



# Innovation at the middle of the pyramid: State policy, market segmentation, and the Chinese automotive sector

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## ABSTRACT

While emerging markets are widely seen as a favorable environment for cost innovation, the existing literature has difficulty explaining why in some cases cost innovation provides a solid foundation for upgrading but in other cases it does not. This paper focuses on how different market segments (low-, medium-, and high-end) within an industrial sector each play a unique role in the development process, and how the absence of any segment may inhibit the upward trajectory of emerging market firms. The low-end offers new entrants "natural" protection from foreign firms with higher cost structures, and allows local firms to cultivate their capabilities, engage in cost innovation, and gain scale. The high-end is dominated by foreign firms that have better access to human resources, capital and technology. The middle segment is a crucial pathway for the development of new capabilities because it forces foreign and local firms to combine and re-combine their respective resources in new ways so as to achieve the exact ratio of price and quality demanded by "value for money" customers. Because market segmentation is shaped by a range of state policies that affect both the demand- and the supply-side, the state may inadvertently restrict the growth of segments that contribute crucial ingredients to the process of capability-building, and adversely affect upgrading outcomes.

## 1. Introduction

Innovation at the middle of the global economic pyramid is widely believed to provide emerging market firms with an initial step on the path towards global competitiveness (Gadiesh et al., 2007; Zeng and Williamson, 2007; Jaiswal, 2008; Govindarajan and Ramamurti, 2011). The innovations that are required are not as radical as at the base of the pyramid, but consumer demand is sufficiently unique to provide emerging market firms with an advantage over the global firms that dominate at the top of the pyramid. By altering processes, business models, and/or products, these new entrants are able to offer "good enough" quality at a low price. It is assumed that over time, sustained improvements will enable these firms to compete with global firms in successively more demanding market segments, and in some cases they may be able to "disrupt" established markets (Hart and Christensen, 2002; Christensen and Raynor, 2003).

While emerging markets are widely seen as a favorable environment for cost innovation, a term that is broadly defined to include any innovation that improves the price/performance ratio, these opportunities do not always translate into sustained growth. The global auto industry provides a range of examples. Toyota and Hyundai are classic examples of cost innovation that ultimately disrupted global markets (Christensen, 1997: 190). The Tata Nano is a successful product

innovation that has had limited impact on global markets (Ray and Ray, 2011).

The empirical focus of this paper is the Chinese auto industry. Although China was widely expected to be fertile ground for new low-cost competitors, the outcome has been decidedly mixed: Chinese firms have struggled to compete with global firms in passenger vehicles, while commercial vehicles and components firms have successfully used cost innovation to compete with global firms. Why, despite similar opportunities, does cost innovation provide a foundation for successful upgrading in some sectors but not others?

The existing literature helps to explain how emerging market firms employ cost innovation to succeed in resource-constrained market segments, but has difficulty explaining the upgrading of capabilities that enables movement between market segments. The literature on innovation in resource-constrained markets looks to the firm-level to explain variation in outcomes within low-end market segments. Entrepreneurial new entrants overcome the lack of resources that is characteristic of the base of the pyramid and solve previously insoluble problems through improvisation, flexibility, and radical innovation (Prahalad and Mashelkar, 2010; Ray and Ray, 2011; Hang et al., 2015). Given the immense size of these market segments, there is no shortage of opportunity for cost innovation, and the burden is on firms to respond entrepreneurially (Prahalad and Hart, 2002). Why this sort of

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innovation sometimes flourishes and other times does not is not readily apparent.

The literature relating to disruptive innovation explains how global incumbents are restricted by their resource allocation incentives (Christensen and Raynor, 2003), their organizational competencies (Henderson, 2006), and/or their failure to understand the impact of new technologies in these low-end market segments (Schmidt and Druehl, 2008), but provides less insight into how new entrants develop the sustaining technologies that allow them to move upmarket (Christensen, 1997).

Building on earlier work by Brandt and Thun (2010, 2016), this paper focuses on how different market segments (low-, medium-, and high-end) within an industrial sector each play a unique role in the development process, and how the absence of any segment may inhibit the upward trajectory of emerging market firms. The low-end offers new entrants “natural” protection from foreign firms with higher cost structures, and allows local firms to cultivate their capabilities, engage in cost innovation, and gain scale. The high-end is dominated by foreign firms that have better access to human resources, capital and technology. The middle segment is a crucial pathway for the development of new capabilities because it forces foreign and local firms to combine and re-combine their respective resources in new ways so as to achieve the exact ratio of price and quality demanded by “value for money” customers. Because market segmentation is shaped by a range of state policies that affect both the demand- and the supply-side, the state may inadvertently restrict the growth of segments that contribute crucial ingredients to the process of capability-building, and adversely affect upgrading outcomes.

The next section reviews the literature on cost innovation and development in emerging markets, and introduces a framework for understanding the interaction of policy, market segmentation, and cost innovation. After a discussion of the case study methodology in Section 3, the data on passenger vehicle original equipment manufacturers (OEMs), commercial vehicle OEMs, and auto component firms in China is presented in Section 4. The variation in outcome is discussed in Section 5, and the implications for practice, policy, and theory are considered.

## 2. Innovation in resource-constrained markets

The *base of the pyramid* (defined as daily income levels of less than US \$5) is characterized by extreme and subsistence poverty, often in remote areas that are constrained by institutional voids. “Frugal innovation” is a response to the extreme challenges of this environment, and requires firm to radically re-think business models, products, and services (London and Hart, 2004; Prahalad, 2009; Rangan et al., 2011; Vadakkepat et al., 2015). The *middle of the pyramid* is relatively poor by developed economy standards, but the consumers at this level are distinctly middle class by global standards (defined as daily incomes between US\$10 and 100, see Brandt and Buge, 2014). This segment of the global economic pyramid demands high levels of “value for money”: the same products as developed markets (e.g. cars, washing machines, mobile phones, etc.), but at lower price points. Firms lower costs through “good enough” innovation (i.e. tailoring functionality to more exactly meet consumers demand, see Gadish et al., 2007) or through “cost innovation” (i.e. achieving the same functionality at a lower costs by exploiting cost advantages in manufacturing, design, and/or administration, see Zeng and Williamson, 2007). The *top of the pyramid* is the global elite, and while this segment may demand cost improvements, consumers are unwilling to sacrifice quality and functionality below a certain level.

While the “fortune” at the base of the pyramid has received much attention (Prahalad, 2009), the middle of the pyramid is crucial both because of the economic opportunity—over the last two decades, economic growth has increased the size of the middle class in emerging markets by more than half a billion people (Brandt and Buge, 2014;

7)—and because of its crucial role as a pathway of upgrading for emerging market firms.

### 2.1. Firms

The literature on innovation in resource-constrained markets identifies numerous firm-level resources (e.g. assets, capabilities, knowledge, etc.) that might be sources of competitive advantage for local firms in emerging markets, allowing the highly price sensitive segments to become “crucibles” for innovation (Wan et al., 2015: 95).

First, the firm must have the technical expertise and the industry experience to detect market opportunities. Hangel et al. (2015: 90) focus on the process of entrepreneurial opportunity, and find that low-end innovations are usually predicated on the unmet needs of certain customer segments, and require a firm to engage in “an experimental process that calls for improvisation in response to unexpected constraints.” The firm must understand the market, and then be able to respond to it.

Second, the innovation processes within a firm are crucial. R&D processes can be used to alter the cost of products. Wan et al. (2015) argue that the industrialization of R&D activities (i.e. dividing activities into small tasks and developing an assembly line approach) and parallel processing (i.e. allowing sequential steps to happen simultaneously) are crucial resources that allow Chinese firms to engage in cost innovation. Design changes (e.g. miniaturization, simplification, etc.) can be used to alter the price/performance ratio (Yu and Hang, 2011). Changes to a product architecture that increase the degree of modularity have the potential to lower coordination costs within a firm and transaction costs between firms (Fujimoto, 2012). Modularity can lead to cost savings through parallel processing in design activities and more rapid “launch-test-improve” cycles (Ray and Ray, 2011; Wan et al., 2015).

A third resource that can be crucial is the capacity for learning. Particularly in the case of relatively mature mechanical products, where much of the knowledge is tacit, the role of experienced engineers within the firm is crucial in assimilating technologies from outside the firm, screening design ideas from the existing knowledge pool, identifying and solving problems that emerge, and coming up with new combinations that lower costs without sacrificing quality (Chen, 2009).

Highly price sensitive market segments also provide local firms with a degree of “natural” protection from global incumbents. This may be a result of a rational process of internal resource allocation on the part of the incumbents: when faced with new competitors in the low-end, the incumbents are “held captive by their [high-margin] customers” and direct investments towards existing technologies that are valued by the mainstream market segments (Christensen, 1997; Christensen and Raynor, 2003). It may also reflect a lack of necessary capabilities. The global incumbents have built knowledge and capabilities around the set of technologies demanded by global high-end segments (i.e. their home markets), and these existing resources shape the embedded organizational competencies and the firm’s capacity (and lack thereof) to respond to challenges from new technology (Nelson and Winter, 1982; Henderson and Clark, 1990; Henderson, 2006).

### 2.2. Market segmentation

A firm’s internal capacity for innovation is heavily shaped by the markets within which it competes, and as a result, the dynamics of innovation will vary by market segment. In each segment, there is a subtle interplay between the demand side (e.g. relative incomes, demographics, etc.) and the capabilities that are created on the supply side (Kline and Rosenberg, 1986: 275).

The demand side provides the incentive for innovation, as “new goods and new techniques are unlikely to appear, and to the enter the life of society without pre-existing—albeit possibly only latent—demand” (Smookler as cited in Fontana and Guerzoni, 2008). Demand characteristics shape the design choices that are made during the

innovation process. As Fujimoto argues, when the expectations of customers are strict, a product's architecture will tend towards integral because the firm will optimize the performance of different design elements, but when expectation are looser, a greater degree of modularity is possible (Fujimoto, 2012, 2014). Rather than there being one best architecture for a product, the “architecture is ultimately selected by the customers in the market” (Fujimoto, 2012: 72). Customers also provide firms with feedback that is crucial for refining products (Chen, 2009; Ohara, 2014). Feedback allows a firm to gauge the exact level of functionality that a product requires: too little and performance will be inadequate; too much and the price will be too high for resource-constrained customers. The exact ratio demanded will vary by segment.

The supply side facilitates cost innovation in two manners. First, the firm complements internal innovation with external sources of knowledge, including public research institutes/universities that provide testing facilities and specialized knowledge, collaborative partnerships with suppliers and customers (Hobday, 1995; Lee and Lim, 2001; Ray and Ray, 2011; Hertenstein et al., 2017), and/or broader ecosystems (Lim et al., 2013). Second, the external environment, and in particular the presence of suppliers with appropriate capabilities, enables specialization and economies of scale. Watanabe (2014) provides an excellent example of how modular product architectures in Chinese industry allow firms to specialize in core capabilities (reducing the need for investment in a broad range of technical capabilities) and enable them to utilize common components and technological platforms (leading to economies of scale in the supply chain). Similar dynamics have been noted in numerous sectors in China (Ge and Fujimoto, 2004; Steinfeld, 2004; Ge, 2005).

The interaction of supply and demand creates distinct market segments for a particular product, each characterized by differing ratios of price and quality. Quality refers to total product quality, which can be improved through changes to both product design and manufacturing (Fujimoto, 1999). Increasing quality along any dimension is typically costly for a firm to produce, requiring some combination of design improvements, superior intermediate inputs, and improved manufacturing processes, hence higher quality goods have a higher price. The size of a particular market segment will depend on: 1) the presence of firms with the capability to supply products at the appropriate levels of quality and price; and, 2) the presence of consumers that are demanding a particular ratio of quality and price (and studies have shown that higher income levels typically lead to higher demand for quality, see Khandelwal, 2010).

Fig. 1 (which is based on Fujimoto, 2012, 2014) depicts a market that has three primary market segments: the blue, green, and red lines depict quality-price product frontiers of firms with different sets of capabilities (low, middle, and high respectively) and customers choose the product that is at the tangency of their indifference curve (the blue line will serve the base of the pyramid, the green line the middle, and the red line the top). When a market contains a broad range of segments, firms are able to specialize in the segments in which their superior skills, capital, and/or technology give them an advantage

(Khandelwal, 2010; Brandt and Thun, 2016). The low-end provides space for domestic firms to incubate their capabilities (i.e. given that it is not possible for a firm on the red frontier to satisfy the cost-conscious customers served by firms on the blue frontier). As the low-end firms build capabilities, they will be incentivized to upgrade by the higher-margin segments above. The high-end attracts foreign firms that have a quality-price frontier along the red line, and they serve customers that demand product quality that is similar to developed economies. The mid-market segments create incentives for these firms to localize activities. Cost innovation is represented by a shift in the frontier downwards and to the right, as firms create new capabilities that allow them to lower price without sacrificing quality or increase quality without raising price (the red, green, and red arrows). If market segments are missing, firms will not have the same incentive to innovate.

### 2.3. State policy

While the progression of market segments depicted in Fig. 1 may appear to be commonplace, it cannot be assumed.

Markets are social constructs, shaped by rules (e.g. property rights, governance structures, competition laws) that enable firms to organize themselves in markets, compete, cooperate, and exchange. As Fligstein (1996: 661) argues, these rules are established by states and vary widely: an interventionist state (e.g. France) engages in state ownership, directs investment, and heavily regulates exit and entry into markets, while a regulatory state (e.g. the United States) creates agencies to enforce general rules in markets.

In a development context, states often adopt a more interventionist approach to the construction of markets. This may be the result of a perceived need for coordinated investment: because there is a fixed cost to innovation, and success requires investment on the part of complementary suppliers and customers, the state may need to play a co-ordinating role so as to avoid a “poverty trap” (Mahmood and Rufin, 2005; Rodrik, 2008). It may also be the result of a perceived need for the state to coordinate the process of technology acquisition and development, which typically is one of learning from earlier developers and making incremental improvements (Evans, 1995; Amsden, 2001).

Through industrial policy, the state attempts to push firms in a desired direction by combining supportive policies (e.g. subsidies, protectionism, etc.) with policies that create challenges (e.g. targets, exposure to competition, etc.) (Schmitz, 2007). On the demand side, the state may use tariffs, taxes, subsidies, product standards, and government procurement to boost or restrict demand. On the supply side, the state may use entry restrictions, state ownership, technology transfer policy, R&D credits and subsidies, and access to credit to steer firm investment in a desired direction.

Each of these policies shape the segmentation of a market, often in unintentional ways: tariffs that raise prices will reduce the size of a low-end segment; restrictions on entry in a sector prevent firms with certain sets of capabilities from competing (Brandt and Thun, 2016). In Fig. 1, the impact of a tariff or restrictions on the entry of low-cost firms, for example, would be an upward shift in the blue curve (reducing the size of the low-end segment).

### 3. Methodology

The empirical section that follows adapts the approach of a “structured, focused comparison” (George and McKeown, 1985) both between sectors within the Chinese automotive industry, and over time. The unit of analysis is the sector within the industry, and choosing three sectors within the same national industry—passenger vehicles, commercial vehicles, and components—makes it possible to hold many factors constant: the macroeconomic environment in all cases is the same, the history and experience of the firms at the start of the reform era was similar, and many of the key firms in the industry produce both passenger vehicles and commercial vehicles. Although component firms

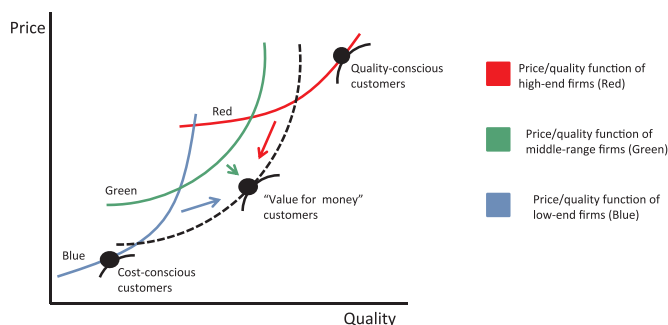


Fig. 1. Cost innovation at the middle of the pyramid.

**Table 1**  
Summary of findings.

	Policy	Markets	Firm Case Study	Outcome
Passenger Vehicles (pre-WTO)	<ul style="list-style-type: none"> <li>&gt; <b>High restrictions</b> on foreign participation (must be JVs, cannot have more than 50% stake; limit of 2 JVs)</li> <li>&gt; <b>High restrictions</b> on entry: licenses (and foreign partners) issued to “3 Big, 3 Small” firms</li> <li>&gt; <b>High tariffs</b> (&gt; 100%)</li> </ul>	<p><b>Supply Side</b></p> <ul style="list-style-type: none"> <li>&gt; Limited competition</li> <li>&gt; Little diversity in ownership</li> <li>&gt; All foreign models</li> </ul> <p><b>Demand Side</b></p> <ul style="list-style-type: none"> <li>&gt; Dominated by state-owned firms and taxi companies that are not price sensitive</li> </ul> <p><b>Market Segmentation</b></p> <ul style="list-style-type: none"> <li>&gt; Limited private ownership</li> <li>&gt; Low-end very small; large mid-market segment (Fig. 1)</li> </ul>	<p><b>Shanghai Auto</b></p> <ul style="list-style-type: none"> <li>&gt; Models based on global architecture</li> <li>&gt; No transfer of design skills within JVs</li> <li>&gt; High cost structure</li> <li>&gt; Market dominance (3 of the 4 top selling models; 29.5% market share) meant there was little incentive for cutting costs or developing new capabilities</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Market dominated by highly profitable JVs producing mid-market foreign models</li> <li>&gt; No “incubation space” in the low-end, and little cost innovation (Fig. 1)</li> </ul>
Passenger Vehicles (post-WTO)	<ul style="list-style-type: none"> <li>&gt; <b>High restrictions</b> on foreign participation continue</li> <li>&gt; <b>Low restrictions</b> on entry for domestic firms</li> <li>&gt; <b>Lower tariffs</b> (25%)</li> </ul>	<p><b>Supply Side</b></p> <ul style="list-style-type: none"> <li>&gt; High competition</li> <li>&gt; High diversity in ownership</li> </ul> <p><b>Demand Side</b></p> <ul style="list-style-type: none"> <li>&gt; Rapid growth of private ownership</li> </ul> <p><b>Market Segmentation</b></p> <ul style="list-style-type: none"> <li>&gt; Rapid growth in all segments</li> </ul>	<p><b>Shanghai Auto</b></p> <ul style="list-style-type: none"> <li>&gt; Acquisition of Rover (UK) designs, but weak capacity for interpreting and implementing</li> <li>&gt; High cost structure and “JV mentality” limits ability to compete in low-end</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Market dominated by JVs</li> <li>&gt; Domestic brands dominate low-end, but are unable to compete in mid- or high-end (Table 3).</li> <li>&gt; Foreign brands are able to fight for cost-sensitive segments (Table 3).</li> </ul>
Commercial Vehicles	<ul style="list-style-type: none"> <li>&gt; <b>High restrictions</b> on foreign participation (same as autos)</li> <li>&gt; <b>Low restrictions</b> on domestic firm entry</li> <li>&gt; <b>Low restrictions on technology transfer</b> (licensing and JVs)</li> <li>&gt; <b>POLICY CHANGE:</b> 1) massive infrastructure development; 2) gradual introduction of restrictions on overloading and higher emissions restrictions</li> </ul>	<p><b>Supply Side</b></p> <ul style="list-style-type: none"> <li>&gt; High competition</li> <li>&gt; High diversity in ownership</li> <li>&gt; Modular domestic designs, well-developed supply chains</li> </ul> <p><b>Demand Side</b></p> <ul style="list-style-type: none"> <li>&gt; Diverse customer base, most are highly price sensitive</li> </ul> <p><b>Change in Segmentation</b></p> <ul style="list-style-type: none"> <li>&gt; Large low-end, increasing demand for quality over time (Figs. 3 and 4)</li> </ul>	<p><b>SAIC-GM-Wuling</b></p> <ul style="list-style-type: none"> <li>&gt; Licensed mini-truck designs from Mitsubishi</li> <li>&gt; Deep distribution network provided knowledge of rural customers and informed incremental improvements</li> <li>&gt; Investments from GM and SAIC focused on process improvements</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Market dominated by domestic firms.</li> <li>&gt; Incremental improvements, and sourcing of foreign components is allowing domestic firms to move into mid-range segments</li> <li>&gt; Rapid expansion of domestic brands into export markets</li> </ul>
Components	<ul style="list-style-type: none"> <li>&gt; <b>Few restrictions</b> on foreign entry</li> <li>&gt; <b>No restrictions</b> on entry for domestic firms</li> <li>&gt; <b>Localization requirements</b> on OEMs force development of local supply base</li> <li>&gt; <b>POLICY CHANGE:</b> Tariffs lowered to 10% after WTO accession</li> </ul>	<p><b>Supply Side</b></p> <ul style="list-style-type: none"> <li>&gt; High competition</li> <li>&gt; High diversity in ownership</li> </ul> <p><b>Demand Side</b></p> <ul style="list-style-type: none"> <li>&gt; Diverse customer base: domestic OEMs in low-end and JVs in high-end</li> </ul> <p><b>Change in Segmentation</b></p> <ul style="list-style-type: none"> <li>&gt; Rapid growth in all segments, increasing demand for quality over time (Table 4)</li> </ul>	<p><b>Yatai</b></p> <ul style="list-style-type: none"> <li>&gt; Adaptation of manufacturing processes to lower costs</li> <li>&gt; Adaptation of product designs to lower costs</li> <li>&gt; Extensive outsourcing to lower costs</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Domestic firms lower cost through innovation in manufacturing processes, product design, and supply chain utilization.</li> <li>&gt; Gradual shift to higher quality products (Table 5).</li> <li>&gt; Less progress in ABS, which has shorter quality ladder (Figs. 5 and 6).</li> </ul>



**Table 2**  
Interviews at brake component firms.

Firm	People interviewed (by position)	Year
Foreign Firm "A"	General Manager	2007, 2007, 2009
Domestic Firm "A"	Vice-GM	2007
Joint Venture "A"	Manager for Operations	2007
Domestic Firm "B"	President	2007
Domestic Firm "C"	President of American Operations	2005
Domestic Firm "C"	1. Chairman	2005
	2. GM of Technical Centre	
Domestic Firm "C"	GM of Technical Centre	2006
Domestic Firm "C"	1. Chairman	2007
	2. GM of Technical Centre	
	3. Assistant GM of Technical Centre	
	4. Deputy GM and Manager	
	5. Director of Quality Advocacy	
Domestic Firm "C"	1. General manager	2011
	2. Director Technical Centre	
	3. Director Finance	
	4. Director Operations	
Domestic Firm "C"	General Manager	2014, 2017
Domestic Firm "D"	1. Chairman	2007, 2007
	2. Director of Technical Centre	
	3. Vice General Manager	
Domestic Firm "D"	Chairman	2015

differ in many respects from OEMs, they are important to include in the analysis because the literature on cost innovation emphasizes that the supply chain is a crucial source of innovation (e.g. Watanabe, 2014).

Given that the purpose of the analysis is to understand “how” policy affects the opportunity for cost innovation and “why” this leads to sustainable upgrading in some cases (and “why not” in other cases), an inductive qualitative approach is particularly appropriate (Yin, 2003; Eisenhardt and Graebner, 2007). The key to successful comparison across a small number of cases is systematic collection of similar data (George and McKeown, 1985) and triangulation between different sources of data (Yin, 2003). Longitudinal case studies are crucial because the objective is to understand how firms develop capabilities over time.

Each case study is divided into two sections. In the first section, the policy environment is described, then the impact of policy on market segmentation is analyzed, and finally the movement of domestic firms between segments is assessed. The data is from published industry level sources, including industry yearbooks, industry reports and databases, and trade data. Table 1 summarizes the variation in policy between the sectors: policy restrictions in passenger vehicles were much tighter than in commercial vehicles or components. Policy in passenger vehicles also changed the most dramatically, and hence is broken down into two periods (pre- and post-WTO accession). In the second section of each case study, the leading firm (based on market share) is used as an “embedded unit of analysis” (Yin, 2003) to understand how cost innovation was used in a sector (or why it was not). The leading firms are chosen because they are expected to be the most likely cases for cost innovation in each segment.

A key methodological challenge is defining market segments according to quality, and then assessing the progress of firms between these segments. For passenger and commercial vehicles, engine size is used as proxy for quality. In the case of passenger vehicles, the low-end is classified as vehicles with an engine displacement of 1.6 l or less, the mid-range is 1.6–2.5 l, and high-end is more than 2.5 l. In a market that values high quality small cars, it would not be possible to use engine size as a proxy measure for quality (e.g. a BMW Mini is small but high quality). In China, where high-end consumers typically favour larger cars, the correlation between quality and car size is roughly accurate. The correlation between quality and car size is confirmed by the J.D. Power Initial Quality Study, which measures vehicle quality through an examination of problems experienced by owners within the first two to six months of ownership. In 2007, using the metric of problems per 100

vehicles (PP100), the average rating for compact cars in China was 297, the average rating for midsize cars was 174, and the average rating for luxury cars was 87 (Power, 2007). In 2013, the ratings were 176 for compact cars, 117 for midsize cars, and 67 for luxury cars (Power, 2013). In the case of commercial vehicles, the engine horsepower is similarly used as a proxy for quality. The low-end is defined as below 230 HP, the mid-range is between 230 and 420 HP, and the high-end is above 420 HP (Russo and Tse, 2015: 10). For both passenger and commercial vehicles, the performance of domestic OEMs vis-à-vis foreign-invested OEMs is tracked.

Defining segments within automotive components is challenging because purchasing data is highly protected by firms. One particular product was chosen—braking systems—because there is a relatively clear path of product upgrading for domestic Chinese firms within braking systems—from drum brakes to disc brakes (in order to improve brake control and heat dissipation) to anti-lock braking systems (ABS)—and multiple sources of data are used to assess the movement of Chinese firms between segments. First, industry association data collected by Fourin is used to track production volumes in each segment between 2000 and 2006, and to identify the leading firms in each segment. Second, data from MarkLines, a Japan-based company that collects data on “who supplies whom” in the global automotive industry, is used to assess the relative strength of domestic and foreign firms in each product segment in 2014. Third, the comprehensive sector-wide data is supplemented with detailed data on the progression of a leading firm in the sector. The combination of industry association data, “who supplies whom” data, and qualitative data from interviews make it possible to triangulate between sources.

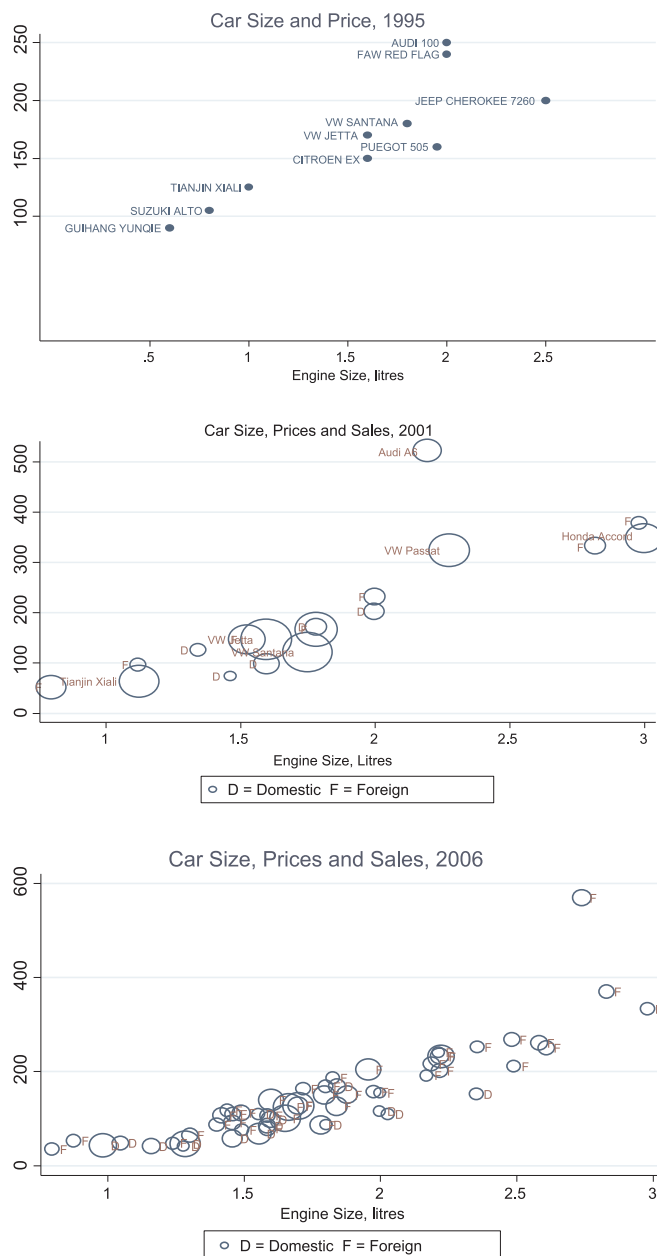
The embedded cases of leading firms are based on interview data. Between 2002 and 2015, 48 interviews were conducted at OEMs in China (both domestic and foreign-invested) and 32 interviews at component firms. At OEM firms, semi-structured interviews were conducted with different levels of the corporate hierarchy and different functions within the firm that were potentially engaged in cost innovation. At the component firms, interviews were conducted with the CEO or General Manager, in order to understand the general strategy of the firm, and then the key managers in potentially relevant functional areas (e.g. purchasing, R&D, manufacturing) (see Table 2). The average length of an interview was one hour, and interview notes were typed immediately after the interviews. The data from firm interviews were checked with discussions with independent analysts covering the industry (e.g. journalists, consultants, and financial sector).

## 4. Case study findings

### 4.1. Passenger vehicles

For three decades, the objective of China's central government has been to develop the automotive sector into a “pillar industry” of the national economy, and the central government has used a series of industrial policies to achieve the objective of globally competitive independent Chinese auto firms. It is useful to separate a description of the policies governing passenger vehicles into two stages: before and after China's accession to the WTO.

In the first stage, prior to China's accession to the WTO, there was very limited competition within the sector and there were strict controls on entry. Table 1 summarizes government policy during this period. On the demand side, high prices restricted the extent of private demand for autos, and the market was dominated by government units, state-owned firms, and taxi companies, none of which were particularly price-sensitive. On the supply side, the single form of ownership and technology transfer—only Chinese state firms in JVs with foreign firms were allowed (with the exception of Tianjin Auto)—limited the form of innovation in the sector. Rather than develop their own designs, each JV adapted a mid-market design from the foreign partner and concentrated on fulfilling government mandated localization requirements.



**Fig. 2.** Car size, prices, and sales in 1995, 2001, and 2006. Data for 1995 from McKinsey; Data for 2001 and 2006 from CATARC. [Brandt and Thun \(2016\)](#)

The result of high barriers to entry and high levels of protectionism was inflated prices for vehicles and a very small low-end market segment. [Fig. 2](#), showing data from [Brandt and Thun \(2016\)](#), depicts the average vehicle price for different car models by engine size in 1995, 2001, and 2006. In the first two panels, sales are clustered around mid-sized cars (and in the second panel the size of the bubble represents sales volumes), and the low-end segments are small. The two Volkswagen JVs alone, both producing mid-sized vehicles, accounted for over half of the sales in the market, and the JVs of the “big three” accounted for 74% of the sedan market ([KPMG, 2003: 9](#)). The average price of a vehicle in the mid-1990s was RMB 130,000, which was forty times per capita income.

After China's accession to the WTO, and a lowering of entry barriers and a drop in tariffs, the price of vehicles dropped sharply and private consumption increased. The increasing size of the low-end segment during this time period is evident in the breakdown of sales by segment

**Table 3**

Leading brands by segment in 2012 (domestic brands in bold).

Source: [Warburton et al. \(2013\): 21](#)

Sales rank	A-Segment	B-Segment	C-Segment	D-Segment
1	<b>Chery QQ3</b>	Chevy Sail	Ford Focus	VW Passat
2	<b>Changan Benben</b>	VW Polo	Buick Excelle	VW Santana
3	Suzuki Alto	Kia K2	VW Lavida	VW Magotan
4	<b>BYD F0</b>	Honda City	VW Jetta	Toyota Camry
5	<b>Lifan 320</b>	<b>FAW Xiali</b>	Chevy Cruze	Nissan Teana

depicted in [Fig. 2](#). Between 1995 and 2010, the number of cars sold in China with an engine size less than 1.6 l increased from 290,717 units to 6,645,875 ([Brandt and Thun, 2016](#)), and the rapid growth of the low-end segment in 2001 and 2006 was dominated by domestic firms while foreign-invested firms continued to dominate the higher-end segments (see [Fig. 2](#)).

The absence of a low-end during the first stage of development created weaknesses that were not easily overcome. The domestic firms could rely on copies of foreign designs to capture market share in the early 2000s, but they lacked the depth of capabilities that would allow them to shift into higher end segments. Between 2001 and 2012, the top selling car in China in all but three years was foreign and there was never more than three domestic brands in the top ten ([Warburton et al., 2013: 16](#)). Data on sales rank by segment in 2012 indicates that the local brands did well in the A-segment (mini-cars), but as the quality of the cars increases in segments with larger cars, the foreign brands dominate (see [Table 3](#)) ([Warburton et al., 2013: 21](#)).

Over time, the size of the low-end segment created strong incentives for foreign firms to find ways to lower their cost structures. These firms focused on improving the efficiency of their OEM production facilities, aggressively localizing their supply chains, and establishing R&D centers in China that could both support the localization efforts and enable them to more effectively respond to the Chinese market. The market share of domestic OEMs peaked in 2010 (at 31.9%) and then declined (falling 5% in 2013–23%) even as the overall size of the market continued to grow ([Mitchell et al., 2014](#)).

#### 4.1.1. Shanghai Auto Industry Corporation (SAIC)

SAIC is the leading domestic OEM in China, and is a good example of how distortions in the segmentation of the domestic market impacted upgrading efforts. One of the original “big three” auto firms, the core of the SAIC group consists of JVs with VW and General Motors (GM), and the group received enormous benefits from high tariff barriers and restrictions on entry ([Fourin 2005a](#)). When China joined the WTO in 2001, SAIC was producing three of the four best-selling passenger vehicle in China (the Santana, Santana 2000, and Passat) with a combined market share of 29.5% ([Fourin, 2004](#)) and the JVs were enormously profitable.

The success of SAIC obscured several difficulties. Most importantly, the group was completely reliant on its partners for designs. GM built a design centre in Shanghai with SAIC, but global architectures and the integral nature of the design process limited the extent to which designs could be adapted for the Chinese market.

Despite the unwillingness of foreign partners to transfer design skills into JV structures, SAIC was enormously profitable and was the dominant automotive manufacturer in China. “The business model of a JV in China is to make cars and make money now,” commented a foreign executive in 2009. A firm that succeeds will grow in size, he continued, and this in turn increases the political power of the firm's top executives (Interview 072109). As a result, SAIC had little incentive to abandon the JV approach or to aggressively pursue cost reductions.

Even after government policy shifted, and the importance of independent product development and national brands began to be emphasized, SAIC had difficulty developing low cost design skills. SAIC acquired the assets of MG Rover and launched the Roewe brand, but the firm's history prevented it from being a low-cost competitor.

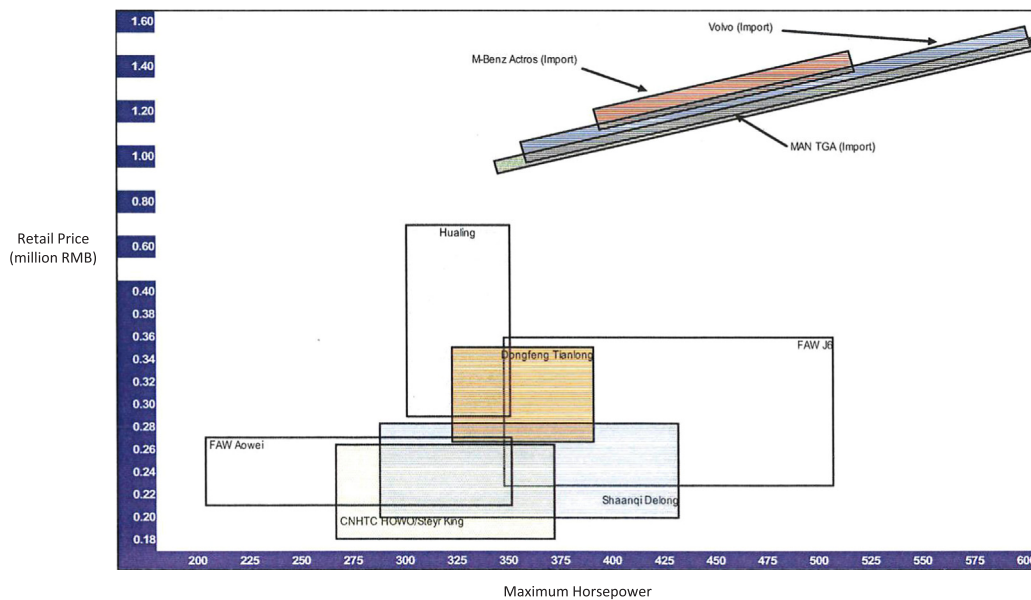


Fig. 3. - Heavy-Duty Truck Market by Retail Price vs. Maximum Power (as of June 2007).  
Source: Fourin (2007b)

First, the cost structure of SAIC was too high. According to a senior executive at SAIC, the costs were approximately 40% higher than a Chinese private sector firm (Interview 080609). The high costs were a result of many factors: the legacy of the excess personnel that came with state ownership, a result of copying the processes of foreign partners, a reflection of the rapidly rising costs in Shanghai, and a consequence of low volumes for the new models.

Second, there continued to be weakness in basic capabilities. “We quickly realised that even though they had sold us these designs, we couldn’t do anything with them [because the JVs had given us no experience in the area of vehicle design and development],” commented an SAIC executive (Interview 031811). In order to help them interpret and implement the Rover designs (e.g. testing and developing tooling for manufacturing, creating specifications for suppliers, performing testing and validation), SAIC established a joint venture with Ricardo, the UK automotive engineering consulting company, called Ricardo 2010 (and SAIC subsequently acquired Ricardo’s share in the JV). The end result was the Roewe 750, a mid-market sedan that was forced to compete head-on with the JV products in China rather than compete in the low-end segment, a fact that was reflected both in the launch price of 210,000 RMB and the wealthy coastal regions where sales were concentrated (Warburton et al., 2013: 167).

#### 4.2. Commercial vehicles

Like in passenger vehicles, the Chinese market for commercial vehicles has enjoyed dramatic growth over the last two decades. Unlike in passenger vehicles, the Chinese domestic firms have been the primary drivers of this growth. In 2010, 97.9% of trucks sold in China were produced by Chinese firms—a percentage that has changed little over three decades—and three of the four largest truck producers in the world (by unit sales) were Chinese companies (KPMG, 2010).

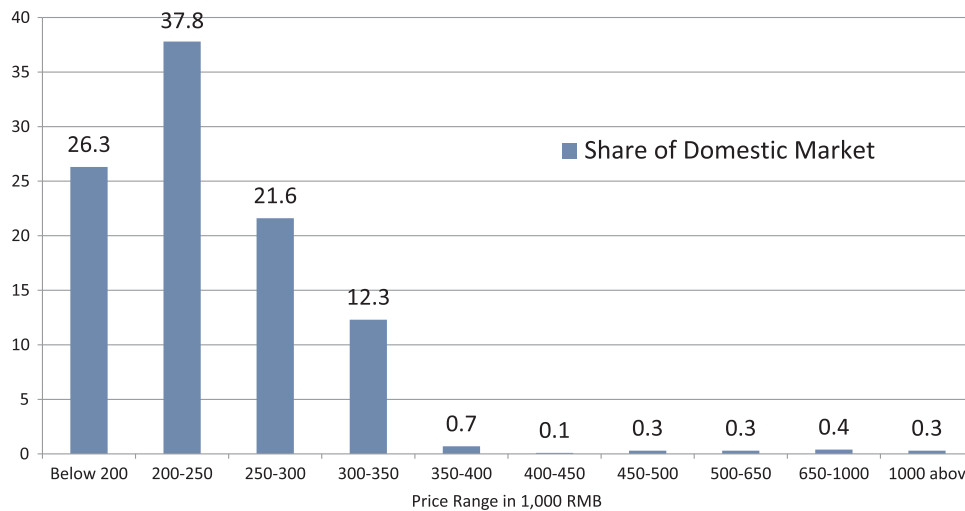
The state policies that shaped the supply side of commercial vehicles were a striking contrast to passenger vehicles. Beginning much earlier, significant resources were dedicated to the sector for strategic reasons, and the primary form of technology transfer was licensing rather than JVs. The first stage of commercial vehicle development in China began in the 1950s with the transfer of technology from the Soviet Union to the First Auto Works (FAW). In the 1960s, due to fear of foreign invasion, the technology of FAW was transferred to the Second Auto Works (commonly known as Dongfeng) in China’s interior, and the

models of these two firms became the standard within the industry and were widely disseminated (partially a result of weak intellectual property protection). The second stage of development was in the 1980s, when firms licensed the technology for heavy trucks (15 t and over) from Austria’s Steyr, and this technology was also widely disseminated throughout the industry. By 2004, 80% of heavy-trucks produced in China were based on Steyr technology (Fourin, 2005b).

The utilization of standard designs in the industry allowed the development of a component base that could be shared by different producers of commercial vehicles, rates of entry were high, and leading OEM and component firms (see next section) engaged in a process of incremental improvements on the base model. As an example of this, the lowest price heavy truck in the market in 2007 was the fifth generation of the Jiefang truck, and it retailed for 210,000 RMB (roughly  $\frac{1}{4}$  the price of a foreign truck) (Fourin, 2007b).

The state has been relatively agnostic about the form of ownership and foreign participation that should prevail, and there has been a growing diversity of firms within the sector: state, private, and foreign-invested. Different types of firms have chosen a variety of strategies for preserving technological leadership within the market. FAW has chosen a purely independent route, and has 12 wholly-owned subsidiaries in commercial vehicles (and no JVs); Dongfeng and CNHTC both have JVs (the former with Nissan and Renault and the latter with Volvo); a wide range of firms have licensing deals (e.g. Beiqi Foton, Shaanxi Auto, Youngman, Qingling) (Fourin, 2005b). A similar diversity is evident for core components, with leading firms choosing different strategies for developing core technological capabilities.

On the demand side, the most striking feature of the commercial vehicle segment has been the consumer emphasis on low purchase price rather than sophisticated technologies, safety standards, and follow-up costs (such as maintenance). The high degree of price sensitivity reflects lower per capita incomes in rural areas (in the mini-truck segment) and low transport prices (in the medium and heavy duty segment). Fig. 3, which breaks the heavy truck segment down by retail price and maximum horsepower (HP), shows the extent to which domestic firms dominate the low to mid-range segment. The trucks sold by the domestic firms are less powerful, but the sales prices are one-quarter to one-third lower than the foreign competition. The high-priced/high-quality segment of the market is supplied primarily by imports. Fig. 4 shows the extent to which the low- and mid-range sales dominate the market, with 98% of the market in either the low- or middle-segments.



**Fig. 4.** - Heavy Duty Truck Market by Segment.  
Russo and Tse (2015)

While the policy environment has long been conducive to a large low-end segment, there have been several policy shifts that have pushed firms to move into higher end segments (i.e. produce vehicles that are higher cost and higher quality). In 2003 and 2011, new restrictions on overloading trucks were introduced (thereby forcing customers to purchase more powerful vehicles) and emissions standards were tightened in 2008 and 2013 (thereby demanding more sophisticated engines) (Russo and Tse, 2015). A demand for more reliable and powerful commercial vehicles was also spurred by the transformation of China's highway system—between 2000 and 2010 the length of national highways in China increased by 2.5 million kilometer—and the resulting improvements in logistics networks (KPMG, 2010). Domestic firms have responded to the increasing demand for more powerful and environmentally-friendly engines in different ways. FAW has used its dominance in low-prices trucks to fund a US \$100 million investment in the next generation of heavy-duty Jiefang truck (Kan, 2007). Other firms deepened their cooperation with foreign firms.

#### 4.2.1. SAIC-GM-Wuling

The leading commercial vehicle producer in mini-trucks over two decades has been SAIC-GM-Wuling (SGMW), and it is a good case study of how domestic commercial vehicle firms compete and innovate effectively in highly price sensitive markets. Until Wuling received investment from SAIC and GM in 2002, it was a low-profile producer of mini-trucks in the interior province of Guangxi. The firm's origins were in tractors, and in 1982 it began producing mini-trucks based on Mitsubishi designs. While the simple designs were inferior to pick-up trucks in power and load capacity, the barebones approach met the needs of Chinese farmers and enabled a sales price below 50,000 RMB (see Ohara, 2014 on the different demand characteristics of rural versus urban markets in China). Only domestic Chinese firms could compete in this segment, and all were based in the interior of China and utilized simple Japanese designs. Intense competition combined with a rapid increase in volumes led to sharp price reductions: a Wuling vehicle that sold for 80–90,000 RMB in 1990 sold for 30–40,000 RMB two decades later (Interview 102711).

When Shanghai Auto and General Motors invested in Wuling in 2002, the strategy was to leave the low-cost design largely untouched, and focus on improvements that could be made on the manufacturing side (e.g. quality control), logistics, and service (e.g. the introduction of fault analysis) (Interviews 102711 and 072109). “In the first year,” commented a Wuling manager, “I learned more than in the past seven” (Interview 102711). GM also learned from Wuling, of course. According to managers at GM, the core value of the JV from GM's perspective was

Wuling's knowledge of the rural customer, a knowledge that was derived from a dealer network that reached into almost each of China's 2800 counties (Interview 072109 and Jian, 2012). As a minor example of Wuling's ability to “understand the customer's voice”, local managers explained that they had overruled GM's suggestion of eliminating covers on glove compartments (and achieving a slight cost savings) because they knew their customers valued a secure compartment in the vehicle (Interview 102711). Rather than make drastic changes to a local design, foreign firms tried to optimize them. A foreign engineer working at a competing JV, pointed to how the weight of a locally-designed vehicle could sometimes be reduced by small improvements (which sometimes eliminated the need for reinforcements) and use of alternative materials (Interview 082910).

SGMW has been one of the most successful automotive firms in China over the last decade, expanding to three production bases within China. General Motors sold 3.73 million units in China in 2015, making it GM's largest market in the world, and the Wuling JV accounted for 2.02 million of this amount. GM appears to be positioning Wuling as its emerging market brand, and SGMW began producing mini-trucks in Indonesia in 2017 with a brand focused on “functionality, attractive styling and value for money (Newton, 2015).”

#### 4.3. Component firms

While the growth of component exports from China over time gives an indication of gradually improving global competitiveness (see Brandt and Von Biesebeck, 2006; Li et al., 2015), there are no studies that track the movement of domestic component firms from low to high quality points within a product area or from low to high-value products.

The policies governing China's automotive component sector were also more liberal than passenger vehicles. On the supply side, there were no restrictions on entry. While the passenger vehicle OEMs initially favored affiliated component firms (i.e. within the corporate group of the Chinese partner), cost pressures eventually forced all firms to search for low-cost suppliers (Thun, 2006; Buck, 2012). After WTO accession, tariffs on auto components were reduced to 10% (compared to 25% on vehicles). On the demand side, the component firms benefited from a wide range of prospective customers, each demanding a different combination of price and quality (e.g. agricultural machinery, commercial vehicles, aftermarket exports, domestic passenger vehicles OEMs, JV passenger vehicle OEMs, exports to foreign OEMs).

The case of braking systems is roughly representative of the component sector as a whole, with the competencies required of firms ranging from simple mechanical stamping to sophisticated electronic



**Table 4**

Passenger car production by brake system type, 2000–2006 (in thousand units).

Source: Fourin (2007a)

	Brake System Type			2000	2001	2002	2003	2004	2005	2006	Growth Rate	Top 3 Brands
	Front	Rear	ABS									
Low	Disc	Drum	No	386	405	535	583	561	499	477	4.5%	QQ, Xiali, Ulion
Medium	Disc	Drum	Yes	111	169	327	722	820	1,196	1,628	36.9%	Jetta, Santana, Cowin
High	Disc	Disc	Yes	108	197	367	883	1,101	1,434	2,197	53.2%	Elantra, Excelle, Accord

software design and testing. On the demand side, the market segments can be defined by the configuration of braking components (i.e. drum, disc, ABS) that are used in a vehicle: a low-end vehicle has a rear drum brake, front disc brake, and no ABS; a mid-range vehicle has a rear drum brake, front disc brake, and ABS; a high-end vehicle has rear and front disc brakes and ABS.

Table 4 shows the growth of each market segment between 2000 and 2006 and the top three passenger vehicle models in each segment. Two trends are evident. First, all segments exhibit growth, but there is a clear shift upwards over time. Second, the leading customers of the low-end brake configuration are domestic OEMs, the leading customers of the mid-range configuration are a mix of JVs (with older models) and domestic OEMs, and the leading customers of the high-end configuration are all JVs. Although the use of low-end drum brakes is shrinking in passenger vehicles, these will also be used in commercial vehicles. On the supply side, there are a wide range of ownership forms, including wholly foreign-owned (e.g. Advics, Akebono, Bosch, Mando, TRW), joint ventures (Continental-SABS), and both state (SAIC and BWI) and private (Yatai, Wanxiang) domestically-owned firms (Fourin, 2007a). In contrast to the OEM sector, the regulations governing entry into the component sector have always been relatively liberal.

#### 4.3.1. Yatai

The case study of Yatai demonstrates how domestic component firms are able to innovate in the low-end and then leverage their participation in multiple value chains to gain the competencies required to upgrade.

Yatai was founded in 1976 as a township village enterprise (TVE), initially producing brake components for 3-wheeled carts. In the 1980s, Yatai imported the equipment necessary to produce drum brakes, and began supplying less demanding and highly price conscious commercial vehicle firms. The quality improvements in Yatai drum brakes is reflected in the firm's ability to supply more demanding customers, as can be seen in the progression from domestic OEMs to foreign-invested OEMs (i.e. the position of the customer on the panels in Fig. 2 is shifting from the lower left to the upper right). By 2007, the firm was supplying drum brakes to virtually all OEMs in the sector (see Table 5), and this finding corresponds well with the Marklines data (see Fig. 5), which indicates that 96% of drum brakes in China are sourced from domestic Chinese firms.

In the 1990s, the same process then began again with the more technically demanding disc brakes. Fig. 6 indicates that between 2007 and 2015 the firm's output shifted away from low-margin drum brakes towards higher margin disc brakes. Table 5 shows how the customer base during the same period became more evenly split between domestic and foreign firms.

In 2013, the company had the largest market share in China for disc brakes, drum brakes, hydraulic brake master cylinders, hydraulic brake

wheel cylinders, clutch master cylinders, and clutch slave cylinders, and 90% of its sales overall went to OEM customers, with the primary selling point being cost innovation: the sale price of the disc brakes and master cylinders was 10–20% less than global rivals and quality was similar (Interviews 090707 and 083107). In 2015, the firm was in the process of becoming a global supplier for VW's MQB platform, and in discussions to open a facility in Mexico.

The firm pursued cost innovation in several ways. First, the firm designed manufacturing processes that allowed it to lower costs and operate more flexibly. Yatai produced brake hydraulic cylinders at two neighbouring buildings in the same facility, one a JV with the German firm FTE and the other a wholly-owned Yatai facility, and each had a different customer base: the former producing for JV OEMs and the latter for domestic OEMs. The JV used licensed technology from the foreign partner and imported valves—so there was less room for product adaptation—and the assembly line was more capital intensive (e.g. more sophisticated machines and a higher degree of automation) (Interview 083007). The less automated Yatai facility had a greater degree of flexibility, and thus had a capacity to work with domestic OEMs that required less lead-time and smaller batches.

A second key source of cost innovation combined product design and supply chain innovation. The supplier worked on either a “drawings-supplied” or “drawings-approved” basis. In the former, the foreign firm provided the blueprints for the component, and benefited from the lower cost structure of the Chinese supplier (e.g. lower overhead and perhaps slightly lower labour costs) and potentially the process innovations of the sort that are described in the previous paragraph. In the latter, the foreign firm was able to benefit from a wider range of cost-innovations because slightly simpler designs and superior understanding of customer requirements allowed more process and product adaptation, as well as the utilization of a wider network of domestic lower tier suppliers. As one foreign manager explained, “In China, exceeding customer expectations is wrong! You meet customer expectation (Interview 051807).” Domestic firms were able to do this far more effectively than foreign firms.

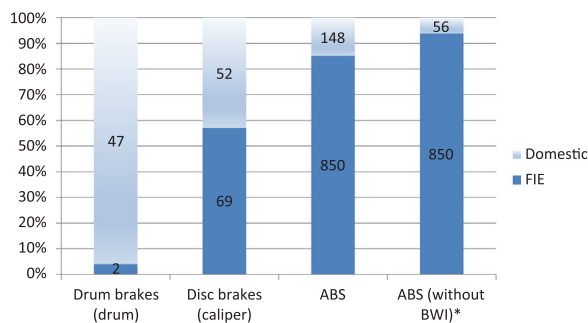
Delphi, a primary foreign competitor of Yatai, provides a useful point of comparison. Delphi's wholly-owned Shanghai facility was essentially a copy of a facility in the United States, including the lay-out of the assembly line, the machinery, and the designs that were used (Interview 102111). When Delphi introduced a product in Shanghai, it would send engineers from the States to give the Chinese team the product specifications, the Chinese team would set up the assembly line (which was designed for Delphi's global operations) and send samples back to the States. The team in the States would then test the results and report the faults. The total plant defect rate of 6 PPM was equal (if not better) than quality levels that were achieved in the States (Interview 083107), but the system created little space for local adaptation. Although 95% of the revenue in the Delphi braking unit came from

**Table 5**

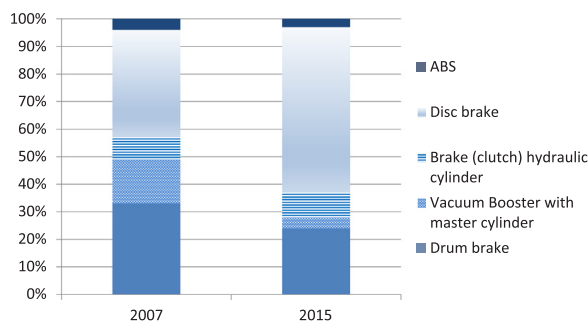
Yatai customer base by segment for drum brake, disc brake, and ABS.

Source: Data for 2007 is from company data; Data from 2015 is from Marklines.

Product (year of introduction)	Drum brake (1981)	Disc brake (1992)	ABS (2000)
2007	Low-End: Chery, Jiangling, Zhengzhou Nissan  High-End: FAW-VW, Shanghai VW, Dongfeng Peugeot	Low-End: Geely, Chery, Changan, Jiangling  High-End: FAW-VW	Low-End: Beijing Jeep, Zhengzhou Nissan, Zhejiang Zhongtai, Chongqing Lifan, Anhui Jianghuai, Beijing Futian High-End: None
2015	Low-End: Brilliance, BYD, Changan, Chery, GAC, Dongfeng, Jiangling, Zhengzhou Nissan, Zotye High-End: FAW-VW, Shanghai VW, Dongfeng Peugeot	Low-End: FAW, BAIC, Brilliance, Chery, Changan, Dongfeng Liuzhou, Great Wall, Jiangling, Zhengzhou Nissan High-End: FAW-VW, Shanghai GM, FAW Mazda	Low-End: Beijing Jeep, Beijing Autoworks, FAW Jilin, Shanghai Huizhong, Zhengzhou Nissan, Zute, GAC, Hunan Jiangnan High-End: None



**Fig. 5.** Brake component suppliers for Chinese car models in 2014: foreign-invested (FIE) or domestic?. \* BWI is a Chinese firm that acquired the Delphi braking system assets. Given that these are foreign developed capabilities rather than domestic, the data is shown with and without BWI. MarkLines Data



**Fig. 6.** - Yatai Product Sales by Value, 2007 and 2015. Company data

China, the General Manager said, the decisions were all made at the headquarters: “It is like having your ears, nose, and mouth in China, but controlled by a brain in North America (Interview 040811).”

Delphi struggled to meet the cost level of domestic firms such as Yatai, and this became increasingly important as the market share of the domestic OEMs increased. According to senior managers at Delphi, the advantage of domestic component firms was not lower labour costs—Delphi's labour costs in Shanghai were only .5% of their total costs—it was their ability to outsource a greater percentage of manufacturing to low-cost local suppliers, and the American firm systematically did teardown analysis of competing domestic products so as to be able to identify their suppliers.

When Delphi increased its utilization of lower tier suppliers, the American firm became responsible for the quality standards within their supply chain. Beginning in the late 1990s, for example, Delphi gave domestic firms the necessary designs for components being supplied to Shanghai General Motors, helped them set up the production

process, helped them negotiate with equipment vendors, and assisted in the implementation of lean techniques. If quality problems emerged, Delphi engineers were dispatched to the domestic suppliers to search for a solution. From the Delphi perspective, the top managers were well aware that they were training potential competitors—and attempts were made not to outsource core competencies—but cost pressure from the OEM left Delphi with little choice (Interview 051807). From the perspective of domestic suppliers, the managers saw the relationship with Delphi as being a mechanism for achieving a high level of competency very quickly, but given that Delphi was cautious about transferring core competencies, the range of capabilities that were acquired was narrow.

The one area of braking systems that Yatai has shown little ability to capture market share is ABS. Yatai was the first domestic firm to develop capabilities in ABS, an effort that began in 2000. No foreign firms were willing to license this technology, so Yatai collaborated with academics at Qinghua University in Beijing to develop the electronic control unit. The firm developed the software and hydraulic valves internally, and designed the motor and sensors but outsourced the manufacturing. Only two other domestic firms in China had the capability to produce these hydraulic valves. Defect rates were initially very high, but by 2007 had been lowered to about 1000 PPM. As Table 5 indicates, Yatai's initial customer was Beijing Jeep, a contract that was secured by offering to customize without charge an ABS unit for an older Beijing Jeep model (that had not previously used ABS), and Yatai then sought customers that had similarly low-demands (Interview 083007). Although the firm was optimistic that it would gradually begin to sell ABS systems to more demanding customers, this did not happen. In 2015, ABS was only 3% of sales (see Fig. 6). As the director of the technical centre at a Chinese brake firm explained, the challenge of ABS is that you have to be perfect and there is little room for incremental improvement (Interview 102111).

## 5. Discussion

Although the middle of the global economic pyramid, which includes middle class consumers in the world's largest developing countries, is often portrayed as fertile ground for cost innovation, the case studies presented in this paper suggest that fertile ground can easily be made barren. Unlike in very low-end or very high-end segments, both of which have relatively clear objectives—low-cost in the former and high-quality in the latter—the middle segments require constant trade-offs. Consumers often demand products that are similar to those in developed markets, but they demand a much lower price. Squaring this circle requires a complex amalgam of foreign and local content, and each segment of the market plays a crucial role: a large low-end provides domestic firms space to incubate their capabilities and engage in cost innovation, while higher end segments provide global firms the incentive to invest and localize technologies and processes that will complement local innovation. Consumers at the middle of the pyramid

demand a price/performance ratio that exactly meets their needs; successful firms understand these needs and draw from multiple segments to meet them.

The case of passenger vehicles illustrates how easily the size of the low-end segment can be reduced. The combination of tariff protection and restrictions on entry raised prices out of the range of private consumers. As a result of the reduced size of the low-end, firms had less pressure to innovate for the local market. Foreign partners in the JVs transferred the skills necessary to improve capabilities in the supply chain (Thun, 2006) and improve the operations of the assembly plants (Nam, 2010), but the foreign partners had little incentive to transfer the design skills that were needed to design new models (Holweg et al., 2005; Thun, 2006; Nam, 2010). Domestic partners were also complacent. Critics of the restrictions on entry in the sector have referred to the ‘JV mind-set’ (“合资主义”): the combination of easy access to foreign brands and technology and the high profit margins that came with an oligopoly meant that the Chinese partners in the JVs had little incentive to invest in the development of independent technological capabilities (e.g. Liu and Li, 2009). While it could be argued that the per capita incomes in China were not yet sufficiently high to support a private automotive market in the 1990s, this seems unlikely given that there were 100 million urban household in China by the mid-1990s, and a conservative estimate of household income for the top five percent would be RMB 20,000 (Brandt and Thun, 2016).

The case study of SAIC also shows that organizational practices that are formed in an initial stage of development are not easily altered even when circumstances change. This logic has usually been applied to incumbents, firms that are unable to respond to new technologies due to embedded organizational competencies (Henderson, 2006), but state policy in China had the effect of making SAIC behave like an incumbent: rather than innovate for the local market, it adapted the organizational practices of its foreign partners (i.e. SAIC was adapting the processes of a firm on the red frontier in Fig. 1, rather than the blue frontier). When the market was protected, SAIC did very well, but when competition increased, the firm had the weaknesses of a global incumbent (e.g. cost structure, processes, culture, and car models) without the strengths (e.g. depth of design capabilities and global scale).

The commercial vehicle and component firms, by contrast, were able to adapt a classic Chinese approach to cost innovation: the basic designs were more appropriate to the domestic market, the high degree of modularity and standardization across the industry facilitated the use of low-cost suppliers, and constant competitive pressure forced a process of steady incremental improvements. Firms in these sectors were able to operate as true new entrants, enjoying “natural” protection from global incumbents in a large low-end market and less restrictions in terms of ownership and foreign participation. These firms employed classic tactics of cost innovation—detecting market opportunities, adjusting product designs and manufacturing processes, and learning from other firms in the sector—in a manner that foreign firms had difficulty matching, and the intense competition (and in the case of commercial vehicles, regulatory changes) within the sector provided a continual incentive for further innovation. The domestic firms started on the blue frontier in Fig. 1, and then shifted to the right as they engaged in cost innovation and captured the expanding middle market segments. Similar approaches to cost innovation in China can be found in motorcycles Ge and Fujimoto (2004), mobile phones Zhu and Shi 2010, and electric bikes Hang et al. (2015). In the case of ABS, however, the demand for high quality meant that the blue and green frontiers in Fig. 1 were largely absent, and new entrants consequently had great difficulty entering the market.

This argument has implications for theory, policy, and practice.

### 5.1. Implications for practice

A key managerial implication for emerging market firms is that

different market segments offer different resources, and firms that are able to operate in multiple value chains have an advantage when trying to innovate for the unique demands of the market. In the case of Yatai, the low-end for drum brakes was low-margin, but provided both a stable source of revenue and the opportunity to broaden its capabilities. The higher-end segments created opportunities for learning, through relationships with foreign firms, and incentives to upgrade (so as to achieve higher margins).

For foreign firms, the difficulty of imitating the cost innovation of domestic firms is clearly evident, and foreign firms had to seek other ways of taking advantage of local capabilities, including localization strategies for purchasing, alliances and partnerships, and/or acquisitions. The implication for foreign firms is that buying a low-cost model (and then working to improve it), or working closely with a local firm, is more realistic than attempting to lower the cost of a high-end model. When entering into relationships with domestic firms, the key strategic challenge for foreign firms is to support the upgrading efforts of domestic firms, while at the same time preventing their core capabilities from being imitated. Keeping core components in-house or safeguarding system integration capabilities are common approaches. Foreign firms involved with braking systems, for instance, were unwilling to collaborate with domestic firms on ABS systems.

### 5.2. Implications for policy

The implications for policy are twofold. First, it is important for policymakers to understand the impact policies will have on the segmentation of a market. Sectors and products with a full sequence of market segments provide a series of incremental steps for domestic firms, each segment plays a crucial role in the development process, and policies may (inadvertently) eliminate a crucial segment. In passenger vehicles, a combination of tariff protection and restriction on entry led to high prices and restricted the growth of the low-end. It is possible to conceive of other policies that might have reduced the size of the high-end (e.g. a luxury tax) and reduced the incentive of foreign firms to invest. This is not to say that all state intervention is negative, but the state should take care not to reduce the size of segments within which domestic firms have a natural advantage. The ABS segment of braking systems illustrates the difficulty domestic firm's face when there is no low-end segment in which domestic firms can gain a foothold in the market.

Second, restrictions on new entrants should be avoided. In passenger vehicles, there was a significant change in the policy environment after WTO accession, and a rapid expansion of the low-end. Given the difficulty of organizational change, however, incumbents such as SAIC had great difficulty taking advantage of the new opportunities for cost innovation, while new entrants were often highly innovative.

Third, policy-makers must understand the role of history: policies can be changed rapidly (e.g. a tariff can be lowered or an entry restriction removed), but because organizational capabilities within firms are constructed slowly, firm behaviour will not respond immediately to the policy changes.

### 5.3. Implications for theory

The existing theoretical literature focuses on the opportunities at the base of the pyramid (Prahalad and Hart, 2002), identifies the firm-level resources that emerging market firms have to realize these opportunities (Chen, 2009; Ray and Ray, 2011; Hang et al., 2015; Wan et al., 2015), and explains the difficulties that incumbent firms face when trying to exploit these new market opportunities (Henderson and Clark, 1990; Christensen and Raynor, 2003). This literature provides important insight into the dynamics at either end of the economic pyramid, but does not fully appreciate the crucial role of the middle segment in providing an upgrading path for emerging market firms.

Understanding the dynamics of innovation in the middle segments of the economic pyramid is conceptually important for multiple

reasons. First, the middle of the pyramid requires firms to balance the ratio of cost and quality far more exactly than in other segments. The ability to supply precisely the level of quality demanded by the customer—too much and the price is too high, too little and the product is not good enough—is a critical competency. The theoretical literature has long debated whether innovation is driven by the supply-side (Dosi, 1982) or the demand-side (Christensen, 1997; Adner and Levinthal, 2001), and many have recognized that both play crucial roles (Mowery and Rosenberg, 1979). The contribution of this paper is the explanation of how the interaction of supply and demand varies by segment. While a balance of quality and price must be achieved in all segments, in the low- and high-end segments there is a dominant tendency according to which the firm can develop competencies and organizational resources; in the middle, no such dominant tendency exists.

This leads to a second point: achieving the appropriate ratio of price/quality in the middle segments often requires new entrants and incumbents to blend their capabilities (e.g. through supplier relations, joint ventures, etc.). While the existing literature often depicts the two in competition (Christensen, 1997; Zeng and Williamson, 2007; Wan et al., 2015), the forms of cooperation between new entrants and global incumbents are equally important, given that both have capabilities that the other lacks. Design choices (e.g. increases in modularity) and supply chain strategies (e.g. increased outsourcing) allow firms to achieve different balances of price and quality.

Finally, a focus on the interaction between different market segments shifts the focus from static capabilities (i.e. how firms compete within a resource-constrained segment) to dynamic capabilities (i.e. how firms develop new capabilities so as to respond to a rapidly changing environment) (Teece et al., 1997). This is particularly important in the context of a developing country, given that successful development is by definition a context of rapid change, and the challenge for firms is leveraging existing assets for new business activities and learning how to combine and recombine assets to address challenges in new markets (Teece, 2008: 106).

The case studies in this study demonstrate how firms develop resources that enable them to compete in their primary market segments—emerging market firms in the low-end and global firms in the high-end as depicted in Fig. 1—while the middle segment promotes the development of dynamic capabilities. This is because: 1) the size of the middle segment creates incentives for these firms to develop new capabilities; and, 2) the unique demand characteristics force both new entrants and incumbents to combine and re-combine resources in new ways (and in ways that they otherwise might not be willing to consider). In the case study of braking systems, for example, the global firm was learning from its local suppliers (i.e. gaining capabilities) at the same time that it was supporting their development (i.e. providing capabilities). When market segments are missing (e.g. autos before WTO entry) the pathway of capability building is broken.

These implications for practice, policy, and theory are not universally applicable. These are arguments for countries with significant domestic markets given that the size of each segment must be sufficient to create adequate incentives for firms. These arguments are also more likely for relatively mature products for which the dominant form of innovation is incremental rather than radical.

#### 5.4. Alternative explanations

There are several potential alternative explanations of the variation in outcomes within the Chinese automotive sector. First, the relationship between brands and status might be more important for passenger vehicles than commercial vehicles: domestic brands dominate at the low-end in passenger vehicles, but as soon as consumers are able to afford a more expensive (and higher-status) foreign brand, they do so. This argument is difficult to discount completely because vehicle price and vehicle quality are very highly correlated in the Chinese market ( $R^2 = .76$ ), unlike in developed markets, where consistently high quality weakens the relationships between price and quality (Power, 2016: 5).

There are indications, however, that Chinese auto buyers are focused on underlying product attributes. In 2005, analysis of the common characteristics of the strongest performing models in Chinese market found that only in the luxury segment was there a model (the BMW 3 Series) whose performance attributes were below average in the category, but the sales of which nevertheless maintained steady growth. In other categories, engine power and fuel efficiency were seen as crucial (Fourin, 2005c). The expectation is that if a domestic brand is able to improve product quality, the sales will increase as well.

A second alternative explanation is that commercial vehicles tend to be more modular than passenger vehicles, and because the standard interfaces of a modular architecture lower coordination and transaction costs, greater savings are possible (Fujimoto, 2012). In other words, the difference in product architecture precluded the same degree of low-end innovation in passenger vehicles. This explanation also seems insufficient. As Fujimoto (2014: 12) argues, there is no such thing as “intrinsic architecture”, but rather the architecture is chosen by the market and society. The argument in this paper is that state policy created an environment in which passenger vehicle firms adapted the integral architectures of their foreign partners rather than engage in cost innovation. One potential means of lowering costs might have been to experiment with modular architectures, but other forms of cost innovation were also possible.

## 6. Conclusion

The automotive industry is a favorite target for ambitious policymakers in developing countries, capable of generating positive spillovers, employment, and national pride. It is also a sector that is thought to be well-suited to the traditional tools of industrial policy: the technology is relatively mature (excluding new energy vehicles), capital intensity is high, and a large number of complementary suppliers are required. China adapted many of the traditional industrial policy tools—high tariffs, restrictions on entry, and tight controls on the form of technology transfer—but these policies were adapted with the idea that the solution for Chinese firms was to learn from global incumbents. As a result, the low-end of the market was severely constricted and the domestic firms adapted the weaknesses of their foreign partners (high costs, products designed for developed markets) without the strengths (independent design skills). Paradoxically, the set of state policies designed to promote competitiveness in export markets, limited the ability of domestic firms to employ the natural advantages of their home market.

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