TECHNOLOGY TRANSFER IN CHINESE AUTOMOBILE INDUSTRY

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Technology Transfer In Chinese Automobile Industry

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ABSTRACT

The purpose of this research is to study foreign technology transfer, combined with government policies in the Chinese automobile industry. The Chinese automotive industry is interesting to examine because of its fast growing production and potential market, which attracts a lot of foreign automakers to establish strategic alliance in China. However, in terms of the studies and results, it is found that the China’s strategy of “trade market access for technology” is not sufficient and Chinese automakers have not yet learned technologies from foreign automakers. By bringing together primary and secondary data from the public research and telephone interviews with evidence from the Chinese automobile industry, the over-dependence of Chinese firms on foreign technology transfer and lack of technological capability is explained. Also, through the study of two automobile joint ventures (JVs) cases, it is found that the industrial policy has been heavily influenced the development of automobile industry and indigenous automakers must improve their technological capabilities.

Keywords: Technology transfer, Chinese automobile industry, Joint Ventures (JVs), Geely, Volvo Cars, FAW-VW
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Xiaoying Qiu
6. Analysis .......................................................................................................................... 30
  6.1 Chinese Automobile industry and policy ................................................................. 30
  6.2 Technology transfer ............................................................................................... 31
  6.3 Technological capability and knowledge learning .................................................... 32

7. Conclusion & Future Research ...................................................................................... 34

8. References ..................................................................................................................... 36

9. Appendices .................................................................................................................. 40
Appendix 1: Background of Geely ................................................................................. 40
Appendix 2: Background of Volvo Cars .......................................................................... 41
Appendix 3: Interviews .................................................................................................... 42

List of Figures:

  Figure 1 World Car Production By Country, 2000-2011 ............................................... 12
  Figure 2 Vehicle Sales in China, 2002-2012 ................................................................ 13
  Figure 3 China’s Vehicle Import and Export Volumes .................................................... 14
  Figure 4 China’s motor vehicle import and export in value ............................................. 14
  Figure 5 Major Vehicle Manufacturers in China ............................................................ 25
  Figure 6 Passenger Car Sales in China ......................................................................... 26

List of Table:

  Table 1 Chinese Auto companies and their foreign joint ventures ............................... 24
Acronyms and Abbreviations

FDI – First Direct Investment
ICE – Internal Combustion Engine
JVs – Joint Ventures
M&A – Merger and Acquisition
NEVs – New Energy Vehicles
R&D – Research and Development
TNCs – Transnational Corporations
TT – Technology Transfer

CAAM – Chinese Association of Automobile Manufactures
FAW – Firs Automobile Works
Geely – Zhejiang
GM – General Motors
OICA – Organisation Internationale des Constructeurs d’Automobiles”
    International Organization of Motor Vehicle Manufacturers
WTO – World Trade Organization
1. Introduction

This section begins with a background introduction to give a general view of the context which this research takes place. The research objective, research question, delimitations and limitations are defined as well.

1.1 Background

The automotive industry of China has been rapidly growing since the year 2000 (Tang, 2012). The annual vehicle production output of China increased from 2 million vehicles in 2000 to over 18 million vehicles in 2011 (OICA, 2011). In the span of a few years, China has become the world’s biggest vehicle producer and the largest automotive market. Despite the fast development of the Chinese automobile industry, the lack of advanced technologies and independent research and development innovation is a major challenge for Chinese automakers. In the 1980s, more advanced automobile technology embodied in capital foreign direct investment (FDI) became an approach for the to Chinese government to allow foreign automakers to enter the Chinese market through established Sino-foreign Joint Ventures (JVs), and hope domestic automakers are able to acquire foreign technology and knowledge through technology transfer initially and improve it through technological learning (Han, 2007). To acquire the advanced technology of foreign automakers became a feasible way for Chinese automobile companies to access the world auto market. It can be seen as a shortcut for Chinese automotive companies to improve their technology through merge or acquire (M&A) foreign companies, including their core technologies and global marketing channels.

Today the Chinese government and automakers are faced with serious air emissions problems, and severe car accidents. Therefore, technology is seen as a foundation in reaching a global method to both environmental and safety problems. Foreign auto companies have been introducing automobile technology into Chinese firms for nearly a decade (Tang, 2012); for example, the German automakers Volkswagen and U.S General Motor have both joined forces with Shanghai Automobile Industry (SAIC) and First Automotive Works Corps (FAW). Japanese firms such as Toyota and Honda have also formed partnerships with FAW and Dongfeng Motor Corp respectively. The new Chinese automaker – Geely acquired Volvo three years ago. However, this study shows that the domestic automakers have not became independence and the major automakers are foreign joint ventures in Chinese market. That is to say, the strategy of “trade market access for technology” was deemed ineffective to promote Chinese automotive industry development.
1.2 Research Objective

This research aims to explore the phenomenon of the utilization of technology transfer in the Chinese automobile industry. Technology transfer is seen as a key factor to help the Chinese automotive industry to gain access into the global market, however, after the exploratory study and the analysis of results, it is seen that the FDI is not sufficient, which have been transferred to Chinese automakers.

1.3 Research Question

The research question is following:

To which extent has the market for technology worked and what are the new challenges in this new round of technology transfer and catching up?

1.4 Delimitations

This thesis focuses on technology transfer of Chinese automakers, and mainly on the domestic firms that have been collaborating with foreign automakers for years. Although, there are plenty of models and skills in the automobile industry, this study is not going to mention those technologies in detail. Due to limitations of time and resources, the target group of this thesis is technology transfer between FAW and VW as well as Geely and Volvo Cars.

1.5 Limitations

This research was limited by two main factors. First of all, although there are a large number of joint ventures automakers in China, it is very difficult to get access to interview Chinese automakers because of the legal boundaries of the Chinese companies. Most of them are unwilling to give any information to outsiders. Besides, there was no response to my questions when contacting the employers and employees of the company. The interview with Mr. Xiaolin Yuan from Geely was very short because of his time schedule. So the information was not as sufficient as it supposed to be. The limited amount of time is the second restriction.
2. Automotive Industry Overview

This section begins with a general overview of the world automobile industry. Then the regulations and the current situation of Chinese automobile industry are presented, which helps in the understanding of the current situation and potential market in China.

2.1 World’s Automobile Industry

The globalization of the automobile industry emerged in 1980’s. The automobile industry was primarily a national industry especially in many advanced countries (Shimokawa, 2002). Under the changes in the structure of the global economy, automobile manufactures are adopting the alliance format to increase competitiveness and to innovation-led growth. During the 1970s a number of firms started new practices such as merges and First Direct Investment (FDI). This phenomenon in the global automobile industry increased fast throughout 1980s (Haklisch, 1989; Burgers, Hill and Kim, 1993; Kang and Sakai, 2000). The mergers were accompanied by a number of manufacturers that had joint relationships in automobile industry that had joint relationships in the automobile industry such as Toyota-Nissan, Daihasu and GM-Suzuki, Ford and Volvo. Theses joint relationships and increased their stock holding rations, which is one of their corporate global strategies (Shimokawa, 2002).

In the recent years, the pursuit for the ultimate environmental friendly cars has resulted in high innovation requirement in the product design. Producing advanced gasoline-powered cars, clean diesel vehicles, hybrids and reducing carbon emissions is a challenge and priority for the automakers in this era (McCurdy, 2010). Due to the higher price and fear of the new technology, the hybrids vehicles, which result from decades of research and development has not became popular since the first land in the late 1990s. The research shows that the hybrid car sales stably grow in last six years. In 2012, as the biggest green car market, the U.S car customers took home about 53,000 electric cars (Voelcker, 2013). Government plays an important role in encouraging private-sector investment and innovation as well as incentivizing people to adopt advanced and low-carbon technologies. However, in different countries the government response has been very different across the world. For instance the government of the United States tax credits to buyer of low-carbon and advanced technology car. This in return, not only increased 20% sales of car, but also avoided 760,000 tons of carbon dioxide over the lifetime of the cars (McCurdy, 2010). The Japanese government has funded green ventures by providing subsidies for fuel-efficient cars. While in China, the government supports the development of New Energy Vehicles (NEV) because it is hard to catch up to foreign manufacturers by developing traditional internal combustion engine (ICE) technologies (KPMG, 2010).
2.2 China’s Automobile Industry

China’s automobile industry developed slowly before the 1990s. Based on the strategy of “trading market access for technology”, China has been using foreign direct investment (FDI) since 1978 (He and Mu, 2011). Meanwhile, foreign automakers like Toyota, General Motors (GM) and Volkswagen built joint venture with Chinese vehicles, which changed the tough situation of the Chinese auto industry. After China joined the World Trade Organization (WTO) in 2001, numerous domestic Chinese automakers emerged and created their own design. Although after 20 years of JV expansion, knowledge and technology have been accumulated by Chinese automakers, the products, which were produced by Chinese automakers, were ill-suited to market conditions. In fact, the Chinese domestic auto manufacturers still struggle to make improvement in the design and quality, due to low technology. Furthermore, the technology of China is 20 years behind Western countries (Tang, 2012).

2.2.1 Regulation Overview

Chinese government plays a critical role in the development of the domestic auto industry. In the 1980s, the policy of the Chinese auto industry required foreign automakers to undertake joint ventures with local manufactures so that the market access could be obtained. Between the year 2000 and 2001, the liberalization of product regulations of China promoted the growth in the private car ownership market (Ward’s Automotive Yearbook, 2001). After joining WTO, China has lowered import tariffs in order to give international automobile companies more access to internal market. For example, the government has encouraged building joint venture Research and Development (R&D) centers in Beijing with advantageous tax policies in order to promote technology and knowledge transfer. In fact, large amount of global automakers have established joint ventures with local companies due to the requirement of current government policies. Moreover, plenty of policies are being implemented to stimulate the use of private vehicles, such as purchase loans and reduced fees for vehicle use, and lengthening the useful life of passenger cars from 10 to 15 years (Tang, 2012).

In 2012, Chinese government announced the 12th Five-Year Plan, one of the targets is to achieve automobile efficiency and promote new energy vehicles (NEVs). (The China Greentech Initiative, 2012). According to China Association of Automobile Manufacturers (CAAM), the main requirements of the latest policy are 1) Limit the pollutant emissions of motor vehicle 2) Increase the promotion of high energy-efficient product 3) Utilize the low-energy consumption and New Energy Vehicles (NEV) 4) Complete the motor vehicle fuel consumption limit standards and low-speed vehicle emission standards (CAAM, 2012).
2.2.2 Market Overview

During the year 2006, China became the world’s third-largest vehicle market. While world major automotive makers were suffering an economic low, the speed of Chinese automobile industry growth reached to a peak during the year 2008 to 2009, which showed the potential of continuous expansion and considerable strength. **Figure 1** illustrates the vehicle production after the economic crisis in which China’s car production increased to 18 million units while the annual production of European Union, United States and Japan was plunging into trouble in 2009 (OICA, 2009). At same time, the Joint Venture (JV) vehicles developed quickly in Chinese auto market and its market share occupied 54% in total vehicle sales volume. In addition, the sales in passenger cars of domestic brand sharply increased during the year 2009 (CAAM, 2009). **Figure 2** shows the growth of Chinese vehicle sales increasing sharply after 2008.

![World Car Production By Country, 2000-2011](image-url)

**Figure 1World Car Production By Country, 2000-2011**

Source: International Organization of Motor Vehicle Manufacturers (OICA)
The export of Chinese cars is way behind, although vehicle exports in 2010 and 2011 showed a growth (figure 3). Chinese automakers Chery Automobile Co, Geely, and Great Wall Motor Co Ltd are leading the Chinese passenger vehicle export market. Most of their cars are sold to 3rd world countries such as Iraq, Kenya and Algeria (Wang, 2013). On the import side, the total amount of imports is more than four times the amounts of exports in value (figure 4).
Figure 3 China’s Vehicle Import and Export Volumes
Source: Automobile Market Outlook (2012)

Figure 4 China’s motor vehicle import and export in value
Source: Automobile Market Outlook (2012)
Despite the fast development of the Chinese automobile industry, the lack of advanced technology and independent research and development innovation is major challenge for the Chinese automotive industry. The domestic automotive manufactures are still lagging behind compared with international automakers. Despite the steady growth of R&D investment in China, the weak R&D capability still exists. Therefore, Chinese domestic automakers have started to buy foreign brands to acquire the advanced technology and access the world auto market. Meanwhile, China’s policy gives priority of developing indigenous car models and innovation technologies and encourages China’s auto firms to carry out more R&D activities. Regulations of the Chinese government for establishing new plants and its goal of building global brands drive companies to encourage in such a joint venture brand development. Besides, Mergers and Acquisition (M&A) is a sufficient way for Chinese automakers to improve their reputation and gain access to advanced technologies to promote product development and R&D capabilities (APCO, 2009).
3. Theoretical Framework

*This section begins with the general theory about technology transfer. It is divided to four specific parts: technology transfer definitions, channels, motivations, and processes. The theory about technological capability is followed, including absorptive capacity, technological accumulation and knowledge management.*

3.1 Technology Transfer

3.1.1 Technology transfer definitions

Technology transfer has been utilized to move the technology from the laboratory to industry, developed countries to developing countries or applications of information to another use (Philips, 2002). Tidd and Bessant (2009) illustrate technology transfer as a point-to-point phenomenon and it expresses putting knowledge to implement. In other words the movement of ideas from the laboratory to the market or the movement of technology from one place to another (Solo and Rogers, 1972). To safeguard they avoid future competition; multinationals are tend to transfer older technologies to developing countries (Glass and Saggi, 1998).

3.1.2 Technology transfer channels

Technology transfer takes place through a variety of channels; for instance through *foreign direct investment (FDI)*, as a bundle of technology which has been regarded as a main approach for the transfer of advanced foreign technologies to developing countries. In this way, local employees are hired and trained by the foreign firms in their subsidiaries (Hobday, 1995; Byun and Wang, 1995). In China, FDI has been used since 1978 and required joint ventures as a condition for FDI inflows over a certain period. In 2001, more than 800 Chinese firms associated to auto industries had received FDI, simultaneously the total agreed investment was worth 233 billion dollars with actual registered capital of 12 billion dollars (Zhang, 2002). Joint venture activity is high in the Chinese automobile industry, as automakers seek to acquire external technological know-how toward the inherent technological uncertainty reduction in those parts. Also, FDI in the Chinese automobile industry contributed to several economic successes. In a *Joint venture*, companies pool their technologies and resources in a freshly established company that is characterized by joint ownership. It can be divided as an equity alliance that builds mutual dependence among the joined firms or non-equity based alliances on intellectual property (Buckley and Casson,
Original equipment manufacturing (OEM) becomes the most significant approach to explore the marketing in 1980s. It is a specific form of sub-contracting developed into joint operations of buyers and latecomer suppliers (Hobday, 1995). These different alliances formed above all pioneered by ongoing processes of technological change. Merger and acquisitions (M&As) is a way that Chinese firms strategically use to achieve specific goals (Rui and Yip, 2008).

3.1.3 Technology transfer motivations

Reisman, Motwani and Kumar (1996) delineated each technology transfer transaction takes place due to some motivations on the element of the respective participants. According to Reddy and Zhao (1991), the impact of international technology transfer can be divided into transferee perspective and transferor perspective. From the transferor perspective, international technology transfer accrued economic and technological benefits to the supplier. It means they can take advantage of generation of exports, tax revenues and employment, accumulated capital and entrepreneurial skills. Also Reddy and Zhao (1993) in their latter research pointed out both transferor and transferee is benefit from cultural and social elements. In addition to personal motivation factors, economic factors exists, which include long-term arrangements that feed technology enhancements, vertical and horizontal integration of an industry, process and product innovation improvements. Basically, the motivation for the developed country was in better purchasing power such as obtain lower costs and wider choice. Additionally, it is an approach for industrialized country to maintain competitive position.

3.1.4 Technology transfer processes

Technology transfer is not a new phenomenon but according to the literatures on technology transfer, it is difficult to implement due to the complexity of the technology transfer process. Generally, the technology transfer should be based on transfer, absorption and adaptation of existing technology within the firm. Schlie et al. (1987) and Ramanathan (2000) point out the different stages of the transferor and transferee. The transferor is the entity selling the technology to the recipient whereas the transferee is the one buying the technology. The stages of the transferor who transfers the technology needed by the transferee fall into four different transfer modes: sales intensive, manufacturing intensive, development intensive and research intensive. At the same time, different modes are used to link the mechanism, for example to OEM, licensing, and JV, which is used to explain prevalent business arrangements that are spread to transfer technology.

There are a number of popular technology transfer models that have been proposed in
past years. According to Reddy and Zhao (1990), international technology transfer should be examined in three major components, for example, home country component (the transferor), host country component (the transferee) and transaction component. Home-country component helps firms to examine some issues such as, government policies on technology transfer of home country, the importance of technology to be transferred and the global R&D investment strategy of the firm. The host-country component involves contents such as government policies related to foreign investment and technology transfer, the scope of upgrading of transfer and the technological capabilities of the transferee. The transaction component involves issues including intellectual property protection; the technology price, payment modalities and tools for make sure the transfer is effective.

Bell and Pavitt (1997) emphasizes firms choose imported and local technology as sources of technical change, and forms several ways for the development of local capabilities. First of all, both training and learning of technology transfer agreement with foreign companies covers not only the acquisition of the ability of operating new facilities, but also focuses explicitly on acquiring various skills including design, engineering and managing. Secondly, establishing R&D centers that focus on technological learning in advance of the acquisition of existing technology or acquiring firms to gain access to particular skills and technologies. However, the technology transfer in developing countries has been much less intensively contributed to the process of domestic accumulation. Foreign auto companies have been introducing automobile technology into Chinese firms for nearly a century, but none of the foreign companies have transferred to China environmental technology that is related to cars (Gallagher, 2002).
3.2 Technological capability

3.2.1 Absorptive capacity

Absorptive capacity includes the organization’s capability to exploit external knowledge of a more intermediate sort; meanwhile it represents the ability to create new knowledge of the organization (Cohen and Levinthal, 1989). Later in 1990, Cohen and Levinthal assert absorptive capacity is the ability of a firm to recognize the value of new, external information, assimilate it and apply it to commercial ends. It can be seen as largely a function of the level of prior related knowledge. The prior knowledge base and intensity of effort are two important elements of absorptive capacity. Zahra and George (2002) define absorptive capacity as a set of routines and processes that are organized and utilized to create a dynamic organizational ability as well as maintain a competitive advantage. However, Tidd and Bessant (2009) argue some firms may find they lack the capability to target their search or to make effective use of the new knowledge. Others may know what they want and need but lack the ability to find and acquire it. In short, absorptive capacity is about gathered learning via multiple and different activities such as search, acquire, assimilate and implement—in the form of routines which firms can repeat the trick.

3.2.2 Technological accumulation

According to Bell and Pavitt (1997), the technical change covers many different ways in which new technology is gathered in the production capacity of companies and economics. Technological accumulation encompasses any process of the resources for generating strengthened technological capabilities. In developing countries, there are three aspects of inter-country variability in technological accumulation: 1) the intensity of accumulation within industrial companies; 2) the structure of accumulation refers to intra-firm, infrastructural institutions, and the interaction between them; 3) the complementarities between technology imports and local technological accumulation. First of all, the strong capability developments are heavily dependent on the accumulation of various engineering capabilities. Secondly, the skilled personnel have played a significant role in different patterns of technological accumulation. In the early age, firms need to have ‘experience acquired by individual through previous overseas employment’ (Westphal et al., 1981).

Besides, training and education institutions have been paying much attention to make improvements in developing countries. In recent decades, many R&D centers have been established in developing countries. The activity for example, acquiring existing foreign technology for absorbing and training people are also adopted and implemented in developing countries. Nevertheless, a large number of firms have built very important training and learning activities in their own ways, such as giving
explicitly managed experience accumulation in process engineering and in basic operations (Bell and Pavitt, 1997).

Moreover, some developing countries have been large importers of technology through Foreign Direct Investment (FDI) as joint ventures via subcontracting and original equipment manufacturing or licensing agreements with unrelated suppliers of designs, equipment, know-how and services (Bell and Pavitt, 1997). The author noted that the firms chose both imported and local technology as sources of technical change. Industrializing firms related to developing local capabilities through international technology transfer have acquired several benefits. Firstly, foreign companies offered much more than the competences for operating facilities since they provided various combinations of design, engineering and project management skills. Secondly, the human resources of foreign firms ensured the process of transfer. Most of the managers and engineers from these countries have high education level as well as work experience abroad, which has provided not only training in technological problem-solving and learning skills, but also access to informal international networks. Thirdly, many firms have acquired foreign technology by sending their employees to study and gain work experience in transferor’s firm, or by inviting their experts and engineers to domestic. Some low advanced firms have set up their own R&D centers that mainly focus on technological learning in addition of the acquisition of existing technology. In order to gain access to particular skills, experience and knowledge, some other domestic companies chose to acquire established firms in advanced countries to obtain new technologies. Ivarsson and Alvastam (2005) studied foreign transnational corporation (TNCs) in automobile industry and distinguished two categories of technological assistance: product-related technology transfers comprise the transfer of product designs, technical specifications and consultations that are transferred through patents and licenses. Process-related technology transfers include the provision of machinery and equipment, advice on tooling and operations, technical support in product planning, quality management, inspection and testing. Additionally, it can transfer organizational and managerial know-how as well as offer different form of training programs to help their suppliers.

### 3.2.3 Knowledge and learning

Knowledge management is related to identifying, translating, sharing and exploiting the knowledge within an organization. Knowledge can be acquired by experience, experimentation or acquisition (Tidd and Bessant, 2009). Explicit knowledge and tacit knowledge are essentially two different varieties of knowledge. Explicit knowledge is public and widely known, which can be codified and recorded in mediums via languages, which means it is easy for communication and sharing (Kikoski and Kikoski, 2004). While tacit and implicit knowledge is learned and accumulated by individuals, thus it is less familiar and can be long and difficult to imitate. Many researchers have mentioned the difficulty of tacit knowledge acquirement. According
to Howells (1996), learning is the most crucial way to acquire tacit knowledge. More specifically, generating and incorporating new technology in design of a new product can activate tacit knowledge. Moreover, it can be activated in the process of learning new improving existing technology through minor transformation based upon learning-by-doing. Tacit knowledge can be gained outside the origination by trying to gain skills from other companies, by acquiring parts of or the whole companies.

Asheim (2007) distinguished three types of knowledge base: analytical, synthetic and symbolic. The analytical knowledge base is dominant of codified knowledge due to documentation in patents and publications. A synthetic mode of knowledge formation can be found in industrial settings, automotive industry is one of industrial examples of synthetic knowledge bases. It occurs through the application of existing knowledge and often relates to product or process development. The knowledge here is often gained from experience and through learning by doing, and it mainly displays concrete know-how, craft and practical skill (Laestadius, 2000; Asheim, 2007). The phrase ‘practical knowledge’ is generated in utilization contexts of new technologies and confirms criteria validity, for example to practicability, functionality, efficiency and failure-free use of special technology. It represents explicit elements as well as implicit elements that are hard to be transferred such as accumulated experience and proven routines for dealing with technical difficulties (Hirsch-Kreinsen, Hahn and Jacobson, 2008).

Kim (1998) mentioned the tacit and explicit knowledge learning at Hyundai of Korean automobile industries. The Korean automaker Hyundai has been through four phases: assimilating assembly operations; developing “Korean” car under license; developing an advanced car under limited license; and becoming independent in the end. Several factors can explain the success of Korean automobile industry. First of all, the American automaker Ford transferred a set of explicit knowledge and helped translate the transferred explicit knowledge into tacit knowledge to Hyundai. At same time, the engineers and technicians worked hard to acquire a production capability and accumulate sufficient tacit knowledge in a short time. Besides, the government planed to develop Korean cars and protect the local market form new entrants at the very beginning. Moreover, Hyundai has utilized a strategy of independence in developing technological capability. By following the model of acquisition, assimilation and improvement, the migratory knowledge increased Hyundai’s prior knowledge base and lead to expeditious organizational learning. Furthermore, Hyundai has changed learning paths from duplicative-imitation-oriented, to a creative-imitation-oriented and then to innovation-oriented in order to increase the intensity of effort at both individual and organizational level.
4. Methodology

This section follows with research methods, research design and how data was collected.

4.1 Research Methods

The multiple-case method is used in this exploratory study. A “Two-case” case study will be better than using a single-case design because the analytic conclusions are more powerful than those coming from a single case (Yin 2002). The two cases FAW-VW and Geely-Volvo Cars which are chosen in this study satisfy literal replications for multiple-case studies. This research is based on the mix of quantitative and qualitative evidence. Qualitative research is implemented to explain the reason of technology transfer in the case, which includes the background of global and Chinese automobile industry. Quantitative evidence is the statistics of the production and sales of vehicles that are used to illustrate the changeability of the auto industry.

4.2 Research Design

First of all, the cases of Chinese automotive firms and its joint venture firms are chosen in this study. The first case company is Chinese automobile firm – Geely and Swedish automobile firm – Volvo Cars (See Appendix). This joint venture was established in 2010. However, it grows very fast in the pervious three years and established R&D center in both countries. The other one is FAW-VW, it is one of the successful joint ventures in China, which was established in the early 1990s (See Appendix). Additionally, First Automobile Works (FAW) was the first auto firm in China that set up the auto in 1950s. As can be seen from the figure 4, it has large market share in major vehicle manufacturers in China. In short, these two cases are chosen to gain general information about technology transfer, the capability level of Chinese industry and the most needed technologies in China.

Second, it follows by both cases conduction and individual report. Three interviews were conducted during this step. The two telephone interviews were conducted with open questions (see Appendix), some of the questions were different with regard to transferor and transferee. The face-to-face interview was very short because of the interviewee has a busy schedule. The length of the telephone interview was about 30 minutes. During the telephone interview, the answer of interviewee has recorded and
4.3 Data Collection

This case study is based on the mix of quantitative and qualitative evidence. Collecting data can be divided into two parts in this study, collecting primary data and secondary data. The statistics is mainly collected from the web of International Organization of Motor Vehicle Manufacturers (OICA), China Association of Automobile Manufacturers (CAAM) and National Bureau of Statistics of the People's Republic of China. The primary data will be collected through telephone interviews of the leader of FAW-VW and Volvo Cars. It aims to understand what kinds of steps were taken in the company while transferring technologies. And what is their opinion of technology transfer models in their company. The secondary data is the data that is collected by someone else; thus in this study sources are coming from newspaper reports, articles, books and the Internet. In order to further strengthen this research, journals, articles and recent news from the Internet were selected carefully to expand the contexts. Based on the huge databases of school; it is easier to get relevant data for this research. Also, the information from webpage of each case company is reliable and updated which helped in the data collection. By following an analytic strategy, both qualitative and quantitative data as well as relevant theories and case descriptions will be analyzed.

4.4 Validity and Reliability

This research used multiple sources of evidence of case studies which is constructed the validity. Both primary data and secondary data is collected and analyzed in this research, especially the interviews which were conducted with representatives of the case study companies. Analyzing each case study, doing cross-case pattern matching, and building explanation, which increases the internal validity. Moreover, the external validity is increased through the use of multiple – case studies, defining boundaries of the research as well as comparing evidences with literatures.

Reliability refers to the procedures of the research that can be repeated by other researchers and come through with similar results. In this research, the primary data is delivered by recording (audio and hand written). Also, it has been given full account of theories, which increases the reliability of this study.
5. Empirical Findings

This section starts with the overview of Chinese Automobile Market. Following, the case study interviews are presented.

5.1 Overview of Chinese Automobile Market

Initially, Chinese government planned joint venture arrangements would allow Chinese car producers to tap the technological and management expertise of their foreign partners. In exchange, foreign automakers would gain access to the vast Chinese market. However, the domestic automakers are perceived that foreign corporations have more than their local partners from these link-ups (Table 1)

<table>
<thead>
<tr>
<th>Chinese Automakers</th>
<th>Foreign Joint Ventures</th>
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<tbody>
<tr>
<td>BAIC (Beijing Auto)</td>
<td>Beijing Benz, Beijing Hyundai</td>
</tr>
<tr>
<td>Brilliance Auto, Huachen Auto Group</td>
<td>BMW Brilliance</td>
</tr>
<tr>
<td>Chang’an Auto (Chana Auto)</td>
<td>Chang’an-Ford, Chang’an-Mazda, Chang’an-Suzuki</td>
</tr>
<tr>
<td>Changhe Auto, Chang’an</td>
<td>Changhe Suzuki</td>
</tr>
<tr>
<td>Dongfeng Motor</td>
<td>Dongfeng Nissan, Zhengzhou Nisan, Dongfeng Honda, Dongfeng YuedaKia</td>
</tr>
<tr>
<td>FAW (First Automobile Works)</td>
<td>FAW Volkswagen, FAWAudi, FAW GM, FAW Mazda, FAW Toyota</td>
</tr>
<tr>
<td>GAC (Guangzhou Automobile Group Co.)</td>
<td>GAC-Honda, GAC Toyota, GAC Flat, GAC Mitsubishi</td>
</tr>
<tr>
<td>Geely Auto</td>
<td>Volvo Cars</td>
</tr>
<tr>
<td>SAIC (Shanghai Automotive Industry Co.)</td>
<td>Shanghai GM, Shanghai Volkswagen</td>
</tr>
</tbody>
</table>

Table 1 Chinese Auto companies and their foreign joint ventures

Source: ChinaAutoWeb A Guide to China’s Auto Industry

Although Chinese government has been promoting indigenous brands and removing some incentives for foreign investment in the auto field since two years ago, the dream of indigenous brands to exceed joint ventures or co-producers is hard to
achieve. In 2012, the top five automakers (Shanghai GM, FAW Volkswagen, Shanghai Volkswagen, Beijing Hyundai and Dongfeng Nissan) were all JVs (Figure 5).

<table>
<thead>
<tr>
<th>Major Vehicle Manufacturers in China (Vehicles sold in 2012)</th>
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<tbody>
<tr>
<td>Sales (thousand unit)</td>
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<tr>
<td>Shanghai GM</td>
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<td>FAW Volkswagen</td>
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<td>Shanghai Volkswagen</td>
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<td>Beijing Hyundai</td>
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<td>Dongfeng Nissan</td>
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<tr>
<td>Chang'an Ford</td>
</tr>
<tr>
<td>Geely Auto</td>
</tr>
<tr>
<td>Shenlong</td>
</tr>
<tr>
<td>Cherry</td>
</tr>
<tr>
<td>FAW Toyota</td>
</tr>
</tbody>
</table>

**Figure 5 Major Vehicle Manufacturers in China**

Source: China Association of Automobile Manufacturer

Apart from joint ventures and co-producers in Chinese market, the other strong stream is foreign brands. **Figure 6** shows the international companies the largely dominant the automotive market in China in the last five years. The most popular world automakers are from Japan, the U.S, Germany, Korea and France, which attract a large amount of consumers in Chinese market.
In this section, two case studies were chosen and analyzed, the first being the technology transfer between the Swedish firm – Volvo Cars and the Chinese firm – Geely and the second being the technology transfer between the German firm – Volkswagen and the Chinese firm – First Automobile Work. Through this the aim is to explore the routines of technology transfer in the respective companies.

5.2.1 The Case of Geely and Volvo Cars

5.2.1.1 Automobile industry policy

Followed by Chinese automobile industry policy that foreign automobile firms can only produce cars in China together with local automakers and establish 50/50 of share holding in JVs. Mr. Nyborg from Volvo Cars explained that China is a high priority market for the automotive industry. In order to stay competitive in Chinese market, Volvo Cars has to produce cars in China, such as production of cars and production of engines. There are different strategies depending on different companies. Mr. Nyborg mentioned that Western companies are rejecting transfer
technology to China. Most of Western companies keep their core technologies in headquarter which are located in Europe or U.S. Volvo aims to develop technology and transfer technology to China to produce and try to localize to produce technology in China. But normally they do not share their knowledge and technology with the joint venture company.

For Volvo, if they want to make good business in China, they need introduce new technologies. During this time, they should be able to control the technology in your joint venture and how is it used in supplier base and how it used in the car etc. So the way to transfer is transfer to you directly by being in very controlled in intellectual property (IP).

According to Mr. Yuan from Volvo’s parent company Geely, who mentioned Volvo Cars has a complete system such as advanced platform, well-managed organization structure and intelligent employees. Volvo Company has been divided into four companies in previous ten years and each section such as, R&D, sales and supply chain system has been linked. In fact, the whole Volvo is a system and it can survive by itself. But Geely offers them a way to reduce more cost and produce efficiently. According to Mr. Yuan, Volvo Cars did not have any sales companies in China before Geely bought it. At that time, the sales of Volvo cars was 10,000 in China, which means Volvo cars only had tiny market share in the huge Chinese market. However, the sales of Volvo cars have increased in the last year.

5.2.1.2 Technological capability

According to Mr. Nyborg, Volvo is using certainly technologies to produce car in locally. First of all, they are totally dependent on local skilled engineers. In Volvo’s R&D center in Shanghai, the majority of the engineers are local Chinese engineers. The engineers from Sweden are there mainly to train and develop the Chinese engineers to build up the competence level and to produce the car as the same quality as the Swedish one. The level of the competence that Volvo Cars has to develop is based upon the engineering they are going to do in China. Besides, they have regular seminars as well as training program in both Geely and Volvo Cars, which can help their employees to acquire know-how skills and enhance the speed of technology transfer. In the long term, the strategy of Volvo is to develop a skill base in China to the level that you can actually design, engineer and verify. When Volvo starts a new project, to build up capability in their own local engineers and to make sure they can actually engineer the unique technical solution is their plan.

However, it is very hard for Volvo to develop capability and skill in China. Although Geely has their universities in different provinces of China, in order to develop its innovative talent model. The Chinese automobile firms lack the capabilities to routinize the new technologies due to the Chinese automobile industry being very young. There are many local car companies today, which are still in the development
phase. In other words, they are lack of maturity and are in the copy phase at the moment. It is also a big challenge for Swedish leaders to train people and develop people, because it is not only theoretical studies but also practical skills and “learning by doing”. Besides, the cultural differences are challenging to both Chinese and Swedish engineers.

5.2.1.3 Technology trajectory

From the Chinese perspective, China is now focusing on new energy vehicle area, and hybrid technologies and pure electric vehicle technologies. They are heavily subsidized by the Chinese government and large amount of money is set to support and develop clean energy technologies. It’s all about minimizing the negative environmental effects. Those technologies are the most attractive technologies from the China side to get hold off and to be able to learn about and develop within China. At the same time, those technologies are the on the age technologies that Western world is competing with so it becomes more challenging for how Intellectual Property (IP) rights is protected in the western world applying into China. And how you can secure that not only within China and in the rest of the Globe. In short, the all technology to new vehicles is needed to transfer to China.

5.2.2 Case of First Automotive Work and Volkswagen

The FAW- Volkswagen Automobile was established in 1991, it is a joint venture passenger carmaker between FAW Group Corporation (share investments of 60%) and Volkswagen AG (share investments of 40%). FAW-Volkswagen adopts advanced technologies and equipment to manufacture some of the world’s most famous brands – Passat CC; Jetta; Bora; Golf; Caddy; Sagitar and Audi (FAW).

5.2.2.1 Automobile industry policy

There are three major motivations driving Chinese automakers to start partnership with foreign automakers: 1. Gain profits; 2. Learn skills and transfer knowledge; 3. Enhance the capability of the whole industry. Basically, Chinese automotive industry can be better developed through technology transfer. It is beneficial for training our skilled personnel in the Chinese automotive industry. From both the enterprises and government perspective, they put priority on how to earn profit. In the early year, the trade inspection showed a vast number of Chinese customers purchased foreign brand cars. However, it was a big challenge for China to produce their own cars in the 1980s due to the limited capability and high cost. The government permits joint ventures in order to learn skills to produce world standard cars and gain profit. After collaborating with foreign firms, the sales of car increased and then we started to build our own brands
5.2.2.2 Technology transfer

Mr. Feng from FAW-VW said that the technology of car manufacturing for example to laser-welding technology has been transferred from foreign automakers. More specifically, different modules of vehicles require different technologies. Thus, when the domestic automakers are going to produce new types of cars, the related technologies will be transferred.

Generally, foreign experts of VW come to FAW-VW’s plants in China to guide Chinese employees. Especially, every time they are going to invest in new products, their German partners will come to our company and work together with us. Moreover, sending employees regularly abroad or to their partner’s company to learn skills, exchange knowledge and gain experience is also an efficient approach. Furthermore, training programs are crucial for transferees to improve the skill of their employees by themselves.

When it comes to the technology transfer difficulties, Mr. Feng concludes some points. Firstly, western countries have been researching and developing vehicle technologies for more than one hundred years. Therefore, they have gained experience and accumulated knowledge. In fact, their technological accumulation is invisible and hard to imitate. Their design concepts and principles of cars are difficult for us to learn and implement.

Environmental and design-related technologies need to be transferred. Due to FAW aims to reach the environmental polices that are launched by the Chinese government and implement the requirements of ISO 9001. Additionally, product-related technologies such as software which is used to improve the production system, as well as the material and manufacturing.
6. Analysis

This section aims to analyze the main factors illuminated in the theoretical part, in conjunction with the empirical findings.

6.1 Chinese Automobile industry and policy

The strategy of “trade market access for technology” has been utilized through foreign direct investment (FDI) since 1978 (He and Mu, 2011). All foreign companies who have joint ventures are allowed to produce in China, thus joint venture activity is high in the Chinese automobile industry and control a large percent of China’s passenger car market (Table 1). Additionally, the top five automakers (Shanghai GM, FAW Volkswagen, Shanghai Volkswagen, Beijing Hyundai and Dongfeng Nissan) are all JVs (Figure 5). The amount of motor vehicle imports from foreign countries is still much higher than the amount of exports (figure 3 and figure 4). However, the fierce competition with foreign car brands in the Chinese market cautioned that the Chinese automobile industry should put more focus on domestic market instead of global market.

Technology transfer takes place through a variety of channels; for instance through foreign direct investment (FDI), joint ventures (JVs), original equipment manufacturing (OEM), and merger and acquisition (M&A) (Hobday, 1995; Byun and Wang, 1995). In China, the FDI policy has been used based on “trading market access for technology” for more than 30 years. It was initially raised in the automobile industry, which requires foreign automakers to establish Sino-foreign joint ventures (JVs) with Chinese partners. First Automobile Works and Volkswagen followed this policy and established FAW-VW in the early 1990s. Although Geely acquired Volvo Cars first, it set up a joint venture with Volvo Car to develop tailor-made models for the Chinese market (ChinaScope Financial, 2012). Initially, Chinese government expected indigenous automobile firms to learn technology from their foreign partners. However, according to the evidence and the results, it is easy to see from the two cases that Chinese automakers have not learned and caught up on the advanced technology. From the transferor perspective, they produce cars locally and recruit local engineers but they do not share core technologies with their joint venture company. According to Kim (1998), the policy and government also played an important role to develop Korean automotive industry. However, unlike other developing countries, the government put high priority on developing their own cars at the beginning. In contrast, Chinese private firms and independent automakers were become popular in the market after China joined WTO in 2001.
Besides, cleaner transportation becomes one of the important elements of China’s 12th Five-Year Plan due to the serious environmental problems need to be controlled. Chinese government now is pushing developing and adopting the new energy vehicles (NEVs) and relevant technologies, and creating opportunities in Chinese automotive market. According to Mr. Nyborg, who also said China is focusing on new energy vehicle area, and hybrid technologies and pure electric vehicle technologies. It can be explained by the Chinese government is heavily subsiding to support and develop clean energy technologies. The three latest regulations in automobile industry: 1) Limit the pollutant emissions of motor vehicle 2) Increase the promotion of high energy-efficient product 3) Utilize the low-energy consumption and NEV 4) Complete the motor vehicle fuel consumption limit standards and low-speed vehicle emission standards (CAAM, 2012). At same time, not only in Chinese market but also the global market is pursuit for the ultimate environmental friendly cars.

Finally, product-related technology is also needed in Chinese automobile industry. According to (Ivarsson & Alvstam, 2005), product-related technology transfers comprise the transfer of product designs, technical specifications and consultations that are transferred through patents and licenses. However, Chinese automakers are still in the imitation level, there is a long way for them to move to the innovation level.

6.2 Technology transfer

Technology transfer has been utilized to move the technology from the laboratory to industry, developed countries to developing countries or applications of information to another use (Philips, 2002). Based on the result, the technology transfer between Chinese automotive industry and foreign automakers is relevant to the following parts, the motivation and process. As Reddy and Zhao (1993) illustrated the benefits of technology transfer in both transferee and transferor is different. Bell and Pavitt (1997) specified the benefits of technology transfer for developing countries. Firstly, foreign companies offered much more than the competences for operating facilities since they provided various combinations of design, engineering and project management skills. Secondly, the human resources of foreign firms ensured the process of transfer. Most of the managers and engineers from these countries have high education level as well as work experience abroad, which has provided not only training in technological problem-solving and learning skills, but also access to informal international networks. For the Chinese automaker FAW, gaining profits, learning skills and transferring knowledge, and improving the technological capability of the whole Chinese automobile industry are three main reasons that drive them to collaborate with Volkswagens. According to the passenger car sales from 2008 and 2012 in China, foreign brands are leading the Chinese automobile market instead of domestic brands. The technology transfer is a way for domestic brands to make progress in both car
quality and the brand value. In the basis of the Chinese automobile regulations, the Chinese government encourages Chinese automakers to establish joint ventures with foreign automakers in order to maintain the domestic market and enter the global market. In contrast, it is so clear to see the Western automakers for example; Volvo Cars wins the Chinese automobile market after an established strategic alliance with Geely. After Geely bought Volvo Cars in 2009, they established headquarter in Shanghai and new plants in Chengdu in China (Volvo Cars), and at the same time the sales increased during the last year.

According to FAW-VW, different modules of vehicles require different technologies. Thus, when the domestic automakers are going to produce new types of cars, the related technologies will be transferred from the Western firm to their localized firm. The technology transfer should be based on transfer, absorption and adaptation of existing technology within the firm Schlie et al. (1987). Kim’s (1998) model suggests the developing countries to follow preparation, acquisition, assimilation and improvement while learning technology from advanced countries. The result shows that Chinese automakers did not prepare and build their knowledge base before the acquisition. Also, Chinese automakers are now moving to last step to complete the technology transfer process. On the contrary, the indigenous automaker for example to FAW stopped producing its dated own brand cars after established JVs with Volkswagen. This also demonstrated that the technology regime “ trading market to access for technology” in Chinese automobile industry is inefficient.

6.3 Technological capability and knowledge learning

The prior knowledge base and intensity of effort are two important elements of absorptive capacity (Cohen and Levinthal, 1990). Unlike the Korean experience (Kim, 1998), the Chinese automakers did not upgrade their knowledge base and maintain independence. The case of Volvo cars explained that most of the Chinese automotive firms are lack of maturity and are in copy phase at the moment. It is a big challenge for Chinese automobile firms to develop technological capabilities in a short time. Although foreign carmakers did bring in capital and relevant technology, the over-independence and inadequate capacity also led Chinese automakers to fail the technological catch-up. Besides, Chinese automakers are lacking of technology accumulation due to the late start in research and development in 1980s while Western automakers have been doing research and innovating for more than one hundred years. The strong capability developments are heavily dependent on the accumulation of various engineering capabilities. Thus, to strengthen the knowledge base while learning from foreign automakers can shorten the time of the indigenous automakers to absorb the new technology.

As mentioned in the theory part, many researchers have attempted to describe the knowledge dimensions (Howells, 1996; Laestadius, 1998; Asheim, 2007;
Hirsch-Kreinsen, Hahn and Jacobson, 2008). Basically, tacit and explicit knowledge are the two most widely accepted two dimensions. Tacit or synthetic knowledge cannot be codified. It is often gained from experience and learned from experience or learning by doing (Asheim, 2007). Both FAW-VW and Volvo-Geely have training programs for employees to learn the tacit knowledge. As mentioned by the manager of FAW-VW, experts from VW come to FAW-VW’s plant to guide Chinese engineers when they have new projects. Meanwhile, they send Chinese engineers to study and learn skills in Germany as well. This is also happening to Geely and Volvo Cars. Geely’s employees come to Volvo Car’s center in Gothenborg, exchanging experiences, learning know-how skills and improving collaboration between them. At the same time, Volvo cars has established R&D center in Shanghai. Swedish experts are there response to train the Chinese engineers and develop the competence level not only through theoretical study but also learning-by-doing. Learning is the most important way to acquire tacit knowledge. By generating and incorporating new technology in design of a new product can activate tacit knowledge. Moreover, it can be activated in the process of learning new improving existing technology through minor transformation based upon learning-by-doing (Howells, 1996). As said by Mr.Nyborg from Volvo cars, the automobile technology is not just theoretical knowledge but also combined with practical skills, which can be gained through learning by doing.
7. Conclusion & Future Research

Conclusion
In order to compete with foreign brands and learn advanced technologies, Chinese automobile industry has been using the Foreign Direct Investment (FDI) approach based on the strategy of “trade market access for technology” since 1980s. Initially, the government expected Chinese automakers to learn advanced technologies through foreign technology transfer by establishing Sino-foreign joint ventures with foreign automakers. Although technology transfer can make localization automobile firms enhance technological capability and allow employees to learn skills and assimilate experiences, the Western firms are rejecting transfer core technologies to Chinese automobile firms. This paper explored the phenomenon of technology transfer in Chinese automobile industry by developing the two cases of automobile joint ventures, combined with government policy and Chinese market analysis.

By analyzing the current situation of the Chinese automobile industry and the case of new joint venture Geely – Volvo Cars and the early joint venture FAW-VW, it is found that the strategy of establishment Sino-foreign joint ventures in Chinese automobile industry is not sufficient. Nowadays, in order to minimize the negative environmental effects, the Chinese government has established many laws to support and develop clean energy technologies. Many domestic firms including Geely are developing pure electric and hybrid technology. It can be seen that the regulation of Chinese government plays a significant role in the development of Chinese automobile industry. Additionally, it is also easy to realize that learning advanced technology through technology transfer is difficult for Chinese automakers to achieve. Due to the lack of absorptive capacity, technological accumulation and knowledge learning process. Thus, the Chinese makers must enhance their knowledge base both in tacit and explicit dimensions, and to improve their competence level. Meanwhile, Chinese automakers are over-dependent on the joint ventures that led them to fail knowledge learning.

It also can be found in the findings that transferor is facing with the challenge to teach their local Chinese engineers skill and develop their capabilities, and the transferee is challenged having to learn and use the new technologies. From the perspective of Western firms, they need to introduce new technology and be able to control the technology in their joint venture if they want to be successful in China. It is also a challenge for them to transfer tacit knowledge to their local engineers. In contrast, transferees must find an efficient way to acquire, absorb and improve knowledge base and enhance their technological capacity.
Future Research

This research did not mention the adaption of foreign technology in Chinese automobile industry; thus, following topics would be interesting to do future research on:

- How do Geely absorb and assimilate the advanced technology and adapt new strategies with Volvo cars?

- What are the new ways for Chinese automobile industry to improve technological capabilities instead of using the strategy of “trade market access for technology“?
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Appendices

Appendix 1: Background of Geely

- In 2009, Geely acquired Australia-based automatic transmission maker DSIH
- In 2010, Geely acquired Volvo Cars with 100% shares and related assets including intellectual property
- In 2012, Geely and Volvo Cars signed the MoU of technology transfer
- In 2013, Geely established the European R&D center in Göteborg of Sweden

Under the current situation of China’s auto industry, a number of domestic automakers challenged by the obstacles and tried to find a sufficient way to overcome the weaknesses. As the China’s largest privately owned automobile firm, Zhejiang Geely Automobile Holdings Group (Geely), completed acquisition of Volvo Cars Corporation (Volvo) form the Ford Motor Company in 2010.

Before Geely Holding Group’s acquisition of Volvo in 2010, they bought Australian transmission firm Drivetrain Systems International (DSI) in 2009, with the rapidly and quietly researching and developing the technology, the first car model equipped in 2011. Geely absorbed and integrated DSI’s technology after the acquisition of DSI by Geely. In fact, this can be seen as an advantageous deal as its deal with Volvo. In addition, its mixing mergers with innovation make this auto firm stand out of domestic brands (Geely, 2011).

Moreover, Geely has developed their own Knowledge Management System to achieve the integration of knowledge keeping, data searching and technical exchange. According to Geely, they transferred technologies and the product development process in Geely Automobile Technical Handbook. In the year of 2010, the Group together with its parent Geely Holding owns 1,822 technology patents in total. At the same time, it has Geely’s R&D staff about 2,381, representing close to 14% of the full number of staff of the company, also reflecting the Geely’s emphasis on R&D capabilities.

In 2013, Volvo Cars and Geely are going to open a new research and development center in Gothenburg in Sweden. It aims to use the new modular architecture to underpin the automaker’s smaller vehicle offerings (Geely, 2013).
Appendix 2: Background of Volvo Cars

Volvo established in 1927 and rolled off the first production line in Gothenburg of Sweden. Before Geely Holding acquired Volvo Cars, it was formed part of the Swedish Volvo Group until Ford Motor Company owned it in 1999. In 2009, Geely Holding acquired Volvo Cars with 100% share. In 2011, Volvo Cars established headquarters in Shanghai includes a Technology Centre, and a plant in Chengdu (Volvo Cars).

Volvo cars are famous for its Safety, Environment and Quality. Firstly, Safety systems such as the automated brake system and passive systems are not only protecting the driver and passengers within the car, but also are protecting the people who surrounded by cars. Secondly, the care of the Environment is a core value for Volvo. They have released an innovation to reduce emissions by around 90 per cent. Thirdly, the have a strong reliability and a commitment to quality and customer satisfaction since 1927. (Volvo Cars)
Appendix 3: Interviews

Interviewee: Mr. Feng – FAW-VW Chengdu Plant Manager  
Interview date: 2013/4/23  
Interview questions:  
1. Why do you want to get technologies transferred from Sweden and other Western countries?  
2. How has the new technology been transferred?  
3. What kind of knowledge and technology is hard to be transferred? (E.g. Design, know-how, software, organizational management etc.)  
4. What kind of technology needs to be transferred from foreign firms?  
5. What are the challenges are you facing with?

Interviewee: Mr. Xiaolin Yuan – Head of Chairman’s office  
Interview date: 2013/5/16  
Interview questions:  
1. How do Geely collaborate with Volvo cars?  
2. What kind of challenges are you facing with?

Interviewee: Mr. Lars Nyborg – Vice President of R&D Volvo Cars China  
Interview date: 2013/5/30  
Interview questions:  
1. What are the motivations of transfer technology to China?  
2. What kinds of problems have you facing in localize production in China?  
3. Are there any problems in capability-related issues?  
4. What kind of challenges are you facing with?  
5. What kind of technology is needed in Chinese automobile industry?