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Implications of China's innovation policy shift: Does "indigenous" mean closed?

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Abstract
China's government aims to become an innovation nation and promotes the development of so-called indigenous innovation. Under this paradigm of state-encouraged innovation, however, it is unclear how domestic firms organize their innovation processes. We distinguish between two strategies in that respect: closed versus open innovation. Our findings suggest that firms with closed innovation processes collaborate in close geographic distance, rely on DUI-modes of learning, and collaborations are based on guanxi. In contrast, firms with open innovation processes collaborate over large distances and rely on STI-modes of learning that are not necessarily guanxi-based. The findings help to understand the heterogeneous nature of indigenous innovation in China.

1 | INTRODUCTION: INDIGENOUS INNOVATION IN CHINA

In recent decades, China's economic growth and its potential for innovation has mainly been explained through integration into global value chains and technological upgrading processes resulting from foreign direct investments (Fu & Revilla Diez, 2010; Lin, 1997). However, the persistence of this growth model has been called into question (Liu, Schwaag Serger, Tagscherer, & Chang, 2017; Wei & Liefner, 2012). In fact, the Chinese government sees huge potential for Chinese firms to innovate independently, and thus, reduce reliance on FDI. China aims to become an innovation nation and the leading country in terms of science and technology indicators (Zhou, Lazonick, & Sun, 2016).

In order to achieve this goal, the government formulated the so-called Medium- to Long-term Science and Technology Development Plan (MLP), published in 2006, which involves the notion of Zizhu Chuangxin (自主创新), roughly translatable as indigenous innovation.

Since then, indigenous innovation policy has been understood in two different ways. Several authors see its main message being withdrawal from international technology sourcing, developing the ability to rely on national sources of technology and emphasizing Chinese techno-nationalism (Li-Ying & Wang, 2015; Liu & Lundin, 2009; Tang & Hussler, 2011). Others view the concept mainly as a call to change the entire economy's focus from being manufacturing-centered to innovation-centered (Gu, Schwaag Serger, & Lundvall, 2016; Liu et al., 2017; Vinig & Bossink, 2015). The first view suggests that innovation processes should be organized in a closed way by involving few well-trusted domestic actors, whereas the second view suggests that innovation processes should be more open and involve selected international partners.

During recent years, many empirical studies have examined examples of successfully innovating Chinese firms as well as innovative industrial dynamics in China (Fan, 2011; Xi, Lei, & Guisheng, 2009; Yang, 2014). These studies, however, usually aim to explain innovation success per se, and do not attempt to examine the heterogeneity of innovation processes within the indigenous innovation paradigm (see Liefner, Wei, & Zeng, 2013).

Yet, recent work demonstrates the differing nature of types of innovation in the light of China's indigenous innovation paradigm (Liefner & Losacker, 2020). In the same way, the definition of indigenous innovation in this article does not refer to a specific (product) innovation, and whether this innovation is "indigenous" or not. In particular, "indigenous" is not to be understood as a feature of an innovation or an explicit type of innovation. In contrast, we refer the notion of indigenous innovation to China's current paradigm of state-encouraged innovation in innovation policy. In order to advance this point, this article differentiates between two modes of innovation processes, which we refer to as closed versus open innovation. In the context of this article, closed innovation processes shall be understood as those relying on in-house capacities and trustful relations to business partners. Open innovation processes shall be understood as building on technology sourcing from collaboration and involving more distant partners and open business relations (Chesbrough, 2003). The study uses information from a company survey among technologically advanced Chinese companies in the machinery industry. The survey sought to establish fine-grained evidence about firms' innovation activities and contributions from collaboration.

Overall, this study seeks to contribute to a better understanding of the nature of innovation processes in China. It seeks to examine the actual meaning of indigenous innovation, investigating whether firms organize their innovation processes based on in-house resources, or based on resources from various and more distant partners.

Thus, the article relates to more general academic debates on innovation and is relevant for the wider community of innovation scholars and practitioners. That is to say, China's indigenous innovation policy contradicts contemporary scholarly discussions on global innovation systems and the importance of international collaborations in the innovation process (e.g., Binz & Truffer, 2017). In addition, it might not support current international mission-oriented innovation policies, aiming to tackle grand societal challenges (e.g., Mazzucato, 2018). The indigenous innovation paradigm in China could thus affect the global development of innovative solutions for societal challenges. Moreover, China's ambition for innovation might reshape global production networks and value chains. In particular, other emerging economies in catch-up processes might find it harder to carry out high-value adding activities in global value chains, such as R&D, due to China's indigenous innovation paradigm. These uncertain outcomes of China's innovation policies are closely connected to the question of how Chinese firms organize their innovation processes. While closed processes could jeopardize global development and hinder societal transitions, open innovation processes could offer supranational benefits.

The remainder of this article is organized as follows. Chapter two comprises the conceptual background of our study, which leads to the development of corresponding hypotheses. In chapter three, we explain our empirical approach, while in chapter four the main findings are presented and discussed. Chapter five concludes with implications for managers and policymakers and some suggestions for further research.

2 | CONCEPTUAL BACKGROUND

2.1 | Closed innovation and open innovation in the machinery industry

The terms closed innovation and open innovation were introduced to the innovation literature with the aim of identifying paradigm shifts in companies' innovation activities regarding sourcing of ideas and involving outside partners in innovation commercialization (Chesbrough, 2003; West, Salter, Vanhaverbeke, & Chesbrough, 2014). With respect to understanding innovation processes in the context of China's indigenous innovation move, however, it is necessary to narrow the use of the terms to the sources of technology and information that contribute to a firm's innovation activities. A distinction between closed and open innovation must include the shares of in-house R&D versus R&D sourcing and the characteristics of partners that contribute to a firm's innovation activities. In sum, our understanding of closed versus open innovation processes is somewhat different from the original definition by Chesbrough (2003). In particular, we follow the outside-in definition of open innovation by Enkel, Gassmann, and Chesbrough (2009). They distinguish three basic dimensions of the open innovation phenomenon. That is, outside-in processes (internalizing knowledge and sourcing external R&D), inside-out processes (externalizing knowledge and sharing internal R&D), and coupled processes (combination of both). For the purpose of this article, we refer to the outside-in process when discussing open innovation. Thus, the share of in-house development indicates whether an innovation is developed in an open or a closed way. For both modes, however, collaboration partners are involved.

The alternatives of carrying out R&D in-house or sourcing R&D receive broad attention in the innovation and organization literature in general (Beneito, 2003; Narula, 2001), and with respect to the specificities of the Chinese economy (Guo, Gao, & Chen, 2013; Sun & Du, 2010). These contributions establish the determinants and outcomes of the strategic decision to carry out most innovation work in-house or to move considerable parts of this task to other firms. According to these studies, closed and open innovation processes can be positioned against each other, reflecting clearly different strategic options.

The general notion of closed versus open innovation processes can principally be applied to the machinery industry, but requires some modifications due to the specific industry context. The machinery industry, and particularly the sub-branch of special purpose machinery, provides investment goods to manufacturing firms, for example robots that carry out a particular task within a production line. Innovation in the special purpose machinery industry hence relies on close cooperation with the customer who ordered the particular machine, and on understanding the customer's needs (Lyu & Liefner, 2018; Menn, Sieckmann, Kohl, & Seliger, 2018). Special machinery producers thus typically carry out a large share of the actual innovation (machine design, testing different machine configurations, types of components, ways of arranging and integrating components) in-house. Collaboration with partners other than the customer may seem unnecessary (Liefner & Zeng, 2016). Moreover, since the work of special machinery firms usually centers on experience and tacit knowledge, intensive exchanges with other organizations that could contribute to the innovation processes also bear the risk of losing sensitive information. Companies should thus seek to restrict close collaboration to trusted partners only. Other producers of special purpose machinery, however, might follow a different approach, open their innovation processes, involve more outside partners, and rely less on in-house R&D. Integrating the expertise and the resources of these partners should help to design and produce complex machines and production solutions. This involves a higher risk of losing knowledge to competitors or the need to implement a knowledge-organizing system. In case of more open innovation processes, collaboration would have to be extended to partners who may contribute essential resources, instead of partners who are mainly well-trusted.

Hence, in the context of individual firms from the machinery industry, both types of innovation processes, closed or open, are to be understood as strategic options chosen by the firms' management. With respect to the industry as a whole, however, the use of these strategies also reflects larger trends within the industry that help to clarify how innovation processes are organized and to which of the two notions of the indigenous innovation paradigm they better conform.

2.2 | Spatial proximity

Arguing that open and closed innovation processes both involve collaboration partners, it is unclear which role spatial proximity to these partners plays. Usually, the role of spatial proximity for firms' innovation processes is explained in a Regional Innovation Systems (RIS) framework, incorporating collaborations, networks and regional institutions, and highlighting the importance of spatial proximity for innovation processes (Cooke, 2001). A regional perspective on innovation systems is justified by intra-regional flows of knowledge and human capital, interactive learning processes, meso-level governance and the importance of tacit knowledge that is difficult to transfer over geographical distances (Asheim, Grillitsch, & Trippl, 2016). In developing countries and especially in China, additional factors such as governmental influence are substantial. Furthermore, Chinese RIS benefit from the embeddedness of MNCs and a sufficient absorptive capacity of residential firms (Asheim & Vang, 2006). In addition to intra-regional flows of skilled workers (Breschi & Lissoni, 2009), it is the immobility, or stickiness, of tacit knowledge which explains a region's innovativeness (Asheim et al., 2016). Within a RIS, tacit knowledge is more easily transferred, which is why interactive learning based on intra-regional collaborations enhances firms' innovative capabilities (Maskell & Malmberg, 1999). According to this strand of literature, it seems favorable for firms to engage in local collaborations, benefitting from regional innovation system dynamics.

On the contrary, firms can engage in extra-regional or international collaborations, seeking for technologically matching partners to source knowledge (Cao, Zeng, Teng, & Si, 2018). This process is often referred to as building "global pipelines" for innovation collaborations (Bathelt, Malmberg, & Maskell, 2004). Such extra-regional linkages are crucial to acquire locally unavailable knowledge. In particular, establishing extra-regional collaborations is a useful means for latecomer firms to gain access to both foreign technology and markets (Liefner, Si, & Schäfer, 2019). This approach is also important for firms' innovation processes as international R&D collaborations are associated with higher innovation quality (Schaefer & Liefner, 2017).

2.3 | Doing, using and interacting versus science, technology and innovation modes

Nevertheless, the manufacturing sector, and especially the machinery industry, is traditionally characterized by incremental product innovations that do not rely on heavy R&D investments and knowledge transfer from universities or research institutes, with innovation stemming rather from user-producer interactions and regional clustering (Wengel & Shapira, 2004). Bearing the sector-specific features in mind, firm-level modes for learning of a DUI-type (Doing, Using, and Interacting) rather than of a STI-type (Science, Technology, and Innovation) are most likely. A DUI-mode of learning describes knowledge accumulation that results from close and frequent interactions with customers and suppliers, the well-known learning-by-using features, as well as experienced-based learning processes (Jensen, Johnson, Lorenz, & Lundvall, 2007). In contrast, a STI-mode of learning describes the acquisition of scientific knowledge via collaborating with universities or research institutes and investing in R&D. Due to the previously mentioned characteristics of state-encouraged indigenous innovation in the machinery industry, we argue that a DUI-mode of learning is linked to closed innovation processes and a STI-mode is linked to open innovation processes. In particular, DUI-modes of learning, that is, collaborating closely with customers or suppliers, leads firms to understand how to improve their products and develop innovations. Thus, research and development can largely be conducted in-house. On the contrary, STI-modes of learning, that is, collaborating with research institutes and universities, indicates that firms open up research and development processes (Jensen et al., 2007; West et al., 2014).

2.4 | Guanxi-based relationships

Firm-level studies in China also need to consider a major feature of business relations that is not found in Western countries: guanxi (关系). The notion of guanxi encompasses a complex social system that relies on mutual trust and commitment. Even though guanxi is a China-specific feature of innovation studies, Doloreux and Porto Gomez (2017) derive from their meta-analysis that trust, which is a key indicator for guanxi, is increasingly attracting attention in regional innovation systems literature.

Guanxi-based relationships are formed on an individual level and extend from friendships, common studies or common associations etc. A firm, however, can benefit from its managers' guanxi network or even firm-level guanxi relations. This is due to the rationale that individual level guanxi networks can extend to the firm level (Zhang & Zhang, 2006). In a pivotal study on the importance of guanxi as a channel for knowledge transfer, Ramasamy, Goh, and Yeung (2006) find that guanxi operationalized by trust, commitment and communication is a major channel for inter-firm knowledge transfer. In particular, they argue that trust is the key indicator for guanxi. This is due to the interrelation of trust to the other dimensions of guanxi, namely commitment and communication. In Chinese management research, guanxi is, moreover, key to explaining corporate success (Luo, Huang, & Wang, 2012). Also, innovation scholars argue that guanxi is decisive in forming innovation networks (Lyu & Liefner, 2018). Guanxi-based relationships consequently affect innovation processes and innovation outcomes (Bathelt & Zeng, 2012; Fu, Revilla Diez, & Schiller, 2013). Moreover, guanxi is a crucial element in Chinese RIS, as guanxi-based relationships are mainly founded regionally and entail regional R&D collaborations, whereas international and less trusted collaboration partners are often not involved in joint research activities (Asheim & Vang, 2006; Lyu & Liefner, 2018). Additionally, guanxi supports the acquisition of knowledge in Chinese outward FDI (Lin, Wang, & Si, 2018). In our definition of a closed innovation process, we argue that guanxi is crucial for these processes, while open innovation processes allow for collaborations that do not necessarily rely on trust, but rather seek technology sourcing from selected leading organizations.

2.5 | Hypotheses

A shift of scholarly work on indigenous innovation toward a more multifaceted view of innovation processes is needed to allow further insights into understanding the notion of indigenous innovation (Liefner & Losacker, 2020).

Building upon the theoretical background delineated above, we derive three hypotheses. We argue that a firm is more likely to develop *closed* innovation if it is embedded in a collaborative regional innovation system appropriately. Therefore, that firm maintains strong collaborations that are at close geographic distance, based on guanxi, and with user-firms, suppliers or customers to absorb knowledge in a DUI-mode. In contrast, we argue that a firm is more likely to follow an *open* innovation strategy if it is linked to extra-regional and international partners. Accordingly, these collaborations do not rely on guanxi, and technology sourcing is sought by collaborating with universities and research facilities in a STI-learning manner.

Hypothesis 1 *Spatial proximity to collaboration partners is linked to closed rather than open innovation processes.*

Hypothesis 2 *Collaborations that encompass learning-by-doing, -using, and -interacting feature closed innovation processes, while open innovation processes are featured in STI-collaborations.*

Hypothesis 3 *Collaborations based on guanxi involve a closed innovation strategy, while firms pursuing an open innovation strategy do not rely on guanxi-based collaboration.*

Table 1 summarizes the key features of closed versus open innovation processes according to our hypotheses.

3 | DATA AND METHODS

The empirical part of the article uses firm-level survey data to establish the driving forces of different innovation strategies. In order to guarantee a sample of technologically advanced Chinese firms, the survey was conducted at a leading industry fair, the 15th China International Industry Fair in November 2013. The sample consists of manufacturing firms in the machinery sector, which is, according to Liefner and Zeng (2016), a favorable industry for indigenous innovation and, additionally, a state-designated industry for indigenous innovation efforts (Yang, 2016). The data were gathered using a standardized questionnaire, which was gradually developed in a two-stage pretesting phase with more than 50 surveyed firms. The finalized questionnaire covers information on the firms' latest machine introduced at the trade fair, information on the firms' innovation environment and collaboration partners, and some general firm-specific data. We therefore collected data on both the firm and focal innovation level. To guarantee high-quality data and consistency, the questionnaire was designed in close accordance with the Oslo-Manual (see OECD & Eurostat, 2018 for latest updated edition). After identifying 268 firms at the trade fair, 260 were willing to participate in the survey. Appropriate tests for plausibility led to a reduction of the number of observations to 171. Missing data in the variables of interest led to the exclusion of another 11 firms, resulting in the final data set comprising information on 160 leading manufacturing firms.

TABLE 1 Features of closed versus open innovation processes under China's indigenous innovation paradigm

Feature	Closed innovation process	Open innovation process
Definition	Closed innovation processes rely on in-house capacities and trustful relations to business partners	Open innovation processes build on technology sourcing from collaboration and involve more distant partners with open business relations
General characteristics	Firms are highly independent and have sufficient internal resources to innovate due to a R&D focus and large firm size. These firms seek to absorb tacit knowledge to develop innovations that fit customer needs	Firms are smaller and do not focus on R&D. These firms need to source technological, codified knowledge for developing product innovations in an open way
Spatial proximity	Spatial proximity to collaboration partners is key for transferring tacit knowledge	Spatial proximity is not important. Therefore, collaborations are used to source technological, codified knowledge which is easy over distance
DUI versus STI	DUI-modes of learning are important for firms to develop internal resources and in-depth knowledge about customer needs	STI-modes are preferred for gathering all relevant technological knowledge. Universities and research facilities are key partners for innovation processes
Guanxi	Trust-based relationships that foster interactive learning increase the firms' internal capabilities for developing innovations	Guanxi is not that important, as collaboration partners need to fit technologically and relationships are more formal than personal

We apply a binary logit model approach to test our proposed hypotheses. The dependent variable INNO is designed to distinguish between closed and open innovation (1 if closed, 0 if open). For this purpose, we define a firm's latest machine presented at the industry fair as a product innovation per se. Next, we differentiate between a closed versus open innovation strategy at a threshold of 90 percent in-house development. Hence, closed innovations are operationalized as all showcased machines that are characterized by a 90 percent or higher share of in-house development, whereas innovations stemming from an open process are characterized by less than 90 percent in-house development. This threshold is legitimate because special machine tools are mostly developed according to customer needs and are thus produced in low volumes, which favors an in-house development and allows such a high share. However, to check robustness, we employed models with different thresholds ranging from 70 to 100 percent and we fitted beta regressions. This operationalization is superior in the innovation literature because related studies do not quantify the share of in-house development, and therefore, define open and closed innovation poorly. In particular, most quantitative studies refer to the number of involved partners in R&D projects or to the number of different kinds of knowledge channels to operationalize open versus closed innovation modes (Laursen & Salter, 2006; West et al., 2014). Our empirical approach provides a more precise measure of open and closed innovation processes. We find that 28.1 percent of the companies surveyed have a closed innovation process, while 71.9 percent rely on open innovation processes.

In order to distinguish firms' innovation strategies, we construct independent variables for each firm's two most important collaboration partners. This research design allows us to control for individual-level properties of each collaboration partner while also taking the other collaboration partner into account. Such a data structure is superior to studies that summarize characteristics of several collaboration partners (e.g., Fitjar & Rodríguez-Pose, 2013) and is also reasonable for the purpose of our study, since innovation processes in China often rely on a small collaboration network (Zhou, 2005). More accurately, most studies on innovation processes refer to collaboration partners in rather undifferentiated ways. That is to say, many studies employ unweighted network approaches, attaching the same importance to all collaboration partners. On the contrary, some studies aggregate information on collaboration partners, which leads to a loss of information. The merit in our approach is that we asked firms for information on their most important collaboration partners. Thus, we obtain information about collaborations that actually matter in the innovation process. Furthermore, for the machinery industry face-to-face interactions are usually assumed to be much more important than non-deliberate knowledge exchange through local `buzz´. These face-to-face interactions are mostly present in R&D collaborations (Asheim, Coenen, & Vang, 2007). Altogether, collecting data for the two most important collaboration partners that are involved in firms' innovation processes also follows the rationale of so-called internal cohesive subsystems in innovation system analyses (Binz, Truffer, & Coenen, 2014).

The three highlighted features are hence operationalized in that manner. First, *spatial proximity* to the firm's collaboration partners is approximated by the co-location of the firm and each collaboration partner in the same city. $CITY_1$ indicates whether the most important collaboration partner is co-located in the firm's city, while $CITY_2$ is constructed for the second most important collaboration partner (1 if co-location, otherwise 0). Second, *Doing, Using, Interacting* are indicated by DUI_1 and DUI_2. These variables distinguish between collaboration partners considered to foster learning in a DUI-mode, such as customers, suppliers, consulting firms or other firms, and collaboration partners linked to STI-learning, such as universities or research institutes (1 if DUI, 0 if STI). Third, *guanxi* is represented through a high level of trust between the firm and the respective collaboration partners, as trust is an established indicator for guanxi. Even though trust is only one dimension in the complex notion of guanxi, it is widely acknowledged to be the main indicator for empirically operationalizing guanxi relations. Additionally, trust captures the quality of guanxi ties (Chen, Chen, & Huang, 2013; Ramasamy et al., 2006). Therefore, $GUANXI_1$ and $GUANXI_2$ mark collaborations that rely on a high level of trust (1 if high level of trust, otherwise 0).

As the Chinese government strongly promotes the concept of indigenous innovation, we construct a variable GOV that captures whether firms rate financial government support as important. Next, we include two common controls in our models. The first, RDEMP, comprises the share of R&D employees in each firm, while the latter, EMP, measures firm size as the total employee count. Both variables are theoretically grounded in the literature on a resource-based view of the firm which links a firm's innovative capabilities directly to its internal resources (Barney, 1991). Beyond that, state-owned firms appear to differ from non-state-owned firms in terms of innovation output as well as collaboration behaviour (Boeing, Mueller, & Sandner, 2016; Kroll & Kou, 2019; Lyu & Liefner, 2018). Consequently, we include a control variable STATE that marks state-owned firms. Another necessary control is RDFIRM, which indicates whether a firm's main activity is R&D in contrast to, for example, manufacturing/production or sales, as R&D is much less institutionalized in China (Li, 2015). Finally, we control for a firm's absorptive capacity by including a variable that covers whether a firm has developed the latest machine's respective core component independently. That variable CORE can be understood as a proxy for the original invention, while INNO represents the actual innovation. A firm's absorptive capacity is a crucial driver of its innovation capabilities and relates to the firms' ability to benefit from technology sourcing (Cohen & Levinthal, 1990). Table 2 summarizes the construction of all variables, while Table 3 contains descriptive statistics.

TABLE 2 Variable description

Name	Description	Scale
INNO	Indicates whether a firm's latest machine was developed in a closed process (1) which is approximated by a minimum share of 90 percent in-house development or in an open process with less than 90 percent in-house development (0)	0/1
$CITY_1$	Indicates whether a firm's most important collaboration partner is co-located in the firm's city	0/1
$CITY_2$	Indicates whether a firm's second most important collaboration partner is co-located in the firm's city	0/1
DUI_1	Indicates whether a firm's most important collaboration partner is a customer, supplier, consulting firm or other type of firm	0/1
DUI_2	Indicates whether a firm's second most important collaboration partner is a customer, supplier, consulting firm or other type of firm	0/1
$GUANXI_1$	Indicates whether the relationship to a firm's most important collaboration partner is based on a high level of trust	0/1
$GUANXI_2$	Indicates whether the relationship to a firm's second most important collaboration partner is based on a high level of trust	0/1
GOV	Indicates whether a firm marks financial government support as important	0/1
RDEMP	Share of a firm's R&D employees	Metric
EMP	Firm's total employee count	Metric
STATE	Indicates whether a firm is state-owned	0/1
RDFIRM	Indicates whether a firm's main activity is R&D (compared to production/manufacturing or sales)	0/1
CORE	Indicates whether the core component of the firm's latest machine was in-house developed	0/1

4 | RESULTS AND DISCUSSION

4.1 | Main findings

Table 4 presents the regression results. All control variables remain robust across the models and show little variation. The following delineation of our results is drawn on model 4, as this is the main model, while the first three primarily serve for the gradual development. All listed models are significant improvements compared to an intercept-only model, which is indicated by Likelihood-Ratio tests ($p < .01$). We find that governmental financial support is not related to a firm's innovation process being open or closed. This can be linked to some common findings. Generally speaking, Chinese innovation policy that is largely based on the notion of indigenous innovation is appraised as promising (Liu, Simon, Sun, & Cao, 2011). However, some scholars argue that adopted innovation policy instruments are limited in terms of efficiency (Chen & Ku, 2014; Howell, 2017). It is thus unclear

TABLE 3 Descriptive statistics

Name	Frequency of 1 in %	Mean	Min	Max	SD
INNO	28.1	–	0	1	–
$CITY_1$	29.8	–	0	1	–
$CITY_2$	42.1	–	0	1	–
DUI_1	67.3	–	0	1	–
DUI_2	91.2	–	0	1	–
$GUANXI_1$	73.1	–	0	1	–
$GUANXI_2$	50.9	–	0	1	–
GOV	38.6	–	0	1	–
RDEMP	–	0.21	0	0.80	0.14
EMP	–	624.04	7	30,000	253.79
STATE	8.8	–	0	1	–
RDFIRM	76.6	–	0	1	–
CORE	67.3	–	0	1	–

TABLE 4 Regression results

	(1)	(2)	(3)	(4)
$CITY_1$		−0.252 (0.496)	−0.255 (0.525)	**1.317* (0.739)**
$CITY_2$		0.574 (0.458)	0.540 (0.463)	**2.282*** (0.732)**
DUI_1			0.209 (0.479)	0.501 (0.528)
DUI_2			0.718 (0.760)	**1.656* (0.878)**
$GUANXI_1$				**3.089*** (0.989)**
$GUANXI_2$				**1.228* (0.668)**
GOV	0.164 (0.419)	0.130 (0.423)	0.179 (0.426)	0.109 (0.466)
RDEMP	−1.079 (1.389)	−0.972 (1.393)	−0.946 (1.403)	0.553 (1.559)
EMP	**0.0004** (0.0002)**	**0.0005** (0.0002)**	**0.0005** (0.0002)**	**0.001** (0.0002)**
STATE	**−2.593** (1.245)**	**−2.704** (1.286)**	**−2.717** (1.311)**	**−3.612** (1.408)**
RDFIRM	**1.318** (0.617)**	**1.425** (0.626)**	**1.456** (0.630)**	**1.619** (0.702)**
CORE	**2.096*** (0.640)**	**2.053*** (0.642)**	**2.051*** (0.643)**	**2.779*** (0.744)**
Constant	**−3.608*** (0.842)**	**−3.862*** (0.894)**	**−3.766*** (0.907)**	**−8.884*** (1.886)**
Nagelkerke R^2	0.36	0.37	0.38	0.50
max.VIF	1.65	1.73	1.74	3.43
Observations	160	160	160	160
LogLikelihood	−75.682***	−74.890***	−74.385***	−64.284***
AIC	165.363	167.781	170.769	154.569

Note: Standard errors in parentheses; values in bold are parameters which are statistically significant.

*$p < .1$; **$p < .05$; ***$p < .01$.

whether governmental financial support is used for actual in-house R&D or for other purposes such as acquiring foreign technologies.

Next, we find that firm size affects innovation processes significantly. In more detail, an increase in the total employee count by one leads to an increase in the odds of conducting closed innovation processes by a factor of 1,004 ($e^{0.0004}$; $p < .05$). This finding is in line with the proposed theories of a resource-based view of the firm and supports the idea that modes of innovation differ according to firm size (Cohen & Klepper, 1996). By implication, it seems that large firms follow closed innovation strategies due to their higher capacities and internal resources, whereas smaller firms follow an open innovation strategy and absorb external knowledge in order to develop innovations. Consequently, closed innovation processes are more likely to be conducted in large firms. This implies that open innovation processes are linked to smaller firms, which is reasonable due to their restricted resources and their need to open up their R&D activities.

In contrast, the share of R&D employees does not appear to affect a firm's innovation process. However, when we limit the dependent variable INNO to only new-to-the-world innovations, the share of R&D employees is linked to closed innovation processes due to enhanced internal innovation capabilities. Closed and more radical, technology-driven innovations are hence supported by an increase in the share of R&D employees (see also Liefner & Losacker, 2020).

Moreover, state-owned firms are less likely to develop innovations in a closed process compared to non-state-owned firms. This can be explained with an inefficient use of R&D resources (Yang, Lee, & Lin, 2012). On the contrary, state-owned firms might be more powerful in negotiation processes, allowing for a more beneficial position in R&D collaboration contracts with external partners. Hence, state-owned firms might be more capable of handling formal collaboration processes, which leads to open innovation strategies. However, the impact of state-ownership on innovation output (and processes) might differ between regions and sectors (Kroll & Kou, 2019). Results, thus, need to be interpreted with caution. Controlling for a R&D-oriented firms in comparison to production-oriented firms, we find that the former are more likely to generate innovations in a closed process than the latter (by a factor of 3.736; $e^{1.318}$; $p < .05$). Finally, controlling for a firm's absorptive capacity, CORE, demonstrates that a high absorptive capacity enables the firm to design innovative products independently under a closed innovation strategy. The respective odds increase by a factor of 8.134 ($e^{2.096}$; $p < .01$). This has crucial implications for firms attempting to pursue an open innovation process. It seems that those firms' absorptive capacity is relatively low. In order to benefit and learn efficiently from (foreign) technology sourcing, these firms need to develop a sufficiently large absorptive capacity beforehand (Cohen & Levinthal, 1990).

However, the results for the three conceptual elements depicted in chapter two—spatial proximity, guanxi, and DUI-versus STI-mode—are more pivotal for this study. When expanding model 2 with the variables $CITY_{1,2}$ there seems to be no significant effect. Likewise, $DUI_{1,2}$ appear not to affect indigenous innovation capabilities in model 3. However, when adding $GUANXI_{1,2}$ in model 4, both concepts expose their effects. This might be due to an omitted variable bias concerning the variables on guanxi, leading to the assumption that guanxi is directly linked to the effects of spatial proximity and DUI versus STI collaboration. Due to that, we checked multicollinearity in two ways: calculating measures of association (e.g., correlation coefficients and Phi-coefficients) and variance inflation factors. Both methods do not indicate multicollinearity issues.

Nonetheless, we find that the odds of developing innovation in a closed process are 3.732 times higher for firms co-located in the same city with their most important collaboration partner ($e^{1.317}$; $p < .1$) and 9.796 times higher for a co-location with the second most important collaboration partner ($e^{2.282}$; $p < .01$). This finding supports our proposed hypothesis for the positive effect of spatial proximity on closed innovation processes (H1).

In contrast, open innovation processes are indeed characterized by extra-regional channels of knowledge transfer. However, there are further effects of spatial proximity on innovation besides co-location of collaboration partners. That is, spatial externalities and knowledge spillovers from neighboring regions are found to be crucial for regional innovation outcomes in China (Sheng, Zhao, Zhang, Song, & Miao, 2019; Wang, Cheng, Ye, & Wei, 2016). These effects might also play a role for the pursued innovation processes in our sample. Additionally, Model 4 suggests that DUI_2 positively affects the dependent variable. More accurately, the odds of developing innovations in a closed process compared to an open process increase by a factor of 5.238 ($e^{1.656}$; $p < .1$). DUI-type learning thus seems to foster firms' internal capabilities to conduct closed innovation processes due to in-depth knowledge on customer needs. Firms learning by doing, using and interacting do not need to open their R&D processes. On the contrary, STI-type learning features open innovation processes where absorbing selected, technological, codified knowledge is more relevant. Thus, firms learning in a more science- and technology-oriented way open up their R&D processes to benefit from external knowledge (H2).

Apart from that, $GUANXI_{1,2}$ both have a significant effect on distinguishing the innovation strategies pursued. If the relationship to the most important collaboration partner is based on a high level of guanxi, operationalized as trust, the likelihood of a firm developing innovation in a closed process is 21.955 times higher ($e^{3.089}$; $p < .01$). For the second most important collaboration partner, guanxi is similarly—though less—important. Holding a guanxi-based relationship to the second most important partner accounts for an increase by a factor of 3.414 ($e^{1.228}$; $p < .1$) (H3). This is in line with previous findings, showing that trustful personal relationships among firms and researchers is not important for Chinese firms when engaging in new (international) R&D collaborations, and thus, opening their innovation process (Liefner et al., 2019). Also, guanxi is found to be a less important channel for knowledge acquisitions in international projects compared to contractual linkages that do not rely on guanxi (Lin et al., 2018). Summarizing this, we find that guanxi and spatial proximity are positive features of collaboration that support firms' internal innovative capabilities and autonomy. However, these effects are not synergic in nature but rather independent from each other. This can be observed when adding interaction terms, denoted by $CITY_1 \times GUANXI_1$ and $CITY_2 \times GUANXI_2$. Neither interaction effect is significant or affects the previously mentioned results. Guanxi and spatial proximity are certainly not only mutually exclusive, but also do not reinforce each other, which could imply a weak systemic performance of Chinese RIS. This deficiency was already observed in previous studies (Chen & Guan, 2012).Likewise, interaction terms for spatial proximity and DUI-learning, $CITY_1 \times DUI_1$ and $CITY_2 \times DUI_2$, do not reveal a significant effect.

The regression results yield important insights into how firms' innovation processes look like under the indigenous innovation paradigm. Firms seem to respond markedly different to the government's call for indigenous innovation. Some firms make use of open innovation strategies, sourcing knowledge from extra-regional partners with high R&D competences. These firms are generally smaller and have less internal R&D capabilities. According to this, it seems that some innovative Chinese firms are not able to innovate independently. In order to contribute to the country's innovation performance, they seek external support and follow open innovation rationales. In contrast, some firms innovate in a closed mode. These firms mostly develop innovations in-house owing to their large R&D capabilities and relying on spatially proximate partners as well as on trust-based relations. Thus, it is mostly other firms (suppliers, customers, consultancies, etc.) and not research institutions with whom they collaborate. This second group of firms follow the call for indigenous innovation in a more literal way, developing new products largely on the basis of Chinese manufacturing expertise.

4.2 | Robustness checks and limitations

We applied several techniques to check the robustness of our results. First, we controlled for regional differences by including dummies for highly innovative regions such as the Perl River Delta, Yangtze River Delta and Bohai Rim Region, and by reducing the data set to firms within those respective regions. Neither technique indicates any regional differences, which might have been the case as regional innovation systems in China are rather heterogeneous (Li, 2015; Yang et al., 2012). Second, we used provinces instead of cities as a proxy for spatial proximity, since scholars on Chinese RIS tend to work on different geographical levels ranging from science parks and cities (e.g., Yang, 2016) to province-level studies (e.g., Kroll & Tagscherer, 2009). We find that the significant effect of spatial proximity is only found for the city level and not for the province level, which underpins the rationale of face-to-face interactions and local learning processes. Moreover, this questions the explanatory power of similar, province-wide studies in China. Third, we employed models with thresholds other than 90 percent in-house development (70, 80 and 100 percent). Our results suggest that for such modifications, CORE and EMP seem to be very robust, while the results for other controls vary. However, $GUANXI_1$ and $CITY_2$ remain the most robust variables of interest, which highlights their value for practical and policy implications. Fourth, we fitted so-called beta regression models. These models are designed to fit ratios and proportions (i.e., dependent variables in an interval between zero and one). For the beta models, we used the share of in-house development as dependent variable. The respective results are in line with the logit models, which, however, are easier in terms of interpretation and better fit our theoretical approach of distinguishing open and closed innovation processes. Finally, we operationalized the dependent variable such that only new-to-the-world innovations are considered. In that design, the importance of R&D employees becomes crucial and shows a strong positive effect for closed innovation processes. This alludes to the fact that for more radical innovation, R&D and STI modes of knowledge are still critical, while for incremental product innovation, DUI modes of knowledge generation are important. We controlled for differences between special purpose and general purpose machines by adding a control that indicates whether the firm actually provides customer-specific (special purpose) machines. This does not affect our results, which suggests that both special and general purpose machines can be developed following any innovation strategy – open or closed. Our results are, however, subject to some limitations due to the empirical approach. In particular, we use trust to operationalize guanxi, disregarding other dimensions such as commitment and communication (Ramasamy et al., 2006).

5 | CONCLUSION

Drawing on research on the importance of spatial proximity, DUI versus STI modes of innovation and guanxi (trust) for product innovation in China, we find that firms' collaboration patterns are crucial for distinguishing their interpretation of the indigenous innovation paradigm. In fact, a co-location with the most important collaboration partners and guanxi-based collaboration are key features for firms pursuing closed innovation processes. Also, DUI-type learning seems to be more beneficial for closed innovation in the machinery industry than STI-types. On the contrary, STI-type learning and technological sourcing from extra-regional partners typify open innovation processes. However, spatial proximity does not reinforce either guanxi or DUI-type learning, which leads to questioning the efficiency of regional innovation systems in China, as there appears to be no additional systemic benefit for firms' internal capabilities.

Although the article employs data for the machinery industry (i.e., special purpose machinery), results of this industry are relevant for the broader field of innovation studies. In particular, special purpose machinery innovations are indicative of trends that are likely to develop in other industries, too. That is to say, special purpose machinery is crucial for other industries to develop as it strongly affects production processes. In addition, the machinery industry is a designated key industry in China's indigenous innovation agenda, which allows translating the results to other key industries such as robotics or green technology development. In general, the government's push toward indigenous innovation seems to be interpreted by firms as meaning that the economy should be based on innovation, but not that the transfer and sourcing of foreign technologies should be avoided. This is reflected in the high proportion of firms with open innovation processes.

The paper's contribution to the theoretical and methodological literature is two-fold. First, assuming that innovation is an interactive process where regional proximity plays a key role should not lead us to believe that innovation is a uniform phenomenon. The observed heterogeneity of innovation strategies, processes and outcomes needs to be considered when analyzing innovation. This alludes to the second contribution, which is of a methodological nature. Our study implies that quantitative studies need to be careful when analyzing innovation in this context, as innovation per se is a heterogeneous phenomenon. Hence, when using regression techniques to explain innovation output in a similar context, the usage of common independent variables (R&D employees, firm size, collaboration patterns, etc.) leads to biased results due to different innovation processes and strategies among firms.

Policymakers need to address this issue by refraining from one-size-fits-all instruments. Also, firms' R&D and operational managers need to scrutinize the features of their collaborative systems. For developing internal innovation capabilities, our study suggests building a guanxi-based relationship to the most important partner, while spatial proximity to the second most important partner is more valuable than a guanxi-based relationship. However, these features are not mutually exclusive. If firms attempt to source technological knowledge and develop product innovations in an open way, R&D managers should seek to collaborate with universities and research facilities. Also, these innovation processes seem to rely on extra-regional channels for knowledge transfer. The importance of tacit knowledge is lower for product innovations resulting from an open process than product innovations resulting from closed processes where detailed knowledge about customer needs is crucial.

Further research needs to address several issues. For instance, profound knowledge on firm strategies under China's indigenous innovation paradigm is still scarce (Liefner & Losacker, 2020). Also, there is little knowledge on how different industries and sectoral systems react to the urge for indigenous innovation according to the MLP. As patent data seem not to reflect innovation in that respect and are increasingly biased due to a massive patent push through subsidy programs (Dang & Motohashi, 2015), we call for more large-scale survey studies and in-depth qualitative studies to analyze the indigenous innovation policy. Lastly, China's indigenous innovation paradigm needs to be analyzed in relation to its global impacts in more detail. In particular, in the wake of China's state-encouraged innovation strategy it is unclear for global value chains how other developing countries will participate in high-value adding activities such as R&D.

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REFERENCES

Asheim, B., Coenen, L., & Vang, J. (2007). Face-to-face, buzz, and knowledge bases: Sociospatial implications for learning, innovation, and innovation policy. *Environment and Planning C: Government and Policy*, *25*(5), 655–670. https://doi.org/10.1068/c0648

Asheim, B., Grillitsch, M., & Trippl, M. (2016). Regional innovation systems: Past—presence—future. In R. Shearmur, C. Carrincazeaux, & D. Doloreux (Eds.), *Handbook on the geographies of innovation* (pp. 45–62). Cheltenham, UK: Edward Elgar Publishing Ltd.

Asheim, B., & Vang, J. (2006). Regional innovation systems in Asian countries: A new way of exploiting the benefits of transnational corporations. *Innovation*, *8*(1–2), 27–44. https://doi.org/10.5172/impp.2006.8.1-2.27

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, *28*(1), 31–56. https://doi.org/10.1191/0309132504ph469oa

Bathelt, H., & Zeng, G. (2012). Strong growth in weakly-developed networks: Producer–user interaction and knowledge brokers in the greater Shanghai chemical industry. *Applied Geography*, *32*(1), 158–170. https://doi.org/10.1016/J.APGEOG.2010.11.015

Beneito, P. (2003). Choosing among alternative technological strategies: An empirical analysis of formal sources of innovation. *Research Policy*, *32*(4), 693–713. https://doi.org/10.1016/S0048-7333(02)00079-3

Binz, C., & Truffer, B. (2017). Global Innovation Systems—A conceptual framework for innovation dynamics in transnational contexts. *Research Policy*, *46*(7), 1284–1298. https://doi.org/10.1016/j.respol.2017.05.012

Binz, C., Truffer, B., & Coenen, L. (2014). Why space matters in technological innovation systems—Mapping global knowledge dynamics of membrane bioreactor technology. *Research Policy*, *43*(1), 138–155. https://doi.org/10.1016/j.respol.2013.07.002

Boeing, P., Mueller, E., & Sandner, P. (2016). China's R&D explosion—Analyzing productivity effects across ownership types and over time. *Research Policy*, *45*(1), 159–176. https://doi.org/10.1016/j.respol.2015.07.008

Breschi, S., & Lissoni, F. (2009). Mobility of skilled workers and co-invention networks: An anatomy of localized knowledge flows. *Journal of Economic Geography*, *9*(4), 439–468. https://doi.org/10.1093/jeg/lbp008

Cao, X., Zeng, G., Teng, T., & Si, Y.-F. (2018). The best spatial scale of firm innovation networks: Evidence from Shanghai high-tech firms. *Growth and Change*, *49*(4), 696–711. https://doi.org/10.1111/grow.12252

Chen, C. C., Chen, X. P., & Huang, S. (2013). Chinese Guanxi: An integrative review and new directions for future research. *Management and Organization Review*, *9*(1), 167–207. https://doi.org/10.1111/more.12010

Chen, K., & Guan, J. (2012). Measuring the efficiency of China's regional innovation systems: Application of Network Data Envelopment Analysis (DEA). *Regional Studies*, *46*(3), 355–377. https://doi.org/10.1080/00343404.2010.497479

Chen, T.-J., & Ku, Y.-H. (2014). Indigenous innovation vs. teng-long huan-niao: Policy conflicts in the development of China's flat panel industry. *Industrial and Corporate Change*, *23*(6), 1445–1467. https://doi.org/10.1093/icc/dtu004

Chesbrough, H. W. (2003). *Open innovation: The new imperative for creating and profiting from technology*. Boston, MA: Harvard Business Press.

Cohen, W. M., & Klepper, S. (1996). Firm size and the nature of innovation within industries: The case of process and product R&D. *The Review of Economics and Statistics*, *78*(2), 232. https://doi.org/10.2307/2109925

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, *35*(1), 128–152. https://doi.org/10.1016/B978-0-7506-7223-8.50005-8

Cooke, P. (2001). Regional innovation systems, clusters, and the knowledge economy. *Industrial and Corporate Change*, *10*(4), 945–974. https://doi.org/10.1093/icc/10.4.945

Dang, J., & Motohashi, K. (2015). Patent statistics: A good indicator for innovation in China? Patent subsidy program impacts on patent quality. *China Economic Review*, *35*, 137–155. https://doi.org/10.1016/j.chieco.2015.03.012

Doloreux, D., & Porto Gomez, I. (2017). A review of (almost) 20 years of regional innovation systems research. *European Planning Studies*, *25*(3), 371–387. https://doi.org/10.1080/09654313.2016.1244516

Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: Exploring the phenomenon. *R&D Management*, *39*(4), 311–316. https://doi.org/10.1111/j.1467-9310.2009.00570.x

Fan, P. (2011). Innovation, globalization, and catch-up of latecomers: Cases of Chinese telecom firms. *Environment and Planning A*, *43*(4), 830–849. https://doi.org/10.1068/a43152

Fitjar, R. D., & Rodríguez-Pose, A. (2013). Firm collaboration and modes of innovation in Norway. *Research Policy*, *42*(1), 128–138. https://doi.org/10.1016/j.respol.2012.05.009

Fu, W., & Revilla Diez, J. (2010). Knowledge spillover and technological upgrading: The case of Guangdong province, China. *Asian Journal of Technology Innovation*, *18*(2), 187–217. https://doi.org/10.1080/19761597.2010.9668698

Fu, W., Revilla Diez, J., & Schiller, D. (2013). Interactive learning, informal networks and innovation: Evidence from electronics firm survey in the Pearl River Delta, China. *Research Policy*, *42*(3), 635–646. https://doi.org/10.1016/J.RESPOL.2012.09.006

Gu, S., Schwaag Serger, S., & Lundvall, B.-A. (2016). China's innovation system: Ten years on. *Innovation*, *18*(4), 441–448. https://doi.org/10.1080/14479338.2016.1256215

Guo, B., Gao, J., & Chen, X. (2013). Technology strategy, technological context and technological catch-up in emerging economies: Industry-level findings from Chinese manufacturing. *Technology Analysis and Strategic Management*, *25*(2), 219–234. https://doi.org/10.1080/09537325.2012.759201

Howell, A. (2017). Picking "winners" in China: Do subsidies matter for indigenous innovation and firm productivity? *China Economic Review*, *44*, 154–165. https://doi.org/10.1016/J.CHIECO.2017.04.005

Jensen, M. B., Johnson, B., Lorenz, E., & Lundvall, B. A. (2007). Forms of knowledge and modes of innovation. *Research Policy*, *36*(5), 680–693. https://doi.org/10.1016/J.RESPOL.2007.01.006

Kroll, H., & Kou, K. (2019). Innovation output and state ownership: Empirical evidence from China's listed firms. *Industry and Innovation*, *26*(2), 176–198. https://doi.org/10.1080/13662716.2018.1456323

Kroll, H., & Tagscherer, U. (2009). Chinese regional innovation systems in times of crisis: The case of Guangdong. *Asian Journal of Technology Innovation*, *17*(2), 101–128. https://doi.org/10.1080/19761597.2009.9668675

Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, *27*(2), 131–150. https://doi.org/10.1002/smj.507

Li, X. (2015). Specialization, institutions and innovation within China's regional innovation systems. *Technological Forecasting and Social Change*, *100*, 130–139. https://doi.org/10.1016/j.techfore.2015.06.032

Liefner, I., & Losacker, S. (2020). Low-cost innovation and technology-driven innovation in China's machinery industry. *Technology Analysis and Strategic Management*, *32*(3), 319–331. https://doi.org/10.1080/09537325.2019.1656333

Liefner, I., Si, Y.-F., & Schäfer, K. (2019). A latecomer firm's R&D collaboration with advanced country universities and research institutes: The case of Huawei in Germany. *Technovation*, *86–87*, 3–14. https://doi.org/10.1016/j.technovation.2019.03.002

Liefner, I., Wei, Y. D., & Zeng, G. (2013). The innovativeness and heterogeneity of foreign-invested high-tech companies in Shanghai. *Growth and Change*, *44*(3), 522–549. https://doi.org/10.1111/grow.12018

Liefner, I., & Zeng, G. (2016). China's mechanical engineering industry. Offering the potential for indigenous innovation? In Y. Zhou, W. Lazonick, & Y. Sun (Eds.), *China as an innovation nation* (pp. 100–132). Oxford: Oxford University Press.

Lin, G. C. S. (1997). *Red capitalism in South China: Growth and development of the Pearl River Delta*. Vancouver, Canada: UBC Press.

Lin, L., Wang, D., & Si, Y.-F. (2018). The limits of Guanxi for Chinese nationals doing business abroad: Empirical investigation into Chinese companies in Germany. *Tijdschrift Voor Economische En Sociale Geografie*, *109*(3), 420–433. https://doi.org/10.1111/tesg.12301

Liu, F.-C., Simon, D. F., Sun, Y., & Cao, C. (2011). China's innovation policies: Evolution, institutional structure, and trajectory. *Research Policy*, *40*(7), 917–931. https://doi.org/10.1016/J.RESPOL.2011.05.005

Liu, X., & Lundin, N. (2009). The national innovation system of China in transition: From plan-based to market- driven system. In G. Parayil, & A. P. D'Costa (Eds.), *The New Asian innovation dynamics: China and India in perspective* (pp. 27–49). Basingstoke, UK: Palgrave Macmillan.

Liu, X., Schwaag Serger, S., Tagscherer, U., & Chang, A. Y. (2017). Beyond catch-up—Can a new innovation policy help China overcome the middle income trap? *Science and Public Policy*, *44*(5), 656–669. https://doi.org/10.1093/scipol/scw092

Li-Ying, J., & Wang, Y. (2015). Find them home or abroad? The relative contribution of international technology in-licensing to "indigenous innovation" in China. *Long Range Planning*, *48*(3), 123–134. https://doi.org/10.1016/J.LRP.2014.03.001

Luo, Y., Huang, Y., & Wang, S. L. (2012). Guanxi and organizational performance: A meta-analysis. *Management and Organization Review*, *8*(1), 139–172. https://doi.org/10.1111/j.1740-8784.2011.00273.x

Lyu, G., & Liefner, I. (2018). The spatial configuration of innovation networks in China. *GeoJournal*, *83*, 1393–1410. https://doi.org/10.1007/s10708-017-9844-1

Maskell, P., & Malmberg, A. (1999). Localised learning and industrial competitiveness. *Cambridge Journal of Economics*, *23*(2), 167–185. https://doi.org/10.1093/cje/23.2.167

Mazzucato, M. (2018). Mission-oriented innovation policies: Challenges and opportunities. *Industrial and Corporate Change*, *27*(5), 803–815. https://doi.org/10.1093/icc/dty034

Menn, J. P., Sieckmann, F., Kohl, H., & Seliger, G. (2018). Learning process planning for special machinery assembly. *Procedia Manufacturing*, *23*, 75–80. https://doi.org/10.1016/j.promfg.2018.03.164

Narula, R. (2001). Choosing between internal and non-internal R & D activities: Some technological and economic factors. *Technology Analysis & Strategic Management*, *13*(3), 365–387. https://doi.org/10.1080/0953732012008818

OECD & Eurostat. (2018). *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation* (4th ed.). Paris, Luxembourg: OECD. https://doi.org/10.1787/9789264304604-en

Ramasamy, B., Goh, K. W., & Yeung, M. C. H. (2006). Is Guanxi (relationship) a bridge to knowledge transfer? *Journal of Business Research*, *59*(1), 130–139. https://doi.org/10.1016/J.JBUSRES.2005.04.001

Schaefer, K. J., & Liefner, I. (2017). Offshore versus domestic: Can EM MNCs reach higher R&D quality abroad? *Scientometrics*, *113*(3), 1349–1370. https://doi.org/10.1007/s11192-017-2533-5

Sheng, Y., Zhao, J., Zhang, X., Song, J., & Miao, Y. (2019). Innovation efficiency and spatial spillover in urban agglomerations: A case of the Beijing-Tianjin-Hebei, the Yangtze River Delta, and the Pearl River Delta. *Growth and Change*, *1–31*, 1280–1310. https://doi.org/10.1111/grow.12329

Sun, Y., & Du, D. (2010). Determinants of industrial innovation in China: Evidence from its recent economic census. *Technovation*, *30*(9–10), 540–550. https://doi.org/10.1016/j.technovation.2010.05.003

Tang, M., & Hussler, C. (2011). Betting on indigenous innovation or relying on FDI: The Chinese strategy for catching-up. *Technology in Society*, *33*(1–2), 23–35. https://doi.org/10.1016/j.techsoc.2011.03.001

Vinig, T., & Bossink, B. (2015). China's indigenous innovation approach: The emergence of Chinese innovation theory? *Technology Analysis & Strategic Management*, *27*(6), 621–627. https://doi.org/10.1080/09537325.2015.1036537

Wang, Z., Cheng, Y., Ye, X., & Wei, Y. H. D. (2016). Analyzing the space-time dynamics of innovation in China: ESDA and spatial panel approaches. *Growth and Change*, *47*(1), 111–129. https://doi.org/10.1111/grow.12115

Wei, Y. H. D., & Liefner, I. (2012). Globalization, industrial restructuring, and regional development in China. *Applied Geography*, *32*(1), 102–105. https://doi.org/10.1016/J.APGEOG.2011.02.005

Wengel, J., & Shapira, P. (2004). Machine tools: The remaking of a traditional sectoral innovation system. In F. Malerba (Ed.), *Sectoral systems of innovation* (pp. 243–286). Cambridge, UK: Cambridge University Press. https://doi.org/10.1017/CBO9780511493270.008

West, J., Salter, A., Vanhaverbeke, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy*, *43*(5), 805–811. https://doi.org/10.1016/J.RESPOL.2014.03.001

Xi, L., Lei, L., & Guisheng, W. (2009). Evolution of the Chinese automobile industry from a sectoral system of innovation perspective. *Industry & Innovation*, *16*(4–5), 463–478. https://doi.org/10.1080/13662710903053755

Yang, C. (2014). State-led technological innovation of domestic firms in Shenzhen, China: Evidence from liquid crystal display (LCD) industry. *Cities*, *38*, 1–10. https://doi.org/10.1016/J.CITIES.2013.12.005

Yang, C. (2016). Evolution of regional innovation systems in China: insights from emerging indigenous innovation in Shenzhen. In R. Shearmur, C. Carrincazeaux, & D. Doloreux (Eds.), *Handbook on the geographies of innovation* (pp. 322–334). Cheltenham, UK: Edward Elgar.

Yang, C.-H., Lee, C.-M., & Lin, C.-H.-A. (2012). Why does regional innovative capability vary so substantially in China? The role of regional innovation systems. *Asian Journal of Technology Innovation*, *20*(2), 239–255. https://doi.org/10.1080/19761597.2012.741393

Zhang, Y., & Zhang, Z. (2006). Guanxi and organizational dynamics in China: A link between individual and organizational levels. *Journal of Business Ethics*, *67*(4), 375–392. https://doi.org/10.1007/s10551-006-9031-7

Zhou, Y. (2005). The making of an innovative region from a centrally planned economy: Institutional evolution in Zhongguancun Science Park in Beijing. *Environment and Planning A*, *37*(6), 1113–1134. https://doi.org/10.1068/a3716

Zhou, Y., Lazonick, W., & Sun, Y. (2016). *China as an innovation nation*. Oxford, UK: Oxford University Press.

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