMP is expected to enable Tata motors to achieve greater economies of scale. It plans to scale down the number of component suppliers to 100 from 200 under AMP. It also plans to introduce two SUVs – a five-seater and a seven-seater – in FY 2018 (April-March).³⁸

ii) Workers training

Lead firms are known to take initiative in the process of training workers over the years while upgrading the in-house training facilities and leveraging the skill partners' capabilities. For example, Maruti systematically trains people and skills them for multiple operations and has invested in the process since the 1980s. Today, the company's entire manufacturing is well orchestrated with support from a strong information technology (IT) system. Multi-skilling has been one of the key focus areas. The company has increased the levels of automation in its newer facilities, especially in areas like the body shop over the years and regularly skills the workers in line with new developments.³⁹

Maruti Suzuki has recently started what it calls the 'Dojo' training centres with its vendor partners.⁴⁰ The idea is to maintain top-class quality at the supplier's end. Dojo is a Japanese term, which roughly translates into 'place or the way' and indicates grass-root level training in the industry.⁴¹ It is typically conducted in a hall or a dedicated space for intensive learning. The company uses Dojo to help its vendors set up such halls or enclosed areas in their facilities to

³⁸For details, see <https://www.autocarindia.com/car-news/tata-motors-unveils-new-brand-identity-405731> (last accessed on March 16, 2018).

³⁹'Robots at the wheel: Machines increasingly replacing manual workers in auto plants in India', Lijee Philip, Economic Times, Dec 01, 2015, <https://economictimes.indiatimes.com/industry/auto/news/robots-at-the-wheel-machines-increasingly-replacing-manual-workers-in-auto-plants-in-india/articleshow/49990001.cms> (last accessed on May 16, 2018).

⁴⁰For details, see <https://www.thehindubusinessline.com/specials/auto-focus/maruti-suzukis-dojo-learning-centres/article23980726.ece> (last accessed on May 26, 2018).

⁴¹ There are different Dojos for different areas of work such as lighting, Heating Ventilation and Air Conditioning (HVAC) or engine parts. Curriculum-driven trainings are complemented with practical demonstrations for fitting and explanation of materials for various parts so that every component is familiar to the worker. Familiarisation with different types of defects (age-related/manufacturing-related/handling-related, etc) is also taught, along with correct 'hand movement' for sensitisation of movements to fast-track processes on the shop floor. The 17-day training programme is divided into various modules with each focused on making workers adept at various standard practices before they join the shop floor, and also helps in keeping attrition levels low.

train new workers. One of its largest suppliers, Uno Minda has a facility in Manesar in Haryana that houses the first Dojo centre. Maruti Suzuki helped set it up in 2016 and it has since been useful for other Tier I and II suppliers. Beyond Uno Minda, the company has 90 Dojo centres with many of its suppliers.

Another lead firm, Hyundai has six training centres in India and train over 15000 workers. It also has its own body and paint training at its skill training centres. The company also plans to open two new skill training centres at Guwahati in Assam and Ahmedabad in Gujarat.⁴²

Apart from direct training initiatives, companies may be involved in skilling as part of their Corporate Social Responsibility (CSR) objectives. In addition to workers' training in 2017, Maruti announced setting up automobile skill enhancement centres (ASECs) in 15 government-run Industrial Training Institutes (ITIs), across 11 states of India. These are part of the company's skill development initiative under CSR. The first of these ASECs was inaugurated at ITI Nizamuddin in Delhi.⁴³ Similarly, Toyota, introduced a scheme called '*Tantrajna*' in association with the Automotive Skills Development Council in 2016 to increase employment opportunities for the age group 18-25 years. 'Toyota *Tantrajna*', launched in May 2016 comprises of 600 hours of classroom training by globally certified skill trainers, with a holistic approach balancing focus on body, mind and attitude.⁴⁴

Many of the firms are training workers in line with the Government of India's pan-India skill training scheme called 'Skill India Mission' launched in 2015 to increase the employability of youth in the country.⁴⁵ Tata Motors has been at the forefront in creating the right set of talent pool for the automobile engineering and manufacturing industry. Tata Motors also announced its plans to provide skill development training to 40,000 people in three years. The company will witness retirements of around 300-500 a year in its plants like Jamshedpur (Jharkhand) and Pune (Mumbai) from 2018. Its skilling initiatives are aimed at preparing a ready supply of workforce for its plants as well as play a part in the 'Skill India Mission' scheme.⁴⁶

⁴² The company planned for training more than 15000 persons in 2017 through its six training centres across India.

⁴³ Each ASEC will be equipped with a state-of-the-art workshop to provide practical training in automobile service and repair to students. The workshops will be equipped with modern-day service tools and equipment and latest Maruti Suzuki vehicles. Maruti plans to arrange training for existing ITI teachers on latest technology and equipment, organize industrial outreach programmes to upgrade skills of students and make them job-ready. In 2015-16, Maruti started courses for denting and painting under car service and repair. Special auto body repair (ABR) and auto body paint (ABP) labs were set up at ITIs in Delhi, Rajkot and Kolkata. The aim is to train 30,000 youth and help them become employable in workshops.

⁴⁴ A comprehensive year and a month plus training module consists of an induction and fundamental skill training, On-the-job development and class room training and trade knowledge training includes language speaking skills, computer soft skills, interview etiquettes, etc. After course evaluation and certification by Automotive Skills Development Council (ASDC), Toyota Kirloskar Motors (TKM) would connect the trainees with prospective employers through job fairs. The first batch of Toyota Tantrajna has trained more than 30 trainees, and the company is looking to impart this skill module to 400 youths by 2020-2021.

⁴⁵ For details, see <http://www.skilldevelopment.gov.in/nationalskillmission.html> (last accessed on June 01, 2018).

⁴⁶ The company, over the past few years has associated with over 135 ITIs across 19 states, to develop skilled and highly competent manpower that's future ready.

iii) Reduction in delivery times

Reduction in delivery times can be an outcome of efforts such as improvements in the production processes and increased use of automation. This has been discussed under process upgrading. Consolidation of platforms also leads to reduction in delivery time. This is elaborated below.

iv) Introduction or improvements in total quality programs

Upgrading auto components' technological capabilities by replacing older parts with more advanced parts to meet with ever changing consumer demands and compete with global suppliers are part of this process. Sometimes, this can be enacted through total quality improvements in production processes. Introduction of automated units in the past few years in the industry by leading players such as Maruti Suzuki is one such initiative. Over 4000 trucks supply components and pick up fully built vehicles in the two factories of Maruti at Gurugram and Manesar in Haryana which reportedly produce over 15 lakh units of 16 models with 1100-plus variants in a year (as in 2017). The company is aiming for an annual sales figure of three million in the next decade.⁴⁷ Over 5100 fool-proofing tools have been installed to ensure high product quality and several automated quality checks ensure world class quality levels.

In April 2017, Hyundai opened its global quality centre at Faridabad in Haryana with an aim for its operations in India to play a bigger role in new product development for domestic and international markets. The India centre will also conduct durability study of existing models and benchmark parts and systems for constant improvement.⁴⁸

v) Introduction of new organizational/ management techniques

The prime focus has been on improving operational efficiency. Competitive pressure has caused manufacturers to ensure quality for both growth and survival, and implement formal quality improvement programs. The entry of multinational enterprises encouraged the firms to upgrade by adopting programs like just-in-time, 5-S, Kaizen, Total Quality Management (TQM), and Total Productivity Management (TPM), and Six Sigma. The number of firms complying with ISO, QS and automotive industry specific TS 16949 certifications, and

⁴⁶'Tata Motors awarded for contribution to Skill India Mission', Business Standard, May 30, 2017, http://www.business-standard.com/article/news-ani/tata-motors-awarded-for-contribution-to-skill-india-mission-117053001881_1.html (last accessed on June 01, 2018).

⁴⁷Maruti's mega car plants lean on new tech to be future-ready, June 25, 2017, http://economictimes.indiatimes.com/articleshow/59308176.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

⁴⁸Hyundai opens quality centre in Faridabad for India's bigger role in product development, Hindustan Times, May 02, 2017, <https://www.hindustantimes.com/autos/hyundai-opens-quality-centre-in-faridabad-for-india-s-bigger-role-in-product-development/story-wdEJsthKORsFzSO6bvgHVM.html> (last accessed on May 12, 2018).

receiving quality awards such as Deming and the Japanese quality medal, also rose over time (Ray and Miglani, 2018)

In May 2017, it was reported that Tata Motors is shrinking the structure of its white-collar workforce to five layers from the existing 14.⁴⁹ Maruti Suzuki India Limited also has such enhanced flexibility in its lines that it is able to produce multi-models on a single line. The company aims to double vehicle sales using auto-gear shift technology (AGS) or Automated Manual Transmission by 2020 (from 94,000 in May 2017 to reach 3 lakh units by 2020).⁵⁰ The unit of Japan's Suzuki Motor Corporation offered the option in recent launches like the Ignis and Dzire (launched in 2016 and 2017 respectively). It has such enhanced flexibility in the product lines to enable production of multiple models on a single line.⁵¹

vi) Improvements in the production process

The trend of fragmentation of demand (models at every price point) and short product cycles led to the trend of platform sharing for non-consumer facing product parts like common chassis underpinning, body structures and core components across vehicle models. Critical system components like power-train technology are kept as standard/ similar across different models while adding distinguishing features like varying wheelbases, suspensions and drive options to the rest of the vehicle. This helps companies bank a profit margin on differentiating consumer-facing features. Also, the trend has given rise to modularization in the industry as it has increased complexities in product development and more variants per model are churned out. This has in turn provided the impetus for innovation to mega suppliers who have the ability to supply modules and manage complex supply chains (Edelweiss, 2014). Some examples are Honda's Mobilio and Amaze; Maruti's Swift, Dzire and Ertiga.

Platform development costs typically account for around 50 percent of total product development costs. Pursuing fewer but larger global platforms helps OEMs achieve greater economies of scale and efficient product launches. With product sharing capabilities, OEMs are also able to spread design, engineering and manufacturing costs across larger volumes on a single platform. The estimates for reduction in costs range from 10-20 percent in fixed costs and 4-8 percent in variable costs. Also, platform sharing enables greater flexibility between manufacturing facilities and increased usage of machinery which reduces capital investment

⁴⁹ 'Biggest restructuring? Tata Motors shrinking structure of its white-collar workforce', Economic Times, Ketan Thakkar, January 23, 2017, <https://economictimes.indiatimes.com/news/company/corporate-trends/biggest-restructuring-tata-motors-shrinking-structure-of-its-white-collar-workforce/articleshow/56723362.cms> (last accessed on May 04, 2018).

⁵⁰ For details, see 'Maruti aims to sell 3 lakh automatic cars annually by 2020', Economic Times, May 28, 2017, <https://economictimes.indiatimes.com/industry/auto/news/passenger-vehicle/cars/maruti-aims-to-sell-3-lakh-automatic-cars-annually-by-2020/articleshow/58879031.cms> (last accessed on May 04, 2018) and 'Maruti aims to sell 3 lakh automatic cars annually by 2020', Livemint, May 28 2017, <https://www.livemint.com/Industry/iGTC6xiqpMmyQ6qTHJYA0O/Maruti-aims-to-sell-3-lakh-automatic-cars-annually-by-2020.html> (last accessed on April 30, 2018).

⁵¹ 'India's Traffic Is So Bad It's Changing the Cars People Buy', Bloomberg, P R Sanjai, 11 September 2017, <https://www.bloomberg.com/news/articles/2017-09-10/india-s-traffic-is-so-bad-it-s-changing-the-cars-people-buy> (last accessed on May 10, 2018).

and assembly line workload. For instance, Honda took such initiatives in the year 2000 developing a flexible production system which could build all its 40 models, decreasing its model switching time from 7 minutes to 3 minutes and helped reduce capital investment and assembly line workload by close to 50 percent. In time, the trend of platform consolidation and modularization in the industry leads to more business distributed among fewer competent suppliers, have a feed-in effect on big suppliers and greater coordination between suppliers and OEMs (Edelweiss, 2014).

Other companies that have undertaken platform consolidation since the year 2000 are GM, Toyota, Volkswagen and the BMW Group. In 2017, Tata motors announced plans to further reduce the number of platforms from six to two to garner the benefit of economies of scale, make the business “future ready”, reduce complexities and cut costs. Tata Motors multi-product variants from two platforms, enduring greater coverage and economies of scale. The management felt that fewer platforms help cut down product development time and pare costs amid rapidly changing consumer buying behaviour.

Another trend which has gone hand-in-hand with modularization is outsourcing greater percentage of vehicle content to auto component suppliers. As a result auto component suppliers have been able to move up the value chain – from supplying just piecemeal components to sub assemblies and corresponding modules over time. OEMs, with their continuing focus on technology (as a crucial ingredient in differentiating vehicles in a platform), have progressively outsourced a greater percentage of vehicle content to auto component suppliers (Edelweiss, 2014). In such cases, modularization helps OEMs reduce employee costs and R&D expenses as work gets shifted to auto component suppliers. These suppliers could be outside of the OEMs or in-house through establishment of subsidiaries. For instance, Tata Motors and M&M have their own innovation centers for development of vehicle parts.

In 2017, Tata Motors created a dedicated vertical in the passenger vehicle business unit called TAMO to facilitate innovation, explore new business models and strike partnerships for future mobility solutions. Auto-gear cars from the facilities of Maruti Suzuki India (and clutch-free feature in future), automatic transmission systems from Honda Motors are some of the product development features developed in the era of modularization. Ever lengthening commutes are pushing the country’s famously price-conscious consumers to upgrade to cars that are easier to drive. Most notably, more are buying pricier models that sport automatic gears and moving away from the manual stick-shifts that have long held sway over Indian roads. Maruti Suzuki India Ltd., aims to double the portion of sales from auto-gear vehicles by 2020. The unit of Japan’s Suzuki Motors has offered the option in recent launches like the Ignis and Dzire. For Tata Motors, the target is to offer the clutch-free feature for about 50 percent of its product portfolio. Hyundai Motor Co. is also set to introduce the feature in its models for India, which many expect to be “game changing” for the company. Another factor behind the move away from manuals is the growing number of women drivers in India. There’s greater demand from women for automatic transmissions, which makes up about 25 - 30 percent of total sales at Honda Motors India.

vii) Increased usage of computer programs and internet for business purposes

Digitization is playing a disruptive role in the sector. Digitization of manufacturing offers abundant opportunities to increase efficiency and reduce costs. The savings potential spans over the full value chain, from manufacturing, to logistics, to maintenance costs. Relative to traditional auto manufacturing plants, digital factories can produce a higher output without major changeover costs, with faster delivery-time, and a higher quality.

For the automotive industry, innovation in production techniques, product quality and delivery methods are vital for competitive advantage and long term success. Automation has proved to be beneficial both at the production stage and in making support decisions related to operations.

Reportedly in 2017, Maruti Suzuki India managed seven process shops and five assembly lines by employing around 1,700 robots, Ford India had 437 robots operating the assembly lines and body shop at its Sanand (Gujarat) plant by 437 robots. Hyundai Motor India has reduced labour costs by utilising over 400 robots in its Sriperumbudur (Tamil Nadu) manufacturing operations. The company has been systematically training people and skilling them to handle multiple operations. The production lines of Tata Nano consist of over 100 robots in the Sanand Plant of Tata Motors. Other enterprises such as Renault India are working in the field of automation of business processes to prevent accidents.⁵²

Global technology and solutions provider Bosch, which is both a leading user and supplier of the advanced Industry 4.0 solutions, is betting big on the key business enabler. In India, Bosch has initiated the implementation of Industry 4.0 in all of its 15 manufacturing facilities in the year 2015. This has enabled it to offer improved levels of quality standards particularly in view of the company's multi-domain approach with engineering and IT solutions. It also expects additional growth through connectivity solutions for products as well as for business and production processes.

At Honda's scooter plant at Vithalapur in Gujarat, five giant robots orchestrate operations substituting the need for men. The factory, Honda's fourth two-wheeler plant in India, is one of the most automated in the world. The press shop produces 4,500 fuel tank frames in 16 hours and 14 people work here in two shifts. Without robots, a manual press shop of this magnitude would have required 72 men.⁵³

Maruti Suzuki's first plant in Manesar in Haryana has 65 automation processes. With one car being produced every 12 seconds, over 2,400 robots aiding 20,000 workers, the company's car

⁵² For details, see Grant Thornton-CII (2017).

⁵³ 'Going, Going, Gone: Automation can lead to unprecedented job cuts in India', Business Today, Goutam Das, June 18, 2017, <http://www.businesstoday.in/magazine/cover-story/going-going-gone/story/253260.html> (last accessed on April 12, 2018).

factories at Gurugram and Manesar have been embracing new technologies at a dynamic pace.⁵⁴

In some cases, such innovations have been a product of in-house facilities. For instance, in 2017, TAL Manufacturing Solutions, a wholly-owned subsidiary of Tata Motors, launched a Made-in-India robot catering primarily to micro, small and medium industries. It is priced 30-40 percent lower than competition. TAL Manufacturing Solutions, a subsidiary of Tata Motors Limited, has formed a technology partnership with Italy-based RTA Motion Control Systems for motors and drives used in its indigenously developed robot,⁵⁵TAL Brabo. A new partnership with RTA Motion Control Systems, a leading Italian based group, for critical components in the TAL Brabo robot has been announced.⁵⁶

B) Product upgrading

Includes improving product quality and increasing value for consumers. It may be stimulated by changes in end markets, or the desire for higher value added, higher quality, and consequently more profitable products on the part of firms.⁵⁷

i) Steps taken to improve product quality

Companies may take steps to improve product quality in three scenarios: First, to meet regulatory norms imposed by the Government; second, to meet consumer demands and; third, own endeavor to innovate and improvise on the existing product portfolio.

In India, increasing government stipulations and norms with regard to emissions and vehicular safety standards have shown the way to companies to undertake this form of product upgrading. Shifts to new technologies give often benefit companies as it helps them in getting higher realizations per unit and better margins.

a) To stay ahead of the competition

Some examples wherein companies have taken the route to product quality enhancement to stay ahead of competition have been in case of Tata Motors (Tiago), Honda (City), Ford (EcoSport) and M&M (Scorpio). Product quality improvements can include upgraded features, design face-lifts, and new and improved engines. For example, the Ford EcoSport is a

⁵⁴ 'Maruti's mega car plants lean on new technology to be future-ready', Livemint, June 25 2017. <https://www.livemint.com/Industry/bdnKISrtBHHLjMeljaJDpI/Marutis-mega-car-plants-lean-on-new-technology-to-be-future.html> (last accessed on May 11, 2018)

⁵⁵ 'Tata Motors arm launches Made-in-India robot', The Hindu Business Line, April 12 2017, <http://www.thehindubusinessline.com/companies/tata-motors-arm-launches-madeinindia-robot/article9634396.ece> (last accessed on March 20, 2018)

⁵⁶ 'Tata Motors arm TAL to partner with Italy's RTA for robot components', Business Standard, April 13, 2017, http://www.business-standard.com/content/b2b-manufacturing-industry/tata-motors-arm-tal-to-partner-with-italy-s-rta-for-robot-components-117041300407_1.html (last accessed on April 23, 2018)

⁵⁷For details, see <https://microlinks.org/good-practice-center/value-chain-wiki/types-upgrading> ((last accessed on May 11, 2018).

subcompact crossover SUV, originally built in Brazil by Ford Brazil in 2003. A second generation concept model was launched in 2012, being also assembled in plants in India, Thailand and Russia. The model sold well and became one of Ford's best-seller models in Brazil, Argentina, Venezuela, and Mexico. Its main competitors were the Fiat Palio Weekend Adventure and Volkswagen CrossFox.

The second generation Ford EcoSport was first showcased in 2012 and launched in Brazil. In addition to China, the SUV was manufactured at Ford India's Chennai plant, for domestic sale and export to the European market. Ford's plant in Thailand manufactured for the Southeast Asian markets. It stood in direct competition with other prominent models like Renault Duster and Nissan Terrano. In November 2016, Ford announced plans to supply the Ford India Ecosport to the market in the US. It was powered by a 1.0 litre, three cylinder turbocharged EcoBoost petrol engine which has a power output of 120 PS (88 kW; 118 bhp) and 170 N·m (125 lb·ft) of torque. In 2017, a yet new version of the car was announced. This came with a new, and a new and an improved engine. The company made considerable changes in the SUV including a design face-lift and new 1.5-litre Ti-VCT 3-cylinder petrol engine that produces 120 bhp of power and 150 Nm of torque. The SUV received both external and internal upgrades in terms of design and specifications. The cosmetic changes included a muscular hood, redesigned front bumper and grille on the front. The SUV had a new alloy wheel pattern and was equipped with bigger fog lights and daytime running lights. The interiors had been upgraded too. Ford EcoSport 2017 came with a new dashboard design and a bigger and upgraded infotainment screen, the support for which was extended to both Apple CarPlay and Android Auto.⁵⁸ This also added to the design and is discussed under the next section on functional upgrading.

Similarly, since entering India two decades ago, the Japanese automaker Honda has strengthened its position riding on the success of its most popular midsize sedan, the City, which still remains the first choice of many sedan-buyers with a budget of around Rs 10 lakh. First launched in 1998, the City has been upgraded and re-launched a number of times, became the identity of Honda Cars India Limited over the years.

In 1998, the City was manufactured and launched in India and it was the third generation of the Japanese model. This petrol-run sedan was straight, simple in design, nothing too fancy; and was put up against the Maruti Suzuki Esteem, then the most popular luxury sedan made in India. Its design was similar to that of the one-litre Esteem, though it sported a more powerful 1.5-litre engine. Its rivals in the field then were the Opel Corsa and Astra, Ford Ikon, Mitsubishi Lancer and Hyundai Accent. The second generation Honda City in India, launched in 2002, was the fourth generation global car. It had a steeper airdam, shorter bonnet and a sleeker boot design. It also had a moniker ZX, powered by 1.5-litre i-VTEC petrol engine delivering 101PS of power and 132 Nm of max torque. During this edition, Honda City took on its competitor

⁵⁸ 'Ford EcoSport 2017 to launch today; comes with refreshed design and new 1.5-litre petrol engine', FirstPost, November 09, 2017, <http://www.firstpost.com/tech/features-auto/ford-ecosport-2017-to-launch-today-comes-with-refreshed-design-and-new-1-5-litre-petrol-engine-4200911.html> (last accessed on May 26, 2018).

Maruti Esteem and Hyundai Accent, while sales of other competing cars Mitsubishi Lancer and Ford Ikon declined. Eventually, Maruti Suzuki discontinued the Esteem in 2005, which increased the sales of the City. The third edition in India, launched in September 2008, was a massive upgrade. The car received a facelift with bigger headlamps, a bigger rear body. In just 12 months, Honda sold over 50,000 units of this City, which went on to become the Indian Car of the Year for 2009.⁵⁹ The fourth Generation City was launched in January 2014. This model, the sixth generation globally, outsold its previous versions, mainly owing to a 1.5-litre diesel engine in India. The upgrade was more of a facelift. An addition was a broad chrome bar holding the Honda badge came over the grille connecting the two headlamps wrapped around the bonnet. It became the fastest selling sedan in India at that time, touching a lakh units' mark in just 15 months. However, it was this model which lost the best-selling mid-size sedan position to the latest competitors, the Maruti Suzuki Ciaz and the new fluidic Hyundai Verna. Honda launched its fifth Generation City in 2017. This was mainly a facelift, with major gadget upgrades inside the cabin. The headlamps and taillights got LEDs, and there a 17.7cm touchscreen was introduced for music and navigation.⁶⁰

b) To meet regulatory norms

Honda is planning to introduce hybrid versions of its hatchback Jazz and City sedan after 2020. It is planning to launch six models in India in the next three years, and the current favourite is the hybrid technology. Honda Accord with hybrid i-MMD system for small and midsize cars, is more efficient than the earlier i-DCD technology.⁶¹

Also the discussion on electric vehicles has to be viewed in context of the changing regulations in the country with respect to emission norms. India is planning to bypass the Bharat Stage V norms and introduce Bharat Stage VI norms (comparable to Euro VI norms) from 2018.⁶²

ii) Introduction of new materials to enhance product range

In the last few decades, efforts have been made to reduce the environmental and ecological impacts of the Indian automobile industry through process and technological innovations as well as technology transfers. Collaborative R&D activities have opened avenues for material

⁵⁹ 'The City over the years: How the sedan established Honda in India', Hindustan Times, February 15, 2017, <http://www.hindustantimes.com/autos/the-city-over-the-years-how-the-sedan-established-honda-in-india/story-G99Fbn7nH7xdCtqRc4tcK.html> (last accessed on May 11, 2018)

⁶⁰ 'The City over the years: How the sedan established Honda in India', Hindustan Times, February 15, 2017, <http://www.hindustantimes.com/autos/the-city-over-the-years-how-the-sedan-established-honda-in-india/story-G99Fbn7nH7xdCtqRc4tcK.html> (last accessed on May 13, 2018)

⁶¹ For details, see <http://world.honda.com/automobile-technology/i-DCD/topic3/> (last accessed on June 01, 2018).

⁶² For details, see <http://www.indiaenvironmentportal.org.in/files/file/Draft%20Notification%20BS-V%20and%20BS-VI%20for%20M%20&%20N%20Category%20of%20vehicles%20above%203.5%20tons.pdf> (last accessed on April 13, 2018).

substitution, better vehicular design that are resource and energy efficient (ARAI, 2013). There is significant scope for achieving higher efficiency levels.

India has traditionally been strong in the casting and forging segment and is a base for many iron and steel foundries which cater to the sector. India is also good at manufacturing engines, though they are designed elsewhere (Ray and Miglani, 2016a.). Factors such as having a component base nearby and strategic geographic location are conducive to trade. The metals used in this industry, iron, aluminium and steel, are also available locally. Lightweight materials⁶³ like magnesium composites⁶⁴ which are not locally available are imported (Ray and Miglani, 2018).

In the past, automobiles have been composed primarily of iron and steel. Steel has remained a major automotive component because of its structural integrity and ability to maintain dimensional geometry throughout the manufacturing process. In response to increasing demands for more fuel efficient cars, the last ten years have seen changes in the composition of materials used in automobiles in the industry. Iron and steel use has steadily decreased, while the use of plastics and aluminum has steadily increased. Aluminum and plastics are valuable car components not only because of their lighter weight, but also their inherent corrosion resistance. Other materials that are being used include high strength steel, magnesium, titanium, carbon fibre composites, glass fibre composites etc.

Weight reduction and electrification are key levers for achieving carbon dioxide (CO₂) emission targets. Upgrading auto components' technological capabilities by replacing older parts with more advanced parts can control emissions only up to a certain threshold limit. Beyond this, light weighting of vehicles is the only option for further efficiency. It is estimated that a 10 kg reduction in weight of a vehicle corresponds to approximately one gram per/km reduction in CO₂ emissions. Automobile design and selective material usage are capable of reducing the 'Curb' weight of a vehicle, without compromising its size, performance attributes, load-bearing capabilities, structural integrity and haulage capacity. For a vehicle, the body, the power-train and the suspension systems are major focus points for weight reduction. OEMs and their auto suppliers have constantly looked at shift from basic iron and steel vehicular applications to greater use of materials like steel alloys like high strength steel (HSS), aluminium, magnesium and plastics. HSS alloys can be used for every vehicle system, including power train components, steering wheels, front end structures, chassis, beams and closure body panels. High end to premium vehicle manufacturers like Honda (Civic) and Mercedes-Benz (C-class) increased HSS usage from approximately 40 percent to between 50-70 percent. Aluminium and its alloys continue to replace mild and carbon steels. Honda was quick to introduce this metal to its product Amaze, which is claimed to have achieved the status of the lightest diesel vehicle in its class by using weight reduction measures like a thin-walled

⁶³ Lightweight materials are used to improve efficiency and reduce emissions. Auto OEMs are looking to shift from basic iron and steel to high strength steel, aluminium, magnesium and plastics.

⁶⁴ Highly inflammable and requires strict establishment of safety norms.

aluminum block, an aluminum head and lightweight cast-iron cylinder liners (Edelweiss, 2014).

Automobiles have also transitioned from metals to plastic components. M&M's XUV500's front frame and Range Rover's tailgate shifted from steel to plastic modules. Although light weighting could lead to a shift towards more expensive materials (up to 10 percent higher cost per mass), the reduction in overall usage of that material can effectively help reduce costs by more than 10 percent. Also, light weighting is a relatively cost effective option for reducing emission as opposed to fitment of new advanced vehicular parts which could require significant development and manufacturing costs (Edelweiss, 2014).

A 100 kg mass reduction achieved on a car saves eight grams of CO₂ per km at the exhaust pipe.⁶⁵ The benefits of light weighting include lower CO₂ emissions due to: i) Direct weight saving because of lighter material usage ii) Indirect weight saving due to downsizing of some components iii) Lower energy demand and so lesser fuel requirement iv) For the same power-to-weight ratio, saving weight allows downsizing of powertrain v) Shortens braking distance for same brake power constant.⁶⁶

*iii) Reduction in reworking rates*⁶⁷

In the case of automobiles, reworking refers to the defect rates or the vehicle recall. The information on vehicle recall is maintained by the industry association Society of Indian Automobile Manufacturers (SIAM).⁶⁸ The maximum recalls have been by Honda and Ford – of 745926 and 445750 vehicles respectively in this period. Some noticeable instances of the huge volume or number of recalls have been in September 2013 when Ford recalled its models Figo, Fiesta, and EcoSport (totaling 166993) for issues like crack in rear TwistBeam (RTB), PAS Hose System and Glow Plug Module replacement. Similarly, Honda recalled a number of its models like City, Civic, Accord, Jazz, and CR-V in 2016 (totaling about 248254) due to issues in airbag deployment. Other smaller recall includes Tata Motors, which had recalled 517 vehicles recalled due to fuel odour and leaking of fuel in their Jaguar XF model. Hyundai Motors recalled 13632 vehicles in their Santa Fe and the Eon models. The former was due to hood upper bale malfunction while the latter was due to clutch cable fouling with battery cable. Maruti Suzuki had a recall of 300831 vehicles in this period. The recalls in the Swift Dzire pertained to fuel seepage from the fuel filter joint, improper screw shape in the fuel cap and

⁶⁵For details, see https://automotivemanufacturingsolutions.com/wp-content/uploads/2013/12/AMSI_2013_Shrikant_Marathe.pdf (last accessed on May 28, 2018).

⁶⁶For details, see https://automotivemanufacturingsolutions.com/wp-content/uploads/2013/12/AMSI_2013_Shrikant_Marathe.pdf (last accessed on May 28, 2018).

⁶⁷'Why car recalls are spiking in India', Business Standard, Ajay Modi, June 15, 2016, http://www.business-standard.com/article/companies/why-car-recalls-are-spiking-in-india-116061400817_1.html (last accessed on April 23, 2018).

⁶⁸ For details, see <http://www.siam.in/siam-voluntary-recall.aspx?mpgid=31&pgidtrail=84> (last accessed on May 15, 2018).

steering column assembly. The recalls in the Ertiga were due to improper screw shape in the fuel cap and steering column assembly etc.

Lead firms like Hyundai and Tata have little history of recalls in comparison. Another company, Toyota's case in the context has been examined in detail in Lucky and Takim (2015). Based on this information, it is difficult to ascertain if there has been a reduction in defect rates for carmakers over the years as a result of upgrading. However, the sales figures of subsequent models (of the same or different cars) introduced by companies such as Honda, Ford, Maruti and others point towards some evidence of success in this regard.

C) Functional upgrading

Functional upgrading is the entry of a firm into a new, higher value-added function or level in the value chain.⁶⁹ Functional upgrading occurs through design, branding and marketing - activities that add value to the firms in the GVC.

i) Design

One of the main reasons for Hyundai's success in India has been its high design value.⁷⁰ When HMIL launched its first product, Santro, in September 1998, the car was unique for its tall boy design, had multi-point injection (when others had carburetors) and met Euro 2 emission standards.⁷¹ These features contributed to the success of the model in the country.

Another example in this context is that of Tata Motors. The company has made significant investment in its design infrastructure recently. Its 'Impact Design Platform' is claimed to be a "huge leap into the future" and involves two new platforms.⁷² It underpins the company's latest

⁶⁹For details, see <https://microlinks.org/good-practice-center/value-chain-wiki/types-upgrading> (last accessed on April 30, 2018).

⁷⁰'Top 5 Popular Car Brands In India', Ameya Naik Auto NDTV, Ameya Naik, April 22, 2017 <https://auto.ndtv.com/news/best-car-brands-in-india-1684619> (last accessed on March 19, 2018)

⁷¹ For details, see <https://www.team-bhp.com/news/santro-car-built-company-bvr-subbu> (last accessed on April 07, 2018)

⁷² 'Ford EcoSport 2017 unveiled in India, receives technology, engine and feature updates', Firstpost, October 2017. <http://www.firstpost.com/auto/features-auto/ford-ecosport-2017-unveiled-in-india-receives-technology-engine-and-feature-updates-4177577.html> (last accessed on May 11, 2018).

⁷² The first is the AMP, or advanced modular platform, which can produce cars ranging from 3.8 to 4.3 metres. The other is a platform borrowed from the company's British arm, Jaguar Land Rover, which will be adapted to India for cars with length of more than 4.5 metres. For details, see 'Tata Motors gears up for its next design wave', January 18, 2018, 'Tata Motors gears up for its next design wave', The Hindu Business Line, Murali Gopalan, January 18, 2018, <https://www.thehindubusinessline.com/specials/auto-focus/tata-motors-gears-up-for-its-next-design-wave/article10040217.ece>, (last accessed on May 31, 2018) and 'Here's how design is leading Tata Motors' renaissance', <https://www.digit.in/car-tech/heres-how-design-is-leading-tata-motors-renaissance-38660.html>, Digit, Souvik Das, 14 December, 2017 (last accessed on June 04, 2018)

models like the Hexa, Tigor, and the new Nexon^{73,74} With this, the company has in fact made an effort towards consolidation, reducing the number of platforms to two from the six at the present. This move is aimed at faster production, leading to greater cost benefits and improving customer satisfaction levels.

ii) Marketing

Technical understanding of the car and all the available features has become a key requirement for salesman (McKinsey & Company, 2014). Car manufacturers are now introducing new retail formats in prime city centre locations. The new formats include online stores which are typically used for preconfigured models. The traditional formats and the new formats are being used simultaneously. Test drive centres, superstores, city stores, mobile or pop-up stores and home visits are being used in Germany.

Maruti has introduced the concept of 'Nexa' stores to sell its premium segment cars including S-Cross, Baleno etc.⁷⁵ Currently Tata Motors has 1400 sales outlets and over 1800 service touch points which the company plans to increase to 1572 sales outlets and over 1969 service touch point by the end of this fiscal year 2017-18.⁷⁶ Tata Motors will invest in modernization of its sales and service network with an aggressive customer centric approach.

iii) Branding

Brand management strategies help make companies more focused and able to differentiate its products from the competition. This can be done through investments in targeted marketing. One of the foremost cases that come to mind in this regard is that of Tata Motors Limited.⁷⁷ Having presence in a number of industry segments, the company (formerly TELCO, short for Tata Engineering and Locomotive Company), is a member of the Tata Group. Founded in 1945 as a manufacturer of locomotives, the company manufactured its first commercial vehicle in 1954. Tata Motors entered the passenger vehicle market in 1991 with the launch of an SUV, Sierra, becoming the first Indian manufacturer to achieve the capability of developing a competitive indigenous automobile. The company benefitted from its popular success and brand image in the commercial vehicles segment. In 1998, Tata launched the first fully indigenous Indian passenger car, the Indica, and in 2008 launched the Tata Nano, the world's

⁷³ 'New Ford EcoSport vs Maruti Suzuki Vitara Brezza vs Tata Nexon', Naveen Soni, Times of India, November 11, 2017, <https://timesofindia.indiatimes.com/auto/cars/new-ford-ecosport-vs-maruti-suzuki-vitara-brezza-vs-tata-nexon/articleshow/61605589.cms> (last accessed on June 01, 2018)

⁷⁴ 'Top 5 Popular Car Brands In India'. Ameya Naik Auto NDTV, Ameya Naik, April 22, 2017 <https://auto.ndtv.com/news/best-car-brands-in-india-1684619> (last accessed on June 04, 2018).

⁷⁵ For details, see <https://www.nexaexperience.com/> (last accessed on June 04, 2018).

⁷⁶ 'Tata Motors to invest Rs 4000 cr; aims to be 3rd largest CV maker globally', ETAuto, Deepanshu Taumar, May 31, 2017, <https://auto.economictimes.indiatimes.com/news/industry/tata-motors-to-invest-rs-4000-cr-aims-to-be-3rd-largest-cv-maker-globally/58921431> (last accessed on June 04, 2018)

⁷⁷ For details, see <https://howmuch.net/articles/most-valuable-brands-2017> (last accessed on June 01, 2018)

cheapest car. Today, Tata is one of the most recognizable brand of India and even known worldwide.

Producing successful models is the more time consuming but surer way to acquire brand value. To take the case of Honda, City has been the company's biggest seller in India, not only establishing the brand as a whole, but also helping other models like Mobilio and Brio attain the premium tag. The City as Honda's flagship product has helped immensely in establishing the Japanese brand in the Indian market. The automaker regularly updates the model to keep it ahead of competition. The City has lived through the two decades, competing with leading models such as the Hyundai Verna, Maruti's Esteem, Accent, SX4, and the present day Ciaz.

In similar case for other firms such as Hyundai's Santro and Tata's Tiago platforms, these designs have helped these companies position their cars in the respective segments.

D) Inter-sectoral upgrading

Inter sectoral upgrading involves applying the knowledge acquired in a sector to move to a new sector (Giuliani, et al., 2005). Innovation and disruption are changing the automobile landscape in India. These changes, particularly the introduction of electric vehicles in the next few years are expected to propel the industry to a new chain. There are two important points to note here.

First, a lot of frugal innovation⁷⁸ is seen in India in the form of localizing global big ideas - be it swappable batteries for electric two-wheelers and auto rickshaws, ride-sharing concepts extended to all forms of transport, or augmented reality apps that try to replicate the capabilities of driver assistance systems, or connectivity options for heterogeneous needs. The second interesting facet of the Indian automotive landscape is that certain government regulations and schemes are helping the industry. While lithium-ion batteries are conventionally expensive, indigenously made Li-ion batteries will lower the cost of electric vehicles. The 'Make in India' initiative of the Government is encouraging in this regard. The 'Niti Aayog: India Leaps Ahead' program lays greater emphasis on electric transport. It will augment the Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India (FAME) scheme of the Indian government. State governments are embracing alternative fuel technologies and providing incentives to people to adopt electric vehicles.

In the year 2017, it was announced that the Indian automobile industry would move from Bharat Stage IV to Bharat Stage VI (skipping Bharat Stage V) emission standards in 2018, and geared up to make the requisite changes. The need to comply with these higher emission norms is now driving advanced engineering and innovation at a component or system level. Another instance is the Indian Ministry of Road Transport and Highways making it mandatory to have an emergency button and vehicle tracking system (VTS) in all public transportation vehicles -

⁷⁸Disruptions in the global automotive industry: Solutions from India?' Forbes, 14 September 2017, <http://www.forbesindia.com/blog/business-strategy/disruptions-in-the-global-automotive-industry-solutions-from-india/> (last accessed on May 14, 2018).

these standards are calling for advanced specifications. So, while regulation is typically seen as a bottleneck, in India it is helping to spur further innovation.

Electric vehicles

Companies have systematically invested in building new machinery to roll out product variants in keeping with the dynamic needs of consumers. With the plans of introducing electric vehicles, car manufacturers in India are gearing up to new production processes and machines.⁷⁹ M&M is the only manufacturer of an electric car - the e20, a micro vehicle at present. Recently, the industry has been witnessing the emergence of original ideas, methods, and products in automotive technology. A leading automobile manufacturer has announced its EV 2.0 platform roadmap for electric vehicles. The key projects in this roadmap include a heavy, high-capacity Li-ion battery with a very high range of almost 400 kilometers, and new power trains that could achieve a top speed of 150-200 kilometers per hour.⁸⁰

Maruti Suzuki Motors revealed plans to manufacture electric vehicles at a factory in Gujarat in 2017. As part of the initiative, Suzuki has committed US\$ 600 million (Rs. 3900 crores) for construction of a new plant at Hansalpur (Gujarat).⁸¹ Maruti plans to produce 35000 electric vehicles annually from 2020.⁸² For this Maruti also plans to set up lithium-ion battery plant with the help of its tripartite joint venture with Toshiba and. The technology for electric vehicles will be sourced by Suzuki from Toyota and Denso Corporation for development of a compact and ultra high efficiency powertrain for India and other global markets. Other companies like Volvo are also planning to expand its plug-in hybrid and electric vehicle portfolio in India.

6. Conclusion

The Indian automobile industry has come a long way since its inception. This paper attempts to identify the role of lead firms in mapping the activities related to upgrading. This has been examined in the context of upgrading in seven of the major automobile firms, using a case analysis approach. Through the use of advanced modular platforms, platform sharing among different car manufacturers, automation and use of newer materials we note that upgrading has been occurring in every category.

⁷⁹ 'Why Suzuki and Toyota's new partnership is a huge deal for India's electric vehicle dream', Devjyot Ghoshal, November 20, 2017, <https://qz.com/1133216/suzuki-toyota-partnership-why-maruti-entry-into-indias-electric-vehicle-segment-is-such-a-big-deal/> (last accessed on April 13, 2018).

⁸⁰ 'Disruptions in the global automotive industry: Solutions from India?', Forbes, 14 September 2017, <http://www.forbesindia.com/blog/business-strategy/disruptions-in-the-global-automotive-industry-solutions-from-india/> (last accessed on April 22, 2018).

⁸¹ 'New Ford EcoSport vs Maruti Suzuki Vitara Brezza vs Tata Nexon', Times of India, Naveen Soni, November 11, 2017, <https://timesofindia.indiatimes.com/auto/cars/new-ford-ecosport-vs-maruti-suzuki-vitara-brezza-vs-tata-nexon/articleshow/61605589.cms> (last accessed on May 08, 2018).

⁸² 'Maruti Suzuki charges ahead with ambitious electric car plan', Livemint, June 06, 2018, <https://www.livemint.com/Companies/pvOr4mmsMehEOE4gKymbQI/Maruti-Suzuki-charges-ahead-with-ambitious-electric-car-plan.html> (last accessed on June 04, 2018).

Upgrading needs to be consistently applied to reap benefits across the board. While this paper has examined upgrading for the lead firms, their suppliers or vendors are often small and medium enterprises (SMEs) which are not upgrading. The major challenges faced by the Indian component manufacturers are high cost of capital, non-availability of skilled labour and rising price of operational cost. Stiff competition from China and other South East Asian countries on the price front is emerging. Converging towards international safety standards and having domestic crash testing facilities, would further encourage firms to adopt (and contribute to) international good practices (Ray and Miglani, 2018). Adoption of automation and the robotics in recent times have helped the industry to significantly improve quality, productivity, delivery and at the same time reduce costs (World Economic Forum, 2017). It also helps in reducing the recall rates.

Upgrading can help derive benefits to SMEs as well. To meet the needs of future (including electrification of vehicles) and stay ahead of competition, SME manufacturers are now gearing up to the challenges of constant up-gradation, digitization and automation. However, in the process, SMEs may require support from the lead firms as well as support from the government.

References

- Athukorala, P. C. (2014)**, How India Fits into Global Production Sharing: Experience, Prospects, and Policy Options in *India Policy Forum 2013-14* (Vol. 10, p. 57). August. SAGE Publications India.
- Amador, J. and S. Cabral. (2016)**, Global Value Chains: A Survey of Drivers and Measures, *Journal of Economic Surveys*, 30(2): 278-301.
- Amighini A. A. (2012)**, China and India in the international fragmentation of automobile production. *China Economic Review* 23, 325-341.
- ARAI (2013)**, Light Weighting in Automotive Industry - Automotive Manufacturing Solutions India Conference. Authored by Shrikant R Marathe.
- ATKearney - Institute of Logistics - CII (2016)**, Gearing Up to Transform. India's Automotive Supply. Chain in the GST Environment.
- Bain (2017)**, Changing Gears 2020: How Digital is Transforming the Face of the Automotive Industry. Authored by Srivatsan Rajan, Joydeep Bhattacharya, Yaquta Mandviwala and Deepak Jain. May.
- Bair, J. (2005)**, Global capitalism and commodity chains, Looking Back and Going forward, *Competition and Change*, 9, 2, 153-180.
- Bair, J. (2009)**, Frontiers of Commodity Chain Research. Stanford University Press.
- Bell, M. (2007)**, Technological Learning and the Development of Production and Innovative Capacities in the Industry and Infrastructure Sectors of the Least Developed Countries: What Role for ODA? Background paper no. 10 for The Least Developed Countries Report, Geneva: UNCTAD.
- Bell M., Pavitt K. (1993)**, Technological accumulation and industrial growth: contrast between developed and developing countries, *Industrial and Corporate Change*, Vol. 2, No. 2.
- Bhargava, R. C. and Seetha. (2010)**, *The Maruti Story: How a Public Sector put India on Wheels*. New Delhi: Collins Business.
- Blyde, Juan S. (eds.) (2014)**, *Synchronized Factories, Latin America and the Caribbean in the Era of Global Value Chains*, Washington, DC: Inter-American Development Bank.
- Bowonder, B. (1998)**, Competitive and technology management strategy: a case study of TELCO. *International Journal of Technology Management*, 15(6-7), 646-680.
- Bruche, G., Dorreenbacher, C., Nagel, F., and S. Ripsas (2010)**, Tata Motor's Transformational Resource acquisition Path, Working paper no. 55, IMB Institute of Management Berlin.
- Chia, S.Y. and M.G. Plummer (2015)**, ASEAN economic Cooperation and Integration: Progress, Challenges and Future Directions, Vol. 8. Cambridge University Press.
- CII-EY (2016)**, Making India a world class automotive manufacturing hub. February.

- D'Costa, A. P. (2011).** Globalisation, crisis and industrial relations in the Indian auto industry. *International Journal of Automotive Technology and Management*, 11(2), 114-136.
- De Backer, K. and S. Miroudot (2013),** Mapping Global Value Chains, OECD Trade Policy Papers, No. 159, OECD Publishing, Paris.
- Edelweiss (2014).** Auto Components: The Future - Mega Trends, Mega Factors, Edelweiss Financial Services Ltd.
- Gereffi, G. (1994),** The Organisation of Buyer-driven Global Commodity Chains: How U.S. Retailers Shape Overseas Production Networks, in G. Gereffi and M. Korzeniewicz (eds), *Commodity Chains and Global Capitalism*, Westport, CT: Praeger, 95-122.
- Gereffi, G. (1999),** International Trade and Industrial Upgrading in the Apparel Commodity GeChain. *Journal of International Economics*, Vol. 48, Num. 1, June, 37-70.
- Gereffi, G. and T. Sturgeon (2013),** Global Value Chain-Oriented Industrial Policy: The Role of Emerging Economies, in D. Elms and P. Low (eds): *Global Value Chains in a Changing World* (Geneva, World Trade Organization).
- Gereffi, G., Humphrey, J., and T. Sturgeon (2005).** The governance of global value chains. *Review of International Political Economy*, 12(1), 78–104.
- Gereffi, G. (2015),** Global value chains, development and emerging economies, UNIDO Working Paper 18/2015. Vienna: UNIDO.
- Gereffi, G. and Fernandez-Stark (2011),** Global value chain analysis: a primer. First edition. Duke University, Center on Globalization, Governance and Competitiveness.
- Gereffi, G., and Fernandez-Stark, K. (2016),** Global value chain analysis: a primer. Second edition. Duke University, Center on Globalization, Governance and Competitiveness.
- Giuliani, E., Pietrobelli, C., and Rabellotti, R. (2005),** Upgrading in global value chains: lessons from Latin American clusters. *World Development*, 33(4), 549-573.
- Giuliani, E., De Marchi, V., and R. Rabellotti (2017),** Do Global Value Chains Offer Developing Countries Learning and Innovation Opportunities? *The European Journal of Development Research*, 1-19.
- Grant Thornton-CII (2017),** 'India's Readiness for Industry 4.0: A Focus on Automotive Sector', March.
- Henderson, R. M., and Clark, K. B. (1990),** Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 9-30.
- Hobday, M. (1998),** Product Complexity, Innovation and Industrial Organization. *Research Policy*, 26:689-710.
- Humphrey, J., Lecler, Y., and Salerno, M. S. (2000),** (eds.) Global Strategies and Local Realities: The Auto Industry in Emerging Markets, Macmillan Press Ltd., Houndmills, Basingstoke, Hampshire and London, St. Martin's Press LLC, New York.

- Humphrey, J. (2003)**, Globalization and supply chain networks: the auto industry in Brazil and India. *Global Networks*, 3(2), 121-141.
- Humphrey, J., and O. Memedovic (2003)**, The global automotive industry value chain: What prospects for upgrading by developing countries.
- Humphrey, J. and H. Schmitz (2002)**, How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies*, 36 (9), 1017-1027.
- Kale, D. (2011)**, Co-evolution of policies and firm level technological capabilities in the Indian automobile industry. In *Science and Innovation Policy, 2011 Atlanta Conference*. IEEE.
- Kale, D. (2012)**. Sources of innovation and technology capability development in the Indian automobile industry. *International Journal of Institution and Economics*, 4(2) 121-150.
- Kaplinsky, R. (2000)**, Spreading the Gains from Globalisation: What Can Be Learned from Value Chain Analysis? Institute for Development Studies, Sussex University, Brighton.
- Kaplinsky, R., and Readman, J. (2001)**, Integrating SMEs in global value chains: towards partnership for development. *Vienna: Unido*.
- Kaplinsky, R., Memedovic, O., Morris, M., and Readman, J. (2003)**, *The Global Wood Furniture Value Chain: What Prospects for Upgrading by Developing Countries? The Case of South Africa*. Vienna: UNIDO.
- Kaplinsky, R. (2004)**, Spreading the gains from globalization: what can be learned from value-chain analysis? *Problems of economic transition*, 47(2), 74-115.
- Keesing, D. and S. Lall (1992)**, Marketing Manufactured Exports from Developing Countries: Learning Sequences and Public Support, in G. Helleiner (ed.), *Trade Policy, Industrialisation and Development*, Oxford: Oxford University Press, pp. 176-93.
- Koopman, R., Powers, W., Wang, Z. and S.J. Wei (2011)**, Give Credit to Where Credit is Due: Tracing Value Added in Global Production Chains, NBER Working Paper No. 16426, September 2010, revised September 2011 (Cambridge MA, National Bureau of Economic Research).
- Lucky, B., and S. Takim (2015)**, Manufacturing Defects in the Automobile Industry, a Case Study of the Remote Causes and Effects of Toyota's Transmission Malfunctions in Cars. *IJEAS*, 2, 15-28.
- Levy, D. L. (2005)**, Offshoring in the new global political economy. *Journal of Management Studies*, 42(3), 685-693.
- McKinsey (2003)**, New Horizons: Multinational Company Investment in Developing Economies, McKinsey Global Institute.
- McKinsey & Company (2006)**, The Road to 2020 and Beyond.
- McKinsey & Company (2014)**, Innovating automotive retail.

- McKinsey (2015)**, Digital manufacturing: The revolution will be virtualized. By Brian Hartmann, William P. King, and Subu Narayanan.
- Milberg, W. (2004)**, The changing structure of trade linked to global production systems: what are the policy implications? *International Labour Review*, 143(12), 45-90.
- Navas-Alemán, L. (2011)**, The impact of operating in multiple value chains for upgrading: the case of the Brazilian furniture and footwear industries. *World Development*, 39(8), 1386-1397.
- OECD (2012)**, Mapping Global Value Chains. TAD/TC/WP/RD(2012)9.
- OECD (2016)**, Upgrading Pathways in the Automotive Value Chain, OCED Initiative for Policy Dialogue on Global Value Chains, Production Transformation and Development, 7th Plenary Meeting, 10-11 November, Mexico City, Mexico.
- Okada, A. (2004)**, Skills development and interfirm learning linkages under globalization: Lessons from the Indian automobile industry. *World Development*, 32(7), 1265-1288.
- Palepu, K., Anand, B., and R. Tahilyani (2011)**, Tata Nano-The People's Car. Harvard Business School Case, 9-710-420: page 8.
- Parhi, M. (2008)**, Indian Automotive Industry: Innovation and Growth, India, Science and Technology, S&T and Industry. NISTADS.
- Pathak, R. D., Husain, Z., and D. Samson (2007)**, Learning and technology management in an international partnership: Honda of Japan and Hero of India. *International journal of manufacturing technology and management*, 11(1), 53-76.
- Peters, S., Chun, J. H., and G. Lanza (2016)**, Digitalization of automotive industry—scenarios for future manufacturing. *Manufacturing Review*, 3, 1.
- Pietrobelli, C. and R. Rabellotti (2009)**, The Global Dimension of Innovation Systems: Linking Innovation Systems and Global Value Chains in B.A. Lundvall, J. Vang, K.J. Joseph, and C. Chaminade, (eds.) *Handbook of Innovation Systems and Developing Countries Building Domestic Capabilities in a Global Setting*, Edward Elgar Publishing.
- Pietrobelli, C. and R. Rabellotti (2010)**, Upgrading to Compete Global Value Chains, Clusters, and SMEs in Latin America, in *Upgrading to Compete: Global Value Chains, Clusters, and SMEs in Latin America*, Carlo Pietrobelli, Roberta Rabellotti, Harvard University Press, 2006.
- Pietrobelli, C., and C. Staritz (2013)**, *Challenges for Global Value Chain Interventions in Latin America*. InterAmerican Development Bank (IDB) Competitiveness and Innovation Division Technical Note, IDB-TN-548 (May).
- Prasad, E., M. A. Kose, K. S. Rogoff and S. J. Wei. (2006)**, Financial Globalization: A Reappraisal, National Bureau of Economic Research Working Papers, 12484. Cambridge, MA: National Bureau of Economic Research.

- Ray, S. and S. Miglani (2016a)**, The Role of FDI in Fostering Growth in the Automobile sector in India, Asia Pacific Tech Monitor, April-June.
- Ray, S., and S. Miglani (2016b)**, Innovation (and upgrading) in the automobile industry: the case of India. ICRIER Working Paper 320, May.
- Ray, S. and S. Miglani (2018)**, *Global Value Chains and the Missing Links: Cases from Indian Industry*, Routledge, London and New York. ISBN: 978-1-138-70902-7 (hbk)
- Roland Berger - CII (2016)**, Automotive Advanced Manufacturing - Taking quality and productivity to the next level amid severe industry disruptions.
- Schmitz, H. (Ed.) (2004)**, Local enterprises in the global economy: Issues of governance and upgrading. Cheltenham: Edward Elgar.
- Schmitz, H. (2006)**, Learning and earning in global garment and footwear chains. *The European Journal of Development Research*, 18(4), 546-571.
- SIAM, Review of Automotive Mission Plan 2006 – 2016.
- Sturgeon, T. J. (2002)**, Modular production networks: a new American model of industrial organization, *Industrial and Corporate Change*, 11, 3, 451-96.
- Sturgeon, T., Van Biesebroeck, J., and G. Gereffi (2008)**, Value chains, networks and clusters: reframing the global automotive industry. *Journal of Economic Geography*, 8(3), 297-321.
- Sturgeon, T. J. and J. V. Biesebroeck (2010)**, Effects of the Crisis on the Automotive Industry in Developing Countries - A Global Value Chain Perspective, *The World Bank*, Policy Research Working Paper, June.
- Sturgeon, T. J. and J. V. Biesebroeck (2011)**, Global value chains in the automotive industry: an enhanced role for developing countries? *International Journal of Technological Learning, Innovation and Development*, Vol. 4, Nos. 1/2/3.
- Sturgeon, T and R. Florida (2004)**, Globalization, deverticalization, and employment in the motor vehicle industry, in M. Kenny with R. Florida (eds.): *Locating Global Advantage: Industry Dynamics in a Globalizing Economy*. Palo Alto, CA: Stanford University Press.
- Sutton, J. (2004)**, The Auto-component Supply Chain in China and India - A Benchmarking Study, London School of Economics and Political Science. February.
- Sturgeon, T. J., Memedovic, O., Van Biesebroeck, J., and G. Gereffi (2008)**, Globalisation of the automotive industry: main features and trends. *International Journal of Technological Learning, Innovation and Development*, 2(1-2), 7-24.
- Taglioni, D. and D. Winkler (2016)**, *Making Global Value Chains Work for Development*. World Bank Group.

TIFAC (2006), FDI in the R&D Sector: Study for the pattern in 1998-2003, Report prepared by Academy of Business Studies, New Delhi.

Tiwari, R., Herstatt, C., and M. Ranawat (2011), Benevolent Benefactor or Insensitive Regulator? Tracing the Role of Government Policies in the development of India's Automobile Industry, East West Center, Policy Studies 58.

Tiwari, R., and C. Herstatt (2014), *Aiming big with small cars: Emergence of a lead market in India*. Springer Science & Business Media.

Tiwari, R. and K. Kalogerakis (2017), Innovation Pathways and Trajectories in India's Auto Component Industry, Hamburg University of Technology (TUHH) Institute for Technology and Innovation Management, working paper 98.

Tyabji, N. (2014), From the Phase Manufacturing Programme to Frugal Engineering; Some Initial Propositions, ISID Working paper, 171.

UNCTAD (2010), Integrating Developing Countries' SMEs into Global Value Chains. New York and Geneva: United Nations.

UNCTAD (2013), Global Value Chains: Investment and trade for development. World Investment Report, United Nations Press, New York and Geneva.

UNCTAD (2018), Investment and New Industrial Policies, World Investment Report, United Nations Press, New York and Geneva.

UNIDO (2015), 'Local Innovation and Global Value Chains in Developing Countries', Inclusive and Sustainable Industrial Development Working Paper Series, Working Paper 05.

World Economic Forum (2017), Technology and Innovation for the Future of Production: Accelerating Value Creation, White Paper.

Media Articles

- 'Tata Motors unveils new brand identity' (2017). AutoCar India. August 21.
- 'India's Traffic Is So Bad It's Changing the Cars People Buy' (2017). Bloomberg. P R Sanjai. September 11.
- 'Tata Motors arm TAL to partner with Italy's RTA for robot components' (2017). Business Standard. April 13.
- 'Two firms will also collaborate to churn out new variants and applications of TAL Brabo robot' (2017). Business Standard. April 13.
- 'Tata Motors awarded for contribution to Skill India Mission' (2017). Business Standard. May 30.
- 'Why car recalls are spiking in India' (2016). Business Standard. Ajay Modi. June 15.
- 'Going, Going, Gone: Automation can lead to unprecedented job cuts in India' (2017). Business Today. June 18.
- 'Top 5 Popular Car Brands In India' (2017). Car and bike, NDTV. Ameya Naik. April 22.

- ‘5 most recalled car brands in India’ (2016). Deccan Chronicle. May 4.
- ‘Tata Motors to invest Rs 4000 cr; aims to be 3rd largest CV maker globally’ (2017). ET Auto. May 31.
- ‘Ford EcoSport 2017 unveiled in India, receives technology, engine and feature updates’ (2017). First Post. October 26.
- ‘Disruptions in the global automotive industry: Solutions from India?’ (2017). Forbes. September 14.
- ‘Honda City Surpasses 7 Lakh Unit Sales Milestone in India’ (2017). India. Charanpreet Singh. October 30.
- ‘Why Suzuki and Toyota’s new partnership is a huge deal for India’s electric vehicle dream’ (2017). Quartz India. Devjyot Ghoshal. November 20.
- ‘Biggest restructuring? Tata Motors shrinking structure of its white-collar workforce’ (2017). The Economic Times. Ketan Thakkar. January 23.
- ‘15 years and still counting: Scorpio most successful SUV of Mahindra & Mahindra’ (2017). The Economic Times. Lijee Philip. July 11.
- ‘Robots at the wheel: Machines increasingly replacing manual workers in auto plants in India’. (2015). The Economic Times. Lijee Philip. December 01.
- ‘Law to be introduced to regulate automobile product recalls in India’ (2017). The Economic Times. Zakir Merchant. April 17.
- ‘Tata Motors arm launches Made-in-India robot’ (2017). The Hindu Business Line. April 12.
- ‘New Ford EcoSport vs Maruti Suzuki Vitara Brezza vs Tata Nexon’ (2017). The Times of India. Naveen Soni. November 11.
- ‘2.24 million cars recalled in India in the past four years’ (2017). Livemint, Amrit Raj. 29 November.
- ‘Product Recalls Rise With Better Detection and Fewer Suppliers’ (2016). The New York Times. Stacy Cowley. May 29.

Websites

<https://www.investindia.gov.in/>

<http://www.makeinindia.com/>

<https://microlinks.org/good-practice-center/value-chain-wiki/types-upgrading>

<http://www.siamindia.com/>

<http://www.skilldevelopment.gov.in/nationalskillmission.html>

<https://www.team-bhp.com/news/santro-car-built-company-bvr-subbu>

LATEST ICRIER'S WORKING PAPERS

NO.	TITLE	AUTHOR	YEAR
359	THE ROLE OF WATERWAYS IN PROMOTING URBAN RESILIENCE: THE CASE OF KOCHI CITY	ZEB A ZIZ INDRO RAY SANDEEP PAUL	MAY 2018
358	TOWARDS SUSTAINABLE, PRODUCTIVE AND PROFITABLE AGRICULTURE: CASE OF RICE AND SUGARCANE	ASHOK GULATI GAYATHRI MOHAN	APRIL 2018
357	SUPPORTING INDIAN FARMERS: PRICE SUPPORT OR DIRECT INCOME/INVESTMENT SUPPORT?	ASHOK GULATI TIRTHA CHATTERJEE SIRAJ HUSSAIN	APRIL 2018
356	SOLID WASTE MANAGEMENT IN INDIA AN ASSESSMENT OF RESOURCE RECOVERY AND ENVIRONMENTAL IMPACT	ISHER JUDGE AHLUWALIA UTKARSH PATEL	APRIL 2018
355	CHANGING TASK CONTENTS OF JOBS IN INDIA: IMPLICATIONS AND WAY FORWARD	PANKAJ VASHISHT JAY DEV DUBEY	MARCH 2018
354	TRADE RULES IN E-COMMERCE: WTO AND INDIA	ARPITA MUKHERJEE AVANTIKA KAPOOR	MARCH 2018
353	SCALING UP ROOFTOP SOLAR POWER IN INDIA: THE POTENTIAL OF MUNICIPAL SOLAR BONDS	SAURABH TRIVEDI INDRO RAY GREGOR VULTURIUS AMRITA GOLDAR LABANYA PRAKASH J SANDEEP PAUL AARSI SAGAR	MARCH 2018
352	CROP INSURANCE IN INDIA: KEY ISSUES AND WAY FORWARD	ASHOK GULATI PRERNA TERWAY SIRAJ HUSSAIN	FEBRUARY 2018
351	DEMONETISATION – A GOLDEN OPPORTUNITY FOR WIDENING THE TAXPAYER BASE	RAJIVA RANJAN SINGH ANANDITA BAGCHI	JANUARY 2018
350	TRADE FACILITATION MEASURES TO ENHANCE WOMEN'S PARTICIPATION IN CROSS-BORDER TRADE IN BBIN	NISHA TANEJA SANJANA JOSHI SHRAVANI PRAKASH SAMRIDHI BIMAL	JANUARY 2018
348	WAITING FOR JOBS	RADHICKA KAPOOR	NOVEMBER 2017

About ICRIER

Established in August 1981, ICRIER is an autonomous, policy-oriented, not-for-profit, economic policy think tank. ICRIER's main focus is to enhance the knowledge content of policy making by undertaking analytical research that is targeted at informing India's policy makers and also at improving the interface with the global economy.

ICRIER's office is located in the institutional complex of India Habitat Centre, New Delhi. ICRIER's Board of Governors include leading academicians, policymakers, and representatives from the private sector. Dr. Isher Ahluwalia is ICRIER's chairperson. Dr. Rajat Kathuria is Director and Chief Executive.

ICRIER conducts thematic research in the following eight thrust areas:

- Macroeconomic Management Financial Liberalisation and Regulation
- Global Competitiveness of the Indian Economy–Agriculture, Manufacturing and Services
- Multilateral Trade Negotiations and FTAs
- Challenges and Opportunities of Urbanization
- Climate Change and Sustainable Development
- Physical and Social Infrastructure including Telecom, Transport Energy and Health
- Asian Economic Integration with focus on South Asia
- Skill Development, Entrepreneurship and Jobs

To effectively disseminate research findings, ICRIER organises workshops, seminars and conferences to bring together academicians, policymakers, representatives from industry and media to create a more informed understanding on issues of major policy interest. ICRIER routinely invites distinguished scholars and policymakers from around the world to deliver public lectures and give seminars on economic themes of interest to contemporary India.

