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UNDERSTANDING GATEKEEPING TRANSFORMATION IN THE CHINESE ELECTRIC VEHICLE INDUSTRY: AN EXPLORATORY STUDY OF THE FOCAL FIRMS' CROSS-INDUSTRIAL INTERACTIONS

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ABSTRACT

In the Chinese electric vehicle industrial innovation, the focal firms, which are the key technological, manufacturing and business wise key players, are increasingly involved in the cross-industrial interactions. However, no studies have analysed how they interact across industrial boundaries as well as their consequences. The aim of this article is to explore the focal firms' cross-industrial interactions in the Chinese EV industrial innovation. Relying on the concept of gatekeeping and using the firms' public information during 2009 and 2014, this study identified that the focal firms' interaction activities include information-gatekeeping, platform-providing, and benefit-gatekeeping. A framework of 'industrial gatekeeping' was developed. It highlights that the focal firms' gatekeeping in the Chinese EV industry settings are transforming: they do not only concern technological information but also firms' benefits. Furthermore, the framework extends the scope of gatekeeping to the cross-industrial settings. Practical recommendations for industrial players and insights for policy-makers are provided.

KEY WORDS

industrial gatekeeping, cross-industrial interactions, gatekeeping transformation, EV industry, China

CLASSIFICATION

JEL: L00

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INTRODUCTION

The electric vehicle (EV) industry offers the potentiality to address the energy crisis, oil security, air pollution and climate change [1, 2]. Therefore, the EV industry is pursued by the world' major economies. In these economies, different stakeholders are involved in the industry evolution and heated discussion are dedicated to the interactions among the key industrial stakeholders [3, 4].

In the Chinese EV industry, government, car manufacturers, EV infrastructure and consumers are identified as the four key stakeholders [5]. Some scholars have studied these stakeholders' interactions, mainly from the industrial ecosystem and value chain views. For example, from the perspective of industrial ecosystem, Shang and Shi [6] explored the effect of interactions between government, firms, associations and customers on the evolutionary pathways. Rong, et al. [7] focused on interaction process between OEMs and other ecosystem partners. Lu et al investigated stakeholders' interactions in ecosystem [8] and proposed a system dynamics model based on the interactions among the four key stakeholders [5]. Li, et al. [9] analyzed interactions between governments and firms along the EV value chain. None of the studies have explored how focal firms interact across industrial boundaries to promote the EV industrial innovation. Given that facilitating the cross-industrial interactions is a big challenge for all the key stakeholders [5, 7], and focal firms play the central role in the industrial innovation process, this study intends to investigate the focal firms' activities in the cross-industrial interactions in the Chinese EV industrial innovation.

In innovation literature, gatekeeping or technological gatekeeping [10] is usually used to investigate focal firms' activities in facilitating interactions. It refers to filter the inflow of external technical information and explore how firms' information receiving, digesting and transmitting activities (i.e., gatekeeping activities) can support product development within a single industry boundary [11-15]. When applying to the Chinese EV industrial innovation, the technological gatekeeping framework encounters some practical issues. The focal firms' interactions involve not only the inflow of external technical information, but also other types of interactive contents [3]. It corroborates the recent research that other types of gatekeeping should be considered as firm's interactions, even within a single industrial, involve more than one type of gatekeeping on technical information [16].

Enlightened by the above-mentioned research gaps, the aim of this article is to explore focal firms' cross-industrial activities by using the concept of gatekeeping. We studied three focal firms from the Chinese EV industry over five years period and identified the firms' cross-industrial activities such as information-gatekeeping, platform-providing and benefit-gatekeeping. The study contributes to the existing literature in the ways that, firstly, it adds to the EV industrial innovation literature by exploring focal firms' activities in facilitating cross-industrial interactions. Secondly, it adds to the gatekeeping literature by reporting firms' gatekeeping transformation in cross-industrial interactions and thereby extends the scope of the gatekeeping [11, 17]. Thirdly, it adds new sights to industrial innovation management. For a long time, emerging industry policymakers neglected firms' across-interactions in benefit. The findings of this study suggest that policymakers may pay attention to firm's benefit-gatekeeping activities and create communication channels for firms to express their propositions.

Subsequently, the article provides a brief summary of industrial and theoretical background. Thereafter, the research methodology is explained. And the Chinese EV industry focal firms' across-industrial interactions are analysed. This research then discusses case findings and develops a conceptual framework of industrial gatekeeping. Finally, the conclusions are discussed.

INDUSTRIAL AND THEORETICAL BACKGROUND

INDUSTRIAL DEPLOYMENT IN CHINA

Though Chinese EV industry develops rapidly in recent years [18], the EV industry is still at its early development stage. The industrial gap between China and the more developed economies is not big and China keeps up with development in the more developed markets [8, 19, 20]. The Electric Vehicle Subsidy Scheme (EVSS) was launched in Jan 2009 signing the first year of EVs wider commercialization, followed by an update in Sep 2013. The two-phase subsidy scheme specifies the subsidy duration, scope, standard, phase-out mechanism and pilot cities for both public and private EV purchase. Besides, various efforts and actions such as 'Thousands of Vehicles, Tens of Cities' program, access management, regulatory support, consumer subsidies and R&D funding have been made, attempting to promote the EV market penetration [21-23]. Given Chinese EVs market with strong growth potential, firms from the related industries such as car manufacturers and electric energy suppliers are actively involved in the EV industry [19, 24].With active intervention, China has become a rising star in the global EV market. The world has seen an anomalous decrease in the market growth rate in 2012-2014 (see Figure1), however, while other major economies have struggled with a stagnated or even declined growth rate in 2014, the Chinese market has an accelerated growth rate (see Figure 2). The recent data shows that, the production of the Chinese EVs may exceed the sum total of all the major developed markets, which makes China the largest EVs market overcoming the US's market [25] at the end of 2015, so that China plans to ban internal combustion engine and diesel vehicles by 2025.

Given its dramatic market growth, Chinese EV industry has received increasing attention of scholars. The discussions focus on two major topics. One is how to enhance industrial effectiveness, including manufacturing and business perspectives. For example, Tan, Wang, Deng, Yang, Rao and Zhang [1] proposed to improve charging price mechanism, multi-approaches of energy supplement and enlarge price subsidy. Hao, et al. [22] found that Chinese EV industry needs the subsidy policy in the short term, because that the economic competitiveness of EVs likely will not appear in the Chinese market in short time. Based on assessing the technologies of Chinese EV industry, Du, Ouyang and Chen [20] proposed that a key issue is to enhance the safety of high-energy density batteries.

The growth of EVs market is not only ascribed to introducing a new product, but also providing the charging infrastructures. It implies that innovation of Chinese EV industry is involved in various industrial players. Therefore the other major research topic is the interactions among the industrial key holders. Four types of key stakeholders were identified.

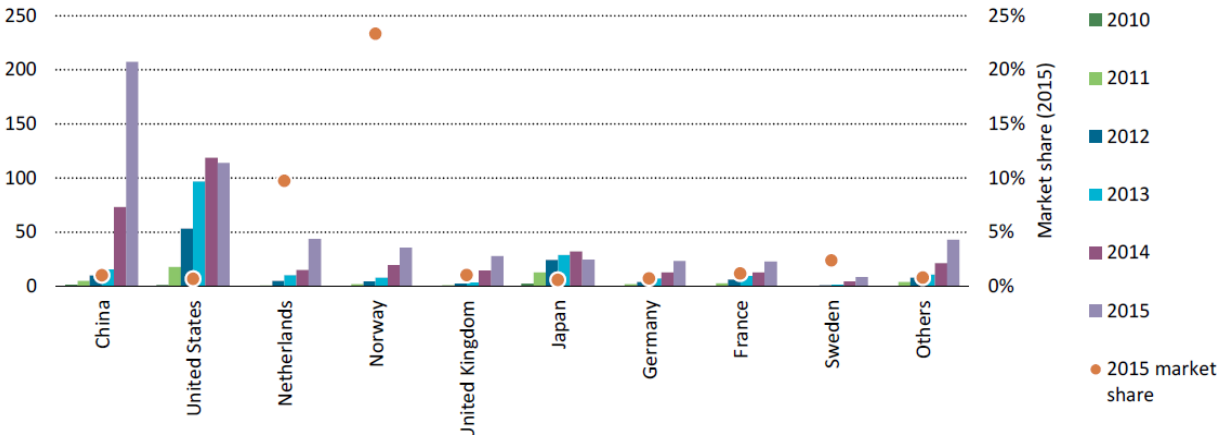

Figure 1. EV sales and market share in selected countries and regions [25].

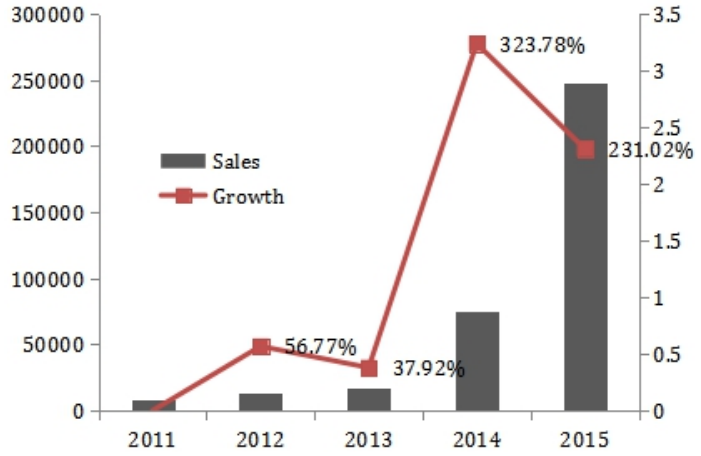

Figure. 2. Sales and Growth of the Chinese EV industry.

According to Lu, Liu, Tao, Rong and Hsieh [5], government, car manufacturers, EV infrastructure and consumers all play critical roles in industrial evolution. Shang and Shi [6] provided a comprehensive analysis of the structure of the EVs business ecosystems. Lu, Rong, You and Shi [8] used an agent-based system to investigate stakeholders' interactions in the ecosystem. They both found that the focal firms need to organize the ecosystem cooperation. Further, Rong, Shi, Shang, Chen and Hao [3] developed the structure and operating mechanisms of business ecosystems. Yang, et al. [26] also considered the support mechanisms among the government, social capital and intermediaries along the EV value chain for constructing charging infrastructures.

FOCAL FIRMS' INTERACTIONS IN THE CHINESE EV INDUSTRIAL INNOVATION

The Chinese EV industrial innovation faces the challenges of achieving product development and securing better business innovation [3, 7, 9], meaning that industry innovation needs to consider how to integrate recharging mode in both the technological and business wises. The EV recharging mode is mainly classified into two types: charging and swapping mode. The charging mode is to directly recharge the batteries placed on vehicles by external power supply facilities. The swapping mode is to directly swap out batteries placed on vehicles by renting or purchasing fully charged batteries. For the focal firms, car manufactures are able to develop EVs and can choose different recharging mode. On the other hand, gird firms can build charging infrastructures and can also choose different recharging mode. Their choices imply that multiple types of interactions may involve in developing the EVs and business models.

Research have shown that the China's EVs innovation and even the market is driven by policies, car users have very limited influence [27]. Promoting the swapping mode will allow the power grid firms to deeply engage in the emerging industry [24, 28], therefore such mode would benefit greatly the power grid firms. However, car manufacturers may be reluctant to adopt such mode as the costs of designing battery and battery management system, which is the core part of the EVs, are rather high [29] and may cause firms to lose control in the product design, not mention that they need to restructure the R&D system in accordance with the grid firms' standards. Therefore, for government, the decision-making is a big challenge. The decision has been left for the focal firms and this led to the interactions between car manufactures and grid firms.

GATEKEEPING IN INNOVATION

The innovation literature often used gatekeeping or technological gatekeeping to illustrate firms' function in facilitating interactions in innovation. Some studies distinguished between

gatekeeping and boundary spanning, claiming that a gatekeeping must be strongly connected both internally and externally but boundary spanning are connected only externally [17, 30, 31]. The existing studies on gatekeeping have focused on two settings of the boundary. One is a single firm boundary. The gatekeeping in specific teams and particular R&D groups [32, 33] and laboratories [34-36] has been examined. Scholars suggested that the main contribution of gatekeeping is to filter external information flows within teams for innovation in the way that: Gatekeepers consistently search for the latest external information through their greater social networks; using coding conventions familiar to internal players, they translate the coding schemes and then quickly spread them to the internal players for product development [37, 38].

The other setting is a single industry boundary. Studies have recently analysed focal firms' gatekeeping. Taking industrial cluster as an example, scholars have investigated local focal firms' gatekeeping in acquiring, using and diffusing knowledge in the local innovation system [12-15, 39] and concluded that the focal firms were the 'gates' of interaction in the clusters' knowledge networks [10, 17] through which the extra-cluster technological information can flow into clusters for product development [16, 40-42]. The performing of gatekeeping employs superior knowledge base, technological capabilities and well-established contacts [16, 41], and is supported by developing interactions in multiple-level knowledge networks [14]. Giuliani and Bell [39] and Malipiero, et al. [43] pointed out that firms' gatekeeping is important sources to net knowledge of the local cluster due to bringing new knowledge in local cluster. However, Hervas-Oliver and Albors-Garrigos [41] found that for knowledge creation of renew stage, the gatekeeping mainly relied on interactions with new firms. Similarly, Giuliani [16] noted that the early gatekeeping was the more popular sources of learning interactions in knowledge networks.

Recently, some scholars called for more studies expanding the research scope of the gatekeeping [11, 17, 44], since gatekeeping may involve more than one type of activities such as technological information inflows and outflows [16]. Responding to the recent calls we explore the Chinese EV industry focal firms' activities across its original industry boundaries.

METHODOLOGY

RESEARCH DESIGN

For inductive analysis, a qualitative approach is usually employed. Recognizing the lack of prior research, this article chose exploratory case study[45]. Case study is often used to investigate contemporary events [45]. In particular, it is useful for observing, explaining, and exploring new phenomena within their real-life setting, especially for answering how questions [46, 47].

In 2009, the *Big Four* car manufacturers dominated the Chinese EV industry: Chang'an Automobile Group, FAW group, DongFeng Automobile Company, SAIC Motor Corporation Limited. The prominent examples of the EV new comers, US's Tesla and China's BYD, are not major players by the time [48]. Tesla delivered its Model S cars to Chinese market in late April 2014 [49] and BYD became a key player after 2013 [50]. Therefore, in this study, we chose two of the *Big Fours*: Chang'an Automobile Group and FAW group. They were also chosen for that they ranked at the top of the Chinese market share and R&D productivity in China, respectively [51, 52]. Furthermore, they are also two of the earliest Chinese automobile companies to develop the EVs. In power grid industry, there are two dominant firms in China: State Grid Corporation of China [53] and China Southern Power Grid. SGCC has the advantages in technology and market, ranked at the top of grid industry and possessed 80 % of the power supply grid and therefore was chosen for this study.

DATA COLLECTION AND PROCESSING

Since this research was interested in investigating focal firms' interactions in innovation. The data from 2009-2014 was collected. In 2009 the Chinese government included the EV industry as one of the leading industries of the strategic new industries and launched the EVSS, signalling starting of the Chinese wider EV commercialization. Until the middle of 2014, car manufacturers and gird firms came to a similar expectation, which signals the sharp decrease of interaction in innovation.

Two primary sources of data were identified in this article. They both were publicly available materials, and can be explained in the same way as interviews-namely as text [54]. The different data sources can ensure the data triangulation [55]. Further, the data triangulation was strengthened by interviews of top management from two firms. The two sources are, firstly, firms' annual report, corporate social responsibility report, various industrial reports [25], as well as news and interviews from professional financial media. This leads to a total collection of more than 30 text documents, and secondly, the English literature database such as LEXIS-NEXIS ACADEMIC. Three case firms' names ("Chang'an", "First Automobile Work shop", "State Grid Corporation of China") and some key words ("electric vehicle*", "construction", "charging", "cooperation") were used to search for the data though the title, keywords, abstract or text. After firstly excluding the duplicate data and irrelevant content, 83 articles were left.

DATA PROCESSING

The data was analysed with NVivo 11 software, a qualitative analysis software package, proceeding in four steps. The first step is to identify text passages that explicitly dealt with focal firms' interactions. By reading through the collected data set, two of authors generated a list of codes, such as '2009 charging mode', '2010 charging mode', '2012 swapping mode', '2013 swapping mode', 'changan', 'FAW', or 'information', and so on. To this end, in step 2, though rereading the feedback and comparing and the identified codes, similar ones were grouped into higher level order codes (an overview of codes as shown in Figure 3). During this

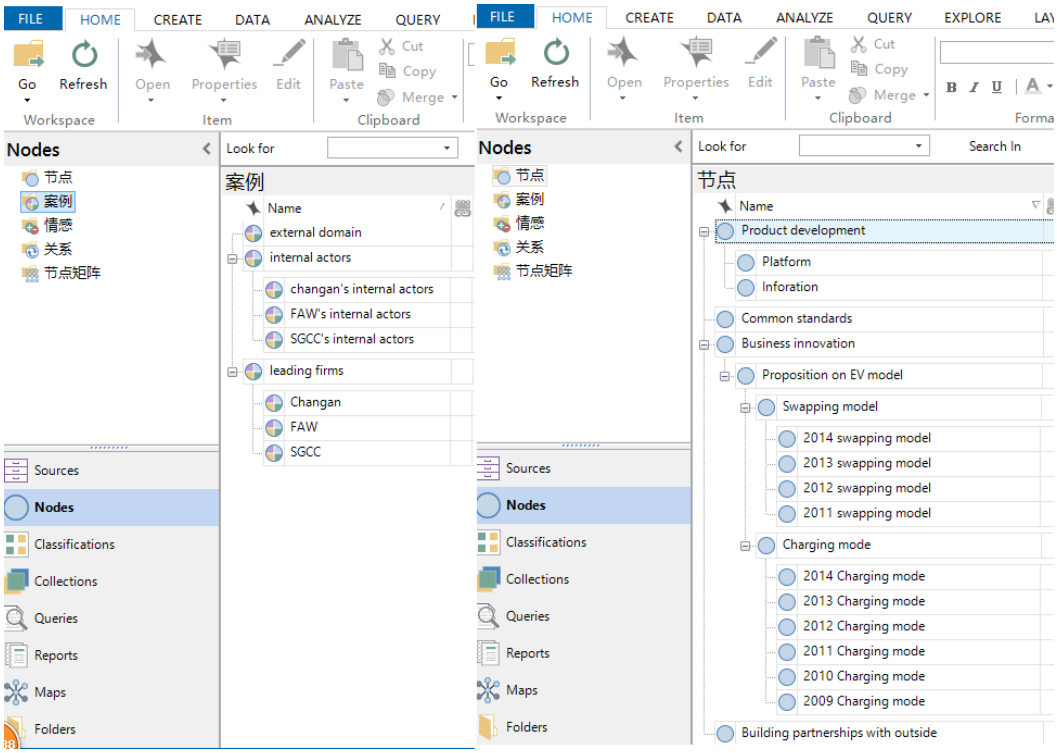

Figure. 3. Overview of codes.

stage, this study identified the critical incidents of the firms' involvement in the EV industry and used them as the foundation for the further analysis of the firms' gatekeeping in innovation. In the step 3, the exploring and mapping of the focal firms' interaction was conducted by using NVivo 11. During this stage, this research formulated the preliminary propositions. Integrating with the propositions formed in the step 2, a framework of industrial gatekeeping was proposed.

For validating the findings, after developing the preliminary research propositions, one of the authors interviewed three times with the board members of one of the studied firm which he was serving. In addition, the authors also took the results to the EV industry summit organized by both central and local governments. Based on the feedback we collected from the firms, industry players and governments, the analysis and results was revised. Such process ends until the firms and industrial administration staff consented on the conclusions.

The last step is to write up the case narrative. To guide the process, we rely on Oeser and Harary [56] structural role theory. We looked the 'persons', 'positions' and 'tasks' in the context. The 'persons' are the studied firms. The 'tasks' refers to the gatekeeping activities these firms perform in the EV innovation and the 'position' refers to the roles of the focal firms.

FINDINGS

PERSONS

Chang'an Automobile Group

In the 2009 R&D capability rank of the Chinese National Development and Reform Commission [57], the product development capability of Chang'an ranked the 1st place in the automobile industry. Chang'an has started EV R&D activities since 2002 and has built 6 labs to study the electric machinery, new energy batteries, and controllers for the EVs. It owns more than 100 technical EV related patents. It has also developed powertrains, functional verification of key component parts, fault simulation, matching and calibration and other test abilities.

First Automobile Workshop (FAW Group)

FAW has formed a product structure with many varieties and has a high sales volume. According to the 2009 R&D capability rank of the NDRC, FAW's product development capability ranks at the 2nd place. FAW started the EV R&D activities in 1998. Now it possesses five EV development capabilities including product planning, architectural analysis, vehicle design, testing, and trial production and has also established a series of development processes including architectural analysis of EV, performance control, control policy, key assembly, test, trial production and product certification.

State Grid Corporation of China (SGCC)

SGCC was founded in 2002. Its core business is to invest in, build, and operate the power grid. As the biggest power grid firm in China, it operates in 26 provincial administrative regions which cover approximately 88 % of the national territorial area of China. Because the service network of the EV charging infrastructure is a critical component of the EV designs, SGCC has a great impact on the EV industry in China. SGCC started to develop EVs since 2006. It has founded a battery character lab and smart power utilization testing centres, in order to better solve the energy problem faced by the EV industry. It has also developed charging and swapping equipment, monitoring systems for operating the smart charging and swapping networks, and formed a preliminary set of charging and switching standards.

TASKS: FOCAL FIRMS' INTERACTIONS AT THE PRODUCT DEVELOPMENT LEVEL

Chang'an group

As the focal firm in its industrial cluster, Chang'an connects the suppliers who are involved in the EV industry and transmits the information with the external domain. This role enables Chang'an to offer its industrial group members the latest translated and encoded external information. To allow its industrial group members to co-participate in developing the EVs, Chang'an provides the suppliers with its own technology. For example, in 2010, when Hafei (Harbin Hafei Automobile Industry Group Co., Ltd.), the subsidiary of Chang'an group, cooperated with the American CODA Company in developing the HFJ7001AEV EV model, Hafei encoded external information for the tier-one supplier which allows the key suppliers to participate in the construction of the virtual vehicle design platform.

Due to the limitation on research and production capabilities and resources, the industrial group members could not directly participate in the external EV R&D projects and are not able to provide sustainable support for Chang'an, Chang'an has to provide them with platforms for cooperation with the external domain. For instance, Wangxiang Electrical Vehicle Co., Ltd., a supplier of Chang'an and has cooperated with the firm for many years, cannot engage in developing EV batteries. In 2013, Chang'an provided Wangxiang with an energy automobile product development project and this enabled Wangxiang to join in developing the Lithium-ion battery system. This system has made Chang'an successful in the EV battery innovation. In addition, Chang'an also promoted suppliers' R&D capabilities by sharing promotional expenses.

FAW group

As the focal firm in its industrial cluster, FAW shares the latest external information with its industrial group members. The firm continuously helps the industrial group members enhance their product development capabilities, take Keboda as an example, and provides suppliers with policy support and technical support, including using development tools, project management training and quality management.

FAW also provides a cooperation platform to its industrial group members to enable them to cooperate with the external domain. For example, FAW-VW (FAW-Volkswagen automobile Co., Ltd.) offered its key supplier Keboda a platform for cooperation with external industry players in the EV R&D activities. Relying on this platform, Keboda was capable of working with Audi to develop global standard products, including an HID controller and an LED controller. Through such cooperation, Keboda made its products more competitive, and can continuously improve its R&D and production capacity to strengthen the strategic service to FAW-VW[1].

SGCC

As the focal firm in its industrial cluster, SGCC shares the external information with its members. Taking the construction of the Charging infrastructure as an example, the communication among participants involved in the construction is hindered, since they usually lack cross-industrial knowledge on charging infrastructure. Hence, SGCC takes the role of facilitating the communication among the participants though interpreting and disseminating information. For example, in 2010, Electricity Power Research Institute (EPRI) a subsidiary of SGCC, as the general contractor in the construction of Tangshan Nanhu EV charging station, solved the technological coordination problem among participants, which was caused by the misunderstanding of communication protocol of a nonstandard charging interface.

The bottleneck of the construction is the lack of standardization across different technology interfaces and standards in the EV industry. Too many participants come from different industries and backgrounds, which makes it difficult to use a single set of interfaces and standards. A platform is needed for negotiating the unification of industry standards. Such platform was provided by the SGCC. In 2011, a symposium on the study of EV's standard battery box and connector technology was hosted by EPRI in Nanjing. NARI-technology, EV manufacturers, battery and connector producers, and other firms attended the symposium. They discussed the production standardization and application of the EV battery containers and connectors, and set up the preliminary structural indicators of the containers and connectors.

TASKS: FOCAL FIRMS' INTERACTION AT THE BUSINESS INNOVATION LEVEL

Viewing Chinese EV innovation, focal firms' interaction was different before and after 2011, especially about business innovation. Before 2011, owing to the emergence of the industry, focal firms rarely interacted with each other in business innovation. After 2011, focal firms started to compete and this led to a greater extent of firm's interaction.

Before 2011

As the leading car manufacturers in the automobile industry, Chang'an and FAW both have a say on the EVs' recharging mode. To control for the value distribution in the EV industry, they proactively set the fast-charging mode as their dominating recharging mode, because such mode makes them a dominant position in the EV industry and can protect the benefits of their industrial group to the greatest extent. In 2009, Chang'an's fast-charging mode EV BenBen mini trial-production was released, and FAW's cars, from the A-class car to the C-class car, all used the fast-charging mode[2].

In 2009, the initial proposition of SGCC was to rely primarily on the charging mode, followed by the swapping mode [53]. This proposition was in line with the major car manufacturers' propositions and eliminated the automobile industry's resistance to SGCC's entry into the EV industry. Meanwhile, SGCC defined its construction objective, location principles, power supply mode as well as the metering and billing standards for charging stations. For example, SGCC built the Caoxi EV charging station, the first EV charging station operating in 2009. In 2010, the first large standard charging station in China was built and operated. Therefore, SGCC successful accessed to the EV industry. While traditional automobile energy providers fell behind SGCC, since they had no advantage in electricity supply and no standard programs designed for the electricity supply.

After 2011

In 2011, SGCC changed its proposition to relying primarily on the swapping mode, followed by charging mode [59]. In the meantime, it accelerated the construction of charging and battery-swapping stations since 2011.

Chang'an then raised its concern that 'building large-scale battery-swapping stations can only be realized with sufficient investment, otherwise, the profitability of such mode should be questioned' [60]. FAW made a clearer rejection to the SGCC's proposition: 'in the current circumstances, or before the EVs can be produced in a large scale, swapping mode is quite challenging. We made our design based on our needs, which is the fast-charging mode design. In other words, fast-charging mode is our strategic choice' [61].

In response to Chang'an and FAW's views, SGCC explained that 'we made such decision mainly because the large-scale, random and moving charging load would cause massive burdens that might threaten power grid construction and operating safety. Besides, at the

current level of battery technology, the battery-swapping station can provide more convenient and quicker electricity supply' [62].

Clearly Chang'an and FAW insisted on charging mode as the proper design and both of them took affirmative actions to commit to their propositions. For example, Chang'an accelerated to produce the plug-in EVs, which led to the release of E30 in 2012. In 2011, FAW's charging mode EV 'Carely' has been included in the new vehicle admittance catalogue. In addition, both firms have led the regulation of industrial policy. Chang'an promoted 10 industrial standards while FAW promoted 5. Chang'an also reviewed the battery station construction standard regulation proposed by the SGCC.

The disputes of the recharging mode went on and caused the disunion of interface standards in battery-swapping mode and huge amount of operation costs. Together with the ignorance of the national policy, the development of the EV industry has slowed down in 2012-2013 (see Figure 2). This led SGCC to change its proposition. In the middle of 2014, SGCC proposed a renewed proposition: 'relying primarily on the fast-charging mode, giving consideration to slow-fast-charging mode, and guide with swapping mode'[63]. This indicates that SGCC has returned to the proposition of charging mode. At this point, the industrial disputes had eased, which directly led to an explosion of Chinese EV market in 2014 (see Figure 2).

RESEARCH PROPOSITIONS AND EXTENDED FRAMEWORK

The empirical findings from the case analysis lead to five propositions concerning focal firms' activities in the cross-industrial interactions.

Firstly, in the Chinese EV industrial innovation, the focal firms' gatekeeping activities experienced some extent of transformation. Our findings noted that the focal firms hold dominant positions in cross-industrial interactions. For one reason, consumers have very limited influence in the Chinese EV industrial evolvement [27] and for another reason, even though the Chinese government has implemented incentives to support the EV industry [8, 22], it is unable and rather reluctant to choose the recharging mode for the industry. EV product development therefore was left to focal firms' cross-industrial knowledge, information and resource exchange [64, 65]. Car manufactures hold the key resources (predominant power of the market and marketing channels) and key technology (e.g. vehicle production capacity, key components and key technologies of battery management system). Power grid firms have absolute control over the Chinese electric energy supply market and hold the capacity and knowledge of power transmission and distribution and can bear plenty of funding for investment. In this context, focal firms' gatekeeping have richer connotation, concerning the support of information and cooperation as well as business innovation. For example, different propositions on recharging mode would lead to different cognitions about the business innovation. Lack of consensus will hinder the industry development [9, 66]. After several rounds of disputes on the recharging mode, focal firms reached a consensus. On this basis, we formulate the following two propositions.

Proposition 1*: Focal firms, car manufacturers and power grid firm, hold a strong position in the cross-industrial interactions within the Chinese EV industry.*

Proposition 2*: In the Chinese EV industry, focal firms experienced some extent of gatekeeping transformation* in *cross-industrial interactions, meaning that their activities include more types of activities than merely the information exchange.*

We found focal firms obtaining external cross-industrial information and transmitting to its industrial group members. In other words, they performed information-gatekeeping activities

and followed the same patter as was in a single industry context [37, 38]. Interestingly, we noticed the benefiting-gatekeeping activities of the focal firms. The analysis showed that the focus of the cross-industrial disputes rarely concerned the superior technology, innovation capability or access to the market which firms' interaction within a single industry boundary usually focus on [9, 66], rather, the disputes are more around balancing focal firms' benefits. Swapping mode will maximize the profits of power grid firms, while charging mode will be more beneficial to car manufacturers. At the beginning of the EV innovation, focal firms from the related traditional industries had little controversy on the business innovation. They all explicitly proposed the charging mode. However, along with the industrial development, firms proposed different recharging modes which are more in the interests of their own [67, 68]. The different propositions then led to heated disputes, which ceased until some players, in our context, SGCC, made compromises and a consensus on the charging mode has been reached among the major players. SGCC's intention was to remain in the game and to capture more future value splitting. Like in other settings, focal firms serve as gates in interactions in business innovation for future value distribution. These observations strengthened our proposition 2 and on its basis, we further formulate the following propositions.

Proposition 3*: In the cross-industrial settings, focal firms perform information-gatekeeping activities as within a single firm or industry.*

Proposition 4*: The gatekeeping activities of focal firms involve benefit-gatekeeping. Such activities are different from firms' technology gatekeeping in that the former concerns focal firms' benefits and the latter concerns firms' information and technologies.*

Another new aspect of focal firms' gatekeeping activities we identified is platform-providing. As the focal firms are usually larger and older [69] and are the most powerful firms in their industrial groups [14], the group members usually establish a lasting, stable and trust partnership with the focal firms [16, 70]. Such partnership enables the group members to easily understand the encoding schemes and conventions of the focal firms [39], which further allows for a platform among the industrial group members. The platforms are often established by the focal firms. It enables the industrial group to cooperate to develop the new products for the emerging industry. The industrial group members can build connections and cooperate with the external domain firms through the platform. In general, through these platforms, the group members can not only have access to industrial manufacturing capabilities and resources requested by the convergent industry, but also free training and necessary management capabilities [71, 72]. This leads to our last proposition.

Proposition 5*: In the cross-industrial settings, focal firms also perform platform-providing activities, providing them necessary connections, resources and capabilities requested by the new industry and through this, the industrial group members can take part in the new product development.*

As seen in our cases, Chinese car manufacturers and power grid firms conduct various interactions at both the product development and business innovation levels. These interactions lead to a complex and new phenomenon which emerged in a convergent industry. At the product development level, focal firms are information gatekeepers and platform-providers. They enable their industrial group members and assist them to cooperate with the external domain in developing new products. At the business innovation level, they are benefit-gatekeepers, negotiating with the other focal firms to capture a dominant position in the EV innovation for future value distribution. To summarize, this study integrates these activities into a framework of industrial gatekeeping, which describes focal firms' activities in cross-industrial interactions (see Table 1).

Table 1. Framework of industrial gatekeeping.

Role	Level	Activities	Descriptions
Industrial Gatekeeping	Product development level	Information-gatekeeping	Locate, translate and encode, share and transmit external information to industrial group members.
		Platform-providing	Establish and provide cooperation platform for industrial group members, and improve their innovation capabilities.
	Business innovation level	Benefit-gatekeeping	Advocate, compete and compromise to balance propositions on business innovation.

CONTRIBUTIONS, MANAGERIAL IMPLICATIONS, LIMITATIONS AND RESEARCH DIRECTION

This study explores the Chinese focal firms' cross-industrial activities in the emerging Chinese EV industry. We discovered that firms' activities concern the technological information, resources capabilities exchange, as well as the business innovation. The nature and characteristics of such interactions are explored and discussed. Our work makes some major contributions as follows.

Firstly, this study contributes to the EV industry innovation literature by exploring focal firms' functions across industrial boundaries. Recent research has studied the Chinese EV industry stakeholders' interactions systematically, but has not looked into specifically the activities of the most key players in car manufacturing: the focal firms. Literature from other economies has noted that focal firms cooperate with each other in innovation [73, 74] and that there are conflicts caused by firms' different propositions [75], but no further analysis was provided to characterize firm's propositions, conflicts and co-operations. Our results show that the focal firms play information-gatekeeping, platform-providing and benefit-gatekeeping activities to facilitate the industrial evolvement.

Secondly, our study adds further knowledge to the technological gatekeeping literature by reporting on focal firms' other types of gatekeeping activities. By digging deeper into the interactions between car manufacturers and power grid firm, we discovered the focal firms' new functions of benefit-gatekeeping and platform-providing in the Chinese EV industry. Integrating the new functions with Allen' technological gatekeeping, we develop the industrial gatekeeping framework. It highlights that the focal firms' gatekeeping in the Chinese EV industry settings are transforming: they do not only concern technological information but also firms' benefits. Some preliminary empirical evidence has been provided. Our framework extends the scope of the gatekeeping. Table 2 compares the technological gatekeeping framework and the industrial gatekeeping framework.

The results of this study offer practical contributions for EV industry policymakers and industry players. For business innovation, our findings suggest that policymakers may consider to create communication channels for the focal firms to express their propositions on business innovation, and that policymakers may govern the innovation by no interference. At the stage when propositions are proposed and focal firms start to have disputes, it is better for firms to resolve the conflicts by themselves. Policymakers may introduce timely supporting policies for industrial players or guidelines for consumers, in order to facilitate the communication which allow for an early consensus. While at the product development level, the information of how focal firms develop products and share with their industrial group members may be leaked and there are also risks that the key technology might be leaked from

Table 2. Comparison of technological and industrial gatekeeping.

Role (position)	**Contexts**	**Levels**	**Activities (Tasks)**
Technological gatekeeping	A single firm	Product development level	Information-gatekeeping
Technological gatekeeping	A single industry	Product development level	Information-gatekeeping
Industrial gatekeeping	Cross industry	Product development level	Information-gatekeeping
			Platform-providing
		Business innovation level	Benefit-gatekeeping
Role(position)	**Contexts**	Levels	Activities (Tasks)
Technological gatekeeping	A single firm	Product development level	Information-gatekeeping
Technological gatekeeping	A single industry	Product development level	Information-gatekeeping
Industrial gatekeeping	Cross industry	Product development level	Information-gatekeeping
			Platform-providing
		Business innovation level	Benefit-gatekeeping

cooperation platforms, therefore, policymakers may consider to strengthen law enforcement and industry regulation to help firms protect the property and trade secrets [76].

For industrial players who are seeking to operate in the EV industry, our findings provided two recommendations: firstly, to expand the propositions based on the industrial competences and understand how resources are allocated within the industry; secondly, to rely on the focal firms or become the focal firms to leverage the knowledge, resources and access to the emerging industry [77]. Firms' effort is meaningful only when they play the role of industrial gatekeeping.

Our study has several limitations. Firstly, our framework was developed based on small heterogeneous cases, which may reduce the generalizability of the conceptual framework. In addition, there might be self-selection bias. All the three cases are state-owned companies in China. They might have significant effects on innovation in the emerging industries, however, their influence is difficult to assess. Our findings could be tested in other case studies. Both single and multiple case studies may be used [78]. Longitudinal multiple case studies might reveal whether the number of standards battles resulting in a single standard is decreasing.

Given the contributions and limitations of our study, there are various promising avenues for future research. Studies may conduct more empirical research to examine our framework of industrial gatekeeping, in particular providing deeper understanding of the steps of new gatekeeping. Especially the studies from other contexts, for example, other countries and other emerging industries are more promising. In view of the methodological limitations, studies of larger samples of focal firms across ownership and industry settings may serve to verify and extend the findings. In addition, this study of benefit-gatekeeping focuses on firms' behaviour, i.e. firm's interaction, rather than firms' interests or inherent motivations, further studies on the interests may contribute to deepen the knowledge of the firms' behaviours and incentives. Finally, this article noted that the slowing-down pace of the EV market growth in 2012 and 2013 and meanwhile the disputes among car manufacturers and power gird firms became rather frequent, further studies may consider if the two phenomenon are related.

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[1]FAW-VW offered us a platform, through which we participated in a global project with Audi. As a result, we had more capacities to serve FAW-VW and other automobile manufacturers', said a Keboda director [52].

[2]In traditional automobile industry, manufacturers sell vehicles and traditional automotive energy providers sell energy such as petrol and gasoline. But in the EV industry, manufacturers may control for both sides. For example, manufacturer can appropriate the rent and service charge of the batteries. This suggests that manufacturers can control the value distribution in the EV industry through the fast-charging mode.

REFERENCES

[1] Tan, Q., et al.: *The cultivation of electric vehicles market in China: Dilemma and solution*. Sustainability **6**(8), 5493-5511, 2014, http://dx.doi.org/10.3390/su6085493,

[2] Un-Noor, F.; Padmanaban, S.; Mihet-Popa, L.; Mollah, M.N. and Hossain, E.: *A comprehensive study of key electric vehicle (EV) components, technologies, challenges, impacts, and future direction of development*. Energies **10**(8), No. 1217, 2017, http://dx.doi.org/10.3390/en10081217,

[3] Rong, K.; Shi, Y.; Shang, T.; Chen, Y. and Hao, H.: *Organizing business ecosystems in emerging electric vehicle industry: Structure, mechanism, and integrated configuration*. Energy Policy **107**, 234-247, 2017, http://dx.doi.org/10.1016/j.enpol.2017.04.042,

[4] Galateanu, E. and Avasilcai, S.: *Framing the Competitive Behaviors of Niche Players: the Electric Vehicle Business Ecosystem Perspective*. Procedia – Social and Behavioral Sciences **221**, 342-351, 2016, http://dx.doi.org/10.1016/j.sbspro.2016.05.124,

[5] Lu, C.; Liu, H.-C.; Tao, J.; Rong, K. and Hsieh, Y.-C.: *A key stakeholder-based financial subsidy stimulation for Chinese EV industrialization: A system dynamics simulation.* Technological Forecasting and Social Change **118**, 1-14, 2017, http://dx.doi.org/10.1016/j.techfore.2017.01.022,

[6] Shang, T. and Shi, Y.: *The emergence of the electric vehicle industry in Chinese Shandong Province: A research design for understanding business ecosystem capabilities*. Journal of Chinese Entrepreneurship **5**(1), 61-75, 2013, http://dx.doi.org/10.1108/17561391311297888,

[7] Rong, K.; Hu, G.; Hou, J.; Ma, R. and Shi, Y.: *Business ecosystem extension: Facilitating the technology substitution*. International Journal of Technology Management **63**(3/4), 268-294, 2013, http://dx.doi.org/10.1504/IJTM.2013.056901,

[8] Lu, C.; Rong, K.; You, J. and Shi, Y.: *Business ecosystem and stakeholders' role transformation: Evidence from Chinese emerging electric vehicle industry*. Expert Systems with Applications **41**(10), 4579-4595, 2014, http://dx.doi.org/10.1016/j.eswa.2014.01.026,

[9] Li, Y.; Zhan, C.; de Jong, M. and Lukszo, Z.: *Business innovation and government regulation for the promotion of electric vehicle use: lessons from Shenzhen, China.* Journal of Cleaner Production **134**(A), 371-383, 2016, http://dx.doi.org/10.1016/j.jclepro.2015.10.013,

[10] Barzilai-Nahon, K.: *Toward a theory of network gatekeeping: A framework for exploring information control*.
Journal of the American Society for Information Science and Technology **59**(9), 1493-1512, 2008, http://dx.doi.org/10.1002/asi.20857,

[11] Breschi, S. and Lenzi, C.: *The role of external linkages and gatekeepers for the renewal and expansion of US cities' knowledge base, 1990-2004*.
Regional Studies **49**(5), 782-797, 2015, http://dx.doi.org/10.1080/00343404.2014.954534,

[12] Graf, H.: *Gatekeepers in regional networks of innovators*.
Cambridge Journal of Economics **35**(1), 173-198, 2011, http://dx.doi.org/10.1093/cje/beq001,

[13] Mitchell, R.; Boyle, B.; Burgess, J. and McNeil, K.: *"You Can't Make a Good Wine without a Few Beers": Gatekeepers and knowledge flow in industrial districts*.
Journal of Business Research **67**(10), 2198-2206, 2014, http://dx.doi.org/10.1016/j.jbusres.2014.01.007,

[14] Morrison, A.: *Gatekeepers of knowledge within industrial districts: Who they are, how they interact*.
Regional Studies **42**(6), 817-835, 2008, http://dx.doi.org/10.1080/00343400701654178,

[15] Wink, R.: *Gatekeepers and proximity in science-driven sectors in Europe and Asia: The case of human embryonic stem cell research*.
Regional Studies **42**(6), 777-791, 2008, http://dx.doi.org/10.1080/00343400701543306,

[16] Giuliani, E.: *Role of Technological Gatekeepers in the Growth of Industrial Clusters: Evidence from Chile*.
Regional Studies **45**(10), 1329-1348, 2011, http://dx.doi.org/10.1080/00343404.2011.619973,

[17] Haas, A.: *Crowding at the frontier: boundary spanners, gatekeepers and knowledge brokers*.
Journal of Knowledge Management **19**(5), 1029-1047, 2015, http://dx.doi.org/10.1108/JKM-01-2015-0036,

[18] Zhang, Q.; Ou, X.; Yan, X. and Zhang, X.: *Electric vehicle market penetration and impacts on energy consumption and CO2 emission in the future: Beijing case*.
Energies **10**(2), No. 228, 2017, http://dx.doi.org/10.3390/en10020228,

[19] Yang, L.-f.; Xu, J.-h. and Neuhäusler, P.: *Electric vehicle technology in China: An exploratory patent analysis*.
World Patent Information **35**(4), 305-312, 2013, http://dx.doi.org/10.1016/j.wpi.2013.06.002,

[20] Du, J.; Ouyang, M. and Chen, J.: *Prospects for Chinese electric vehicle technologies in 2016-2020: Ambition and rationality*.
Energy **120**, 584-596, 2017, http://dx.doi.org/10.1016/j.energy.2016.11.114,

[21] Yong, Z.; Yu, Y. and Bai, Z.: *Analyzing public awareness and acceptance of alternative fuel vehicles in China: The case of EV*.
Energy Policy **39**(11), 7015-7024, 2011, http://dx.doi.org/10.1016/j.enpol.2011.07.055,

[22] Hao, H.; Ou, X.; Du, J.; Wang, H. and Ouyang, M.: *China's electric vehicle subsidy scheme: Rationale and impacts*.
Energy Policy **73**, 722-732, 2014, http://dx.doi.org/10.1016/j.enpol.2014.05.022,

[23] Wu, Y.; Xie, C.; Xu, C. and Li, F.: *A decision framework for electric vehicle charging station site selection for residential communities under an intuitionistic fuzzy environment: A case of Beijing*.
Energies **10**(9), No. 1270, 2017,
http://dx.doi.org/10.3390/en10091270,

[24] Weiller, C. and Neely, A., *Business model design in an ecosystem context*.
University of Cambridge, Cambridge Service Alliance 2013,

[25] IEA: *Global E V. Outlook 2016, Beyond one million electric cars*.
International Energy Agency, Paris, 2016

[26] Yang, T.; Long, R.; Li, W. and Rehman, S.U.: *Innovative application of the public–private partnership model to the electric vehicle charging infrastructure in China.*
Sustainability **8**(8), No. 738, 2016,
http://dx.doi.org/10.3390/su8080738,

[27] Zhang, X.; Rao, R.; Xie, J. and Liang, Y.: *The Current Dilemma and Future Path of China's Electric Vehicles*.
Sustainability **6**(3), 1567-1593, 2014,
http://dx.doi.org/10.3390/su6031567,

[28] Brandstätter, G., et al.: *Overview of optimization problems in electric car-sharing system design and management*.
In: Dawid, H.; Doerner, K.; Feichtinger, G.; Kort, P. and Seidl, A., eds.: *Dynamic Perspectives on Managerial Decision Making. Dynamic Modeling and Econometrics in Economics and Finance* **22**. Springer, Cham, pp.441-471, 2016,
http://dx.doi.org/10.1007/978-3-319-39120-5_24,

[29] Hein, R.; Kleindorfer, P.R. and Spinler, S.: *Valuation of electric vehicle batteries in vehicle-to-grid and battery-to-grid systems*.
Technological Forecasting and Social Change **79**(9), 1654-1671, 2012,
http://dx.doi.org/10.1016/j.techfore.2012.06.002,

[30] Allen, T.J.: *Managing the flow of technology: Technology transfer and the dissemination of technological information within the R & D organization*.
MIT Press, Cambridge, 1977,

[31] Tushman, M.L. and Katz, R.: *External Communication And Project Performance – An Investigation Into The Role Of Gatekeepers*.
Management Science **26**(11), 1071-1085, 1980,
http://dx.doi.org/10.1287/mnsc.26.11.1071,

[32] Katz, R. and Tushman, M.: *An investigation into the managerial roles and career paths of gatekeepers and project supervisors in a major r-and-d facility*.
R&D Management **11**(3), 103-110, 1981,
http://dx.doi.org/10.1111/j.1467-9310.1981.tb00458.x,

[33] Whelan, E.; Golden, W. and Donnellan, B.: *Digitising the R&D social network: revisiting the technological gatekeeper*.
Information Systems Journal **23**(3), 197-218, 2013,
http://dx.doi.org/10.1111/j.1365-2575.2011.00384.x,

[34] Allen, T.J. and Cohen, S.I.: *Information Flow in Research and Development Laboratories*.
Administrative Science Quarterly **14**(1), 12-19, 1969,
http://dx.doi.org/10.2307/2391357,

[35] Ettlie, J.E. and Elsenbach, J.M.: *The Changing Role of R&D Gatekeepers*.
Research-Technology Management **50**(5), 59-66, 2007,
http://dx.doi.org/10.1080/08956308.2007.11657463,

[36] Taylor, R.L.: *The technological gatekeeper*.
R&D Management **5**(3), 239-242, 1975,
http://dx.doi.org/10.1111/j.1467-9310.1975.tb01243.x,

[37] Harada, T.: *Three steps in knowledge communication: the emergence of knowledge transformers*.
Research Policy **32**(10), 1737-1751, 2003,
http://dx.doi.org/10.1016/S0048-7333(03)00060-X,
[38] Whelan, E.; Teigland, R.; Donnellan, B. and Golden, W.: *How Internet technologies impact information flows in R&D: reconsidering the technological gatekeeper*.
R&D Management **40**(4), 400-413, 2010,
http://dx.doi.org/10.1111/j.1467-9310.2010.00610.x,
[39] Giuliani, E. and Bell, M.: *The micro-determinants of meso-level learning and innovation: evidence from a Chilean wine cluster*.
Research Policy **34**(1), 47-68, 2005,
http://dx.doi.org/10.1016/j.respol.2004.10.008,
[40] Graf, H. and Krüger, J.J.: *The Performance of Gatekeepers in Innovator Networks*.
Industry and Innovation **18**(1), 69-88, 2011,
http://dx.doi.org/10.1080/13662716.2010.528932,
[41] Hervas-Oliver, J.-L. and Albors-Garrigos, J.: *Are technology gatekeepers renewing clusters? Understanding gatekeepers and their dynamics across cluster life cycles*.
Entrepreneurship & Regional Development **26**(5-6), 431-452, 2014,
http://dx.doi.org/10.1080/08985626.2014.933489,
[42] Lazaric, N.; Longhi, C. and Thomas, C.: *Gatekeepers of knowledge versus platforms of knowledge: From potential to realized absorptive capacity*.
Regional Studies **42**(6), 837-852, 2008,
http://dx.doi.org/10.1080/00343400701827386,
[43] Malipiero, A.; Munari, F. and Sobrero, M.: *Focal firms as technological gatekeepers within industrial districts: knowledge creation and dissemination in the Italian packaging machinery industry*.
DRUID Winter Conference, 2005,
[44] Barzilai-Nahon, K.: *Gatekeeping: A critical review*.
Annual Review of Information Science and Technology **43**(1), 1-79, 2009,
http://dx.doi.org/10.1002/aris.2009.1440430117,
[45] Yin, R.K.: *Applications of case study research*.
SAGE Publications, 2011,
[46] Verner, J.M. and Abdullah, L.M.: *Exploratory case study research: Outsourced project failure*.
Information and Software Technology **54**(8), 866-886, 2012,
http://dx.doi.org/10.1016/j.infsof.2011.11.001,
[47] CAAM: *The 2009 report on production and sales of Chinese automobile*.
http://www.caam.org.cn/zhengche/20100111/1705034322.html,
[48] Altenburg, T.; Schamp, E.W. and Chaudhary, A.: *The emergence of electromobility: Comparing technological pathways in France, Germany, China and India*.
Science and Public Policy **43**(4), 464-475, 2016,
http://dx.doi.org/10.1093/scipol/scv054,
[49] Chen, B. and Midler, C.: *Designing strategy for the globalisation of innovation: perspectives for foreign electric vehicle manufacturers in China*.
International Journal of Automotive Technology and Management **16**(4), 436-463, 2016,
http://dx.doi.org/10.1504/IJATM.2016.081633,
[50] Weiller, C.; Shang, A.; Neely, A. and Shi, Y.: *In Competing and co-existing business models for EV: Lessons from international case studies*.
Electric Vehicle Symposium and Exhibition 2014, pp.1-12, 2014,
[51] National Development and Reform Commission: *The 2009 report on evaluation results of enterprise technology center identified by National Development and Reform Commission*.
http://www.ndrc.gov.cn/zcfb/zcfbgg/200911/t20091106_311901.html,

[52] CAAM: *Newslist*.
http://www.caam.org.cn/newslist/a34-1.html,
[53] SGCC: *The 2009 CSR report of SGCC*.
SGCC, Beijing, 2009,
[54] Stremersch, S.; Wuyts, S. and Frambach, R.T.: *The purchasing of full-service contracts: An exploratory study within the industrial maintenance market*.
Industrial Marketing Management **30**(1), 1-12, 2001,
http://dx.doi.org/10.1016/S0019-8501(99)00090-5,
[55] Yin, R.K.: *Case study research: Design and methods*.
SAGE Publications, 2014,
[56] Oeser, O.A. and Harary, F.: *A Mathematical Model for Structural Role Theory, I*.
Human Relations **15**(2), 89-109, 1962,
http://dx.doi.org/10.1177/001872676201500201,
[57] Zacharias, M.E.: *Reviewed Work:* "*Longitudinal Qualitative Research: Analyzing Change Through Time*" *by Johnny Saldaña*.
Canadian Journal of Education **27**(2/3) 341-343, 2003,
http://dx.doi.org/10.2307/1602237,
[58] Li, W.H.: *A big R&D system is being established by FAW and its suppliers*.
http://auto.cntv.cn/2013/06/21/ARTI1371780380235574.shtml,
[59] Liu, Z.Y.: *In SGCC report on working conference 2011*.
The second congress of the staff and workers of SGCC. Beijing, 2011.
[60] Shao, Y. and Li, H.: *Battle between charging mode and battery swapping mode, what they want*?
http://auto.163.com/11/0711/11/78M6M29Q00084TV1_2.html,
[61] Li, J.: *In FAW takes charging mode for the development of new energy vehicles*.
Annual Meeting of the Society of Automotive Engineering of China in 2011. Beijing, 2011,
[62] Wang, X.: *Why EVs relies primarily on the battery swapping mode, follows by charging station mode*.
China Energy News, 2013,
[63] Liu, Z.Y.: *In SGCC report on working conference 2014*.
The fifth congress of the staff and workers of SGCC. Beijing, 2011,
[64] Bröring, S. and Leker, J.: *Industry Convergence and its Implications for the Front End of Innovation: A Problem of Absorptive Capacity*.
Creativity and Innovation Management **16**(2), 165-175, 2007,
http://dx.doi.org/10.1111/j.1467-8691.2007.00425.x,
[65] Kim, N.; Lee, H.; Kim, W.; Lee, H. and Suh, J.H.: *Dynamic patterns of industry convergence: Evidence from a large amount of unstructured data*.
Research Policy **44**(9), 1734-1748, 2015,
http://dx.doi.org/10.1016/j.respol.2015.02.001,
[66] Bohnsack, R.; Pinkse, J. and Kolk, A.: *Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles*.
Research Policy **43**(2), 284-300, 2014,
http://dx.doi.org/10.1016/j.respol.2013.10.014,
[67] Cross, R. and Sproull, L.: *More than an answer: Information relationships for actionable knowledge*.
Organization Science **15**(4), 446-462, 2004,
http://dx.doi.org/10.1287/orsc.1040.0075,
[68] Sigurdson, J. and Ericsson, P.: *New services in 3G – new business models for streaming and video*.
International Journal of Mobile Communications **1**(1/2), 15-34, 2003,
http://dx.doi.org/10.1504/IJMC.2003.002458,

[69] Camuffo, A. and Grandinetti, R.: *Italian industrial districts as cognitive systems: Are they still reproducible*?
Entrepreneurship & Regional Development **23**(9-10), 815-852, 2011,
http://dx.doi.org/10.1080/08985626.2011.577815,

[70] Lorenzoni, G. and Lipparini, A.: *The leveraging of interfirm relationships as a distinctive organizational capability: a longitudinal study*.
Strategic Management Journal **20**(4), 317-338, 1999,
http://dx.doi.org/10.1002/(SICI)1097-0266(199904)20:4<317::AID-SMJ28>3.0.CO;2-3,

[71] Ishikawa, J.: *Leadership and performance in Japanese R&D teams*.
Asia Pacific Business Review **18**(2), 241-258, 2012,
http://dx.doi.org/10.1080/13602381.2010.532907,

[72] Mesquita, L.F. and Lazzarini, S.G.: *Horizontal and vertical relationships in developing economies: implications for SMEs' access to global markets*.
Academy of Management Journal **51**(2), 359-380, 2008,
http://dx.doi.org/10.5465/amj.2008.31767280,

[73] Hockerts, K. and Wüstenhagen, R.: *Greening Goliaths versus emerging Davids – Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship*.
Journal of Business Venturing **25**(5), 481-492, 2010,
http://dx.doi.org/10.1016/j.jbusvent.2009.07.005,

[74] Ansari, S. and Krop, P.: *Incumbent performance in the face of a radical innovation: Towards a framework for incumbent challenger dynamics*.
Research Policy **41**(8), 1357-1374, 2012,
http://dx.doi.org/10.1016/j.respol.2012.03.024,

[75] Kley, F.; Lerch, C. and Dallinger, D.: *New business models for electric cars – A holistic approach*.
Energy Policy **39**(6), 3392-3403, 2011,
http://dx.doi.org/10.1016/j.enpol.2011.03.036,

[76] Breschi, S. and Catalini, C.: *Tracing the links between science and technology: An exploratory analysis of scientists' and inventors' networks*.
Research Policy **39**(1), 14-26, 2010,
http://dx.doi.org/10.1016/j.respol.2009.11.004,

[77] Cho, E. and Voss, H.: *Determinants of international environmental strategies of Korean firms: An explorative case-study approach*.
Asian Business & Management **10**(3), 357-380, 2011,
http://dx.doi.org/10.1057/abm.2011.13,

[78] Dul, J. and Hak, T.: *Case Study Methodology in Business Research*.
Routledge, London, 2008.