ADVANCING THE STRUCTURED ANALYSIS OF REGIONAL INNOVATION IN CHINA. INTEGRATING NEW PERSPECTIVES IN A COMPREHENSIVE APPROACH

Ingo Liefner and Henning Kroll

With 3 figures and 2 tables
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Summary: Acknowledging the obvious diversity in development trajectories of Chinese regions, this paper seeks to address the prevalent lack of complexity in comparative studies on that country's regional innovation systems and innovation outcomes. It argues that the prevalent dichotomy between rich yet idiosyncratic case studies and one-dimensional quantitative benchmarking of 'technological capacities' limits the explanatory and predictive power of existing research. Against this background, it suggests a structuring heuristic that compiles different perspectives of analysis which earlier studies have identified as important. It emphasizes, firstly, that opportunities for innovation in regional settings are not only shaped by the regional technology base, but also triggered by (latent) demand and access to users. Additionally, the actual manifestation of opportunities is contingent on local stakeholder agency and the shared perceptions and cognitive frames (mindsets) that shape it. This paper states, secondly, that these regional characteristics determine the types of innovation produced. To demonstrate this as well as how this approach can indeed provide additional insights, the authors perform structured literature reviews using the proposed multi-perspective framework.

Zusammenfassung: Angesichts ausgeprägter Unterschiede der Entwicklungsverläufe chinesischer Regionen stellt dieser Beitrag einen Ansatz vor, der es erlaubt, vergleichende Studien zu regionalen Innovationssystemen und Innovationsergebnissen umfassender anzulegen als bisher. Es wird argumentiert, dass die vorherrschende Dichotomie zwischen umfangreichen Fallstudien einerseits und eindimensionalem quantitativen Benchmarking technologischer Kapazitäten andererseits die Erklärungs- und Prognosekraft der vorhandenen Forschung einschränkt. Vor diesem Hintergrund wird eine Strukturierungsheuristik vorgeschlagen, die verschiedene Analyseperspektiven zusammenfasst, die in früheren – westlichen und chinesischen – Studien als wichtig identifiziert wurden. Zum einen wird betont, dass Innovationsmöglichkeiten nicht nur durch die regionale Technologiebasis geprägt sind, sondern auch durch (latente) Nachfrage und den Zugang zu Nutzern ausgelöst werden. Darüber hinaus hängt das Ergreifen von Innovationsgelegenheiten vom Handeln lokaler Akteure und ihren gemeinsamen Wahrnehmungen und kognitiven Rahmenbedingungen (Mindset) ab. In diesem Artikel wird zweitens ausgeführt, dass diese Merkmale die Art der Innovation bestimmen. Um dies zu demonstrieren und um zu zeigen, wie dieser Ansatz tatsächlich zusätzliche Erkenntnisse liefern kann, führen die Autoren strukturierte Literaturrecherchen unter Verwendung des vorgeschlagenen multiperspektivischen Rahmens durch.

Keywords: China, innovation systems, innovation types, agency, shared perceptions

1 Introduction: perspectives on regional innovation systems

In recent years, an ever increasing number of empirical analyses on regional innovation in China have been appearing. Mimicking the national-level discourse on middle-income economies, however, many remain inspired by a one-dimensional, technology-driven development perspective. Quite prevalently, innovation capacity has come to be regarded as a performance criterion according to which regions are classified into categories such as 'outstanding', 'good', 'mediocre' and 'low' (Yi and Fengyan 2015), aiming to score 'better'. What is relevant at the national level (Viotti et al. 2002), however, does not necessarily suffice for informed and informative regional analysis, in which local diversity plays a decisive role. While some studies have begun to consider structural and systemic factors, taking into account inputs or framework conditions, the substantial majority of them continue to frame regional innovation capacities in terms of a positivist 'domestic flying geese model', with some provinces leading, some lagging behind and some catching up (e.g. Liu and White 2001; Yi and Fengyan 2015; Prodi et al. 2016).

While understandable as part of a catching-up or leapfrogging discourse, such an approach cannot, in theoretical terms, be entirely convincing. According to established textbook literature, innovation is an interactive, multidimensional process with not only multiple sources, but multiple outcomes as well (von Hippel 1988). While technology very often plays an enabling role for 'the introduction of new solutions on the market' (OECD 2005), innovation is neither always prompted by breakthrough discoveries nor commercially most effective when it is.

In recent years, the standardization of innovation research (OECD 2018) has promoted the use of rigorous quantitative approaches at the expense of more idiosyncratic, evolutionary or spatially contingent explanations. Innovation, however, remains a complex social phenomenon, while approaches based on testing quantitative relations between individual factors and innovation performance must restrict themselves not only regarding data and methods, but also in terms of perspective. While such empirical rigor is advisable to clarify particular relations, its *ceteris paribus* approach can come at the expense of context sensitivity, unduly overlooking the fact that central conditions are in fact not equal. What remains lacking, against this background, is an explanatory approach that explicitly takes into account a broader range of region-specific and context-dependent factors, thus allowing future research to more systematically cover a broad range of the core principles that determine the innovation performance of regions.

To that end, qualitative approaches are the appropriate methodology, as they help to reveal systemic interdependencies and ambiguities that must by definition be ignored in one-dimensional, performance-oriented studies. From numerous conversations with Chinese experts and innovators, this paper's authors know that there are indeed a number of such relevant factors affecting the characteristics of regional innovation processes and outcomes, which have often been ignored for that reason. This paper focuses on including these aspects in a more integrative framework to make future studies more comprehensive and strengthen their analytical power. Within the scope of this paper, however, it is not possible to provide deep qualitative or quantitative analyses. This paper instead draws on a literature review complemented with insights from interpretative interviews. In comparison to established quantitative approaches, such preliminary attempts to broaden the scope of analysis may initially appear to lack clarity and rigor. However, it is often not least through the qualitative consideration of hitherto ill-defined factors that the foundations for better informed quantitative studies are laid.

Methodologically, this paper integrates findings from the related literature, existing statistics, as well as from various interviews and conversations on a timeline from approximately 2000 to 2018. It is close to approaches found in Chinese regional innovation studies, which are frequently based on researchers' interpretations of long-term collections of empirical evidence from different sources (Wei and Liefner 2014; cp. Woodside 2009). With this paper, the authors aim to provide both conceptual foundations as well as empirical evidence as to why and how a broader set of factors should be better acknowledged in the study of regional innovation in China.

2 Theoretical background: drivers and forms of innovation

2.1 Problem definition

A great number of scientific publications from different disciplines examine innovation systems in China (e.g. Chen and Guan 2011; Sun et al. 2013; Wang et al. 2014; Liefner and Wei 2014; Kroll 2016), and the last two to three decades of empirical research have yielded ample evidence of regional diversity in many dimensions (Liefner 2009; Kroll and Schiller 2010; Wang et al. 2014).

From the government-driven high-tech districts of Beijing (Zhou and Xin 2003; Chen and Kenney 2007) to the internationally connected technology hub of Shanghai (Liefner et al. 2012; Liefner et al. 2013) and the flexible, sometimes maverick production environment of Guangdong (Fu et al. 2012; Dong and Flowers 2016), no two regional innovation systems ever appear alike (Wang et al. 2014). Moreover, national and regional governments consciously allocate specific roles to certain regions within the national system (Huggins et al. 2014).

China faces levels of spatial inequality and spatial hierarchy that are far beyond the respective levels in most industrialized or developing countries. Despite ample media coverage and obvious efforts by the central government to ramp up innovation in the interior provinces, there has as yet been little research that finds China's West to be anything other than an innovation backwater.

As a response to observed heterogeneity, research is now broadening its view on drivers and forms of innovation. For instance, besides technol-

ogy innovation, several examples of user-oriented low-cost innovations from or for China have been reported and studied, both at the grassroots level and in the corporate domain (e.g. Ge and Ding 2008; Corsi et al. 2015; Sun et al. 2016), while even in leading provinces, the local heritage of past, user-centered approaches such as the 'Wenzhou model' (Shen 2015; Chen 2015) or the 'Shanzhai cluster' (Dong and Flowers 2010; Zhou et al. 2013; Fernandez et al. 2016) continue to support value creation to a substantial degree.

Similarly, the campaign for urban 'mass innovation' (Lindtner 2014; Saunders and Kingsley 2016) and rural grassroots innovation in the context of 'TaoBao villages' (Lin et al. 2016; Leong et al. 2016; Tan et al. 2016; Zhang et al. 2017) suggest that variety in innovation is not a thing of the past. Remarkably, even the 13th Five Year Plan now suggests 'upgrading' China's creative economy and innovative capacity 'from below' through 'collaborative innovation.' (Yu 2017)

Consciously or unconsciously, the orientation of most current studies reflects the government semantics of China's catching-up in science and technology to become an 'innovation leader', replacing old drivers and forms of innovation with an advanced technology-driven path (Yi and Fengyan 2015). Acknowledging that this will be the likely course of China's national economy and thus a worthwhile perspective for internationally comparative analysis, the authors maintain that for several reasons, this perspective is unfit as a single structuring moment for regional analysis.

2.2 Key element and relations

A broadened and more comprehensive view of innovation calls for an integration of key elements and relations affecting innovation in a comparative approach. These elements are grouped into *technology-related*, *market-related* and *mindset-related* factors.

The group of *technology-related* factors includes the regional technological competence base and industrial structure. Since these factors are often included in similar studies (Yi and Fengyan 2015; Wei and Liefner 2014; Liu and White 2001), they need not be discussed in detail here.

Market-orientation and *market-related* factors, however, are sometimes overlooked. Against this background, one of this paper's propositions is that future studies of China should take into consideration new conceptual advances that are based on other countries' experiences, for example not ignoring the India-centered literature on jugaad, frugal, inclusive, polycentric, grassroots or catalytic innovation (Christensen and Ruggles 2006; Brem and Wolfram 2014; Radjou and Prabhu 2015). The opportunities inherent to innovation for low-threshold user needs on large low to middle-income markets will thus be included here, for example indicated by income levels and user innovations. Innovations for the less affluent continue to be a main point of reference and a great source of economic wealth for many Chinese firms today (Lindtner 2014), and the (potential) relevance of the issue has already been acknowledged in several initial publications (Zhou and Xie 2012; Meriade 2016).

At the same time, the discussion on alternative approaches to innovation is becoming increasingly involved in reality checks, as alternative innovation models face difficulties taking root in many countries. Conflicting with strong narratives of upgrading, many alternative approaches meet with non-economic barriers such as local mindsets, established practices, and path-dependencies in social and organizational frameworks (Kroll 2016): In China, the belief that the nation is on track to become a global innovation leader reduces appetite for types of innovation that are not technology-centered.

Hence, this paper proposes that *mindset-related* factors such as regionally shared perceptions, visions and cognitive frames play a central role as enabling or obstructing factors in the emergence of regional economic and innovation trajectories (Romanelli and Khessina 2005). Despite recent recentralization tendencies in governance (CNN 2017), moreover, substantial differences remain between local political approaches to support industrial development as well as the images projected for this purpose (Wu 2000; Berg and Björner 2014; Prodi et al. 2016; Shin 2017; Lu et al. 2017).

The influence of shared perceptions and characteristic mindsets on the way societies respond to innovation pressure and opportunities has not received much attention in the dominant streams of the innovation literature, which have been centered in the industrialized West. However, authors from developing country backgrounds, for example in Viotti's (2002) work on passive and active learning systems in Brazil and South Korea, and Chinese authors in particular, pay more attention to these factors (e.g. Ou 2005). They have provided few but insightful discussions that highlight the importance of a regional variation of characteristic mindsets. Since the early beginnings of the opening up and reform

policy in China, the local uptake and manifestation of global business opportunities has depended not least on preexisting regional business cultures, including the required business model and technological innovation (Chen 2003; Shen 2015; Chen 2015). Despite all homogeneity with regard to national institutions, the affinity of local actors to engage with technology rather than application, government rather than businesses or domestic rather than international partners continues to differ substantially (Yin 2016; Ning et al. 2017; Lyu and Liefner 2018). As earlier studies have shown, the cognitive, social and organizational distances between local societal actors, including those from science, industry and society, tend to differ notably between localities (Oakes 2000; Goodman 2002; Goxe 2012). In different ways, both the political and the industrial system continue to incorporate bottom-up and experimentalist or in any case regionally differentiated components (Keane and Zhao 2012; Li and Wu 2012; Prodi et al. 2016; Shin 2017).

The review of Chinese contributions addressing these issues and an underlining of the awareness of Chinese researchers regarding the influence of local mindsets can easily be further extended (for example Zhou 1988; Kong 1992; Han 2006; Zhu and Bai 2008; Yu 2015). Moreover, the linkages between 'regional characters' or 'cultural spirit' and the business context were broadly acknowledged in almost every interview that the authors conducted on this topic. Hence, despite the fact that the Western literature on China has so far only sporadically focused on differences in the innovation landscape that are linked to regional mindsets, this paper includes this category in the framework which it provides (Fig. 1).

In addition to an actual availability of diversity in 'pre-existing technical and economic circumstances' (Fernandez et al. 2016; Jia et al. 2018), a constructive uptake of given opportunities by local coalitions or at least groups of actors is the necessary condition for the emergence of the above-mentioned pathways of development (Garud and Karnøe 2003; Fu et al. 2012). According to at least parts of the recent discussion in Europe, the United States and elsewhere, alternative approaches to innovation are at least as often inhibited by the failed uptake of opportunities by regional actors as by the absence of opportunities as such (Clifton 2013; Kroll 2016).

Technology-related, *market-related* and *mindset-related* factors thus shape innovation and create distinctive innovation outcomes, i.e. types of innovation. These types characterize regional innovation settings more comprehensively than one-dimensional per-

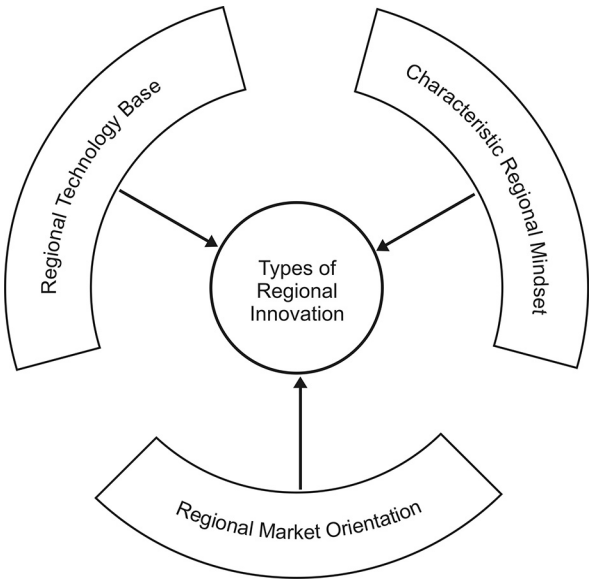

Fig. 1: Factors affecting the variety of regional innovation systems

formance tables, and can, in future research, either serve as starting points for the deeper investigation of particular aspects or help to methodologically improve and embed existing quantitative benchmarking approaches by adding further, inherently geographic dimensions.

2.3 Types of innovation

The large body of literature on innovation provides a number of different classifications of innovation types, of which the categories product innovation – process innovation – organizational innovation, and radical innovation versus incremental innovation, which can be traced back to Schumpeter's early work (1934), may be the two most frequently used ones. Other typologies differentiate according to the drivers of innovation – technology push versus demand pull – (di Stefano 2012), focusing on process characteristics – bricolage versus breakthrough – (Garud and Karnøe 2003), focusing on the origins of ideas – science-led versus grassroots – (Smith et al. 2017), or highlighting attributes of the innovation itself – good enough or frugal – (Agarwal and Brem 2012).

This paper's analysis selects four types of innovation based on the fact that they can be intuitively linked to the key regional innovation characteristics explained above. Two of these have been established and broadly defined in the innovation literature,

while the other two are more tailored towards the specific Chinese situation. The two established categories are science-driven innovation, exemplifying a particularly strong technology focus, and cost-oriented innovation, designed to meet the needs of less affluent consumers. The two more China-specific categories are high-end user-driven innovation, meeting demand from the rising urban middle class in China's coastal centers, and grassroots innovation (Taobao), which is based on new opportunities to identify and meet users' needs.

The selection of these four categories does not provide an all-encompassing typology to capture the innovation outcome of Chinese regions, and it is not intended to do so. Its mere purpose is to indicate that regional innovation characteristics correspond with certain types of innovation outcomes. This paper proposes such a connection and discusses the examples of selected regions in China. Establishing such a connection more broadly, and with an analytical approach, must be left to future studies.

3 Data and methods

Against this background, this paper will review existing findings on selected innovation systems in China, informed by a comprehensive review of academic literature and statistics, and validated by several on-site visits and in-depth interviews with experts from business, research organizations and intermediaries. Since the year 2000, both authors have repeatedly conducted field research in China, typically based on blocks of at least 20-30 interviews with researchers, entrepreneurs and officials at particular localities. Specific topics have included the organization of knowledge absorption in Shanghai and Beijing (2000-2005, cf. Liefner et al. 2012; Liefner et al. 2013), entrepreneurship in Beijing, Zhejiang and Central China (2003-2004; cf. Kroll and Liefner 2008), innovation management in the Pearl River Delta and Southwest Coastal China (2006-2014; cf. Peighambari et al. 2014; Liefner and Jessberger 2016), innovation policy in Guangdong (2008-2009; Kroll and Tagscherer 2009; Kroll and Schiller 2012; Liefner et al. 2016), as well as industry-science linkages in Beijing, Shanghai and Guangdong (2008-2015; cf. Kroll and Schiller 2010; Tagscherer et al. 2012). Besides these specific interview efforts, both authors have conducted repeated quantitative analysis and extensive desk research on the topic of regional economic development in China (cf. Kroll and Frietsch 2014). They have also regularly taken part in exchanges, summer schools and conferences at leading academic institutions and universities in China – at both the national and regional level.

In particular, however, this paper was triggered by consideration following a further effort to gather, triangulate and validate empirical material from different provinces during a DFG-funded research project in the period 2016-2018. This research project involved extensive desk research prior to subsequent field visits to five main study regions. The study regions (see Fig. 2) allow the contrasting of successful and wealthy regions (Beijing, Shanghai, Guangdong) with seemingly unsuccessful and poor regions (Chongqing and Guizhou). During the field visits, semi-structured interviews were conducted with experienced scholars, innovators and government officials - documented in detail and analyzed systematically with common techniques of qualitative research (e.g. coding and aggregation). Interview partners included CEOs, CCP secretaries, professors and directors at high-ranking organizations such as CAS institutes, 211 universities, national-level SOEs, as well as provincial and city governments. The authors gained access to most of them based on a 'snowball principle' expanding on existing networks and central contact points in China. The exact interview format, e.g. one-to-one or group discussion, was chosen upon consideration of the specific context.

Subsequently, the authors juxtaposed and complemented the findings of these interviews with those from earlier interview rounds (see above). Naturally, earlier studies' interviews had been designed for different main purposes, hence not constituting a direct match. Nonetheless, ample empirical insights could be gained from the targeted reconsideration of existing documentation using new conceptual frameworks developed for the 2016-18 research project. On many occasions, older insights served to confirm current findings, and on some, they placed them in perspective. Existing material could also be used to reproduce findings for regions not intensively covered during the 2016-18 research project.

Finally, the authors visited leading Chinese innovation researchers and economic geographers to discuss this paper's topic and approach, presenting it at conferences. During 2018, several hours of conversation were thus spent on validating initial conclusions and finalizing the elements that constitute the comprehensive approach shown in Tab. 1 and Tab. 2 (chapter 4.4 and 5).

Fig. 2: Regions included in the structured review

4 Structured review: elements of diversity in regional innovation systems

For different examples, the review will demonstrate how a focus on market orientation and mindset can yield additional insights into the workings and driving factors of local innovation processes that a mere technology-oriented perspective would not yield. It analyzes pairs of regions that would appear similar in a one-dimensional benchmark of economic well-being or technological capacity (cf. Fig. 3 and Fig. 4). Hence, it will illustrate which substantial structural differences such an approach would conceal.

4.1 Science and high-tech-driven innovation: Beijing and Shanghai

Beijing and Shanghai are the country's lighthouses of *science and technology*, with abundant and broad-based capacities in public research (Fan and Chen, 2014; Liefner and Hennemann 2011; Kroll and Frietsch 2014). Both are home to leading universities as well as a substantial share of other public research units surrounded by high-tech development zones (Zhou and Xin 2003; Liefner et al. 2006; Chen and Kenney 2007). Historically as well as today, both are national centers of global exchange and home to China's few genuinely metropolitan populations.

Beijing has traditionally been characterized by its capital function, and in all domains, including science and the economy, it has placed an emphasis on following government guidelines. Following the demands of its discerning upper-class population, it has long been a national leading market for high-quality services. What it lacks, however, is a broader industrial basis (Kroll and Frietsch 2014), which was never strongly developed in the first place and has further diminished in recent years through relocation out of the capital area. Traditionally, the local elites were not necessarily very open to foreigners.

Shanghai, on the contrary, established itself in the course of the 20th century as the country's main hub of global exchange, with a view both to merchandise and to new political ideas and universal thought (Liefner and Zeng 2008). When China reopened in the 1980s and 1990s, Shanghai was already a developed center of high-quality manufacturing and featured a substantial industrial basis with dense links to science and industry (Ernst 2008) before the first greenfields in Guangdong were broadly developed.

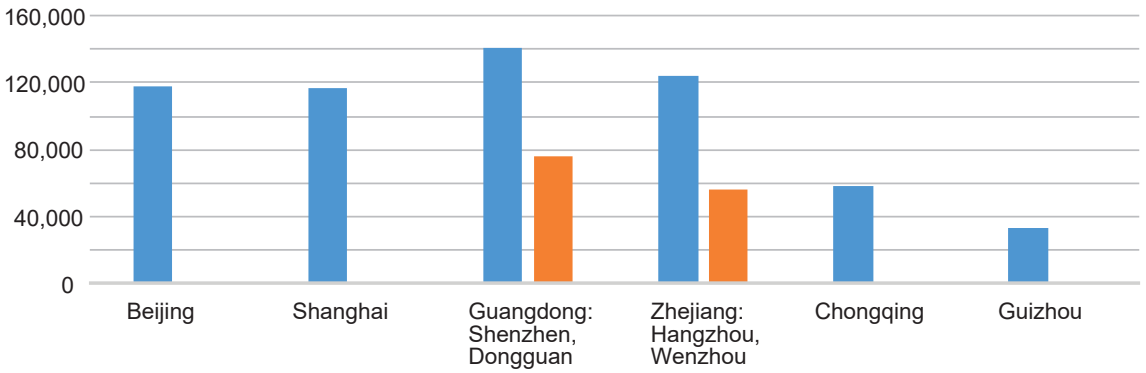

Fig. 3: Regional disparities regarding wealth and cost levels: GDP per Capita 2016 (CNY) in the study regions. Note: blue and orange columns juxtapose values of specific provinces' more and less wealthy cities. In Guizhou, GDP per capita levels in the capital Guiyang will be higher, but were not available. Source: Data taken from NBS 2017; CSP 2017a, b.

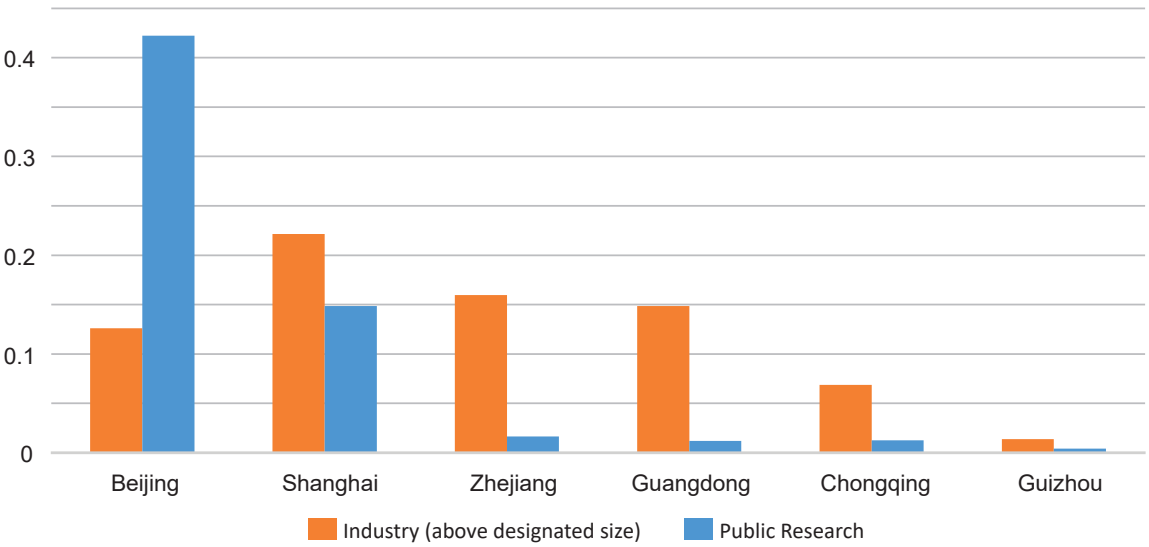

Fig. 4: Regional disparities regarding technology: total investment in R&D per inhabitant 2015 in the study regions. Source: Data taken from NBS 2017; CSP 2017c.

In the absence of local production, Beijing's *market orientation* derives mostly from its service sector. A central element of the productive local economy (i.e. leaving out administration and real estate) is the globally leading software sector as well as several aspects of industrial design. With the rise of China's software economy, Beijing's Zhongguancun quarter has grown into a second Silicon Valley with a vibrant start-up and discerning user-innovator community in and around the universities (Kroll and Liefner 2008; Liefner and Hennemann 2011). Moreover, it receives a constant stream of elaborate procurement from key users in the national administration. Typically, however, the demand that drives software and design innovation in Beijing substantiates elsewhere in the country. Most industrial designs are implemented in Shenzhen, Shandong or Shanghai, and government applications of Beijing's leading ICT solutions stretch across the entire nation.

Shanghai was among the first locations to attract foreign investment not only for assembly, but also for high-quality industrial production (Liefner et al. 2013). Here, market demand emerges at the interface between global production networks and the high-end segments of the Chinese domestic market (Yeung and Coe 2015). During the 1990s and 2000s, many foreign firms invested in the region to produce high-tech goods both for export and for the emerging domestic high-tech sector (Ernst 2008; Sun et al. 2013). Compared to Guangdong, however, the orientation towards global markets was based less on low production cost and large-scale assembly, and more

on high-quality, high-specification products that provided opportunities for technological upgrading and learning (Liefner et al. 2013; Wang et al. 2014). In contrast to Shenzhen, therefore, local producers never developed strong direct interfaces with the low to mid-income segments of the domestic market (Ernst 2008). Demand for capital goods from Shanghai's high-tech parks more commonly emerged from China's upgrading industry or from high-level government procurement (Sun et al. 2013; Zhang 2014).

With a view to *mindset*, many in Beijing share the perception that economic development is a derivative firstly of public guidance, and secondly of the transforming force of science and technology. As the city is home to leading institutions in both domains, this perception is natural and, for the local system, not inaccurate. More strongly than by the market as such, innovative activities in Beijing may be triggered by public directives, enabling support of central government or, indeed, the abundance of science and technological results locally available. As a result, the notion of 'low-tech innovation' does not align readily with the local mindset, at least not with a view to explicitly articulated ambitions.

In Shanghai, the mindset is substantially different. While the municipal government is a strong and in part directive rule-setter, and the universities are acknowledged as relevant sources of applicable knowledge, the dominant motivating moment of the local mindset remains industrial leadership. Though less individualistic than in Guangdong and more compliant with regulations, Shanghai entrepreneurs tend to be proactive and open to various roads to success, including the integration into international value chains as much as the involvement and integration of local users in 'open innovation' (Saunders and Kingsley 2016). In general, the conditions for bottom-up innovation are therefore even better than in Beijing, where entrepreneurs tend to be more reluctant to act without external triggers. Due to a long history of serving high-quality markets and the availability of capacities to do so, however, most Shanghai businesspeople do not feel overly inclined to specifically target the low to middle end of the market.

4.2 New centers of entrepreneurship and innovation: Zhejiang and Guangdong

Zhejiang and Guangdong have developed their leading status with a view to economic and innovative development on a different trajectory than China's historically grown urban centers (Fu et al. 2012; Dong and Flowers 2016). While both display notable historic foundations of trade, craft and entrepreneurship in the merchant cities of Guangzhou and Hangzhou, they remained equally left behind during China's first wave of modern industrialization in the 20th century, while at the same time, isolationist policies severed their traditionally strong links to foreign markets. Moreover, both provinces lack an equally established tradition in public research and higher education as found in Beijing or Shanghai (Kroll and Frietsch 2014).

When the opening up and reform policy 'took the lid off' the contained entrepreneurial dynamics in both provinces, independent economic development resumed, manifesting itself in various localized setups, of which the Wenzhou and Dongguan 'models' or Shenzhen's entrepreneurial Shanzhai ecosystem (Zhu and Shi 2010; Zhou et al. 2013; Dong and Flowers 2016) were but the most prominent. Notably, most of them emerged outside the traditional centers of Hangzhou and Guangzhou in what were formerly either parts of the rural periphery or smaller, traditional craft towns.

A commonality between the two provinces is thus that there are few cases in which the recent dynamism of economic growth is notably older than thirty years. In both, catch-up growth was of a pronounced bottom-up nature, and while systemically contained by state regulation, it did not always respect formal limitations. Furthermore, both systems focus on commercial success more than on science (cf. Liefner and Zeng 2016). Due to their history, they focus on a variety of often light industries. Their local business systems are not very integrated with the select leading universities (Kroll and Schiller 2010; Yang 2014), and their provincial governments have traditionally held a comparatively independent position within the nation's overall governance system (Kroll and Tagscherer 2009).

However, the two regions also display notable differences, firstly regarding *technology* and *market orientation*. Well into the 2000s, Guangdong and its landmark city Shenzhen grew largely based on serving foreign markets as well as domestic rural markets. Many production facilities were initially activated as low-cost assembly segments within international value chains ('Dongguan model'), and many continue to play this role today. Later, the capacities thus acquired were transferred to flexible applications on the domestic market ('Shanzhai model', Dong and Flowers 2010; Zhou et al. 2013), while at the same time, firms such as Huawei and ZTE combined them with learning from foreign

technology inflows (Wang et al. 2014) to upgrade their technological capacities and become independent providers of telecommunication solutions. Eventually, therefore, Shenzhen became one of the world's leading high-tech hubs and start-up hotspots. Parallel to this, a legacy - or rather positive heritage - of flexible production in the low to mid-market segments remains, continues to be exploited on both domestic and foreign markets, and – in aggregation - still provides one robust foundation of Guangdong's economic well-being (Lindtner 2014, Yang 2014, Liu et al. 2015).

In contrast to the large-scale assembly lines of Guangdong, manufacturing activities in Zhejiang are mostly performed by small to mid-sized firms serving niche markets. Today, the majority of Zhejiang's local firms still remain focused on the low-end to middle price segments of the market for Chinese low to middle-income customers relying mostly on non-R&D or micro-innovation (Zheng et al. 2016; Zhou et al. 2017). In contrast to Guangdong, Zhejiang's main industries, such as textiles, chemical products, electrical machinery and ordinary machinery, were less directly susceptible to rapid technological upgrading than Guangdong's computer and telecommunication assembly sector. Low-tech and business model innovation remains the prevalent model today in the province's various light industries, and leading high-tech companies in the software (Alibaba) or pharmaceutical sector remain loosely connected to the local production basis.

In Guangdong, the 1980s and 1990s saw the vigorous creation of a production system in an environment where neither science nor industry had much precedence (Chen and Kenney 2007; Kroll and Tagscherer 2009; Liu et al. 2015), and in which *regional mindset* helped to navigate into unknown territory. With a long history in trade, however, Cantonese entrepreneurs were ready to accept external investment and integrate themselves into global production networks (Yeung and Coe 2015) in whatever way promised to be profitable. The greenfield situation, unhampered by specific traditions, allowed for maverick behavior and volatile, flexible arrangements motivated by commercial opportunity (Keane and Zhao 2012; Ren et al. 2016).

In Zhejiang, local craftsmanship had a long tradition sometimes likened to that of Northern Italy and some, even if limited, prior industrial basis (Chen 2015). In the opening up and reform policy, it was thus less the opening up than the reform - i.e. liberalization - element that prompted the reinvigoration of local activities (Chen 2015). Local craftsmen in various communities remembered old capabilities and reinterpreted them in new business models. Despite an equally strong motive of gain, local entrepreneurs thus did not just start 'random' activities, but more commonly 'stuck to their traditional trade' (e.g. textiles and shoes). Likewise, completely maverick behavior was limited by developing social contexts (Shen 2015; Chen 2015). On the downside, the more limited presence of new foreign-invested plant sites limited the creation of new hubs around which new, flexible, Shanzhai-type ecosystems could have emerged. Instead, a large number of individual firms serve similar national markets in direct, often price-dominated competition, as evidenced by the 'Wenzhou model' of the 1990s (Shen 2015; Chen 2015).

4.3 Learning or lagging behind in the West: Chongqing and Guizhou

Chongqing and Guizhou share the common feature that they are latecomer regions with limited scientific and technological capacities, environments that have only started to fully participate in China's innovation-driven development in recent years. Originally characterized by heavy industries and surrounded by agriculture, both have since diversified their economic basis, although moving at different paces and in different directions, and focusing on different *technological resources* and *markets*.

Traditionally, both provinces served domestic markets with standardized products from state-controlled industries such as coal, iron, steel, metal products or processed food. Consequently, there are very limited local traditions with a view to international trade, entrepreneurship or collaboration in light industry districts. Despite the notable size of the major cities in both regions, few of them can be characterized in societal terms as metropolitan or as the home of a particularly discerning customer base.

In Chongqing, the relocation of coastal industries has led to the rise of a previously insignificant computer and telecommunications sector, turning the region into one of the country's hotspots for laptop production (Gao et al. 2017; Yang 2017). Export-oriented firms have thus become relevant players in a local industry that is, to a greater extent than before, exposed to rising requirements and demands from international markets (Enright 2017). Importantly, this relocation of coastal industries follows an economic logic, as wages in Chongqing remain lower and agglomeration disadvantages less pronounced

(NBS 2017). At the same time, the region has lost much of its former remoteness due to improved rail links. Accordingly, the relocation trend has been dynamic and has led to the emergence of a genuine new cluster (Enright 2017).

In Guizhou, one of China's poorest provinces and home of several so-called 'resource-dependent cities' (Li et al. 2015), industrial restructuring is happening at a slower pace and taking a different direction. A first trend observed is the beginning of a technological rejuvenation of existing heavy and resource-based industries, mainly with respect to a reduction of waste and pollution (Dong et al. 2016). The second development concerns policy approaches and activities for using natural resources, cultural heritage and tradition, including those of ethnic minorities, for the development of respective industries such as medicine or tourism (Li et al. 2015; Zhu et al. 2017). In both cases, no effort is made to break away from traditional paths.

With a view to the differences in *mindset* in the local population, Chongqing's main issue may well be that of cost-driven economic changes and the upgrading of production capacity running ahead of local societal capacity with a view to both qualification and demand (Gao et al. 2017; China Daily 2017). On the other hand, a broad consensus regarding the fundamental transformation of Chongqing's economic base is clearly visible. This seems to be profoundly different in Guizhou, where local stakeholders display little impetus to invest in learning and upgrading and to commit themselves to far-reaching economic restructuring. The notion of a permanent economic backwardness leads to a passive approach that stresses the importance of central government subsidies and development initiatives. Not surprisingly, industry studies reveal deficits regarding the capacity to design and implement strategies and measures to move forward (Dong et al. 2016).

In contrast to Guangdong and Zhejiang in the 1980s or 1990s, however, neither region provides a fertile cultural seedbed of opportunity-takers who would autonomously pursue novel options and leverage newly transplanted potentials for their personal benefit and thus initiate a self-emergent process of regional economic transformation. While in Guangdong, a newly established assembly firm spurred the rapid co-location of various Shanzhai designers, it would most probably receive less response from its direct environment in Chongqing or Guizhou (Enright 2017). While in Zhejiang, entrepreneurs devised new business models based on existing capabilities with which to profit, Chongqing has experienced the transplantation of new business models (Enright 2017; China Daily 2018), and Guizhou has mainly witnessed efforts to keep existing industries alive, representing a production-based mindset bearing the legacy of heavy industry.

4.4 A synoptic overview

The following table (Tab. 1) seeks to summarize the above-explained features of innovation drivers and underlying mechanisms in a condensed form. It deliberately uses categories that relate to the propositions raised. Of course, several of the entries may raise controversy, and some of them are highly selective. However, since the main objective of the table is to show that the multitude of factors examined helps to better understand regional heterogeneity, the individual pieces of information are less important.

5 Discussion: corresponding types of innovation

It can be shown that both the above-mentioned similarities and the structural differences have tangible consequences for innovation and economic development, which can be demonstrated with a view to the categories - i.e. types of innovation - introduced above (2.3, see also Tab. 2).

5.1 Science-driven innovation

Science-driven innovation of the kind often propagated by central government remains the domain of leading urban environments, first and foremost Beijing (Gao and Hu 2017). In 2015, Beijing alone accounted for 35% of all 'transaction value in technical markets' in China, a common measurement of formal technology transfer. This constitutes more than 5 times the respective value of Shanghai and Guangdong. While these observations are as such possible without an additional focus on markets or local mindset, the above figures swiftly illustrate that the standardized technology transfer or science-industry collaboration model on which much prior research focused is – and will remain – characteristic for a limited subset of Chinese regions. At the same time, the majority of industrial R&D spending in China's coastal provinces remains relatively unaffected by it.

Tab. 1: Structured overview of innovation systems in China

	Beijing	Shanghai	Pearl River Delta	Zhejiang	Chongqing	Guizhou
Technology Base	++	++	++	+	O	-
Focus of competence	public	public and private	private	private	private	absent
Sectoral focus	ICT	high-tech production	production & ICT	light industry, agriculture	production	agriculture, heavy industry, tourism
Role of local user base	driving	driving	driving	following to passive	following	passive
Market orientation	+	++	++	++	O	-
Income level	high income	high income	high income & low income	middle to low income	high income & low income	low income
Local industrial base	limited; mostly services	strong & elaborate	strong	strong	updating	lagging behind, weak
Local user-innovators	upper class lead users	broad urban communities	young start-up communities	craftsmen entrepreneurs	n/a	n/a
Government as pacesetter	high	medium	below average	below average	medium to high	very high
Characteristic mindset	+	++	++	+	O	-
Joint narrative	scientific leadership	business reputation	commercial success	entrepreneurial flexibility	fragmented	subsidy-oriented
Mode of agency	following directives	balancing demands	bottom-up, maverick	interpreting local capacity	seeking opportunities	seeking grants & rents
Mode of organization	coordinated	collaborative	volatile organization	fragmented competition	idiosyncratic	dependent
Outward orientation	domestically guiding	globally integrative	global sales-oriented	domestic focus	shifting	domestic focus

Source: Own analysis, literature review

5.2 Cost-oriented innovation for domestic and global markets

Most Chinese regions produce predominantly for the domestic market, which is in most respects not yet a high-income market, despite the increasing absence of absolute poverty and the rising urban middle class (Chen and Wen 2016; Dong and Flowers 2016). Many industries focus on low to mid-end market segments, innovate with a view to user benefit and are very versatile in developing new solutions in precisely those segments that customers demand, irrespective of technological content (Ge and Ding 2008; Corsi et al. 2015; Shan

Tab. 2: Prevalent types of innovation

	Beijing	Shanghai	Pearl River Delta	Zhejiang	Chongqing	Guizhou
Basic types of innovation						
Science-driven innovation	X	(x)				
cost-oriented innovation			X	X	X	(x)
Recent types of innovation						
High-end user-driven innovation	(x)	X	X			
Grassroots innovation (TaoBao)				X		

and KHAN 2014; SUN et al. 2016). Naturally, these developments are not what the Western observer encounters in Beijing or Shanghai. Likewise, they are increasingly easily overlooked in Guangdong and Zhejiang, if one fails to look past the hubs of Shenzhen or Hangzhou. Nonetheless, this is the backbone of Chinese industrial R&D, characteristic for all but a few provinces and behind many of the official R&D figures. Predominantly, this model can be expected to thrive in environments such as Zhejiang or Shandong, where domestic market orientation is prevalent and entrepreneurial capacities well developed – while outward orientation has less of a tradition. Importantly, however, it also constitutes a relevant sub-segment of the larger industrial system of Guangdong.

At the same time, the fact that much of the country's exports still emerge from Guangdong's assembly lines (25%) is indirect testimony to a continuously broad market orientation of Chinese exports. More directly obvious is that Chinese companies are gaining increasingly large market shares on developing and emerging low-income markets – providing sound evidence that they still know how to serve low-income customers. While these may be in increasingly short supply domestically, it is more than evident that the business model as such has not been dropped. In some areas, such as Shanghai and Jiangsu as well as Shenzhen proper, however, the quality of exports has upgraded notably in the past decade.

Finally, the advantages of taking into account market and user orientation and specific local mindsets can be illustrated by the consideration of two relatively recent trends and elements in the Chinese innovation system.

5.3 High-end user-driven innovation

In leading coastal metropoles, local universities and a dynamic urban middle class are becoming increasingly involved in innovation processes, as evidenced by Beijing's student makerspaces (LINDTNER 2014; SAUNDERS and KINGSLEY 2016). However, the actual dynamics of these new developments differ according to local mindset. In Beijing, makerspaces are mostly affiliated with leading universities and expressly endorsed by central government. In Shenzhen, they are embedded in a technology-oriented start-up community that thrives on its direct connection to local industrial firms that can influence and small-scale manufacture their prototype designs. In Shanghai, with its more cosmopolitan and open society, local makerspaces additionally involve ordinary middle-class citizens and deal in a less playful manner with more practical problems which they have better opportunities to influence in the area – even if much is still relayed to Guangdong (SAUNDERS and KINGSLEY 2016). Shenzhen, in turn, does not have the same sort of urban lead user community, meaning that the actual uptake of citizen inputs to innovation is more inhibited. While makerspaces generally profit from a closeness to universities and have been opened in many places, genuine communities have - despite concerted efforts for example in Chongqing (China Daily 2018) - remained limited to a few urban areas, and without the specific societal conditions of Beijing, Shanghai or Shenzhen have failed to gain traction elsewhere (SAUNDERS and KINGSLEY 2016).

5.4 Grassroots innovation (the example of TaoBao villages)

'TaoBao village' refers to a rural community that designs and produces specific goods and sells them on Alibaba's TaoBao online platform, thus taking advantage of a new connection between rural craftsmanship, creativity and national markets (Lin et al. 2016; Leong et al. 2016; Tan et al. 2016; Zhang et al. 2017), combined with the new opportunities provided by fintech (Ding et al. 2018). With a view to its likely spread across the many principally suitable backward areas of the country, recent research suggests that much of the momentum has so far been limited to the backcountry of Jiangsu, Zhejiang and Guangdong (Liu and Ai 2018). In provinces that are lagging behind in a general manner, however, the new opportunity has by and large not yet been taken up. Apparently, an entrepreneurial mindset and a certain closeness to domestic leading markets constitutes a necessary condition even for those low-end innovation activities that do not necessarily require any technological input (cf. Zhou and Xie 2012; Meriade 2016).

The in-depth consideration of selected examples indicates that there is indeed ample evidence of alternative pathways to regional innovation and value creation other than those traditionally considered in the academic literature on China. In the past, low-threshold or business model innovations have been socio-economically very successful and they continue to remain so today – more so than in much of the West. Side by side with technological capacities, both leading user communities and a continued low to mid-end market demand have been identified as central drivers of innovation in different regions. Moreover, the concrete setup of regional actor coalitions and the local particularities of relational and institutional capital have been identified as central determinants of why some of the commonly discussed opportunities are exploited or not. The case studies analyzed emphasize that local arrangements of stakeholders, institutions and relational assets can and have provided a robust basis for alternative regional pathways to innovation to come to fruition.

As Zhou et al. (2013, 139) put it: "many local organizations [build] the social infrastructure needed for firms to [develop] business models" as they "have a great deal of tacit knowledge [that] is useful to understand the local market (social) mechanisms", or "[only] embedded in the social network [,] firms can learn quickly from the market as well as new technology along the supply chain." (Ren et al. 2016). These constellations, however, are swiftly emerging in a non-deterministic manner, driven by chance and opportunity. Nonetheless, all of them leave an imprint in the social and institutional fabric of regions, on which political actors can later build by means of "place-based strategies to embed technological upgrading, such as driving [locally specific] indigenous innovation activities" (Prodi et al. 2016).

6 Conclusion

As this paper has demonstrated, the hitherto most commonly studied aspects of Chinese economic growth, namely science-industry relations and embeddedness in global value chains, remain limited to those locations that have in the past been the predominant subject of studies in economic geography: Beijing, the Yangtze River Delta and the Pearl River Delta. When it comes to other central contributors to Chinese economic growth and R&D investment, these two standardized explanations not only do not suffice, but, when used as a framework of analysis, could lead to a misinterpretation of current trends and developments.

Against this background, this paper has advocated the additional consideration of two continuously central aspects for economic success in the Chinese innovation system: market-driven, low-threshold innovation and local mindsets that enable or impede new types of contributions to the innovation process. It does so at a time when the integration of a broader basis of users in line with a robustly strengthened role of government is about to affect China's geographies of innovation and production substantially.

Only by acknowledging what exactly makes for and constitutes regions' success will future studies gain greater explanatory power and suitably interpret emerging, specifically Asian (Yeung 2006; Reslinger 2013) approaches to innovation. Whether the recent changes in Chinese national governance will fundamentally change the elaborated logics of innovation remains to be seen. Arguably, however, many of the additional logics that this paper highlights are, as of today, already supported by various levels of government. In line with the above, however, this support is not necessarily articulated under the headline of science and technology policy.

As stated in the introduction, this paper has sought to enable a comprehensive and accurate stocktaking of the current state of China's overarch-

ing architecture of regional innovation systems. At a time when many of China's established regional innovation systems are undergoing rapid transition, such clarity about context-specific starting conditions may well prove essential to understand and ideally foresee ongoing transitions.

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Authors

Prof. Dr. Ingo Liefner
Leibniz University Hannover
Institute of Economic and Cultural Geography
Schneiderbegr 50
30167 Hannover
Germany
liefner@wigeo.uni-hannover.de

Dr. Henning Kroll
Fraunhofer Institute for Systems and
Innovation Research
Breslauer Str. 48
76139 Karlsruhe
Germany
Henning.Kroll@isi.fraunhofer.de