Automotive in South Asia

From Fringe to Global

Extended Version of the Industry Case Study Done for:

South Asia's Turn

Policies to Boost Competitiveness and Create the Next Export Powerhouse

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SELECTED ABBREVIATIONS AND ACRONYMS

ACMA	Auto Components Manufacturing Association
ASDC	Auto Skill Development Corporation
ASI	Annual Survey of India
CAGR	Compound Annual Growth Rate
CAM	Computer Aided Machining
CBU	Completely Built Unit
CII	Confederation of Indian Industries
CST	Central Sales Tax
CV	Commercial Vehicle
DIPP	Department of Industrial Policy & Promotion
EFQM	European Foundation for Quality's Business Excellence Model
EOU	Export Oriented Unit
EPZ	Expert Processing Zones
FDI	Foreign Direct Investment
FICCI	Federation of Indian Chambers of Commerce and Industries
GST	Goods and Services Tax
GVC	Global Value Chain
HEEAP	Higher Engineering Education Alliance Program
ICRA	Investment Information and Credit Rating Agency of India
MoMSME	Ministry of Micro, Small, and Medium Enterprises
NATRIP	National Automotive Testing and R&D Infrastructure Project
OEM	Original Equipment Manufacturer
OICA	*Organisation Internationale des Constructeurs d'Automobiles*
PAAPAM	Pakistan Association of Automotive Parts and Accessories Manufacturers
PPM	Parts (of defects) per million
PPP	Public Private Partnership
QCI	Quality Council of India
SIAM	Society of Indian Automotive Manufacturers
SME	Small and Medium Enterprises
SPV	Small Passenger Vehicle
TC	Technology Collaboration
TCSP	Technology Center System Project
TFP	Total Factor Productivity
TIDZ	Technological Industrial Development Zone
TVET	Technical Vocational Education and Training
VAT	Value Added Tax

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Executive Summary

The automotive sector is one of the most important industries globally and in South Asia, contributing 19 million of direct and indirect jobs in India alone. The study uses experience of India and Pakistan, two of the biggest markets in South Asia, to understand key trends for the region.

The potential for South Asia to become globally competitive in this sector is shown by the experience of Indian auto-parts manufacturers who became world leaders by having first acquired technical and managerial skills from leading original equipment manufacturers (OEMs) established in India, followed by a process of serving increasingly discerning customers in competitive export markets. Although level of investment in R&D remain low, a few leading global manufacturers are moving their R&D centers to India pointing to the region's potential to be at the heart of the technological revolution taking hold in this critical industry with important ramifications to many others—e.g. electronics, machining and tooling.

The challenge for the region is two-fold. First, to spread these world class firm capabilities throughout the industry, from OEMs and tier 1s to tier 2 and tier 3 suppliers. In effect, large productivity gaps persist in the sector, with most OEMs (together with their suppliers) having subscale/fragmented operations with low capacity utilization, quality levels and investments in skills below international benchmarks. A second—and connected—challenge is moving up the global value chain through greater innovation, investment in R&D and commercialization of new products which remain below global average, with local suppliers primarily relying on build to print models.

Policies such as high import tariffs on completely built units (CBUs) of passenger cars, which helped attract market-seeking OEMs in the 1990s and 2000s, are now slowing down the spread of world class managerial good practices. The situation is worse in Pakistan than India because only a few OEMs are "competing" behind even higher import tariffs on both CBUs and auto-parts. The experience of the Indian auto parts and commercial vehicle sectors shows that a gradual reduction of import tariffs, far from leading to the debilitation of an industry, could be a powerful catalyst to its global success. Converging towards international environmental and safety standards, as the Indian government is planning to do, would further encourage automotive firms in South Asia to adopt (and contribute to) international good practices. These reforms complemented with continuing to ease the trade-logistics barriers within India which contribute to the fragmentation of the industry and raise operational costs; providing assistance to help small and medium enterprises (SMEs) develop linkages to value chains and clusters, to improve their operations; and, supporting programs for innovative design and R&D activities in the value chain will enable the region to fulfill its great potential in this key and rapidly globalizing industry.

The automotive sector in South Asia is now ready to move from a 'domestic growth under protection' model to a more sustainable 'productivity driven global growth' model.

1. Motivation and methodology

The auto sector -including the auto parts industry- is a key contributor to jobs and economic growth in India and Pakistan. The Indian automotive sector is one of the top five industries in the economy in terms of factory gross value,[1] is the sixth largest producer of vehicles globally, attracted US$12.3 billion of cumulative foreign direct investment (FDI) between 2000 and 2015,[2] and supported 19 million people in direct and indirect employment in 2012. Pakistan's auto industry is the sixth largest manufacturing subsector; the passenger cars segment alone provided employment to 2–3 million people directly and indirectly[3] (the market for, and employment in, auto parts may be under estimated because of the large presence of informal firms).[4]

This case study focuses on the automotive sector in India, and to a lesser extent, Pakistan (the two main automotive producers in the region). It focuses on the auto value chain, including OEMs (assemblers and final customers in manufacturing), Tier 1 firms (typically large firms who play the role of integrators and supply critical components), Tier 2 firms (suppliers of individual parts to Tier 1s and OEMs), and Tier 3 firms (raw material providers). It excludes services aspects of the value chain, such as dealer networks and after-service as the focus is on design and manufacturing activities. The paper focuses on passenger cars, which has by far the largest share of the vehicles markets, but it touch on commercial vehicles (India) as well as motorcycles and tractors (Pakistan) where useful. China, and in a limited number of cases Korea and Vietnam, are used as comparators.

2. Performance of the auto sector in India and Pakistan

Although the sector experienced rapid growth in both India and Pakistan in the 1990s and 2000s, growth has markedly slowed down in recent years, exports remain only a small fraction of production, and productivity is well below levels in East Asian countries, including China. In the next section, the paper discusses the performance of the sector with regard to output, trade, and productivity.

2.1 Output

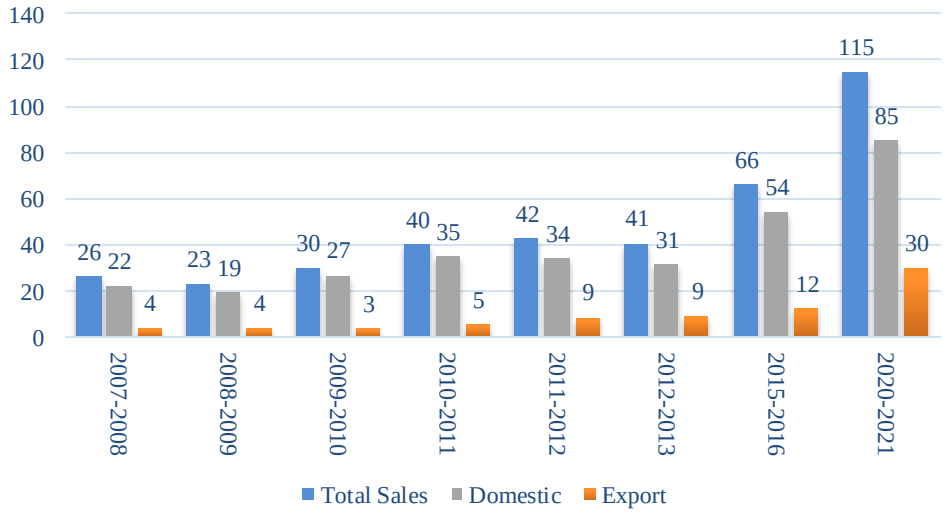
A combination of size, growth, potential, and protection has made India one of the most attractive auto markets in the world, and several global OEMs from East Asia, Europe, and the United States have installed production bases in the country. The Indian auto industry grew at a compound annual growth rate (CAGR) of 11–15 percent between 2005 and 2015, with a marked slowdown since 2012. By volume, India ranks sixth among the world's markets for four wheelers, second for two wheelers, and eighth for commercial vehicles. In 2013, India claimed around 4 percent of global car production, the largest segment by value and volume,[5] and captured 9.3 percent of total growth in the auto industry from 2005-13. Although this is impressive considering past performance, China achieved a 26 percent share of global production in auto and accounted for over 80 percent of the growth during this period.[6] With penetration rates in India 50 percent of China's levels, a growing middle class, incomes improving faster than car prices,

[1] SIAM and BCG Report 2013.
[2] Annual Survey of India (ASI) 2012–2013; Statistics from Department of Industrial Policy and Promotion (DIPP) 2015.
[3] Presentation on "Regional Competitiveness Study on Auto Sector," Institute of Development and Economic Alternatives 2015.
[4] Pakistan does not appear in the top 40 producers of OIAC ranking.
[5] SIAM Statistics Report 2015; ACMA Presentation 2014.
[6] LeBeau 2014.

new investments in infrastructure and other favorable demand drivers, there is significant potential for further growth in India's automotive sector.

Auto parts in India increased by 11 percent a year from 2010-2015, with 70 percent of production coming from the organized sector and a rising share of exports.[7] This submarket grew in absolute terms and in trade flows following the gradual reduction of import tariffs in 1990s. Size estimates of the auto parts industry vary, but it was estimated at around US$20 billion–US$41 billion in 2013, which is a large share of the overall auto market (see Figure 1).[8] The total number of auto parts producers is over 2,500, out of which 500–600 are in the organized sector and contribute to 70% of production (including exports).[9] Remaining production capacity served after-markets and commoditized parts markets, which are typically less demanding on quality standards. The Indian auto parts sector is characterized by a few large players that can produce at export quality, while functioning in a sea of highly fragmented, organized and unorganized firms.

Figure 1: Auto parts sales in India (in US$, billions)



Source: ACMA, SIAM Reports (2013-2015)

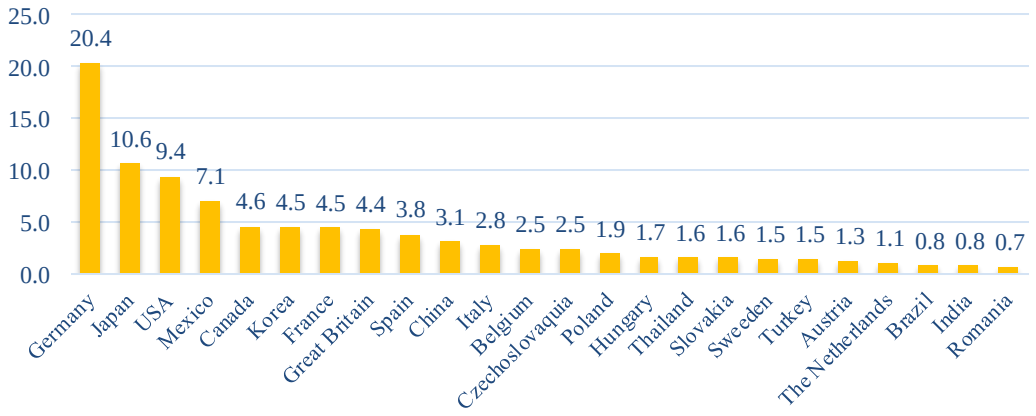
By contrast, the production of passenger cars in Pakistan is at one-third of the Indian level (on a per capita basis) and has been stagnant since 2006. However, motorcycle production has been rising. The penetration for passenger cars is 30-40 percent lower than in India. From a low base, the production of motorcycles has increased tenfold since 2001, reaching 2 million in 2014, since 2005 boosted by the entry of new firms, including Chinese 'clones.' However, Pakistan's motorcycle market is still being mainly supplied by Honda (50 percent) and a series of local brands. There are about 115 players in this market, and about 80 of them are currently active. Pakistan ranks within the top 10 in the world for motorcycles (in volume).

[7] ACMA Presentation 2014; Narayan, B.G. et al. 2008.
[8] SIAM BCG Report (2013) pegs it at US$20 billion while ACMA figures show it is US$39 billion. It probably falls within this range.
[9] World Bank Enterprise Survey, India 2014. Among the 500+ firms surveyed anonymously in the Enterprise Survey, 60–70% are auto parts firms, remaining includes large OEM players and other firms.

2.2 Trade

The shares of production devoted to exports in the Indian and Pakistani auto sector are low (Figure 2). Even though India is the world's sixth largest auto producer by volume, and auto exports increased at 18 percent per year over 2009-2013, India owns less than 1% of global export markets. This is attributable to India's large domestic market, as it is easier for auto firms to fulfill domestic demand than export (India exported less than 20 percent of its passenger vehicle production in 2013). Among BRIC countries, only China has been able to achieve a substantial share of the global auto markets despite having a large and growing domestic market. The average auto firm in India exported only 5 percent of its total sales, compared to 16 percent in China. However, if we look at only 'exporting auto firms' in India, the share of exports to annual sales rises to 15–16 percent. Intra-region trade for India is not significant, with the closest largest automaker Pakistan being a relatively closed market. Pakistan did not feature in the top 40 exporters in 2014.

Figure 2: Share of exports in production in the automotive sector (in %, 2014)



Source: WITS-UNCTAD, 2014

Auto parts manufacturers have a higher share of exports to production compared to OEMs. Nearly 44 percent of auto parts produced in India is exported, as opposed to less than 20 percent of final cars. Exports of auto components increased by 15 percent a year from 2009-2014, [10] a higher rate than production growth. The OEMs and Tier 1 firms accounted for 80 percent of end customers, indicating high quality demands at the customer end. Less than a decade ago, only 35 percent of parts were going to the OEMs, with the rest going to the after-sale market. Even with this progress, India's share of global auto parts exports is only 1 percent, while China's is 10 percent and Korea's is 2.5 percent, implying a significant potential for further growth.[11]

Import tariff structures are different for auto parts vs. vehicles in India. The bulk of automotive imports are either commercial vehicles or auto parts, which are charged an import duty of 12.5 percent.[12] By contrast, the tariff on completely built units (CBUs) of passenger cars is as high as 60 percent (compared to 25 percent in China, and a mere 7.9 percent in Korea), so that most car imports are premium vehicles

[10] ACMA and McKinsey Report 2014. WITS-UNCTAD puts auto part exports at US$2 billion in 2009 and US$6 billion in 2014.
[11] Ibid.
[12] In the 2015 budget, the government of India increased the import tariff on commercial vehicles to 40 percent to "help boost domestic production."

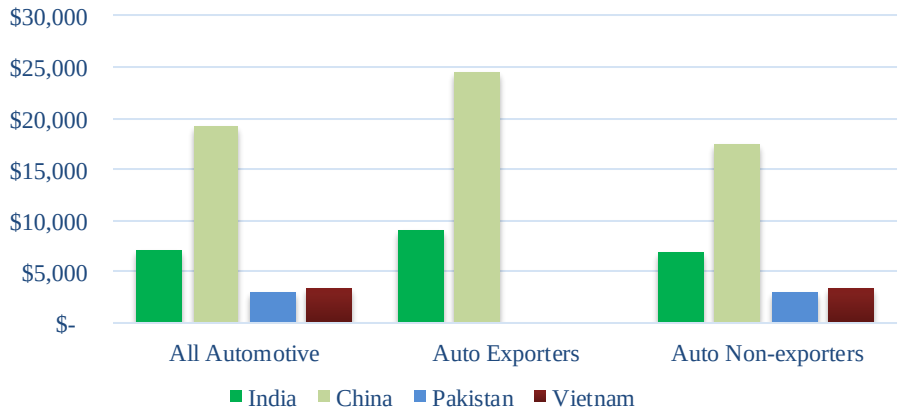
from Germany (41%) and UK (21%). Although imports of auto parts increased from US$8 billion in 2009 to US$13 billion in 2013–2014,[13] the net trade in auto parts has remained constant due to the concomitant rapid rise of exports.

Pakistan has higher import tariffs than India. The import tariff on motor vehicles in Pakistan is 76 percent, compared to 60 percent in India, and the tariff on auto parts is 35 percent, compared to 12.5 percent in India. The simple average tariff on all vehicle imports in Pakistan is 40 percent—almost twice the average nominal tariff rate in India.[14] High tariffs have sharply limited the import of motor vehicles to only US$689 million. While most of the components used for local car manufacturing are imported, motorcycles and tractors largely are built with locally-sourced components because they rely on old technologies. At the same time, high protection has discouraged production for export. Pakistan's most noticeable exports in the broad automotive industry are tractors and auto parts—but at very low levels of US$36 million and US$22 million respectively. Furthermore, most of its exports consist of low value parts for the after-sale markets and tractors relying on old technologies, mostly destined to Afghanistan.

2.3 Productivity

Value added per worker in India's auto sector is higher than in Pakistan, but less than one-third the level in China (Figure 3).[15] China's higher productivity is not only due to its earlier start in developing the auto sector and its higher per capita income (and thus greater investment in automation than the relatively low-wage South Asian countries), but notably higher scale, capacity utilization, and quality. These factors are discussed in greater depth in Section 3. From 1993 to 2004, the growth rate of TFP in China's automotive sector was 6.1 percent per year, compared to only 1.1 percent in India, and the growth rate of labor productivity 9.8 percent per year, compared to 3.1 percent. [16]

Figure 3: Value added per worker (US dollars) [17]



Source: World Bank Enterprise Surveys (India 2014; China 2012; Pakistan 2013, and Vietnam 2009)

[13] Ibid.
[14] TRAINS database, downloaded from WITS-UNCTAD, September 28, 2015.
[15] World Bank Enterprise Survey, India 2014, which surveyed over 500 auto firms, including both OEMs and suppliers; World Bank Enterprise Survey, China 2012.
[16] Bosworth, B and Collins. S.M. 2008. "Accounting for growth: Comparing China and India," *Journal of Economic Perspectives*, 22 (1) (2008).
[17] The sample size for exporting firms in Pakistan and Vietnam is too small to give us figures for value added.

Size, export orientation, and share of foreign ownership of auto firms are positively associated with productivity in both India and Pakistan. The relationship between size and productivity, which is expected in the capital-intensive auto sector, is confirmed by the economic literature and field interviews in both countries.[18] Large auto firms in the two countries are able to achieve economies of scale, start captive skill development centers for managerial training, and spend more on innovation and R&D. Size is so critical in this sector that leading firms choose to locate close to their buyers to receive 'repeat, big orders', expand into international markets and follow a 'few models, high volume' strategy to achieve scale. However, in both India and Pakistan, restrictive labor regulations (firing laws), rigidities across labor markets and policies that influence size considerations, have contributed to a concentration of small and medium firms that neither grow nor exit the market. Exporting firms, most of which are large, also have higher productivity than firms producing for the local market (see section 3). Finally, foreign-owned firms tend to have greater access to advanced technology, which can provide an edge in productivity. Leading firms report that alliances with foreign firms through technological collaboration and/or joint ventures provide access to new technical knowledge. Please see Table 4 in the Annex for further details.

3. Drivers of competitiveness (productivity) within and across firms

As the impact of labor and capital market rigidities on South Asian manufacturing have already been covered in the economic literature, this section will focus on firm-based and across-firm determinants of competitiveness. This section considers scale and capacity utilization, quality, skills, and innovation as drivers of competitiveness within firms, and spatial arrangement/clusterization and linkages to GVCs as drivers of competitiveness across firms. The mechanics behind these drivers will be illustrated via evidence collected from semi-structured surveys and primary interviews with the middle management, senior executives and plant-level technical staff of leading suppliers that managed to scale, innovate and get linked to GVCs. Motherson Sumi Ltd. (MSSL) and Bharat Forge are Tier 0.5/1 integrators that feature among the top global suppliers from India. Sandhar Technologies (Sandhar) and Hi-Tech Gears Ltd. (HTGL) are Tier 2 component suppliers that are leaders in their product categories. A more granular understanding of how leading firms succeeded is provided in boxes in the following section and may provide useful lessons for how policy can foster success in similar contexts.

3.1 Scale manufacturing and capacity utilization to reduce costs

Scale and capacity utilization at the plant level are critical to success in capital-intensive industries. In the auto sector, large firms (e.g. Maruti Suzuki and Hyundai in India) tend to be more profitable and resilient to downturns than less scaled firms. We consider OEMs separately from auto parts suppliers, given that they face different import tariffs. With the exception of commercial vehicles, the products of OEMs are protected by import tariffs of 60% in India and 80% in Pakistan, while tariffs for the auto parts market were reduced from 60% to a current rate 12-20% in India, but remain high in Pakistan.

3.1.1 OEMs

Despite the importance of size for competitiveness in the auto sector, most OEMs in India and Pakistan operate below efficient scale. Only four of the 18 OEMs operate at the industry standard for efficiency of 100,000 units per model. Most OEMs who are 100 percent foreign-owned started by

[18]. Economic literature that links size to productivity for India includes Bollard et al (2011) and Francis (2015).

introducing existing models as a quick go-to-market strategy. Introducing an existing model was 10–15 times cheaper (and many times faster) than investing in new design. For the most part, these models were mid-range or premium cars rather than high volume segments. Operating below optimum line capacity reduced profitability over time. In contrast, Maruti went for a *few models-high volume* strategy: at least 3 Maruti models achieve more than 200,000 units annually and are profitable. Hyundai, Honda, and Mahindra & Mahindra also have managed to cross the 100,000 break-even mark. Except for tractors, Pakistan suffers from subscale production and low capacity utilization in all segments. By contrast, in China, 25 out of 27 OEMs are functioning above this level. In 2014, 47 models were produced at annual volumes higher than 100,000 units, including 22 models at more than 200,000 units[19].

To make matters worse, capacity utilization is low in many OEMs. India produced around 4 million cars in 2013, compared to production capacity of 6 million. Bullishness about the Indian market is revealed in actions of companies like Ford, which despite losing around US$250 million in 2013**,** plans to invest US$1 billion in Gujarat for a new vehicle assembly plant.[20] A combination of excess capacity—exacerbated by a marked slowdown in demand since 2013—multiple models and fragmentation of these market segments has reduced profitability for global OEMs. In a bid to improve utilization rates, Volkswagen started using India as an export hub for Mexico—just to keep the plant operating at 75 percent levels.[21] GM announced they would shut down factories in India as they recorded one of their biggest losses in FY14: ~US$600 million.[22] Accumulated losses by GM were equivalent to the cost of setting up a car factory in India. Maruti, Honda, and Hyundai were the few OEMs that operated at efficient scale in 2014-2015 (see Table 1). Capacity utilization among the OEMs in Pakistan is below 50 percent, and scale is small as the total production capacity (280,000 units) is spread over 3 OEMs and 6 model platforms (see Table 2).

Table 1: Volume and capacity utilization of OEMs in India

Companies	Production capacity (in units)	Current capacity utilization (in percent)	Planned expansion (in units)	Timeline	Total investments (in rupees crore)	Exports (in units)
Maruti Suzuki	1,500,000	86.16	1,500,000	2017	37,000	121,701
Hyundai	700,000	87.41		Installed	9,471	191,221
Honda cars	240,000	82.27	60,000	2016	385	8,398
Mahindra	545,000	42.35	200,000	N/A	4,000	6,842
Ford	200,000	78	240,000	2016	6,200	81,703
Toyota	310,000	51.28		Installed	5,920	17,650
Fiat-Tata	200,000	5.2		Installed	4,113	39
Volkswagen	200,000	55		Installed	3,865	69,994
General motors	282,000	19			12,000	2,011
Hindustan motors	63,000	N/A		Installed	465	0
Mahindra Reva	30,000	N/A		Installed	N/A	N/A
Mercedes-Benz	20,000	N/A		2020	1,200	N/A
Tata motors	500,000	33		Installed	6,000	3,757
Skoda-Audi	40,000	37.5 (Skoda)		Installed	888	0
BMW India	14,000	N/A			180	N/A
Isuzu	120,000	N/A		2017	3,000	0

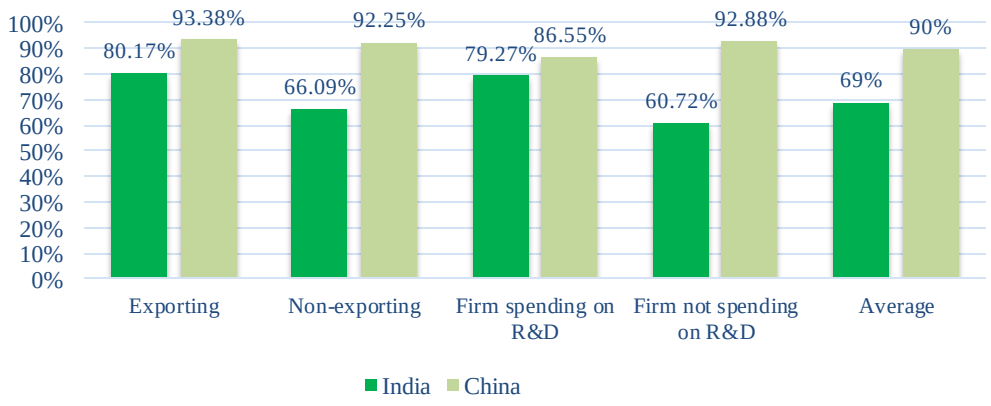
[19] Maruti Suzuki Annual Reports (till 2015). Accessed on Aug 3rd 2015 from www.marutisuzuki.com
[20] Vats 2014.
[21] Raj 2015. Roughly 50 percent of production out of VW's Pune plant is destined for exports this year
[22] Ibid.

Total	**4,964,000**		**2,000,000**		**253,350**	**622,470**

Table 2: Capacity utilization in key automotive categories in Pakistan[23]

	Capacity (Units)	Rate of Utilization (%)
Assemblers		
Cars	279,040	43.6
Motorcycles/Rickshaws	2,165,000	69.1
Tractors	67,000	110.2
Trucks/Buses	10,800	40.3

Figure 4: Share of firms with capacity utilization greater than 75% (India, China)



Source: World Bank Enterprise Surveys (India 2014; China 2012)

Indian and Pakistani firms achieve lower capacity utilization than their Chinese counterparts. Less than 70 percent of auto firms in India report capacity utilization rates of above 75 percent, while over 90 percent of Chinese auto firms exceed this level (figure 4). The gaps between China and India are smaller for exporting firms and for firms that invest in R&D. Local firms that do not export or do not invest in R&D have much lower capacity utilization than their Chinese counterparts.[24]

3.1.2 Auto parts suppliers

In India, more suppliers than OEMs have achieved efficient scale, high levels of capacity utilization, and participation in export markets. Typically, low capacity utilization among OEMs in a vertically-integrated industry like automobiles is reflected in low capacity utilization among suppliers. In India, however, low tariffs on imported auto parts encouraged (or sometimes, compelled) suppliers to expand their footprint in export markets to diversify customer risk and acquire new technologies.

[23] PAMA (http://www.pama.org.pk/home/members), APMA (http://www.motorcycleexport.com/) Presentation on Automobile Sector EDB.

[24] In the Enterprise Survey, it is not possible to separate firms by size due to sample size issues. However, there is significant overlap between export firms and size (large to medium).

Leading suppliers sought to reduce the buying power of their Indian OEM customers by diversifying through exports. For instance, in the 1990s, almost all of Motherson Sumi's (MSSL) turnover was bought by Maruti. MSSL decided to diversify its risk so that "No single customer, country, or component constitutes more than 15 percent of the turnover." Maruti, which had 85 percent of the total Indian market in the 1990s, now has less than 5–6 percent[25]. Bharat Forge followed a different strategy of investing in non-auto sectors such as oil and gas, railways, power, and defense, among others.[26] In 2013, revenue from non-auto sectors in India was close to 40 percent of the total. In addition, both MSSL and Bharat Forge acquired and set up subsidiaries in sophisticated auto markets outside India (for example, Germany). In a large domestic market with few OEMs, Hi-Tech Gears Limited (HTGL) also realized it stood the risk of getting locked in to one customer, and started to diversify.

Diversification to exports may have improved profitability. According to a study of 95 Indian auto suppliers, firms in which exports accounted for a large share of sales from 2005 to 2013 achieved a significant rise in profits, while firms that did not export, or where the share of exports was low, saw a sharp fall in profits (Table 3). Field surveys confirm that diversification not only helped to manage volatility in local markets, it also helped these firms increase productivity.

Table 3: Change in gross margins of Indian auto part suppliers (2005 to 2013) [27]

Export as % of firm sales (2013)	> 40	15–40	< 15
Change in gross margin for auto supplier in India (2013-2005) %	+13	−29	−41

The reduction in import duties on inputs enabled some leading suppliers to begin exporting. Sandhar initially focused on increasing the volume of production, largely for the domestic market. "Building exports was expensive for a small company like ours. It meant learning what those customers want. We had to invest in it through exhibitions, a legal framework, prototypes, travel, and technology. Inputs were expensive." The decline in import duties enabled Sandhar to improve quality and reduce costs through importing intermediate inputs, which helped to overcome some of the fixed costs of exporting[28].

Many auto-parts suppliers achieved increases in production by serving sophisticated markets. Instead of increasing sales through aftermarkets, these firms competed in export markets. "Many players at that time went into aftermarkets because barriers to entry were low and there was promise of high margins, but we avoided this route like the plague." shared the MSSL senior executive. Working for a demanding customer meant that the firm was forced to be efficient, adopt international standards, and keep costs down.[29] For Bharat Forge, exports started as early as 1995 to the former USSR. They focused on forging technologies. "Exports challenged us to design, develop, manufacture, and supply products to discerning

[25] Motherson Sumi Systems Ltd. Reports (till present). Accessed on Aug 3rd from www.motherson.com
[26] http://auto.economictimes.indiatimes.com/news/industry/how-baba-kalyani-is-making-bharat-forge-diversify-into-non-auto-segments/31512531#./31512531?&_suid=144493277640507828256693732645.
[27] ACMA and Mckinsey 2014—percent change on EBITDA on index of 100 in 2005.
[28] http://www.businesstoday.in/magazine/special/indian-firms-key-suppliers-of-car-components/story/21374.html .
[29] http://forbesindia.com/article/work-in-progress/how-motherson-sumi-became-a-giant-auto-parts-manufacturer/34693/1.

customers in global markets. This in turn motivated us to scale up the value chain and adopt new technologies," said the Bharat Forge senior executive.

Exporting has been the key to productivity and growth. Essentially, firms that chose to ramp up production for export markets with demanding customers were able to diversify their customer base, achieve scale and improve efficiency. For several others, lack of scale and low capacity utilization among OEMs - and to an extent among auto-part suppliers - limited the scope for new technology adoption/automation, with increasingly detrimental effects on innovation, design capabilities quality and skills as one goes down the value chain.

3.2 Focus on innovation, design, and R&D

Firms that invested in the early acquisition of technology through alliances were better positioned to participate in GVCs (Box 1). Local firms who have become global suppliers cite investments in design capability as a key asset**.** Local Tier 1s who did not enhance design capabilities have begun to lose ground to those who became single source suppliers to global OEMs, as design and contract allocation becomes increasingly centralized and subcontracting of tasks increases. Markets in Slovak Republic, Brazil, and Poland have already witnessed a demotion of local Tier 1s into Tier 2s and Tier 3s. Global OEMs now expect design capabilities from firms at all levels of the value chain, because subcontracting makes sense only when the supplier can be held responsible for entire modules of tasks. During interviews, global Tier 1s mentioned that design capabilities are becoming critical factors in selecting Tier 2 subcontractors. Indeed, the global auto supply chain that was traditionally organized in tiers is facing a restructuring. Erstwhile Tier 1s are becoming *large* global firms, either specialized in complex systems or as integrators of several simpler subsystems, constituting formation of a 'Tier 0.5.' They are expected to have substantial responsibility in the design of these systems and to coordinate the supply chain necessary for their manufacturing and assembly[30]. In turn, firms that supply to the Tier 0.5s also need to take on design responsibilities for their submodules or components to become preferred partners. With a few exceptions, firms in India and Pakistan are not demonstrating sufficient and quick uptake of design capabilities, which is likely to impair their competitiveness and ability to link to GVCs.

[30] Veloso and Kumar 2002.

Box 1: Leading firm case - Alliances for early investments in design and innovation

Breaking into GVCs requires technological innovation and high level design capabilities. It takes either a proven track record or knowledge of key technology to land a contract. After focusing primarily on supply of parts to Hero Honda for four years, HTGL wanted to acquire the technology necessary to diversify into exports. HTGL began a technical collaboration arrangement with Musahi (Honda Motors, Japan) to learn the new technologies involved in *precision forging*. It entered into a joint venture with GETRAG in the United States to manufacture timing gears (which had the advantage of GETRAG's experience and access to American machines) and became a manufacturer of parts for Cummins from the United Kingdom, replacing their previous supplier. They started manufacturing for the TATA Cummins' unit in India, and now they produce for firms in Germany and the UK.

Leading firms became expert at absorbing the technology required to expand production of related products. Sandhar and MSSL began to produce inputs into their existing products to upgrade and expand their product lines. For instance, if they were making interior locks and needed zinc parts, Sandhar would improve their ability to work with zinc. "If we do a good job with locks, we would suggest we could handle their plastic needs. We had already built trust with the customer. That way, even if we haven't made that product before, they would give us the order," said the senior executive at Sandhar. Once MSSL had acquired a new technology and delivered to the customer, management would ask their engineers, "What more could we do with it? What would that take?" MSSL expanded from basic plastic components to building tooling and injection molding machines, to deliver complex plastic products. MSSL initially imported wires for their wire harness products, but then started to buy copper to manufacture wires. This allowed them to increase sales to existing customers and enter new products.

Some firms found it profitable to adapt technologies through collaboration with leading OEMs, while others developed new technologies in-house. For those who took the alliance route, continuity in technology upgrades proved challenging. Some firms managed to upgrade their design capabilities. Bharat Forge is an example of a leading firm that has managed to break into design, engineering, R&D, testing, and other higher value-added services. In 2000, the company established an in-house R&D team to produce lightweight products which would enable lower energy consumption across business lines. "Some products that were largely imported, we can do it in house now," said the senior executive. Many small firms have found it challenging to develop integrated design and engineering functions. Sandhar would like to focus more on design and R&D. "We cannot say we have very meaningful R&D internally. It is an area for us to grow as its becoming more important." Leading firms are all committed to improving technology through R&D, but approaches differ.

Source: Author's interviews with firms during fieldwork

While the importance of design capability is rising, investment in R&D and commercialization of new products in India remain below the global average, and local suppliers rely primarily on build-to-print models. In most cases, specifications are provided by the customer and the execution is done by the local firm. Design abilities are closely linked to a firm's R&D capabilities. The average expenditure on R&D in Indian auto firms ranges between 0 percent and 2 percent of sales, which is much lower than the global average of 4.7 percent[31] (see Figure 5 and Figure 6). Interestingly, although R&D expenditures by firms in China are higher than in India, the difference is insignificant, indicating that China may also need to ramp up R&D. During field interviews, firms appreciated the importance of R&D for the sector, but very few had factored in increases in R&D outlays in their budget for the next fiscal year or were licensing technology from foreign firms. Many firms expected more support from the government on R&D. At the same time, foreign companies such as BMW, Mercedes, Renault-Nissan, Volvo, GM, and Honda have been

[31] Odgers Berndtson Search Intelligence 2014. Some of the expenses on Indian R&D are made to avail the tax/depreciation benefits of 200 percent, according to an auto supplier interviewed in Noida.

exploring using India to set up R&D centers, in which intellectual property rights associated with the research would typically reside with the mother company overseas.

Figure 5: Expenditure on R&D (% of sales) in India

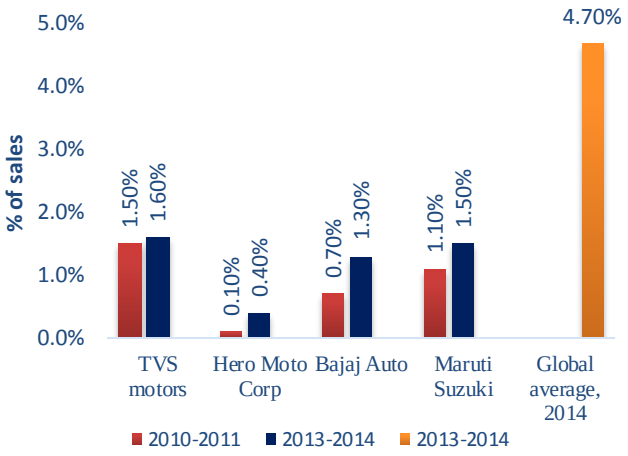
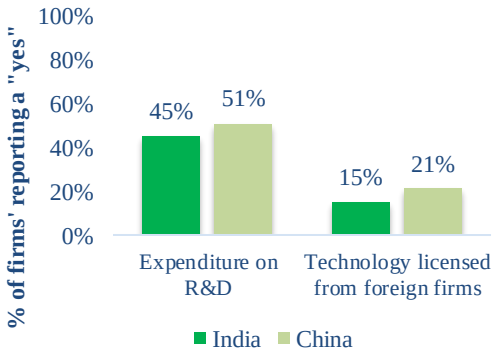


Figure 6: Expenditure on R&D (India, China)



Box 2: Leading firm case - Strong governance frameworks with GVC partners for technical collaborations

Strong governance frameworks with innovation partners helped to manage complex, geographically diverse relationships. As their global activities expanded, MSSL, and Bharat Forge confronted some of the costs of cross-border collaboration: greater diversity in teams, frictions generated by cultural differences, and more complexity and costs involved in coordinating tasks. "The auto industry in India at that point was rife with examples of estranged partnerships and dysfunctional JVs," said the senior executive at MSSL. MSSL managed to deepen its technical collaborations with other firms. "We have a clear system of recruitment in the JV based on the business needs. A local who can work smoothly with locals fills the Chief Operating Officer (COO) position. The Chief Technology Officer (CTO) is chosen by our Japanese partner. The Chief Financial Officer (CFO) is a local and the Chief Marketing Officer (CMO) can be anyone," shared the senior executive. JV terms required the partner to put in cash so that it received a share of profits if the company did well. Such arrangements encouraged the tech partner to constantly upgrade its capabilities and share new developments. The senior executive of Bharat Forge said, "Reputation matters in this small community. If you get known as an extractive partner with one Japanese company, forget about partnerships with any other Japanese company."

Source: Author's interviews with firms during fieldwork

3.3 High levels of quality control among Tier 2 and Tier 3 firms

The tightness of quality controls is uneven at the Tier 2 and Tier 3 levels of the supply chain in India and Pakistan. In interviews with over 50 local auto firms in India, it emerged that high rejection rates may reduce profits by as much as 5 percent–7 percent. Internal rejection rates are harder to quantify, as they

need to be gauged during the production process. More than 70 percent of suppliers, mainly Tier 2 and Tier 3 firms, were checking for defects at the end of line with few process controls in place. Site visits revealed that production systems were not set up so that defects could be identified at source and debugging done in time to contain the domino effect of a mistake. In Pakistan, the problem is as bad, or even worse. An analysis done by a global auto expert finds the losses due to a lack of standardized processes, including quality controls, could reduce profits by up to 5 percent (see Table 6 in Annex).

Although some leading Indian suppliers are nearing world class standards, average external rejection rates among suppliers are above industry benchmarks. External rejection rates are easier to measure in terms of parts (or defects) per million (ppm) produced. As external rejection rates tend to be product specific, we draw on the example of seat makers in India.[32] The international best practice standard for seat makers is between 100 and 500 ppm. In India, two-thirds of suppliers were able to achieve these rates, and some of the leading ones are nearing 120 ppm. However at the tail end, one-fifth of suppliers are experiencing rates as high as 1,000 to 2,000 ppm.[33] High levels of defective parts also affect the end customer. External rejection rates are extremely high among Tier 2 suppliers who serve after-markets, where performance and quality requirements are achievable without huge difficulties. India's reliance on after-markets grew by 13 percent per year between 2006 and 2013. As 40 percent of the value added of a car lies in the Tier 2 and Tier 3 segment, the competitiveness of the auto industry depends on its ability to improve quality, deliveries, and competitiveness in these segments.[34]

The lack of authority of on-duty line managers to 'pull the line' in SMEs is partially responsible for high rejection rates. In more than 60 percent of auto firms interviewed, the on-line duty quality manager cannot stop the line at the first sight of a defect, but must gain permission from the SME owner. At the same time, the technical operator did not appear to possess the skills required to fix first-level line issues. Some factory managers mentioned that the use of contract labor and lack of continuity among technical operators made it difficult to develop the skills of the workforce. This led to 'longer learning times and greater reliance' on line managers who were already stretched. As most operators were not multi-skilled, the line manager had few options for replacements if an operator needed a break or fell sick. All these problems resulted in higher than usual line downtimes, longer breaks between changing lines, and lower capacity utilization— yet another issue faced by Tier 2 and Tier 3 firms. However, where the OEMs and Tier 1s worked closely with their Tier 2 and 3 suppliers, quality levels were better.[35]

The share of firms that are very poor performers is larger in India than in China, according to a comparative study by Sutton (2004). Pakistan has similar issues. In India and China, the leading Tier 1s and some Tier 2s are close to world class standards. However, the lack of quality management is driving very low competitiveness in many Indian SMEs. In Pakistan, too, there are many very poor performers, and quality issues are more pronounced than in India due to the low level of competition in the domestic market. Table 6 in the Annex summarizes the findings from the plant-level interviews conducted by an automotive expert with experience in managing plants in Japan, Korea, and China. Lack of scale had a critical impact on the bottom line of OEMs, while lack of standardization in process and quality control as well as unskilled

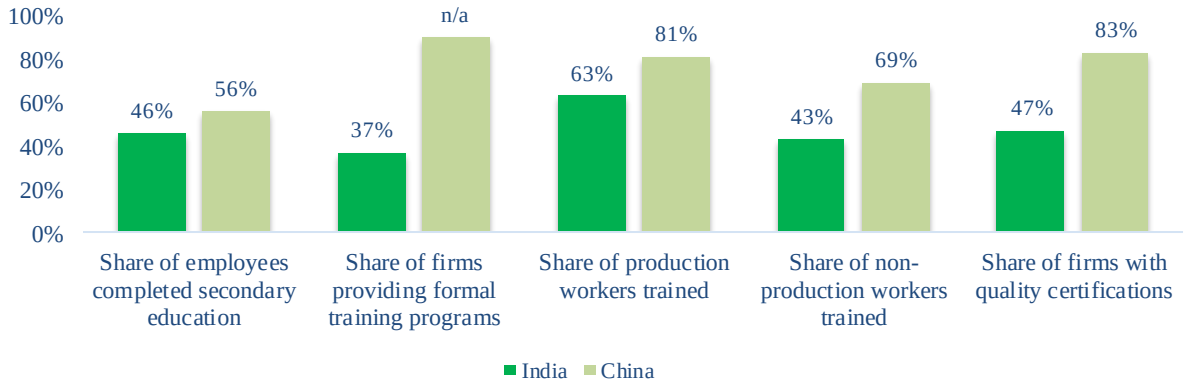
[32] Sutton 2004.
[33] Ibid; Bank site visits to Indian auto clusters in December 2014.
[34] From field interview notes—it is interesting that most of the firms blame their suppliers for high rejection rates, while they also admit that better process planning could partly reduce these defects.
[35] From field interview notes—high line downtime can also be caused by delays in external resources due to lack of reliable transport and infrastructure.

managers posed significant challenges for Tier 2 and 3 suppliers. Tier 1s come out in the middle, and need to be more uniform in achieving both volume and process standardization.

3.4 Investing in skilling of workers and managerial staff

Large skill gaps are prevalent among nonproduction workers, particularly managers. Only 43 percent of nonproduction workers in auto are formally trained in India, compared to nearly 70 percent in China (see Figure 7).[36] According to the CEO of one of the fastest growing Tier 1 exporters, "Skill gaps among managerial staff are a big headache and we have started in-house skilling centers to overcome this issue." A similar strategy was described by other leading firms in India (see Box 3). Only 47 percent of auto firms in India have internationally-recognized quality certification, compared to 83 percent in China. This difference is starker for SMEs, where quality is emerging as a severe constraint on productivity.

Figure 7: Overview of skills in Indian and Chinese firms



Source: Enterprise Survey (India 2014, China 2012)

Although there have been improvements, levels of pre-service and in-service training of auto workers are worse than in comparators. Pre-service training, going back to secondary and primary school education, inculcates important non-cognitive social and behavioral skills such as teamwork, leading, engaging, and managing that affect the overall efficiency of the shop floor. Nearly 60 percent of the full-time permanent employees engaged in the automotive sector in China have completed secondary school. Based on the Barro-Lee Educational Attainment Dataset, 18 percent of India's population has completed secondary education, while only 4 percent has completed tertiary education. India has done well in securing near universal primary education, but the quality of learning outcomes remains a major challenge.[37]

[36] Nonproduction workers include (a) managers and supervisory personnel with responsibilities for the performance of shop floor supervisors; (b) employees in sales, transport management, advertising, credit and collection executives, and purchasing, financing, and legal personnel; and (c) employees on the payroll of the manufacturing firm engaged in the construction of major additions or alterations utilized as a separate work force.
[37] World Bank 2015.

Box 3: Leading firm case- Investment in skilling workers and managerial talent

Leading firms made significant investments in acquiring skilled manpower at all levels to compete in global markets and meet international standards. When asked about their main challenge to growth, the chairman of Bharat Forge said, "*Talent*." Even though there were numerous publicly-subsidized training programs, leading firms invested in their own training programs to ensure a constant supply of talented line managers, business managers, and technical floor-level workers. Bharat Forge developed a system called 'BFL Excellence System' to develop staff and introduce transparent performance management systems, among other goals. "We have leveraged our tie-ups with leading academic institutions to create a strong talent pipeline. Our efforts have resulted in creation of an over 7,000-strong global pool of skilled engineers and technicians," said the chairman. To improve labor productivity, MSSL uses a system of proprietary benchmarks called DO 33: improve everything by 33 percent.[38] Their philosophy is to benchmark against 'self' to maintain consistency in long-term strategies. To enable quick decision making at the middle manager level, every MSSL entity has a one-pager that summarizes receivables, rejection rates, and improvements over time. MSSL's CTO works closely with each supplier to define specs. HTGL has started a captive Skill Development Center (SDC) where they train their own workers. According to the senior executive, "We train workers and lose them to the OEMs. But we still train because the ones who stay are crucial for our productivity. Unskilled workers are cheaper but costs match up when their mistakes are financially accounted for."

Source: Author's interviews with firms during fieldwork in India

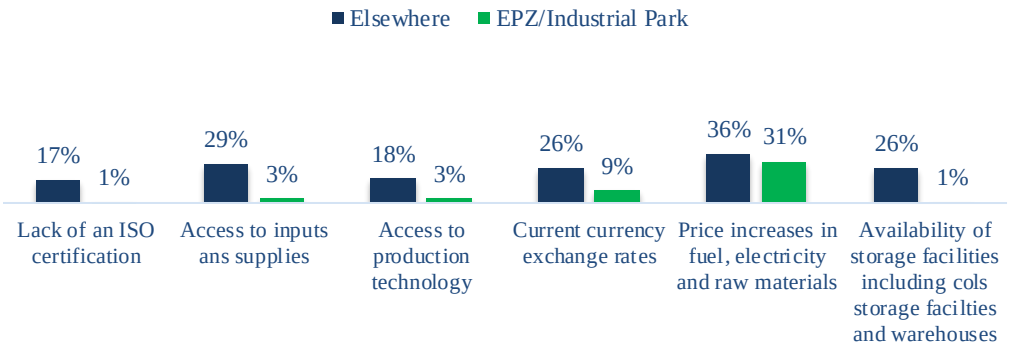
Fewer auto firms in India than in China provide formal training. With the final products becoming more complex, the manufacturing processes now increasingly require a diverse range of skill sets instead of just the traditional ones. There is evidence that in developing countries, skill sets are leaning toward higher technological content through upgrading skills on the job or in-service within the same industry.[39] In China, 90 percent of auto firms provide training to their employees, as opposed to 37 percent in India.

3.5 Agglomeration economies and spatial arrangement in clusters

The auto sector's spatial arrangement has evolved toward working in clusters, with entire supply chains co-locating. More than 80 percent of auto firms in India lie in clusters, including export processing zones (EPZs) or industrial parks, compared to 55 percent in other manufacturing industries. Evidence from interviews with the OEMs and Tier 1s suggests an unambiguous trend towards encouraging - or requiring - suppliers to co-locate.[40] For auto firms, being located in clusters is positively associated with greater success in navigating business climate issues, lower operating costs, and higher capacity utilization. In a survey of over 500 auto firms, only 3 percent of firms located in clusters report access to production inputs as a major/very severe obstacle, in comparison to 30 percent of those outside clusters (see Figure 8). Similar differences are seen with respect to access to production technology, price increases in fuel, electricity and raw materials, and availability of storage facilities. Auto firms are also able to adjust their lead times more efficiently when located in the clusters (see Figure 9).

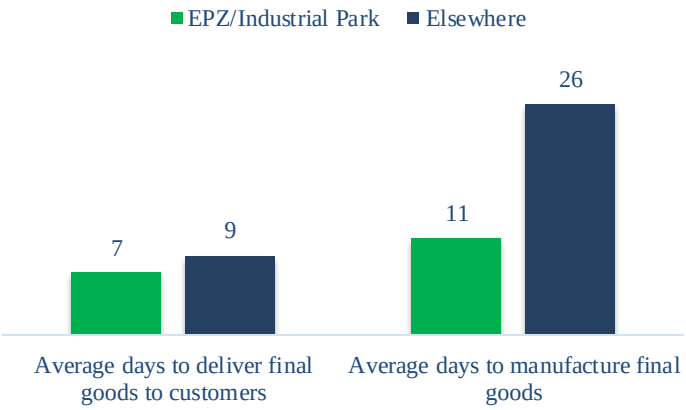
[39] Berman and Machin 2000.
[40] Factor endowment theory developed by Hecksher and Ohlin applies here. Firms invest in locations where manufacturing expenses are the least. Co-location of suppliers brings down costs of transport, inventory, and taxes.

Figure 8: Operational constraints to firm performance (cluster versus elsewhere) (India 2014)



Source: World Bank Indian Enterprise Survey, India 2014.

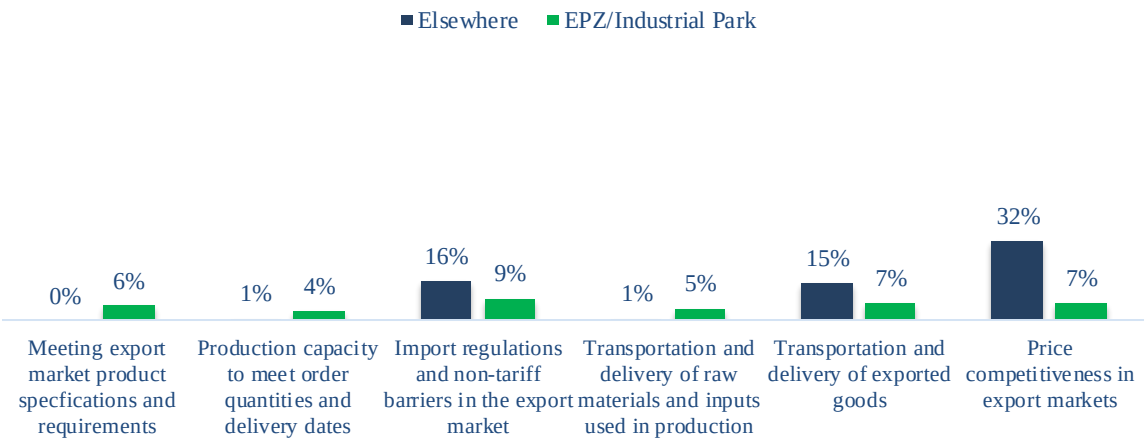
Figure 9: Lead times (cluster versus elsewhere) (India 2014)



Source: World Bank Enterprise Survey, India 2014.

Location in a cluster is positively associated with better results in exports and logistics performance. The average auto firm in a cluster takes less time than one outside to manufacture and deliver final goods. It appears that auto firms in clusters are able to reap the benefits of close proximity to ports, better information about custom clearances, and more connectivity to roads to deliver their goods to customers in less time (see figure 10). A lower share of cluster firms report trouble with transportation and delivery of exported goods (7 percent of cluster firms versus 15 percent outside) and competitiveness in export markets (7 percent versus 32 percent outside). It is possible that some combination of richer information exchanges about export markets, frequency of interactions among co-located players in the supply chains, common action among these firms, and proximity to transport and labor hubs are driving these results.

Figure 10: Constraints to export activity (cluster versus elsewhere) (India 2014)



Source: World Bank Enterprise Survey, India 2014.

A portion of the superior performance of auto firms in clusters may reflect the characteristics of the firms rather than the benefits of clusters. It is possible that only the better firms are chosen to locate with other firms, so that their superior performance reflects a selection bias. A *probit* analysis shows that a firm's characteristics explain some of the better performance, but not all.[41] Interviews with suppliers suggest that the residual may be due to benefits that accrue from being physically present in the cluster. Frequent daily interactions with OEMs facilitate knowledge transfers and business opportunities that are critical to the development of new products. These observations are consistent with findings from the literature that auto sector firms in India and Pakistan benefited from proximity to similar firms (see the survey in Rosenthal and Strange 2004 or Martin et al. 2011 for more recent results).[42] Estimations show that localization benefits are positively and robustly associated with firms' TFP: a 10 percent increase in the automotive sector labor force in a district is associated with a rise of 0.5 to 0.9 percent in firms' productivity (see Table 7 in Annex). Being in a cluster appears to have helped suppliers understand emerging customer needs better, develop new products, and increase their share of customers' purchases (see Box 4).

[41] Examples of such characteristics are level of export orientation, firm size, using technology licensed from foreign owned company, capacity utilization rates, and so on.

[42] There are two types of agglomeration economies: localization and urbanization. While the former is measured by the total number of employees of the same sector in the same location, the latter is calculated by the total number of employees of other sectors in the same location. Both might affect productivity.

Box 4: Leading firm case - Locating close to customer

Proximity to the customer appears to have helped upgrade products, processes, and functions. Co-location allowed MSSL to hold frequent meetings with the OEM on existing products, and new requirements would sometimes emerge during the course of these discussions. "We make the decision to co-locate based on several factors. Is the job big enough in size to justify co-location? Is the OEM reputed enough to learn from? Is there potential to increase share of wallet? Is there potential to learn something new completely?" said the MSSL senior executive. The physical proximity of business managers to the plant and to each other enabled quicker product development. Similarly, proximity to the customer helped Sandhar become a fully integrated supplier of locks and mirrors, including design. According to the Sandhar senior executive, "A leading OEM was having trouble with one of its Indian suppliers doing US$2 million in revenue from locks. The locks however weren't meeting delivery or quality standards. During a lunch with them, the client mentioned this challenge. He needed a new supplier and I proposed myself even though we had never made locks before." One thing led to another, and pleased with Sandhar's performance in metal sheets, Hero Honda helped them set up a technical collaboration with one of their lock suppliers in Japan. Sandhar reduced costs by integrating production in-house and became the single-source supplier of locks to the largest two-wheeler company in India.

Among OEMs, Maruti is known for helping suppliers grow. "We wanted our suppliers to do well, be profitable, grow. If they grew, they could deliver the volumes at the quality we needed at the costs we required," mentioned the ex-chairman of Maruti. Indeed, Tier 1s and Tier 2s that started as suppliers to Maruti in the 1990s have done well. Maruti currently has 300 Tier 1 suppliers and around 4,000 Tier 2s.

Source: Author's interviews with firms from fieldwork

Not all clustering increases long-term competitiveness. Sometimes, the choice of cluster location is driven by incentives offered by areas competing to attract OEMs, rather than efficiency. For example, one OEM shifted capacity to a hilly region in India in response to incentives, and pulled its suppliers along, resulting in high transport costs for all firms. Such examples of capacity fragmentation are not uncommon in both India and Pakistan. The auto industry's integrated nature uniquely positions it to impose co-location demands on suppliers, with the risk that suppliers divert substantial amounts of investments away from plant upgrading and building human capital into setting up yet another plant or acquiring land.

3.6 Linking to global value chains and learning from discerning customers

The few world class Indian auto parts firms are all linked to GVCs through exports and technology agreements. Firms with more export experience demonstrate higher productivity gains. This may reflect the greater ability of more productive firms to break into international export markets (Melitz 2003). However, economic literature, empirical evidence and interviews with leading firms in India suggest that access to large foreign markets has generated several benefits. First, it facilitates access to cheaper intermediate products, a wider variety of products, and a higher quality of foreign inputs which improve product range and quality. Second, it enables firms to achieve economies of scale. Finally, competitive pressures on firms that interact within GVCs, especially with those in mature markets, induce quicker adoption of modern, international standards, leading to deep knowledge transfers and technological spillovers (see Box 5).

Box 5: Leading firm case - Working with discerning customers in local and global value chains

Leading suppliers in India first acquired their technical and managerial capabilities from leading domestic OEMs like Maruti Suzuki and Hero Honda. With the birth of Maruti Udyog in 1983, several auto component manufacturers came into existence in India. MSSL started producing a humble t-coupler (a very small component) for Maruti. MSSL's big break came when Maruti Suzuki—Maruti's JV with Suzuki in India—was looking for a wire harness supplier (a bigger and more complex product). According to a senior executive at MSSL, "We did not have a background in automotive pre-Maruti. We were cable manufacturers in the industrial area of Noida. When Sumitomo, the Japanese supplier to Maruti Suzuki, entered India to supply wire harnesses, our proprietor spotted an opportunity to enter a new and promising sector. Through a technical collaboration with Sumitomo, he set up a wiring harness in India. Within 1–2 years, the TC became a JV between the Indian and Japanese supplier leading to MSSL setup, a key supplier to Maruti." At that time, more than 85 percent of MSSL's sales were to Maruti. Similarly, in the 1980s Maruti was the key customer for India's largest forging company, Bharat Forge.

The story is similar for firms involved in two-wheelers. HTGL started as a preferred supplier of gear cutting tools to Hero Honda, another leading OEM JV (between Indian Hero and Japanese Honda). Although producing auto parts was a natural evolution, effective interaction with the large OEMs required improved soft skills. According to a senior HTGL executive, the industry was characterized by "close working relationships between suppliers, or ancillaries" where "many knew each other and families for years where we were located." After landing their first order with Hero Honda, HTGL moved into tubular parts, both aluminum- and steel-based items. The choice of this product segment was driven by the fact that steel (of the standard required by the OEM) was not available in India and hence, HTGL worked with the OEM to locate two steel suppliers. They began to supply 100 sets per day, facing a steep learning curve to meet the high standards demanded by the OEM. At the same time, Honda was getting some of its own suppliers to locate in India and the "interactive working relationship between HTGL, Honda's suppliers, and the OEM helped us [HTGL] learn rapidly." HTGL executive shared that, "I wanted to find the most discerning customers, whether in India or abroad. I would bend over backwards to work with them because I found we learnt the most when we worked with OEMs who held very high standards."

Source: Author's interviews from fieldwork in India

Compared to China, fewer OEMs in India and in Pakistan are linked to automotive GVCs. Less than 10 percent of Maruti's and 3 percent of Mahindra's output is for overseas markets even though there are few formal barriers to exporting. By contrast, all of the six largest producers in China are engaged in GVCs and cater to domestic production via joint ventures (JVs) with local and foreign firms spurring rich interactions and learning. Geely and Chery are examples of domestic Chinese OEMs that have been acting as contractors to European and American players even though they function in a large, growing domestic market such as China. As early as 2006, SAIC in China, a JV partner of General Motors (GM) and Volkswagen, announced plans to start exporting and competing with its JV partners in overseas markets (see Tables 12 and 13 in Annex). With the exception of Hyundai that exports more than 50 percent of its production from India, most OEMs focus squarely on the domestic market despite low capacity utilization.

However in the auto parts submarket, there are signs of specialization emerging in the type of component India exports versus what it imports. Exports include categories like chassis and engines along with a variety of smaller parts that are labor intensive, while imports are focused on higher technology content or scale purchases. Among the top export categories for India were gear boxes, hydraulic power steering, steering gear systems, wheels, drive axles, turbo chargers, gas compressors, crank shaft for engines, brakes, head lamps and other lighting equipment, and so on. Among imports were technology-intensive parts in engine, drive, transmission and steering parts, as well as some commodities (screws,

rubber parts, and so on) where China is trying to increase imports to India. In general, the auto parts segment has been finding its place in GVCs through specialized imports and exports, and high level of interactions with customers and suppliers in various end markets.

Indian auto parts suppliers are beginning to participate in the large automotive GVCs focused on end markets in North America and Europe, but compared to China, fewer OEMs are linked to automotive GVCs. Mature markets in Europe accounted for the largest share of exports from India (38 percent), followed by Asia (25 percent), and North America (22 percent) in FY13. Being able to meet the standards (safety, environmental, other technical) required in mature markets is a good proxy for the level of sophistication of the domestic industry. With the exception of Hyundai, that exports more than 50 percent of its Indian production, most OEMs focus squarely on the domestic market despite low capacity utilization.[43] By contrast, all of the six largest producers in China are engaged in GVCs and cater to domestic production via joint ventures with local and foreign firms.

The quality of auto exports from India has improved only slightly. According to a measure of export quality and sophistication (PRODY),[44] the quality of exports from India and Pakistan has remained low (see Figure 17 in Annex). A recent IMF study finds that the average level of sophistication for India's manufacturing exports is lower than for the rest of Asia, in sharp contrast to India's performance in the services sector.[45] For the narrowly defined product of small passenger vehicles, India's unit value is lower than that of developed markets (see Figure 18 in Annex).

4. Main constraints to improved productivity across the industry

Traditional cross-cutting investment climate issues do not seem to have a strong impact on the performance of the automotive sector. In the World Bank Enterprise Survey for India, constraints due to the political climate, crime, corruption, access to finance, taxes, electricity, labor regulations, and workforce education were all rated as either moderate or minor by firms. However, electricity, crime, and access to finance are found to reduce productivity (see columns 1 and 2 of Table 8 in Annex). Industry-specific factors may be more binding constraints, it seems. These are covered in four categories: trade policies by product (OEMs vs auto parts), industry standards (environmental, fuel, worker safety), logistics and taxes (central and state taxes, logistics), and lead firm-SME linkages (soft and hard factors).

4.1 Trade protection limits firms' exposure to global good practices

Policies such as high import tariffs on completely built units (CBUs) of passenger cars, which helped attract market-seeking OEMs in the 1990s and 2000s, are now slowing down the spread of world class managerial good practices. The situation is worse in Pakistan than India because only a few OEMs are "competing" behind even higher import tariffs on both CBUs and auto-parts. Over time, high tariffs appear to have encouraged OEMs to focus on the domestic market at the expense of exports, as demonstrated by India's growing production but low share of global exports. Limited competition from imports in CBUs, it appears, has lowered the incentive for local OEMs to achieve higher efficiencies.

[43] Hyundai exports to countries across Africa, Middle East, Latin America, Australia, and Asia Pacific. Maruti also has a mix of markets, including Indonesia, Japan, and Western Europe.
[44] PRODY is a weighted average of the per capita GDP of countries producing auto goods (including auto parts), with weights derived from Revealed Comparative Advantage calculations.
[45] IMF Working Paper 2015.

The experience of the Indian auto parts and commercial vehicle sectors shows that a gradual reduction of import tariffs, far from leading to the debilitation of an industry, could be a powerful catalyst to its global success. When trade liberalization has occurred in the Indian automotive sector, it has generated benefits. Tariffs on auto parts and commercial vehicles in India have fallen sharply since the 1990s, with increased production and exports (Figures 11 and 12). Exports now comprise more than 40 percent of production, imports have grown and firms are able to trade with mature end-markets in GVCs. Millions of local jobs were created during this time. Similarly, the decline in import duties on commercial vehicles were associated with increases in production and employment, and the subsector currently shows a trade surplus[46]. It appears that competition exposed the auto parts sector to global good practices and pushed them to improve productivity to compete in world markets.

Figure 11: Domestic production of auto parts and nominal tariff reduction in India

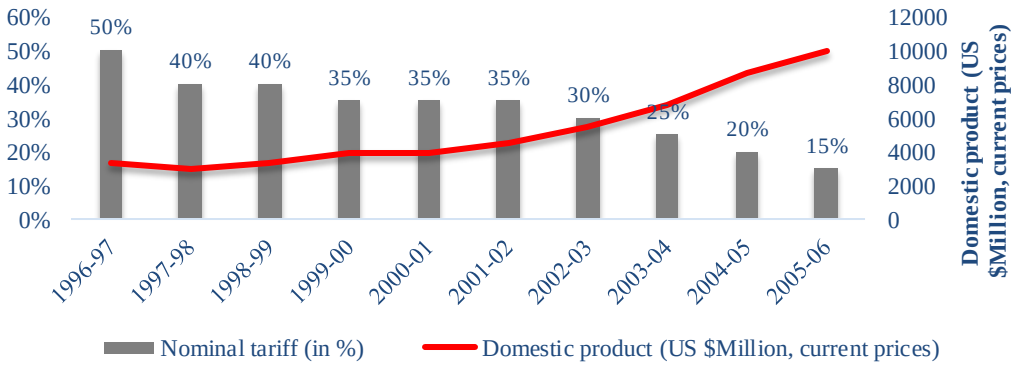
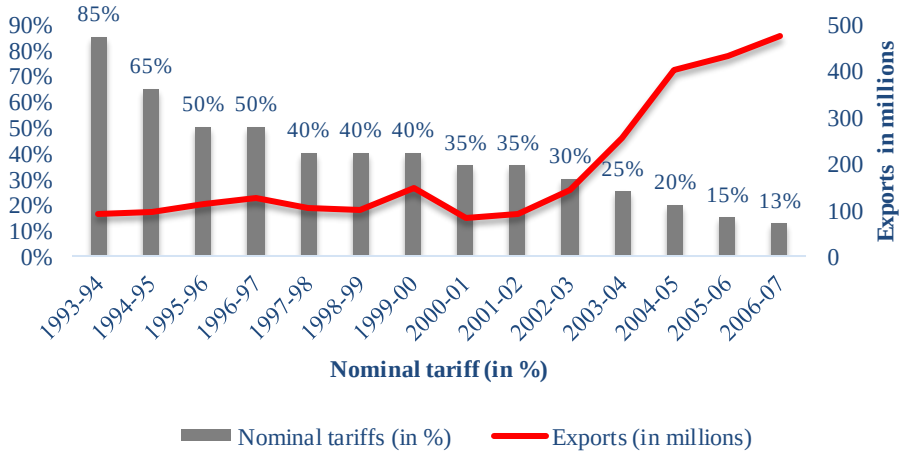


Figure 12: Exports of commercial vehicles and nominal tariff reduction in India



Source: WITS-UNCTAD 2014; ICRIER; ACMA[47]

[46] Levels of protection remain higher on inputs than on final goods in the Indian tractor market, according to the FICCI report of July 2015. Tractors can be imported from Japan with a 5.5 percent tariff and from Thailand with zero tariff, while the tariffs on the inputs (axles, wheels, gears, pumps, engines) vary from 7.5 to 10 percent. Inputs attract a 12.5 percent counter veiling duty while outputs do not. These issues require attention, even though the import duty on finished vehicles is lower than for passenger vehicles.

[47] Tariff rate by years from ICRIER (page 84; Competitiveness of Indian Auto Industry; ICRIER calculated using Customs Manual); Export for commercial vehicles data from WITS-UNCTAD Database; Production data for auto parts from ACMA

Theoretically, gradually reducing tariffs to expose local producers to more competition may have efficiency-improving effects. While the extent of pass-through of lower prices depends on the nature of markups and market power,[48] it is likely that firms that are currently subscale would need to bring down marginal costs and adopt efficient ways to defend their product spaces through 'within firm' reforms.[49] In the short run, less productive firms may have to fight to survive, but the more productive firms will see increased production from inter-firm reallocative transfers.

4.2 Industry standards not yet in sync with global practices limit exposure

Remaining gaps in harmonization of local norms with international standards reduce the need to invest in adoption of quality tools and develop managerial skills. Thus, local firms in India are not fully prepared to meet the latest international standards and face constraints when they try to compete globally. This is exacerbated by the late entry and uneven adoption of international auto standards in the local markets. Euro I, which was introduced in the EU in 1983, came to India in 1996. While Euro II was introduced in the EU in 1997, it was only applied throughout India by 2005. The situation is worse in Pakistan, which has not adopted Euro II norms. Europe has now moved to Euro VI which India plans to adopt by 2020, leaping over Euro V. Converging towards international environmental and safety standards, as the Indian government is planning to do, would further encourage automotive firms in South Asia to adopt (and contribute to) international good practices.

4.3 Tax policies and inefficient logistics lead to domestic market fragmentation

Difficulties in transporting goods—across and within states—along with complex tax rules increase operating costs and encourages fragmentation of production. The average daily distance travelled by a truck in India is only 200–250 km, while the world average is 400 km. Conditions in Pakistan are similar. A goods truck in India spends only 40 percent of journey time in productive driving, with 25 percent spent at check posts, state borders, city entrances, and other regulatory stoppages (the remainder represents rest periods).[50] The commercial, excise, and VAT absorb the most time at checkpoints, for example to reconcile the sales taxes in one state with those in the other, such as the imposition of the additional 2 percent in Central Sales Tax. Firms reported an average of 2.7 days for inbound freight and 3.7 days for outbound freight spent in regulatory compliance, with a very large standard deviation of 2.2 days for inbound and 2.6 days for outbound. Direct effects due to delays and indirect effects on inventories and sales can make logistics 10–14 percent of the operating costs of manufacturing firms. Suchy high costs impair the competitiveness of automotive firms in India and Pakistan.

Auto firms reported that cumbersome tax administrative procedures and the complex interstate taxation structure severely constrained productivity. Over 20 percent of Indian and Pakistani auto firms reported tax administration rules and fragmented tax structures in India as one of their major/very severe obstacles, as compared to 10 percent or less of their Chinese counterparts. In India, there are significant interstate differences in tax systems. For example, in the state of Maharashtra, octroi taxes are levied on trucks carrying vehicles or parts made outside of Maharashtra to be consumed in the state. Firms in this state find it expensive to procure parts from outside, and those outside have had to invest in plants within

[48] De Loecker and Goldberg 2014.
[49] Hsieh and Klenow 2009.
[50] Bhattasali et al. 2013.

the state—often inefficiently—to compete for sales. Such tax systems distort investment decisions by reducing the role of longer-term factors like infrastructure and human capital considerations[51].

Inefficient logistics also affect international trade. An exporter in Tamil Nadu in India reported diverting his shipment by several hundred kilometers, and not using the high-quality and nearby Cochin port, simply to avoid the Tamilnadu-Kerala border crossing. Inefficient trade logistics not only raise costs, but also hinder efficient asset utilization planning, increase inventory costs and impair export competitiveness. According to estimates by the Investment Information and Credit Rating Agency of India (ICRA) in 2004, Indian firms suffer a 20-30 percent cost disadvantage on account of taxation and infrastructure, which can vitiate the 5–20 percent labor cost advantage over comparable ASEAN-member countries, including Thailand. Last mile transportation remains an issue even for firms located in clusters, which are able to navigate barriers to trade logistics more effectively..

4.4 SME-specific challenges, including linkages with lead firms

SMEs - a significant proportion of the Tier 2 and Tier 3 supplier community - in the automotive sector find it difficult to address constraints to productivity themselves. Evidence from enterprise surveys and field interviews suggest that SMEs are less able than larger firms to address these constraints due to information asymmetries and coordination issues. Primary among SME-specific constraints are barriers to engaging with anchor firms, finding land near OEMs, obtaining finance, developing managerial skills/quality tools, and navigating investment climate issues.

Barriers to engaging with anchor firms are both hard and soft in nature. The major hard barrier is limited access to land near OEMs for smaller suppliers. Although OEMs and their main Tier 1 suppliers do not have difficulties finding land, SME suppliers are often trapped in rapidly-growing urban settings and lack the funds necessary to move closer to their main customers. At the same time, soft barriers are also important—absence of structured networking opportunities with anchor firms for suppliers trying to break into export markets, lack of information to anchor firms about emerging champions, and lack of clarity on how to meet the standards required to break into newer markets.

Managerial skills—both at the business and shop floor technical level—are poor. While there are public sector support programs in India and Pakistan aiming to help MSME's improve labor skills, SMEs face difficulties in obtaining information about them, and SME participation has been low. OEMs and Tier 1s are able to access skilled labor by either paying a premium or starting captive skill-development institutes. It does not appear that large OEMs and Tier 1 firms are taking an active role in helping fill training gaps for suppliers downstream.

Suppliers (mostly Tier 2s and Tier 3s) have not fully adopted quality tools. Suppliers either lack full knowledge about the right tools, or lack the right linkages with foreign and local companies required to learn. Large firms make little effort to help suppliers downstream develop key capabilities. Most Tier 2s and Tier 3s in India build-to-print without participating in the design segment of the value chain. Part of

[51] In another example proving this trend, two states in northern India were able to attract capital investments due to tax incentives. One state provided exemption from central excise for ten years of establishment as well as 100 percent income tax exemption for the first five years. A leading OEM in India reported having to close down its plants after setting up factories here—"Long transportation delays and lack of reliability of deliveries in a hilly state were a continuous burden over us."

this is attributable to low levels of R&D investment, especially among Tier 2 and Tier 3 firms. This problem also exists for Tier 1s, who need to take on the role of integrators in global markets.

5. Suggested measures to remove key constraints and boost competitiveness

Improving productivity of auto firms in the region is necessary to move from being a fringe player to a truly global producer in vehicles and parts with deep connections to global good practices and GVCs. Key steps include reducing import tariffs on CBUs and converging towards international environmental and safety standards to encourage automotive firms in South Asia to adopt (and contribute to) international good practices. These reforms complemented with continuing to ease the trade-logistics barriers which contribute to the fragmentation of the industry and raise operational costs; providing assistance to help small and medium enterprises (SMEs) develop linkages to value chains and clusters, to improve their operations; and, supporting programs for innovative design and R&D activities in the value chain will enable the region to fulfill its great potential in this key and rapidly globalizing industry. In the next section, each of these suggestions is discussed in greater detail.

5.1 Gradually lowering import tariffs on final cars

Tariff protection for passenger cars and two wheelers should be brought down gradually to the level prevailing for components. This will reduce the 'induced attractiveness' of the home market in comparison with the international market, thus encouraging greater production for export markets and improvements in quality of product in line with international standards. Firms that produce at inefficient scale will lose the protection of high duties and may exit, and/or reallocate resources to the more productive firms. It is likely that mergers and consolidation among firms may help to rationalize model ranges, scale operations, and bring costs down among firms. For firms that remain competitive in absence of the tariff effect, expansion or growth is likely.

Reducing tariffs would not result in a dramatic decline in local production or job creation. A senior executive of a global OEM felt it was very unlikely that his firm would service the Indian market mostly through imports, if tariffs were reduced, Believing in the potential of this market, OEMs have already invested in large local plant capacities; these are sunk costs, and are unlikely to be closed for at least 10 years. India is particularly good in making certain types of cars that could not be made as competitively in the second best location regionally. OEMs are likely to respond to lower tariffs in India by a global rebalancing of their sourcing strategies. They might consider making India a preferred production base, boosting activities in some product categories, for example small passenger vehicles, for domestic and export markets, while serving the Indian medium vehicle segment completely through imports. In such a scenario, it is likely that local production could even grow. When tariffs were reduced on commercial vehicles, the OEMs ended up using the local production base to export vehicles to markets with similar preferences due to the cost advantages.[52]

Lower tariffs would improve productivity across the value chain and likely increase exports. In the automotive sector, pressure (or lack of it) on an OEM flows to its suppliers. More competitive exposure will mean that foreign OEMs operating in India will have to bring more customized designs instead of

[52] In China, GM, the foreign sales leader, uses Chinese factories to make nearly 99 percent of its cars sold within China rather than import cars (25 percent import duties exist). This level of localization is much more than the 60 percent local content regulation stipulated by the government of China and a lower import tariff than India, of 25 percent.

selling last-decade models to Indian consumers.[53] They will have to invest more in understanding consumer preferences, become operationally tighter, and reduce overcapacity. Countries that have closed their markets to Indian vehicle exports in retaliation for high tariffs may be forced to reconsider. In 2012, Sri Lanka retaliated against Indian trade policy by doubling its duty on Indian cars,[54] reducing India's $800 million in exports to near zero, according to the Society of Indian Automotive Manufacturers, SIAM. Parts suppliers may see increased demand for their products, thus increasing jobs.

Recent experience shows the potential for improvements following trade liberalization. The rise in competitive pressures following China's accession to the World Trade Organization (WTO) was felt throughout the value chain. Productivity levels increased among suppliers.[55] Automotive output grew by 25 percent a year and net trade in cars rose from US$672 million to US$5.3 billion between 2002 and 2005, while import tariffs on cars were reduced from 90 percent to 25 percent. Similarly, Pakistan should reduce its high tariffs on auto parts, learning from India's example, where a gradual reduction in import duties on auto parts helped suppliers get connected to GVCs and improve production and exports.

5.2 Converging toward global environmental and safety standards

Greater predictability of rules on environmental and safety standards would enable firms in India and Pakistan to improve their planning. For instance, the industry needs to know ahead of time the medium-term vision for rules governing the use of petrol versus diesel to forecast production and adapt processes. A long-term, growth-oriented, stable policy road map for the automotive industry is critical to align domestic regulations with international requirements. This is exactly the intention of the Indian government which announced in January 2016 its plan to adopt the current global Euro VI norms by 2020, leaping over the Euro V norms.

Changes in pollution and crash test regulations will need to include provisions for India and Pakistan's (large) existing fleet of cars. At the very least, India's objective should be to fully address Euro IV / Bharat IV specifications in three years. At the same time, the end of life (vehicle scrappage) policy and emission norms should be revisited. Vehicles that are being used well beyond the end of their expected life typically have higher emission content, lower fuel efficiencies, and lower safety standards. As the volume of cars in India rapidly increases, inefficient cars and commercial vehicles should be retired to limit the rise in pollution and accident levels. The government of India is contemplating an incentive scheme to encourage surrendering old vehicles, which would create demand for new and clean vehicles.

Safety norms for workers should be improved, especially in supplier factories in both India and Pakistan. Initiatives are required to improve safety consciousness and competence among workers, supervisors and senior management in supplier companies. Safety training for workers and management, an improvement in supply chain safety audits from OEM/Tier 1 manufacturers, and sharing of best safety practices would improve safety. This approach has been used successfully with cooperation among OEMs/Tier 1 firms and the government in the Slovak Republic under their supplier development initiative.

[53] Chen 2012.
[54] NDTV Profit 2012.
[55] Humphrey and Memedovic 2003.

Box 6: Promoting green vehicles in India and Pakistan

More support for green technology, for example, electric cars and hybrid vehicles, is recommended. This is a relevant for India and Pakistan, which are young markets and not key producers of petrol and gas. Governments around the world in major auto producing nations have begun to invest in green vehicles and think of ways to stimulate demand in this category. In Korea, the government is stimulating demand through public procurement and infrastructure (for example, plans for electric public buses in the future, electric car charging stations) and subsidies for buyers and renters. For example, in India, this could take the form of launching university/industry projects in hybrid power trains, electric vehicles, and in fuel cell vehicles, at least partly funded by the government.

5.3 Integrating the domestic market

Successfully implementing the Goods and Services Tax (GST) and the common Value Added Tax (VAT) across states is the number one priority in India to simplify transport and tax administration. GST is a unified administration, which would eliminate the need for reconciliation when crossing checkpoints at every state border. GST at the center, along with a common VAT at the state level, would greatly reduce interstate variations in taxes and subsidies.

India also needs to quickly improve the state of its infrastructure. The network of roads throughout the country, including in rural areas, should be expanded and its quality improved. Improving the connectivity of railways is also important. Some ports, for instance Chennai, should have the capacity to handle deep-sea vessels, and current levels of port congestion should be reduced. Power availability and quality should be increased, so that local firms do not bear the high costs of backup generators and losses due to power outages. These problems have been discussed extensively, but continue to afflict all manufacturing sectors.

5.4 Providing support to SMEs and improving linkages in clusters

Tier 1 and Tier 2 suppliers can become innovation leaders due to their low-cost models. To achieve this, they need more support to engage with leading anchor firms, build effective teams, increase adoption of quality tools, and actively develop an 'R&D mindset' to tackle design-related tasks. This section reviews lessons for India and Pakistan from successful countries' programs to strengthen supplier linkages.

5.4.1 Enabling environment and linkages

Improvements to the enabling environment would help suppliers thrive and become exporters. Global experiences show that an intermediary institution (an aggregator), such as a cluster management body, can strengthen linkages between suppliers and lead firms. With the exception of a few leading suppliers, many SMEs in India and Pakistan face difficulties in linking with larger firms and in understanding how to achieve product requirements. In the Slovak Republic, the former Yugoslav Republic of Macedonia, and South Africa, the government and the national investment promotion agency set up broad-based technical assistance programs, with the automotive cluster/zone management body becoming the channel of delivery, in close collaboration with the large anchor firms. In Macedonia, anchor firms outlined their needs (quality requirements, product types, pricing comparisons with imports), which the Technological Industrial Development Zones (TIDZs) then used in designing training programs for suppliers. This program built a database of suppliers' profiles and supported a website with information about products and services available from local suppliers and requested by investors and anchor firms. By playing the role of an aggregator and connecting many suppliers with a few anchor firms, programs like TIDZ in Macedonia attempt to reduce information gaps in the supply chain and improve coordination and common action among peer-suppliers.

Some anchor firms in South Asia have played the role of aggregators and supported supplier development. After the liberalization of the licensing regime in the 1990s, Maruti started a program to train component manufactures in the technical and managerial skills required to deliver components that met Maruti's design requirements, in turn helping Maruti climb the value chain.[56] Minimum local content requirements provided the initial trigger, in addition to the cost advantages of sourcing locally rather than importing. Anchor firms' adopting an aggregator role has been useful in supporting SMEs, but this has been accomplished by only a few OEMs in India and Pakistan. Leading OEMs also have supported their suppliers by negotiating for land on their behalf, although suppliers attempting to build their links to lead firms still face difficulties in obtaining land. In general, OEMs report that they rely on either imports or a few good suppliers for their inputs, as most Indian firms cannot quickly provide the goods they need at the right quality and price.

India and Pakistan should focus on improving the capacities of intermediary institutions to support suppliers' engagement with anchor firms. Lessons from global programs suggest that an effective intermediary requires close links with investors. Intermediary personnel may require training in understanding engineering and quality issues, and in being commercially minded. Intermediaries need to understand the problems SMEs face, but also work with large foreign and domestic anchor firms.

5.4.2 Skilling the workforce (business and technical)

All levels of workers—technical and managerial—in the sector would benefit from more quality training. Public and private Technical Vocational Education and Training (TVET) institutes in India and Pakistan have had mixed success in delivering pre-service training. On-the-job training is more effective than government-led programs or independent efforts by workers, although it has some skill bias toward existing needs. SMEs need to attract and retain high-caliber engineers. Family-owned enterprises require short-term, rapid delivery courses in quality management, accounting, and Kaizen, as well as longer-term programs to strengthen human resource management. Mechanical engineering, information technology, and advanced composite materials are important technical areas, given the increasing electronic content of car production and the shift to weight-saving materials. Marketing, languages, supply chain, and purchasing are key business skills to access export markets. Establishing educational partnerships and upgrading university and vocational curricula in procurement, supply chain, and marketing competencies (including e-marketing and e-commerce) will be important to help business managers communicate with global firms. Firms should forge more robust linkages with local/technical universities.

Large companies could play a larger role in delivering these skills in the auto value chain. For example, a stable business climate, attractive financial incentives like tax rebates, improved infrastructure, and international trade pacts encouraged foreign firms to locate manufacturing plants in Vietnam. Facing an acute skills shortage (similar in nature to that in India), Samsung, LG, and Intel trained thousands of employees through reaching agreements with universities, digitizing and open-sourcing materials, and setting up 'training the trainer' programs with leading Vietnamese and U.S. universities. These programs played a key role in the rapid growth of hi-tech sectors and skilled workers, and helped workers and suppliers work better with customers, solve problems on the factory floor early on, and access export

[56] Okada, A. 2004. Skills Development and Interfirm Learning Linkages under Globalization: Lessons from the Indian Automobile Industry, World Development, Vol. 32, No. 7.

markets. In India and Pakistan, policies that can encourage large companies to train their own workers and those in supplier firms have great potential for success.

In the textile and dairy sectors, mezzo-level partnerships with lead firms or aggregators have had more success than supply-side solutions in improving skills. Policy support in Bangladesh and Zambia played an enabling role in mezzo-level cooperation among firms to strengthen skills (Sharif 2014). In 1979, the establishment of export processing zones and easing of restrictions on FDI encouraged Daewoo, a leading Korean garment exporter, to collaborate with a local Bangladeshi garment start-up on technical training. Around 130 workers were sent to the Pusan factory in Korea for hands-on managerial courses, and they returned to set up 3 additional production lines, train 500 workers, and export 43,000 shirts.[57] Within two years, several of these managers left to start their own businesses, spurring entrepreneurship in the region. Such cooperation in skills delivery would have been unlikely without a supportive policy framework. A reform of the investment climate in Zambia led Parmalat—a leading dairy processor—to support the formation of the Palabana Cooperative to train informal milk producers in financial literacy and nutritional supplements for cow breeds.

The quality of primary and secondary education in India and Pakistan lags behind that in some emerging auto exporters. Social and behavioral skills, such as willingness to learn, reliability, teamwork, and communication, are important to success for entry level workers performing complex tasks. These skills are learned during the early years in a person's life. Educational systems should focus on both academic achievement and non-cognitive skill sets, for example team work, leading, engaging, and managing.

Access to finance is not a major constraint on training in India and Pakistan. In both countries, central and state governments have allocated generous subsidies for public and private training provision. For instance, in the Punjab province of Pakistan, the Punjab Skill Development Fund (PSDF) allocates funding to public institutions and private providers (including firms) through competitive bidding. Similar mechanisms in India include the National Skill Development Corporate (NSDC) and industry-specific entities like the Auto Skill Development Corporation (ASDC). However, the provision of on the job training remains low. India and Pakistan need to create incentives to encourage skilling efforts, particularly by the large firms. At the same time, publically-funded training should include lifelong skills that contribute towards the job at hand, but are fungible.

5.4.3 Adoption of quality tools

Suppliers need to deepen their adoption of quality tools. The auto parts associations (for example, the ACMA in India and the PAAPAM in Pakistan) could create support teams to disseminate quality tools, for example design Failure Mode Effects Analysis (FMEA), process FMEA, Fault Tree Analysis, 5S, 5W2H, and Quick Response for Quality Control[58]. Most of the Tier 2 and 3 suppliers are 'sorting' rather than 'building' quality products. Both auto-parts associations are moving in this direction by creating quality circles, but much more effort is needed to increase supplier participation. Quality teams in Tier 1 suppliers

[57] Saraf (2014)

[58] 5S was developed in Japan and stands for the Japanese words seiri (tidiness), seiton (orderliness), seiso (cleanliness), seiketsu (standardization), and shitsuke (discipline). The 5S concept is one of several lean manufacturing ("Lean") tools designed to improve workplace efficiency through facility-wide organization and cleanliness. Each of the 5S guidelines help managers and workers achieve greater organization, standardization, and efficiency—all while reducing costs and boosting productivity. 5W2H stands for 5 Ws and 2Hs or Who, What, When, Where, Why, How and How much.

could provide support to Tier 2 and 3 suppliers by setting up improvement plans, tracking progress, and helping with certifications. Some leading Tier 1s have used such methods to reduce costs, improve the reliability of parts, and to design new products with their Tier 2s.

Suppliers need to obtain systems certifications such as QS9000, which are becoming prerequisites for selection by leading firms. Tier 1 suppliers use certifications to assess suppliers' abilities to develop products, including the number and qualification of workers involved in development, the number of Computer Aided Design (CAD) stations and their software, the characteristics of the testing and prototyping facilities, and the knowledge of design methods and tools (for example, FMEA, Design for Assembly/DFA, and Quality Function Deployment). Keeping up with international and national standards/certifications on a continual basis is essential. In India, ACMA, the Auto Skill Development Corporation (ASDC), and the Quality Council of India (QCI) can help firms adopt quality tools and certifications. PAAPAM and other relevant central and provincial level bodies could take the lead in Pakistan.

5.4.4 Access to finance

The high cost of borrowing constrains the expansion of small parts manufacturers. Improving access to finance would help Tier 2 and Tier 3 companies invest in quality certification, compensate talented management, and increase production. This problem is less serious for the larger firms, which can access low-cost credit lines.

5.5 Providing more support for design capabilities/R&D organization

More emphasis is needed on improving design capabilities within local firms to increase participation in GVCs. Tier 1 suppliers need to become end-to-end design and development suppliers, taking on the role of integrators**.** India has tremendous potential to become a global design hub. One Tier 1 established its global R&D center in the country to perform research for both its Indian products and global facilities. Other Tier 1s should consider launching a design center in India with test facilities to validate modifications, new suppliers, and later on, new projects.[59] Tier 1s who seek more global reach could collaborate with foreign firms to establish R&D facilities to perform adaptation and process R&D, as well as fundamental research. They could also sponsor PhD theses and capstone projects with academia to develop advanced solutions, prepare future industry leaders, and reinforce links with the university. Such funding should focus on students of engineering, chemical sciences, industrial design, and so on.

The Indian auto sector should adopt a structured development plan for collaborative R&D under the 'Make in India' initiative.[60] The goals for R&D should include better linkages among the OEMs and local suppliers/SMEs to encourage technical support programs among firms in the value chain (see recommendation on linkages in the cluster). Collaboration with engineering institutes, technology centers (TCs) in auto clusters, and the National Automotive Testing and R&D Infrastructure Project (NATRiP) could create a common, industry-specific R&D infrastructure, including laboratories-oriented material

[59] This assumes existence of an operational Tier 2 supply chain to apply a product and process development approach, discussed in the recommendation on 'quality tools' later.

[60] Further work is needed to evaluate whether current R&D subsidies are helping SMEs or the larger firms who have the wherewithal to invest in R&D. In Korea, tax benefits on R&D were differentiated for SMEs versus non-SMEs. SMEs could claim up to a 25 percent deduction from income and corporate tax for research and human development costs related to general R&D activity, but non-SMEs could only claim 3–6 percent. It is possible that the current form of R&D subsidies is reducing investments in R&D by the larger firms. Other forms of support that could be explored are exemption from local tax on real estate owned by corporate in-house R&D institutes for SMEs and no tax charge on researchers' income derived from a research activity.

analysis, measurement systems, modeling software attuned to the needs of the cluster, and advanced research for new processes like tooling, machining, heat treatment, cutting tools, and so on. Support packages would facilitate technology transfer from universities, assistance from consulting companies on management improvements, brand development in GVCs, product standardization, and commercialization of firms' R&D.

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TECHNICAL ANNEX

Table 4: Yearly volume of vehicles in India (2011–2020)[61]

Segments, India	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	% In 2015	% In 2020
A- Basic	1,347	1,420	1,169	1,161	1,316	1,441	1,445	1,573	1,669	1,759	31%	21%
B- Subcompact	1,228	1,253	1,338	1,529	1,714	1,986	2,361	2,754	3,150	3,604	40%	0
C-Compact	250	459	378	414	494	617	735	830	990	1,144	12%	14%
D-Midsize	14	13	8	9	11	13	17	19	23	28	0%	0%
SUV-SUV	22	29	31	33	53	93	153	203	245	291	1%	3%
P-Pickup	523	566	402	420	473	544	657	744	849	969	11%	12%
V-Van	239	288	185	182	220	277	312	383	454	528	5%	6%
E-Large	8	6	7	7	7	10	12	15	18	22	0.20%	0.30%
F- Large Plus	0.5	0.5	0.4	0.8	1	1.4	1.9	2.3	2.8	4	0.00%	0.00%
Total volume (in '000 units)	**3,632**	**4,035**	**3,518**	**3,756**	**4,289**	**4,982**	**5,694**	**6,523**	**7,401**	**8,349**		

Table 5: Top 15 largest producers by units produced in the global automotive sector[62]

Ranking	Country	2014 (units)	Market Share (%)	% Change
1	China	23,722,890	26.4	7.3
2	USA	11,660,699	13.0	5.4
3	Japan	9,774,665	10.9	1.5
4	Germany	5,907,548	6.6	3.3
5	Korea	4,524,932	5.0	0.1
6	India	3,840,160	4.3	-1.5
7	Mexico	3,365,306	3.8	10.2
8	Brazil	3,146,118	3.5	-15.3
9	Spain	2,402,978	2.7	11.1
10	Canada	2,393,890	2.7	0.6
11	Russia	1,895,474	2.1	-13.5
12	Thailand	1,880,007	2.1	-23.5
13	France	1,821,464	2.0	4.4
14	UK	1,598,879	1.8	0.1
15	Indonesia	1,298,523	1.4	7.6
Global Production		**89,734,228**	**100**	**2.8**

Table 6: Vehicle volume exports for India, 2007–2013 (in '000 units)

Passenger vehicles, volume in '000 units	*2007-2008*	*2008-2009*	*2009-2010*	*2010-2011*	*2011-2012*	*2012-2013*
Domestic sales	1,549	1,552	1,951	2,501	2,618	2,686
Exports	218	335	446	444	507	554
Total	1,767	1,887	2,397	2,945	3,125	3,240
Ratio Export/Sales %	**12%**	**18%**	**19%**	**15%**	**16%**	**17%**

[61] LMC Automotive Global Industry Database 2014.
[62] *Organisation Internationale des Constructeurs d'Automobiles* (OICA)

Table 7: Drivers of productivity (firm based factors) – Automotive

Obstacles to Productivity-Automotive

Dependent variable	(1) Labor Productivity	(2) Total Factor Productivity	(3) Averages
Log (Size)	0.1251* (0.018)	0.0685 (0.018)	123
Log(Age)	-0.0943 (0.017)	0.0057 (0.011)	19
Foreign	1.1602** (0.064)	0.5994** (0.015)	0.60%
Exporter	0.0914 (0.065)	-0.1168 (0.051)	11%
Constant	9.9365*** (0.040)	-0.4000 (0.121)	
Observations	833	364	952
R-squared	0.0564	0.0747	

Robust standard errors in parentheses *** p<0.01, **p<0.05, *p<0.1

Table 8: ICT Index for India and Pakistan by sector and size [63]

Categories	India	Pakistan	South Asia	Africa (Average)
Aggregate	131	84	81	65
Specific Sectors				
Food	136	91	73	90
Apparel	106	113	90	48
Electronics	142	103	124	109
Automobile	127	94	93	108
Others	132	81	78	64
Size				
Small	108	58	57	56
Medium	129	91	91	87
Large	158	131	141	126
City Size				
Over 1 million	137	85	81	68
Under 1 million	126	77	74	56

[63] Based on calculations using Enterprise Survey calculations in Volume 1 (South Asia Competitiveness Report Chapter 2: ICT). ICT use and intensity are summarized by an aggregate index, a combination of the internet index and the computer and software index. ICT index is standardized to average 100 and deviation 100.

Table 9: Loss estimate on firm bottom line due to various factors[64]

Items	OEM	Tier 1	Tier 2/3	Impact	Loss estimate
Production volume				Development amortization excess	Pay back?
versus initial plan				Equipment amortization excess If volumes <100k / year for small vehicles	Up to 15%
				Manpower excess & downtime	2%
Lack of flexibility				Long change over time	Capacity loss
				Investment dedicated to one or few references: sensitivity to need variations	Over investment
				Line downtime	Over investment
				Dedicated line	Over investment
				Manpower longer training	< 2%
No Process				Poor manpower flexibility	up to 3%
standardization				Long line debugging	Longer launch
				Quality issues	
				No learned lessons	Up to 5%
				Longer experience curve leading to productivity loss	
				Line duplication or longer change over time	2 to 5%
				Investment increase/ High amortization level	Over investment
				Process validation additional cost	Longer launch
No Product/Module				Manpower longer training	< 2%
standardization				Poor manpower flexibility	Up to 3 %
				Long line debugging	N/a
				Quality issues	Longer launch
				No learned lessons: long experience building	Up to 5%
				Longer experience curve leading to productivity loss	
				No Quality analysis and solution at the line level	2 to 8%
				No autonomy to stop the line at first defect leading to additional	1 to 3%
				added value on defected part	
				No auto control: additional Quality operators	Manpower increase
Lack of manpower				Operator is not able to fix the line issue for small problems	Line micro
education				no first level quality analysis and fix	stoppages
				Line downtime due to the delay for external resources	Up to
				to address the line issue	5%
				No multi skills operators able to run the line with various	Up to 4%
				number of operators in the line	
				Long operator training	Indirect cost
				Need for micro management of the line	0 to 3%
				Long time before to reach production standards	from 2 to 6 %
Poor design for				Existing designs not addressing local needs leading to productivity issues	Depends on
manufacturing				Design not adapted to manual operations	Products
				Investment duplication & amortization increase	3%
Location				productivity loss due to finance constraint	Up to 10%
dissemination				Lack of volume flexibility	Depends on
(Cluster approach)				Excess of production capacity	products
				Engineering know how dissemination	Know how
				Slow experience transfer for engineering and Quality	loss
				Low competition level thanks to monosourcing in every cluster	Up to 10%
				Increase of middle management needs	Up to 3%
				Quality issue very costly to address due to volume of parts in the	Depends on
Overseas supply				transportation flow	products
				High inventory	Up to 30 days
				Exchange rate variations	N/a
				Inventory excess	4 to 6 days
Lack of transport				Transport cost: direct and indirect due to additional resources	x2
reliability				need to dollow part flows	
				Components and finished goods including cars, damaged during	Depends on
				the transportation	products
				Packaging cost to protect products against corrosion and mishanding	0 to 4%
Raw material				Import of HSLA steels	Up to 15%
purchase				Raw material costs for Tier 2 & 3 suppliers buying small volumes with limited negotiation power	Up to 5%

	Critical Impact
	Medium Impact
	Low impact

Rough estimate

[64] Based on auto expert estimates from field interviews with over 40 firms based on comparisons with international good practices

Table 10: Results of agglomeration economies in firms' TFP[65]

	1	2	3	4
Dependent Variable: TFP	Two-Digit		Three-Digit	
Localization District	0.0913***	0.0796*	0.0492***	0.0637**
	(0.028)	(0.042)	(0.019)	(0.032)
Urbanization District	-0.1195**	-0.1233*	-0.0887*	-0.1165**
	(0.049)	(0.073)	(0.046)	(0.053)
Diversity District		0.1962*		0.1387
		(0.107)		(0.117)
Competition District		-0.0146		-0.0250
		(0.110)		(0.048)
Constant	0.5810	0.3913	0.6586	0.6806
	(0.469)	(0.811)	(0.499)	(0.534)
Observations	1,253	1,253	1,253	1,253
R-squared	0.0114	0.0164	0.0066	0.0085

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Obstacles to Productivity (external environment factors) - Automotive

	(1)	(2)	(3)
Dependent Variable	Labor Productivity	Total Factor Productivity	Averages
Finance	-0.0473**	-0.0034	1.10
	(0.002)	(0.013)	
Political	-0.0425	-0.0116	1.18
	(0.016)	(0.025)	
Crime	-0.0838***	-0.1441***	0.71
	(0.001)	(0.001)	
Taxes	0.1002	0.0417	1.43
	(0.034)	(0.024)	
Corruption	-0.0118	0.0648	2.24
	(0.002)	(0.020)	
Informal Sector	0.1136**	0.1059	0.96
	(0.003)	(0.023)	
Labor Regulations	0.0447	0.0741	1.03
	(0.017)	(0.013)	
Workforce Education	0.0099	0.0287	0.99
	(0.016)	(0.006)	
Electricity	-0.1273**	-0.0689***	1.52
	(0.004)	(0.001)	
Constant	9.9365***	-0.4000	
	(0.040)	(0.121)	
Observations	833	364	952
R-squared	0.0564	0.0747	

Robust standard errors in parentheses
*** p < 0.01, ** p < 0.05, * p < 0.1

[65] Latest World Bank Enterprise Survey Data for India and Pakistan

Table 12: Indian automakers and JV partners, 2013

Indian automaker	Indo-foreign JV	Foreign carmaker in India
Maruti	Maruti Suzuki	
Hindustan Motors		
Mahindra & Mahindra		
Tata Motors		
		Hyundai
		Honda
		Ford
		Toyota
		Volkswagen
		GM
		Mercedes-Benz
		Fiat
		Skoda-Audi
		BMW India
		Isuzu

Table 13: Chinese automakers and JV partners, 2013

Chinese automakers	Sino-Foreign JVs	Chinese automakers	Sino-Foreign JVs
BAIC (Beijing Auto, Beigi)	Beijing Benz, Beijing Hyundai, Fotom Daimler	Hawfai	Hawfai Hyundai
Briliance Auto, Huachen Auto Group	BMW Briliance	Huraghai, SG Automobile	
BYD Auto, BYD Company	Shenzhen BYD Daimler	JAC (Jianghuai Auto)	
Chang'an Auto Chana Auto	Chang'an Ford, Mazda, Suzuki, Chang'an PSA	JMH (Jiangling Motor Holding)	Jiangling Ford
Changteng Auto		Jonway Auto	ZAP Jonway
Changhe Auto, Chang'an	Changhe Suzuki	King Long Motor	
Chery AutoCHTC Auto	Ooros	Lifan Motors	
CHTC Auto		Luzhou Wuling Motors	AIC-GM-Wuling
Dongfeng Motor, DFM	Dongf eng Nissan, Peugeot, Citroen, Honda, Yueda Kia	Qoros	
Dongfeng Yuton		SAIC	Shanghai GM, Volkswagen, GM, Wuling, Nanjing

			Iveco, Sunwin Bus
First Automobile Works (FAW)	FAW Volkswagen, Audi, GM, Mazda, Toyota	Shanghuan Auto	
Foday (Guangdon Foday Auto)		Sichuan Auto	
Foton, BAIC (Beigi Foton)	Foton Daimler	Shinotruk	
Fujian Motors	Fujian Berz	Soueast	Soueast Mitsubishi
GAC	GAC Honda, Toyota, Fiat, Mitsubishi	Youngman	Youngman-Neoplan, MAN AG, Proton
Geely	Volvo Cars	Yulon	
Gonow		Zhongxin	
Great Wall Motors		GAC	
Hafei Auto		Hawfai	Hawfai Hyundai
Haima		Huraghai, SG Automobile	

Figure 13: Sophistication of automotive exports from India and Pakistan (PRODY)

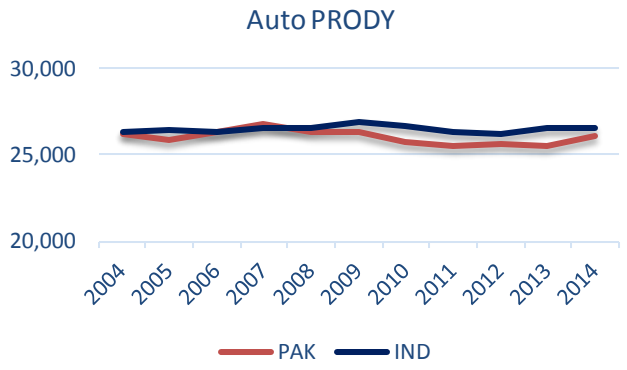

Figure 14: Unit value for small passenger vehicles