Supplementary Material

# Chinese Government Encouraging Innovation in Auto Industry

The Chinese government has been playing a significant role in the internationalization and technology acquisition by Chinese firms. From the 5th five-year plan (1976–1980), the government started its open-door policy and placed economic development and industrial modernization at the forefront of its developmental goals. The 6th (1981–1985) and 7th (1986–1990) five-year plans reformed many policies and started the decentralization of decision making in many industries to provide entrepreneurial opportunities and allow POEs to flourish domestically (Child & Rodrigues, 2005). The 8th (1991–1995) and 9th (1996–2000) five-year plans still focused on overall and regional economic development and, at the same time, turned the attention toward further opening up different industries and creating opportunities for inward FDI (Ebbers, 2018).

China made innovation one of its long-term planning central points since the 2000s and formally outlined this plan in the 10th (2001-2005) five-year plan. The Chinese government started to encourage Chinese firms to 走出去 (*zouchuqu* meaning ‘go out’) for even more aggressive pursuit of technological know-how (Child & Rodrigues, 2005) and provided them with comprehensive backing including but not limited to insurance, legal support, and low-cost loans (Overholt, 2018; Shambaugh, 2013). In fact, in 1995, the phrase 自主创新 (*zizhu chuangxin*) – which roughly translates to ‘self-directed’, ‘independent’ or ‘indigenous’ innovation – was introduced into the Chinese government's lexicon (Liu, Simon, Sun, & Cao, 2011). Li Peng, then the prime minister, in his 1996 report on the 9th five-year plan, referred to this phrase (for the sake of parsimony, we call it ‘indigenous innovation’) through knowledge acquisition and assimilation from abroad for the economic growth, suggesting a change of the gear from scale-driven to innovation-driven (China.org.cn, 1996). In the 9th five-year plan, the government of China anticipated the country’s transition to focus more on indigenous innovation by 2010.

From the 10th five-year plan the focus officially shifted to innovation, and indigenous innovation received greater attention. Learning from previous years of experience, the government furthered policy improvements to facilitate indigenous innovation in more areas. In the 10th five-year plan, indigenous innovation was mentioned three times, and in the 11th five-year plan (2006–2010), the number increased to 24 times. The focus on innovation, particularly indigenous innovation, was accompanied by substantial reforms and inputs into the national innovation system of China (Chen & Naughton, 2016; Liu et al., 2011; Overholt, 2018). Ever since the 11th five-year plan, and with 12th to 14th five-year plans, China increased its emphasis on indigenous innovation in many industries and required its firms to be competitive globally. As of the 12th five-year plan, innovation became one of the main parts, chapters, and paragraphs of each five-year plan and was referred to hundreds of times. For instance, as of the 12th five-year plan, industrial and scientific innovation was recognized as the primary driver of strategic development. From the 13th five-year plan, the issue of innovation upgrade, from the seventh article, was promoted to the second and most crucial article of the five-year plans, making all subsequent plans contingent on innovation. In the 14th five-year plan, the government required innovation, modernization, and digitalization of all aspects of the economy to build a higher level socialist market economy system and achieve its (i.e., party's) centennial goal of ‘building a moderately prosperous society in all respects’. However, in this five-year plan, the emphasis on ‘indigenous’ innovation is reduced and can be seen in Part IV, Article 12, Section 1.

The Chinese government designates a pillar industry category to the automotive industry. Chinese auto industry's development has been a typical example of the government's strong and evolving influence. One of the first EJVs in China was born in this industry in 1983. The Auto Industry Policy issued in 1994 continued to encourage local firms to establish EJVs with foreign OEMs. The policy made it clear that this approach was instrumental to Chinese automakers’ technology upgrading. Later the state realized that EJVs exposed Chinese automakers to world-class manufacturing technologies and led to their specialization into less technology-intensive value chain activities, such as peripheral component manufacturing and assembly. In 2004, the Auto Industry Policy was updated according to the 10th five-year plan and called for intensive R&D input, indigenous innovation, and indigenous brands from Chinese automakers. The 12th five-year plan emphasized the structural change in the auto industry and stated that ‘The automobile industry must strengthen the research and development capabilities of complete vehicles, realize the autonomy of key parts and components…’ (Part III, Article 9, Section 1). This makes our selection of this industry timely.

In recent years, China's automotive industry has notably excelled. and the progress has made China one of the major markets in the world for passenger cars and an advantageous location for automotive technology development and its related technologies (Teece, 2019). Figure 1 of this supplementary material shows the considerable rise in the number of registered patents in the automotive industry by China compared to the US, Korea, Japan, and the EU in the first two decades of the 21st century. While the validity of patent registration from China has been questioned (Santacreu & Zhu, 2018), the improvements are also observable in growing China's automotive market as measured by the total number of different types of cars manufactured and/or sold in China (Chin, 2009), making China the world's largest market for automobiles in terms of demand and supply since 2009 (OICA, 2019).

-------------- Figure 1 -----------------

Historically, the top five largest Chinese automakers are all SOEs. In order of sales, they are Shanghai Auto Industry Co. (SAIC), First Auto Works (FAW), Dongfeng Motor Co (Dongfeng), Chang’an Automobile Group (Chang’an), and BAIC. From the 1980s, with the increasing private wealth, China witnessed the emergence of privately owned firms. Table 1 of this supplementary material shows the growth of POEs in the industry as demonstrated by the improvements in the ranking of POEs amongst the top 16 largest Chinese automakers (i.e., passenger car, SUV, crossover, minivan, minibus, and bus) for the 14 years between 2006 to 2019. The increasing role of POEs in China's passenger automotive industry implores the investigation concerning their approaches to acquiring advanced technology and the role of the Chinese government in doing so.

---------- Table 1 -----------

# Recent Updates on Further Innovations in BAIC and Geely

BAIC Motor and Geely Auto were the primary acquisition beneficiaries of BAIC Holding and Geely Group. Each of them witnessed a significant boost in their sales shortly after their company's respective acquisition of Saab and Volvo. Figure 2 shows the trend of each company's passenger car sales and market share in China. Figure 3 also shows Volvo's sales data in China, European Union, the U.S. between 1999 and 2020. This shows that Geely was also able to improve Volvo's performance in all three big markets.

---------- Figure 2 & 3 -----------

According to BAIC (personal interview), up to 2018, BAIC had introduced 16 different models of cars using technology acquired from Saab. The list of products that had noticeable aspects of Saab technology are provided in Table 2 of this Supplementary Material. BAIC noted that their other products also have benefited from this technology, but we could not independently verify this due to our lack of expertise. On the other hand, Geely also co-developed many products based on the platform developed by CVET, its subsidiary, some together with Volvo. These products are also listed in Table 2.

------------- Table 2 --------------

Apart from these products, from the time of the initial submission of this paper to its acceptance for publication in the end of 2021 many things happened that need to be noted. As shown in Figure 2, BAIC experienced a drop in sales in 2017. During 2017, while China's auto market grew by 3.04%, Senova's market was reduced by 50% (Sohu, 2018). Whereas up to 2015 and well into 2016, experts and the market favored Senova, they and consumers seemed to believe the new models were poorly designed and equipped with out-of-date technology that did not match with the high-end image that BAIC was advertising for the Senova brand (Chejingshe, 2019; Qiu, 2017). Some automotive experts believed that BAIC’s growth after partnering with Hyundai (in 2002) and Daimler (in 2005) – BAIC's only two international EJV partners – was based on the production and sales of these two brands. BAIC's two EJV with internationally known brands, Daimler (Mercedes) and Hyundai, could increase its sales numbers and create an image of a mid-to the high-range carmaker. BAIC borrowed some interior concepts from Mercedes to improve Senova's brand image because its EJVs with Mercedes and Hyundai maintained their high-end image. However, they were still unable to differentiate themselves in terms of technology, looks, or price (Chejingshe, 2019).

In 2018, the entire China automobile market shrunk by 3% (Car News, 2020; Pan, 2019), and BAIC found Senova in a worse position than in the year before, while the sales of Beijing-Benz and Beijing Hyundai improved during the same period. By July 2018, Xu announced the suspension of the production of Senova and old Saab technology in its Beijing factory, citing ending the era of internal combustion engine vehicles as the reason (China Auto Time, 2018), which is also aligned with the Beijing Municipal government's plan to stop the sales and operation of such cars within the city limits. Discontinuation of Senova was not because of deficiency or the absence of innovation because, as outlined above, Senova proved to be an innovative product. Apart from expert reviews, the market failure of a product could be due to many factors (Cooper & Kleinschmidt, 1987). In BAIC's case, it could be because of various products' mismatched technology and positioning. Unlike Geely, BAIC did not give up the lineup of its low-end brands but tried to fit Senova within its EJV brands, which experts did not accept. While this decision was announced two years before introducing the 14th five-year plan, as a high-ranking member of the party, Xu might have also been aware of the governments' decision to reduce their emphasis on the ‘indigenous’ aspect of innovation.

On the other hand, consistent with our prediction of synergistic planning at Geely, they have created further synergy. Geely expanded its array of mid-range to high-end brands with the introduction of new Volvo and Geely models, as well as the latest brands, Lynk & Co., Polestar, and Geometry (see Table 2 for details). As we analyzed through the case of acquisition of Volvo technology, all new brands and models are co-developed with Volvo and based on the platform developed by CEVT, operated jointly by Volvo and Geely Auto. Geely has introduced these new brands as "co-developed" and not indigenous or independent brands.

In his New Year's speech on 31 December 2020, Shufu Li announced Geely Auto's planned IPO in 2021, but this plan was scrapped due to the minimum requirement for innovation investment to be listed on Shanghai's Star Market (Yiu, 2021). This further highlights the importance of innovation policy change for POEs. By February 2021, the company announced the extent of closer collaboration between Geely Auto, Volvo, Polestar, and Lynk & Co. and the integration of some of their resources (e.g., marketing and distribution channels, joint R&D and product development, and information sharing) while emphasized on the independence and unique structure of each subsidiary (Volvo Cars, 2021). However, in October 2021, Geely's subsidiary, Volvo Car AB, was listed on Stockholm's Nasdaq, solidifying Volvo's independence. We already recognized cooperation in innovation as Geely's path to success. Li, in his 2021 New Year and again in February 2021 speeches, emphasized that each company will maintain its independent identity and continue to work together and cooperate on the development of hybrid and electric vehicles (Sohu, 2021; Volvo Cars, 2021), which are considered to be the future of the automotive industry (Ramey, 2020; Teece, 2019). Geely Auto and Volvo were already working together closely with Geely's other subsidiaries, particularly through CEVT. CEVT has been acting as a knowledge broker between various arms of the Geely Group (Jin & McKelvey, 2020), and the introduction of Polestar, Geometry, Lynk & Co., and other Geely brands has been the result of these collaborations. Closer cooperation between brands based on the same platforms can reduce redundancies in R&D, testing, and planning for future developments and cost saving from economies of scale. These point to more synergistic gains that Geely can achieve from its acquisition.

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FIGURE 1: Number of patent applications in auto industry for top filing economies

Notes: Searched with keywords "automobile OR Car OR vehicle ANDNOT airplane ANDNOT aerial vehicle ANDNOT electric ANDNOT space ANDNOT aircraft ANDNOT aeronautical ANDNOT air ANDNOT aviation ANDNOT airplane" The major applicants are big auto makers. Patents in the same family are counted only once.

Source: WIPO (2021)Figure 2: Historical sales of passenger, SUV, and minivan from BAIC Motor and Geely Auto between 2006 and 2019 (million units)\*.

NOTE: The data includes their brands of passenger cars developed from indigenous platforms and does not include EJV or brands based on foreign platforms.

Source: (China Automobile Industry Yearbook, 2007-2019)

\* This data only reflects sales and market share of said subsidiaries of BAIC Holding and Geely Group, and do not include sales of other subsidiaries' or EJVs' passenger cars.

Figure 3: Number of units of Volvo sold in the E.U., U.S., and China market from 1999 to 2020.

\* The E.U. market share for 2018 was not available.

Source: Data was obtained from <http://carsalesbase.com>, with modifications (accessed 29 July, 2021). This data only reflects locally manufactured cars and does not include imported numbers.

Table 1: Ranking of China's automakers' volume of production between 2006 and 2019 and their ownership.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company/brand | SOE\* | 2019 | 2018 | 2017 | 2016 | 2015 | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 | 2008 | 2007 | 2006 |
| SAIC | Y | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Dongfeng | Y | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 |
| FAW | Y | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| BAIC | Y | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 |
| GAC | Y | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 5 |
| Chang'an | Y | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 6 |
| Geely | N | 7 | 7 | 7 | 8 | 10 | 12 | 9 | 10 | 12 | 11 | 10 | 10 | 10 | 8 |
| Great Wall | N | 8 | 8 | 8 | 7 | 7 | 8 | 8 | 8 | 10 | 12 | 12 | 13 | 12 |  |
| Brilliance Jinbei | Y | 9 | 9 | 9 | 9 | 8 | 7 | 7 | 7 | 8 | 7 | 10 | 8 | 8 | 9 |
| Chery | Y | 10 | 10 | 10 | 10 | 11 | 9 | 12 | 9 | 7 | 7 | 7 | 7 | 7 | 7 |
| BYD | N | 11 | 11 | 12 | 12 | 12 | 11 | 10 | 12 | 11 | 8 | 8 | 12 | 15 | 13 |
| JAC | Y | 12 | 12 | 11 | 11 | 9 | 10 | 11 | 11 | 9 | 9 | 9 | 11 | 11 | 10 |
| JMC | Y | 13 | 13 |  |  |  |  |  |  |  |  |  |  |  |  |
| CNHTC | Y | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 14 | 15 | 13 | 13 | 15 | 16 | 14 |
| Shaanxi | Y | 15 | 16 | 16 | 18 | 18 | 17 | 17 | 18 | 17 | 14 | 16 | 17 | 18 | 17 |
| Zotye / Jiangnan | N | 16 | 15 | 13 | 13 | 14 | 16 | 16 | 15 | 16 |  |  |  |  |  |

NOTE: Empty cells means the volume of production was not among the top 20 manufacturers or was not established as an independent entity.

\* State holding controlling shares.

Source: China Automobile Industry Yearbooks (2007-2020)

Table 2: BAIC's and Geely's new products developed based on the acquired technology

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **BAIC\*** | | | | **Geely** | | | |
| **Brand/Model** | **Year** | **Type** | **Fuel** | **Brand/Model** | **Year** | **Type** | **Fuel** |
| Senova CC | 2015 | Compact coupe | Gas | Volvo XC40 | 2017- | Compact SUV | Plug-in hybrid & Hybrid |
| Senova D20 | 2014 | Small hatchback sedan, 5-door, and small crossover | Gas | Lynk & Co 1, 2, 3, 5, & 6 | 2017- | Sub-compact, compact, and midsize SUV and sedan | Gas, mild-hybrid, & plugin hybrid |
| Senova D50 | 2013 | Compact sedan | Gas | Polestar 2.0 | 2020 | 5-door sedan | EV |
| Senova D60 | 2014 | Compact sedan | Gas | Geely Xingyue (also Tugella) | 2019- | 5-door coup SUV | Gas, hybrid |
| Senova D70 | 2013 | Midsize sedan (business) | Gas | Geely Xingrui (also Preface) | 2020- | 5-door sedan | Gas, hybrid |
| Senova D80 | 2015 | Medium and large sedan | Gas | Volvo C40 | 2022 | Lux sub-compact SUV | EV |
| Senova X25 | 2015 | Small SUV | Gas |  |  |  |  |
| Senova X35 | 2016 | Small SUV | Gas |  |  |  |  |
| Senova X55 | 2016 | Compact SUV | Gas |  |  |  |  |
| Senova X65 | 2014 | Compact SUV | Gas |  |  |  |  |
| Senova Zhidao | 2018 | 5-door sedan | Gas |  |  |  |  |
| Senova Zhixing | 2018 | 5-door SUV | Gas |  |  |  |  |
| Senova EV | 2013 | Midsize sedan (Business) | Electric |  |  |  |  |

\* According to BAIC, Saab technology appears in other local brands of BAIC cars, but they are not reported here.