Science and Public Policy, 2021, **00**, 1–18
DOI: https://doi.org/10.1093/scipol/scab059
Article

A comparative analysis of innovation policies in Hong Kong and Shenzhen within the Greater Bay Area initiative

Naubahar Sharif [1,2,*] **and Kevin Chandra** [1]

[1]Division of Public Policy, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong SAR, China and [2]Shenzhen Research Institute, Hong Kong University of Science and Technology, Shenzhen, China

*Corresponding author. E-mail: sosn@ust.hk

Abstract

Combining documentary analysis with hierarchical cluster analysis (HCA), we conduct a comparative study of innovation policies in two municipalities included in the Greater Bay Area (GBA) initiative—the Chinese government's plan to link eleven cities into an economic and business hub. After identifying innovation policies/agencies in Hong Kong and Shenzhen, we apply the HCA to compare similarities and differences between their innovation policies and assess how these policies align with the 'cross-border regional innovation system' (CBRIS) conceptual approach. We find that Hong Kong's innovation policies are multitudinous, fragmented, and overlapping, whereas Shenzhen's innovation policies are more targeted and more clearly differentiated, with a strong focus on strategic emerging industries. The two cities could strengthen their developing but weakly integrated CBRIS by collaborating in four areas of innovation policy: talent recruitment, joint R&D activities, enterprise competitiveness, and support for start-ups. The GBA initiative can succeed by driving innovation from a CBRIS perspective.

Key words: innovation policy; cross-border regional innovation system; hierarchical cluster analysis; Hong Kong; Shenzhen

1. Introduction

With the 'Greater Bay Area' (GBA) initiative—launched in February 2019—the Chinese government will link the Southern Chinese cities of Hong Kong, Macau, Guangzhou, Shenzhen, Zhuhai, Foshan, Zhongshan, Dongguan, Huizhou, Jiangmen, and Zhaoqing into an integrated economic and business hub. The central government aims to transform Hong Kong and ten cities in or near the Pearl River Delta into a thriving global center of technology, innovation, and economic vibrancy, with a timetable that will have the framework for the GBA built by 2022.

Hong Kong and Shenzhen have been earmarked as two of the four key cities of the GBA and as core engines for regional development that will turn them into innovation and technology hubs. The plan calls for the Hong Kong and Shenzhen governments to enhance mutual communication and cooperation to support innovation policy (as well as policy in other areas).

One fruitful way to make sense of this new policy development is to deploy the innovation systems conceptual approach. The most commonly known variant of this approach focuses on the concept of a 'national innovation system' (NIS; see Freeman 1987; Lundvall 1992; Nelson and Rosenberg 1993), which emphasizes the nation-state as the unit of analysis. Alternative frameworks include the associated conceptual approaches that target regional innovation systems (RISs; Cooke et al. 1997; Asheim and Isaksen 2002; Asheim and Gertler 2004; Asheim and Coenen 2006), technological innovation systems (Carlsson and Stankiewicz 1991), and sectoral innovation systems (Malerba 2002).

While the innovation systems conceptual approach has branched along several dimensions, the regional dimension remains important (Tödtling and Trippl 2005) because subnational regions in particular are diverse and have their own sectoral specializations, knowledge spillovers are closely linked to geographical proximity, and local governments and institutions know their own regions better than national governments do.

Despite this scholarly history, neither the NIS conceptual approach nor even the RIS conceptual approach has adequately examined the issue of innovative capacity in cross-border regions (Trippl 2010). Partly in response to this gap in the existing literature, the 'cross-border regional innovation system' (CBRIS) concept was proposed (Trippl 2010; Lundquist and Trippl 2013; Van den Broek and Smulders 2015; Makkonen and Rohde 2016). The CBRIS concept applies to regions that overlap each other along the border(s) of two (or more) states (e.g. San Diego–Tijuana and El Paso–Ciudad Juarez are metropolises along the US–Mexico border) or to places with their own regional identities that are nonetheless divided by national borders (e.g. Alsatian culture in the Alsace–Baden region that encompasses parts of both France and Germany).

In this paper, we analyze Hong Kong's and Shenzhen's innovation policies in depth to inform a comparative analysis of those policies using the more sharply focused CBRIS framework. The CBRIS is most appropriate for our study given that these cities are among the most dynamic economic hubs in Asia, neighboring one another in one of the world's most populous cross-border metropolises, and both aspire to become innovation and technology hubs. Given their ambitions, authorities in the two cities—not least since the formal launch of the GBA initiative earlier this year—have been enthusiastically devising a range of plans, schemes, and other measures to jointly maximize their innovative capacities.

Our use of the CBRIS framework is slightly modified from that of Trippl (2010) and Lundquist and Trippl (2013) insofar as our 'cross-border' concept here refers to territorial borders between different regions *within* a country.

Through the application of a novel methodology to our analysis of policy documents, we seek to answer two research questions in the following sequence:

- What are the similarities and differences between Hong Kong's and Shenzhen's innovation policies?
- Do the innovation- and technology-related policies in the two cities align such that they contribute to the creation of a CBRIS?

By addressing these research questions, we aim to fulfill three objectives. First, we apply the CBRIS concept in a cross-border region in Asia, filling an *empirical* gap in the extant CBRIS-related literature. Second, by using a novel *methodology*—hierarchical cluster analysis (HCA)—to analyze the innovation policy frameworks in the two cities, we identify policy areas that Hong Kong and Shenzhen are currently prioritizing to indicate the GBA initiative's potential to drive innovation and technology development in both cities. Third, we identify innovation areas in which Hong Kong and Shenzhen can collaborate and underscore the challenges to be addressed if any such collaboration—and by extension the GBA initiative as a whole—is to succeed.

This paper is structured as follows. First, we present a literature review where we discuss the current state of innovation policy frameworks in Hong Kong and Shenzhen. Second, we detail our research methodology. Third, we present our findings and the results of our analysis. Fourth, we discuss our findings and their policy implications with respect to efforts to build a Hong Kong–Shenzhen CBRIS. Finally, we close the paper by highlighting the significance of our research.

2. Conceptual framework and literature review

2.1 An overview of the CBRIS concept

The CBRIS concept—first formulated by Trippl (2010)—originated out of concern that the existing NIS and RIS approaches inadequately addressed questions pertaining to regions located along a country's borders. Trippl (2010: 150) wrote that 'the rise in importance of cross-border regions is the outcome of various factors … [as a result of which] the exclusive focus of the RIS concept on regions within a national context becomes increasingly inadequate'.

The CBRIS concept has a 'national' dimension insofar as a region is delineated within a clear, national administrative border and is bound to the existing national arrangements in the territorial state in which it is based (Hassink et al. 1994; Koschatzky 2000; Perkmann 2007; Smallbone and Welter 2012; Sohn 2014). Simultaneously, however, it also includes a strong 'regional' dimension, as border regions often take on regional identities that—more often than not—transcend administrative borders (Garcia-Alvarez and Trillo-Santamaria 2013; Makkonen and Rohde 2016).

Even as it references borders, the CBRIS concept challenges the notion of a 'border'. Makkonen and Rohde (2016) argue that there remains no consensus in the innovation-systems literature as to how an RIS should be delineated. Asheim et al. (2011), the OECD (2013), and Sohn (2014) maintain, however, that borders are becoming 'open and fuzzy' and, as such, the definition of a cross-border region needs to remain flexible, given the unique circumstances and conditions characterizing many cross-border regions. Sohn (2014) further adds that the evolving meaning—and flexible interpretation—of the term 'border' can explain the emergence of cross-border metropolises across the world.

Given the context of this paper—in which we compare a municipality and a highly autonomous region within the same country—we side with Asheim et al. (2011), the OECD (2013), and Sohn (2014) in adopting a flexible view of the definition of the term 'border'. Our conceptualization of the border is, in this regard, not that of a legal border between two nation-states; rather, we conceptualize a 'border' as a delineation of distinctive institutions, cultures, and systems that keep societies functioning through their own mechanisms within administrative boundaries (Hong Kong is a highly autonomous region that runs its own institutions, largely independently, while Shenzhen was designated as China's first special economic zone in 1980). Furthermore, our conceptualization of the 'border' concept also echoes Peck and Mulvey (2016), as they also focused on the sub-state boundary between England and Scotland to illustrate how the emphasis on distinctive societal identities and the shifting historical–political dynamics shaping Scotland's autonomy informed the context of their collaborative cross-border economic development with England.

Our adoption of this broader perspective on borders implies that a border is more than a simple entry/exit barrier. In particular, a border can also be perceived as a resource. In such a conception, borders operate as interfaces, or gateways, from one region to another (Sohn 2014). Over recent decades, Hong Kong has benefitted enormously from these aforementioned—and distinct—roles played by the 'border', namely as both a 'gateway' through which enterprises across the world enter Mainland China and an 'interface' through which their counterparts from Mainland China access the global economy.

According to Coenen et al. (2004), Trippl (2010), and Makkonen and Rohde (2016), cross-border policy actors must complete five policy tasks to establish a CBRIS: (1) socialize the public to embrace the benefits of a CBRIS, (2) promote the creation of a 'regional identity', (3) utilize policies to incentivize two-way cross-border knowledge flows, (4) establish bridging organizations (intermediaries) to address existing gaps, and (5) facilitate dialogue between cross-border policy networks and civil society actors.

To be sure, the significance of these policy tasks also depends on other factors, such as the presence of forces that drive collaboration, the type of proximity (Boschma 2005) that characterizes a cross-border region, and the degree of (a)symmetry in regional relations between the places of interest. Although none among Coenen et al. (2004); Trippl (2010), and Makkonen and Rohde (2016) offered insights into the relative weighting or prioritization of these policy tasks (beyond describing them as 'most critical areas of intervention'), we can analyze each of these tasks so as to segregate the relative importance of the five CBRIS-related tasks.

On one end of the spectrum, Tasks 1 and 2—involving socialization and creating a regional identity—relate essentially to the idea of political promotion. As cross-border regions are, by and large, socio-political constructs rather

than political–administrative units (cf. Perkmann and Sum 2002; Gualini 2003), actors expend considerable political capital in promoting the viability of such regional development initiatives. Pursuing Tasks 1 and 2 is fraught with challenges and, therefore, of lesser importance. First, little is gained through political promotion that fails to account for the complexities and institutional preconditions that enhance cross-border flows of knowledge and innovation activities (Koschatzky 2000; Miorner et al. 2017). Second, when localities conceive of the 'regional identity' of a cross-border region as open-ended and multi-layered, they too easily focus narrowly on their own particularities instead of emphasizing their distinctive commonalities in what Lofgren (2008) has described as an 'advertising war'. Third, sensitivities relating to past histories of cross-border regions require institutional entrepreneurship on the part of policymakers that foreground initiatives designed to first address policy-related technicalities, followed by subsequent, more difficult, action that emphasizes cultural skills (Perkmann and Spicer 2007). This process has been described as 'healing the scars of history'.

At the other end of the spectrum, Tasks 4 and 5—involving bridging work and dialogue—encourage communication and cooperation between stakeholders. These tasks, too, seem less important not least because the existing cross-border literature offers a mixed picture of the role of intermediaries or bridging organizations. On the one hand, these organizations have been vital actors in addressing information asymmetries and building cross-border networks as demonstrated by the roles of, for example, clean technology entrepreneurship associations (Kiryushin et al. 2013) and education alliances (Miorner et al. 2017) in the Oresund region. On the other hand, however, such intermediaries more often than not also reflect their localities' interests (Sohn and Giffinger 2015), particularly when regions on two sides of a border have asymmetrical knowledge and resource capabilities. In their case study of the Austria–Slovakia border region, Sohn and Giffinger (2015) demonstrate empirically that regions that promote cross-border collaboration more assertively—through policy networks and interest groups as proxies—may see more benefits tip in their favor. Such findings point to the need for policy coordination and proactive communication between relevant authorities that account for asymmetries in the knowledge capabilities of two bordering regions (Cooke 2005).

That leaves us with Task 3: utilizing policies to incentivize two-way cross-border knowledge flows. Presently, a majority of cross-border regions worldwide—whether in Europe, North America, or Asia—remain regions 'on paper', with limited two-way flows of knowledge, ideas, people, capital, etc. (Perkmann and Sum 2002; Makkonen and Rohde 2016). Simultaneously, though, economic globalization is increasingly accompanied by the widespread regionalization of both formal and informal trade, industrial, and financial activities (Perkmann and Sum 2002), particularly in closely related, but diverse, sectors/industries (Asheim et al. 2011). This phenomenon suggests that a growing number of regions are embracing regionalization, but the role of government policy action—as well as the efficacy of that action—has been insufficiently discussed in the existing literature. Although policies on their own cannot always resolve regional differences, they are also necessary to synchronize cross-border regional collaboration (Hassink et al. 1994). Given the context of our study—the innovation policy landscape on both sides of a border—our focus is firmly on innovation policy. Furthermore, we investigate innovation policy on both sides of a border in light of the dimensions proposed by Church and Reid (1999), including the nature of collaboration, contributions by organizations of interest, and linkages between existing and emerging policy spaces.

2.2 Hong Kong and Shenzhen: a tale of two cities

Hong Kong and Shenzhen make for an interesting case study. They currently rank among the world's largest cross-border metropolises, with a combined population of nearly 20 million (see Table 1 for basic socioeconomic indicators for both cities). Moreover, both cities have been undergoing structural economic transformations; for its part, Hong Kong has ramped up its efforts to move into innovation-oriented activities, while Shenzhen is attempting to move into services more broadly (in addition to its increasingly dominant role in high-technology sectors; see Table 2 for basic innovation indicators for both cities). Finally, despite incorporation in the same country, Hong Kong and Shenzhen differ substantially in regional characteristics, history, culture, economic structure, and performance, as well as socio-political dimensions, especially regarding institutional and governance structures. For example, Hong Kong's legal system continues to reflect the common-law approach, whereas Shenzhen's structures are integrated into mainland China's overall political and legal configurations.

2.2.1 Hong Kong–Shenzhen relations: a brief overview

Wu (1997) offered the first serious account of Hong Kong–Shenzhen economic relations, and most subsequent studies have focused mainly on economic integration (Yang 2004, 2005; Shen and Luo 2013; Shen 2014, 2017) rather than specifically on innovation policies. Overall, these studies have shown that the Hong Kong–Shenzhen relationship was driven initially through a bottom-up process, with Hong Kong manufacturers relocating their low-value-added industrial operations across the border shortly after the opening-up of China in 1979 (Sharif and Tseng 2011). Any relationship between the two governments at the municipal level, however, barely existed; the then-British colonial government communicated only with the central government in Beijing, with little effort made to initiate formal contacts with the Shenzhen municipal government. Structural differences, particularly with regard to the two cities' wide gaps in economic performance and political systems, accounted for the absence of formal contact between authorities in Hong Kong and those in Shenzhen.

Even after the 1997 handover, official contacts between the two governments remained limited. The Bauhinia Foundation Research Centre (BFRC) (2007: 153) described the relationship as 'Shenzhen being enthusiastic, Hong Kong being indifferent'; Shenzhen's government was more proactive in driving the relationship, while the Hong Kong government largely 'took a backseat'. Shen and Luo (2013: 945) characterized this attitude as 'fortress Hong Kong'.

The relationship evolved, however, after 2003 in the aftermath of a years-long economic downturn and the severe acute respiratory syndrome (SARS) health crisis in Hong Kong. It was then that the Comprehensive Economic Partnership Agreement—an economic agreement between Hong Kong and Mainland China—was signed (Shen and Luo 2013;

Table 1. Basic socioeconomic indicators for Hong Kong and Shenzhen (as of 31 December 2017).

Indicator	Hong Kong	Shenzhen
Area (km^2)	1,106	1,997
Population	7,391,700	12,528,300
Population growth rate (%)	0.8	5.2
Unemployment rate (%)	3.1	2.2
GDP (billions HK$)	2,661	2,621
Per-capita GDP (HK$)	359,996	213,874
Major (top 4) industrial sectors (% GDP; rounded to closest whole %)	1. Import/export, wholesale, and retail (22%) 2. Financing and insurance (19%) 3. Public administration, social, and personal service (18%) 4. Real estate, professional, and business services (11%)	1. Manufacturing (39%) 2. Financial intermediation (13%) 3. Wholesale and retail sales (11%) 4. Real estate (8%)
Gross exports (billions HK$)	3,876	1,931
Gross imports (billions HK$)	4,357	1,341
Share of tertiary/service sector in GDP (%)	92.2	58.5
Local language(s)	English/Cantonese	Cantonese/Mandarin

Sources: Hong Kong Special Administrative Region Government (HKSARG) (2018) and Shenzhen Municipal Government (2018).

Table 2. Innovation-related indicators for Hong Kong and Shenzhen (as of 31 December 2017, or for the year 2017, unless otherwise indicated).

Indicator	Hong Kong	Shenzhen
Innovation inputs		
R&D spending (% GDP)	0.80	4.34
R&D spending (billions HK$)	21.32	105.83
Number of full-time equivalent (FTE) R&D personnel	29,846	281,400
R&D personnel as % of population (%)	0.40	2.25
Innovation outputs		
Number of patents granted by USPTO	1,335	3,285
Top 3 patent assignees for USPTO patents filed over the period 2001–2015	1. SAE Magnetics (local firm) 462 (6.1%); 2. ASTRI (local research institute) 337 (4.5%); 3. HKUST (local university) 314 (4.2%). (*n*: 7,545)	1. Hon Hai-Foxconn (nonlocal firm) 6,907 (34.7%); 2. Huawei (local firm) 4,756 (23.9%); 3. ZTE (local firm) 2,475 (12.4%). (*n*: 19,909)
Comparison of innovation performance: Citations for USPTO patents filed over the period 2001–2015	All firms: 5.92 (*n*: 7,545); Local firms: 5.68 (*n*: 2,875); Foreign firms: 6.07 (*n*: 4,670)	All firms: 1.82 (*n*: 19,909); Local firms: 0.96 (*n*: 11,205); Foreign firms: 2.92 (*n*: 8,704)
Number of scientific papers published	11,638	2,676
High-technology start-ups	51	85

Sources: Hong Kong Special Administrative Region Government (HKSARG) (2018); Shenzhen Municipal Government (2018); United States Patent and Trademark Office (USPTO) (for patent data); Lens.org (for scientific papers); Crunchbase (for high-technology start-ups).
Notes: ASTRI = Applied Science & Technology Research Institute. To calculate the absolute amount of R&D spending for Shenzhen, we converted the CNY values to HKD using 1 CNY = 1.08 HKD. The absolute amount of R&D for Hong Kong and Shenzhen were based on the current market values reported by the governments in accordance with the years in which the yearbooks were published. For 'high-technology start-ups', we refer to active organizations that were founded in 2017, received funding at any stage (seed, early-stage, and late-stage), were headquartered in the respective cities, and listed in Crunchbase.

Shen 2014, 2017). This was followed by the first annual government-to-government Hong Kong–Shenzhen Cooperation Forum in 2006 and the signing of the Shenzhen–Hong Kong Innovation Circle in 2007, which included several proposed areas of cross-border innovation policy coordination between the two cities (Bauhinia Foundation Research Centre (BFRC) 2007).

2.2.2 The development of an innovation policy framework in Hong Kong

A considerable body of scholarship discusses the state and evolution of Hong Kong's innovation system (Leung and Wu 1995; Sharif and Baark 2005; Sharif 2006; Sharif and Baark 2008; Fuller 2010; Sharif 2010; Tsui et al. 2015). In general, these authors acknowledge the Hong Kong government's largely laissez-faire attitude toward promoting innovation, given the city's long-standing status as a trade entrepôt. The colonial-era government established several agencies to boost productivity in Hong Kong enterprises (e.g. the Hong Kong Productivity Council), but there was no official framework for innovation policies in the city prior to 1997.

Formal governmental efforts to actively develop Hong Kong's innovation system materialized in 1998 (Sharif 2006). Several studies have identified problems faced by Hong Kong in developing its innovation system (Sharif and Baark 2005; Sharif 2006; Fuller 2010; Sharif 2010). First, government intervention is largely reactive (providing assistance only

when necessary). Second, the government's approach to innovation policy has been characterized as 'too little, too late' (Sharif and Baark 2005: 475). Third, there is a chronic lack of policy coordination across government agencies (Baark and So 2006).

2.2.3 The development of an innovation policy framework in Shenzhen

Scholarship on the innovation system in Shenzhen is considerably more limited than that on Hong Kong's innovation system, and the coverage is also relatively more recent. Much extant scholarship is comparative, as it situates Shenzhen in relation to other major Chinese cities. Chen and Kenney (2007) and Breznitz and Murphree (2011) conducted comparative analyses of Shenzhen with Beijing and Shanghai, respectively. Mao and Motohashi (2016) compared the performance of Tsinghua University business incubators in Beijing and Shenzhen. Yang (2014, 2015) focused on the 'developmental-state' approach in Shenzhen, through which it supports strategic emerging industries. Chen and Ogan (2017) provided descriptive profiles of Shenzhen's major 'national champions', namely BYD, DJI, Huawei, and Tencent. Liu and Cai (2017) discuss the stages of its Triple Helix dynamics.

A main takeaway from these studies is that although Shenzhen, in contrast to Hong Kong, adheres closely to the central government's policy directions regarding science, technology, and innovation, the city is allowed some degree of autonomy in formulating local policy measures in accordance with local conditions so long as they broadly align with the central government's directions. According to Yang (2014, 2015), Shenzhen's innovation policy framework resembles the 'top-down developmental-state' approach, in which the government is actively involved in setting the direction for certain sectors—mostly high-technology industries—into which the city then directs substantial investments. This is echoed by Prud'homme (2016) in his analysis of the adoption and implementation of local government plans based on central government directives.

3. Methodology

HCA entails generating a hierarchy of clusters by identifying unique and common values from observations in a dataset by 'merging' common values and 'splitting' unique values into groups—and subgroups—of clusters. HCA is used to determine taxonomic associations between observations in a dataset based on variables that share similarities. While HCA has been used to examine policy typologies in social welfare (cf. Saint-Arnaud and Bernard 2003) and environmental/transport policy (cf. Tapio 2003), it has so far never been used to examine innovation policies.

In this study, we utilized HCA to analyze Hong Kong's and Shenzhen's innovation policy priorities.[1] The analysis helps us answer our first research question regarding similarities and differences between the two governments' innovation policies.

HCA provides several advantages. First, through the typologies presented in the resulting HCA-generated dendrograms—diagram trees that describe taxonomic associations between observations—we are able to identify areas of interest the two governments prioritize. Second, by comparing and contrasting the dendrograms of the resulting clusters, we are able to identify similarities and differences between the two governments' innovation policies. Third, and in relation to our second research question on policy coherence, the dendrograms enable us to observe the degree of policy overlap between various government agencies.

Table 3. Innovation policy instruments based on the EU classification system.

Key policies	Key framework conditions–related policies
• R&D policies • Industrial and SME policies • Education and skills policies • Regional and cohesion policies	• Financial support • State assistance and tax policies • Public procurement • Competition policies • Regulatory frameworks • Standardization regimes • Intellectual property rights • Partnerships and coordination initiatives • Innovation culture incentives

Source: European Parliament (2016).

As a research method, HCA is also subject to several limitations. First, it offers only an approximate categorization of the thematic landscape of the observations being studied. Second, the method does not consider the possibilities of policy changes throughout the period of analysis (that said, our detailed observations of policy documents revealed no apparent substantive shifts in policy content and/or implementation with respect to polices covered in our study period). Third, this method may suffer from clustering errors for a small proportion of the observations whereby a small number of observations may be 'misplaced' in categories that do not necessarily fit with their descriptions (Witt et al. 2018). Fourth, it is impossible to measure the degree of influence of distinct agencies and policies, given the absence of benchmarking standards for evaluating policy outcomes across institutional settings (McCann and Ortega-Argiles 2013). As such, we cannot rule out the possibility that some agencies may be more important and influential than others.

We collected our data from September through December 2018 from government agency websites in Hong Kong and Shenzhen. We focus on innovation policies formulated by both governments from 1 January 2013 through 31 December 2018 (i.e. a 6-year period). We identified and determined which innovation policies are relevant/irrelevant by relying on the EU Innovation Policy Classification System, given its broad conceptualization of innovation policy tools, the details of which we provide in Table 3. If a Hong Kong or Shenzhen policy that we identified was related to one of the 'key policies' and/or 'key framework conditions–related policies' (from the EU classification system), we deemed that policy relevant; other policies were omitted.

Using the EU criteria listed in Table 3, we identified 112 innovation-related policies formulated by 23 government agencies in Hong Kong as well as 98 such policies formulated by seven government agencies in Shenzhen. We assessed the validity of the policy documents by applying a face validity check to ensure that the identified policies promote, support, and/or regulate the transformation of an idea and/or invention by relevant stakeholders into a value-added good and/or service for its beneficiaries. The full lists of the

agencies are shown in Appendix Tables A.1 and A.2 in the Appendix.

In conducting our HCA, we generated matrices comprising the observations of interest and variables using the following two-step process. First, we reviewed policy documents collected from government agency websites. Then, following the methods employed in Lee and Song (2007), Saint-Arnaud and Bernard (2003), and Witt et al. (2018), we summarized the documents by creating a series of dummy variables based on observable characteristics of the policy documents using three main criteria: (1) which agency formulates the policies, (2) at whom and/or at which sectors the policies are aimed, and (3) the content of the policies. By way of illustration, if a policy is specifically aimed at a certain industry, say, biotechnology, we assigned 1 to the variable in that policy and 0 to others that do not cater to this sector.

Progressively, we added as many dummies as possible given the diverse characteristics of these policies, such as types of funding/support/other resources offered, what kinds of entities are eligible to benefit from the policies, whether the policies support the incubation of high-technology firms, whether they are intended to support only for-profit organizations or their nonprofit social welfare-oriented counterparts as well, and so on. Using this approach, we generated 110 binary variables for the Hong Kong case and 113 for the Shenzhen case.[2]

Some scholars have expressed concerns that cluster analysis results rely on too many variables (cf. Steinbach et al. 2004), in particular, when the number of binary variables exceeds the number of available observations, so we reduced the number of dummy variables by reclassifying them into a simplified, more generalized set of categories. First, we removed those with the lowest degree of relevance to the observations (i.e. when more than 90 percent of binary variables are '0s' or when the variables describe ambiguous features—i.e. a dummy variable representing 'asking for clear deliverables'). Second, we combined variables whose attributes are closely similar. For example, in the case of Shenzhen, we found 11 dummy variables that pertain to the 'innovation intermediary' category alone (such as dummies for technology business incubators, enterprise technology centers, public technology service platforms, industrial parks, etc.); we combined all of them into a single 'innovation intermediary' dummy.

Using this approach, we were able to reduce the number of binary variables to 43 for Hong Kong and 27 for Shenzhen. We kept more finalized binary variables for Hong Kong than for Shenzhen because we retained the implementation agency dummies; as shown in Table A.1 in the Appendix, Hong Kong has a larger number of agencies responsible for innovation policies.

The HCA analysis was conducted using R software, by which the dendrograms were generated. The algorithm we used was Ward's linkage (Mooi et al. 2018).[3] Ward's linkage optimizes the degree of within-cluster variance (or within-cluster homogeneity) by limiting the increase in variance value to minimize the possibility of homogeneity bias (i.e. when in-group members are perceived to be more diverse than those in the out-group).[4]

Given that all our variables are binary, we measured the degree of dissimilarity (i.e. differentiation) between observations using squared Euclidean distance. Squared Euclidean distance is a method suitable for differentiating observations when Ward's linkage algorithm is utilized. The lower the resulting dissimilarity score, the less differentiated the observations (an indication that the policies, although clustered, have considerable overlap and are more difficult to differentiate).

To estimate the optimum number of clusters, we used the Duda–Hart Index (Milligan and Cooper 1985) as recommended by Witt et al. (2018), given its suitability for large-scale datasets (those with four or more clusters) in particular.[5]

Finally, analyzing the dendrograms also allowed us to uncover areas of opportunity for innovation collaboration between Hong Kong and Shenzhen. These areas of common interest were revealed by (1) reviewing the dendrograms from both Hong Kong and Shenzhen; (2) screening each of the policy names, as listed in both dendrograms, and reviewing the summaries of these policies, with a particular focus on policy areas covered and the beneficiaries of the policies; (3) matching and categorizing the policies—and their related clusters—into areas of potential collaboration when these policies share similar objectives and goals; and (4) labeling these areas based on their common policy objectives. Figure 1 provides a flowchart-based summary to explain, from start to finish, the steps of our methodological approach.

4. Findings

The results we obtained using the HCA method are visualized in the dendrograms displayed in Figs 2 and 3. The contents of the clusters are further elaborated in Table 4 from the top to the bottom of each figure. In the same table, we also highlight the differences, similarities, and opportunities to generate complementarities in innovation policies between the two cities. Specific to complementarities, these findings will be further discussed in the subsection on areas in which Hong Kong and Shenzhen could collaborate.

4.1 The Hong Kong case

The results of the cluster analysis of innovation policies in Hong Kong are presented in the dendrogram displayed in Fig. 2.

We summarize our findings for Hong Kong below:

- *Clusters are numerous and fragmented*: Here, we use the dendrogram to highlight taxonomic associations between innovation policies that can then be used to identify clusters (i.e. areas of interest on which the government focuses). The dendrogram in Fig. 2 shows that the framework of innovation policies in Hong Kong is highly fragmented.[6] These results are consistent with Sharif (2006, 2010) and Fuller (2010) insofar as there is a lack of coordinated direction for the development of innovation policies across agencies. The high number of clusters is not merely a function of the large number of government agencies in the city; rather, it reflects the lack of coordinated direction in the government's innovation policy framework priorities.[7]
- *Differentiation between the clusters is low*: The squared Euclidean distance, given the optimum number of clusters (at 20), is only slightly above 3. This indicates that, at this number of clusters, the degree of differentiation between policies is low. In other words, the extent to

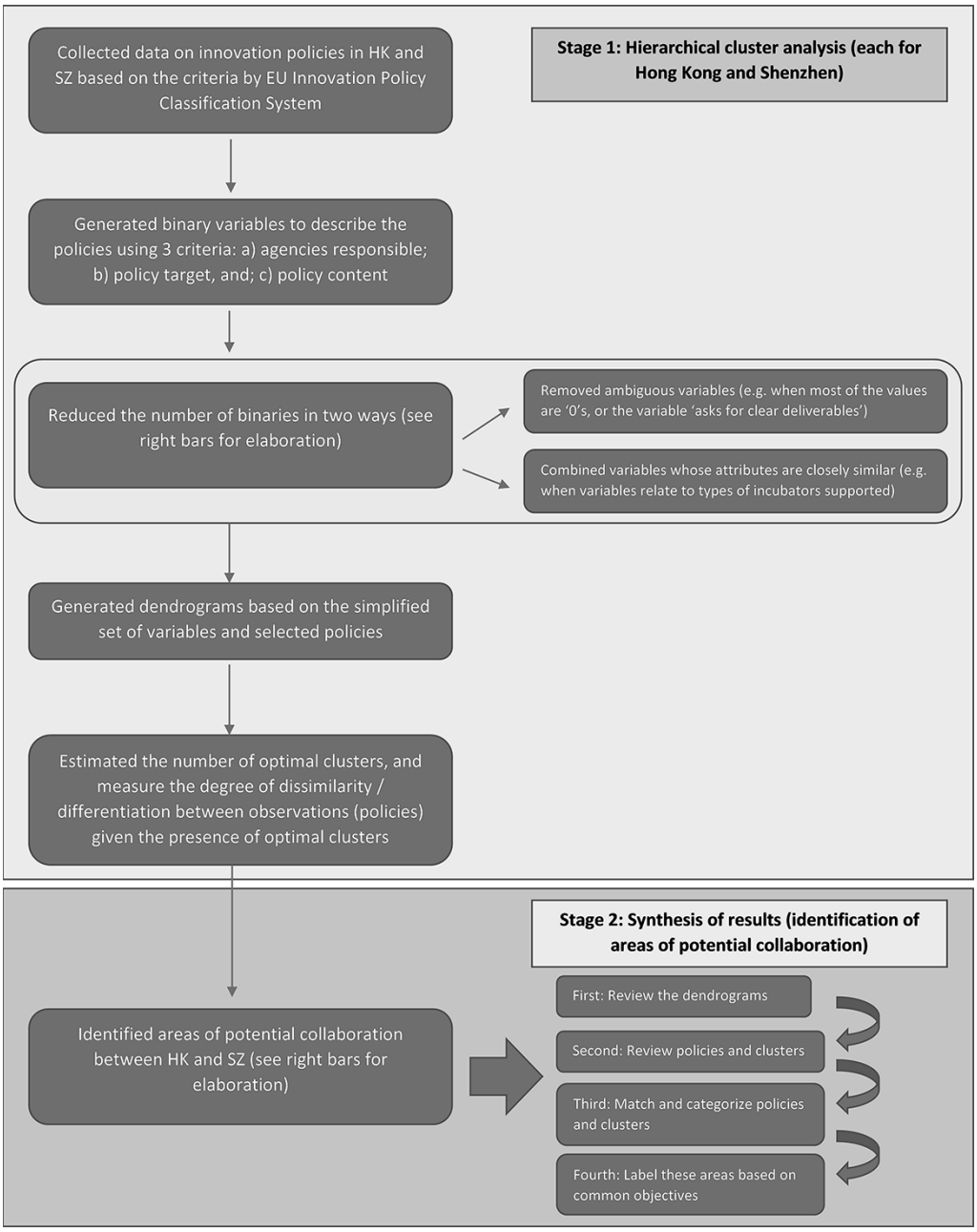

Figure 1. Summary of the methodological approach to CBRIS analysis.

which innovation policies under separate agencies overlap is high.

- *There is a pattern of 'parallel developments' across the agencies involved*: This trend occurs as a result of what we observe as the 'high-fragmentation, low-differentiation' nature of the dendrogram. This indicates that, in many an individual case, multiple agencies develop their own approaches (high fragmentation) to the same innovation policy objective. Such fragmentation is attributable to the absence of a 'big picture view'. Such a lack has led to 'innovation bottlenecks that Hong Kong has been unable to break through' (Fuller 2010: 2). On the other hand, the degree of differentiation across their implementation plans is not very high (low differentiation).[8]

4.2 The Shenzhen case

The results of the cluster analysis of innovation policies in Shenzhen is presented in the dendrogram displayed in Fig. 3.

Our findings for Shenzhen are summarized below:

- *Clusters are fewer and highly concentrated*: The dendrogram displayed in Fig. 3 demonstrates that the clusters in Shenzhen are considerably less fragmented than those in Hong Kong as there are fewer clusters. The overall pattern shows a strongly hierarchical ordering of the taxonomy trees, indicating that the policies—driven by a clear, top-down policy formulation framework—exhibit a high degree of targeted concentration. In other words, the division of responsibilities related to the objectives the policies aim to achieve is clearly outlined.[9]

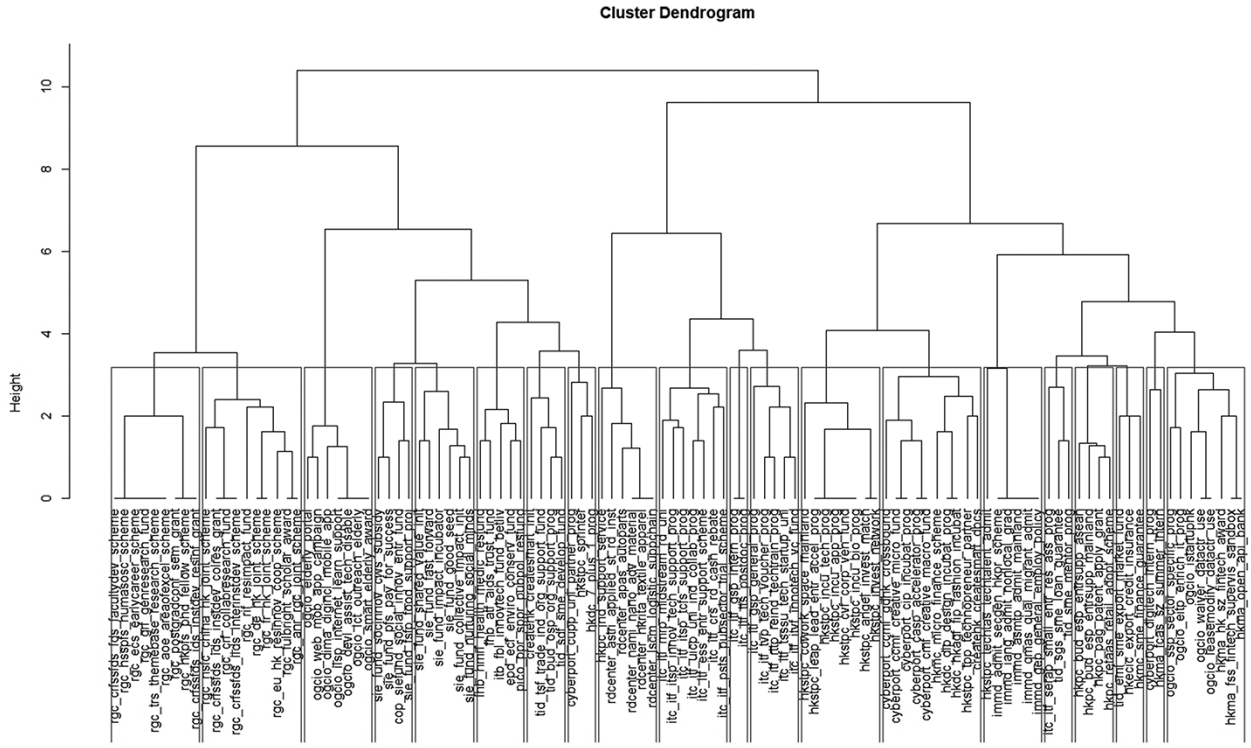

Figure 2. Dendrogram of clusters of innovation policies in Hong Kong.

- *Differentiation between the clusters is high*: Using the Duda–Hart Index, we find that the optimum number of clusters for the Shenzhen dendrogram (Fig. 3) is seven. Its squared Euclidean distance—slightly above 5—is considerably higher than Hong Kong's, an indication that at this number of clusters, there is a higher degree of differentiation—and thus less overlap—across the clusters. This could be explained by the relatively centralized—and highly targeted—framework of innovation policies at the municipal level: Shenzhen has fewer government agencies involved in crafting innovation policies.
- *There is overlap among government agencies in certain clusters, but the overall division of duties is clear*: Here, we identified three clusters in which the agencies pursue overlapping agendas but the task division is clear. First, the cluster relating to 'funding incentives for talents', SZHRSS, focuses on providing welfare services for talented individuals and their families, regardless of their areas of expertise, while SZSTI's scope largely encompasses talented individuals related only to STI areas. Second, in the 'intellectual property rights' cluster, SZIPR handles IPR registration, while SZSIA involves processing software-related IPR and certification processes for Shenzhen-based software firms. Third, with regard to the 'enterprise competitiveness (non-technical)' cluster, SZSME provides assistance services for SMEs, mostly in financing (and to a lesser extent in business operations), while SZDRC operates subsidy schemes to attract firms from outside Shenzhen to establish headquarters in the city.

Our analysis of the dendrograms also allows us to uncover four areas of activities related to innovation collaboration between Hong Kong and Shenzhen (despite their vastly different approaches to innovation policy formulation): (1) talent recruitment from overseas; (2) joint R&D in science, technology, and innovation; (3) enterprise competitiveness; and (4) support for start-up development. In Table 5, we summarize the four collaboration areas, clusters of innovation policies (from both cities), and agencies in both cities that are involved. We elaborate on each of these areas in the next section.

5. Discussion: opportunities for collaboration, challenges, policy-related and theoretical implications

We observe several contrasting patterns in the dendrograms our HCA generated. To summarize: Hong Kong's innovation policy agenda is fragmented (as it involves a very large number of government agencies with their own separate agendas) and overlapping (in that they follow nearly similar implementation plans with limited differentiation, as shown by the support for the start-up development case). The evidence of 'separate agendas' is further strengthened by our qualitative, systematic reviews of the agencies' vision and mission statements posted on their websites. Shenzhen's innovation policy agenda is targeted and highly sector specific, which explains its greater differentiation and relatively low fragmentation. Our robustness check—in which the agency dummy variables are excluded from our consideration—confirms that there are more policy clusters in Hong Kong (with the corresponding greater fragmentation) than in Shenzhen (and

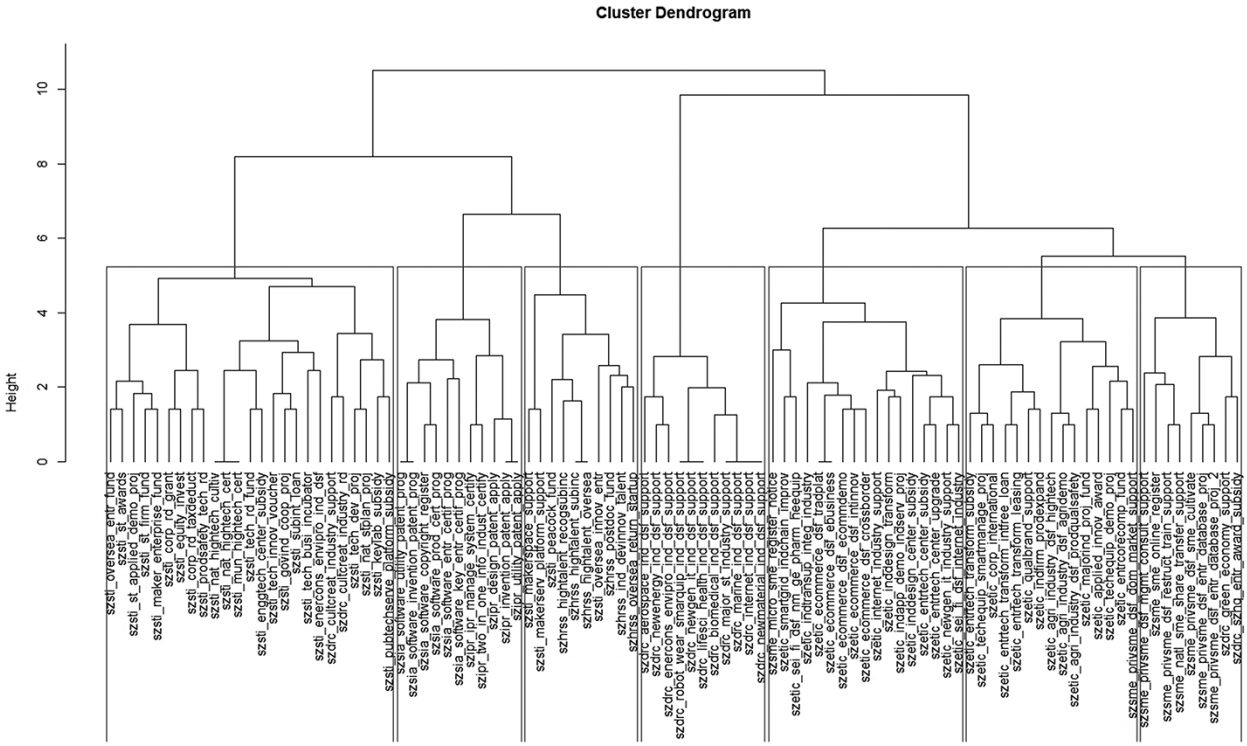

Figure 3. Dendrogram of clusters of innovation policies in Shenzhen.

excludes the possibility that our findings are simply a function of there being more agencies in Hong Kong than in Shenzhen).

What do these findings imply for Hong Kong–Shenzhen relations in the context of the CBRIS concept? If we apply Lundquist and Trippl's stages-of-integration model (2013), we observe that the current CBRIS that includes the two cities is weakly integrated (i.e. it corresponds to Stage 1 as shown in Table 6). Nonetheless, there are some aspects in the two cities' relationships that closely resemble 'Stage 2'.

For their part, agencies in Hong Kong have begun to offer incentives to build linkages with their Shenzhen counterparts in innovation-related areas, but the effort remains hampered by a lack of coordination and the existence of Hong Kong's separate, parallel, and unconnected policy agendas. This is further compounded by low social acceptance of the notion of building a common cross-border region (i.e. the GBA initiative). Hong Kong's advantage—given its positional advantage as described by Sohn (2014)—also turns out to be a vulnerability: as Shenzhen's ambition to be an innovation hub continues to grow, and it is steadily closing in on its economic and technological capability gaps relative to Hong Kong, Hong Kong's advantages are diminishing.

Given this, the existing framework of the two cities' relationship needs to be redefined, an objective for which the GBA initiative was introduced. In reference to our prior discussion of the need to prioritize policy initiatives over the other policy tasks, cross-border synchronization can first be initiated through the harmonization of the policy landscapes on both sides of the border, followed by building mutual communication channels through cultural skills (Perkmann and Spicer 2007). Our study of the innovation policy landscape within both Hong Kong and Shenzhen is one step toward highlighting the opportunities for building a coherent CBRIS by overcoming the challenges, particularly within the GBA context.

5.1 Opportunities for collaboration

As noted in the previous section, despite the contrasting patterns, we can identify four areas with considerable potential for driving collaboration between Hong Kong and Shenzhen.

- *Talent recruitment from overseas*: Here, we see significant potential for the two cities to collaborate in facilitating easier mobility to enable talents to move between Hong Kong and Shenzhen. Indeed, talent mobility is one of the areas addressed in the GBA initiative (as the plan calls for implementing policies relating to immigration, customs clearance, employment, and residency and encourages interaction and exchanges between technological and academic talent). Nonetheless, given the vastly different interests of the two governments, it is also possible that such a scheme may instead generate heightened competition, or even conflicts of interest, rather than the projected benefits. Differences between legal systems and taxation as well as technology standards may impose significant barriers to such exchanges. At present, Hong Kong and Shenzhen are in the process of building a joint science and technology park, the 'Lok Ma Chau Loop'. In this scheme, talents from the two cities working in the zone may enjoy special access to cross-boundary mobility between Hong Kong and Shenzhen. It is projected that the park will

Table 4. Clusters identified from Hong Kong and Shenzhen dendrograms

Hong Kong		Shenzhen	
Cluster name	Agencies involved	Cluster name	Agencies involved
Research funding for universities	RGC	Funding and other support for applied R&D- and S&T-related activities	SZSTI
Research funding for universities (nonlocal and intersectoral collaboration)	RGC	Intellectual property rights (IPR)	SZSIA SZIPR
ICT development and application for social welfare support	OGCIO	Funding incentives for overseas returnees and talents and start-up activities	SZSTI SZHRSS
Social innovation and entrepreneurship (investment and/or subsidies for social enterprises)	SIE Fund	Strategic emerging industries	SZDRC
Social innovation and entrepreneurship (research on social welfare issues)	SIE Fund	Enterprise competitiveness (technical, related to ICT industries)	SZETIC
Research funding (various purposes)	FHB ITB EPD PICO	Enterprise competitiveness (technical, related to non-high-tech industries)	SZETIC
Government funding support for trade and industry organizations	TID	Enterprise competitiveness (nontechnical, mainly for SMEs)	SZSME SZDRC
General training programs and workshops	Cyberport HKSTP HKDC		
R&D intermediaries	HKPC ASTRI APAS NAMI HKRITA LSCM		
Applied R&D and technological innovation (intersectoral collaboration, involving universities, industries, and government)	ITF		
Applied R&D and technological innovation (research employment)	ITF		
Applied R&D and technological innovation (investment and other resource support for technology commercialization)	ITF		
Incubation support for start-ups (specific to HKSTP)	HKSTP		
Incubation support for start-ups (non-HKSTP)	Cyberport HKMC HKDC CreateHK		
Visa schemes to attract talent	HKSTP Cyberport ImmD		
Financing schemes for enterprises	ITF TID		
Enterprise competitiveness and upgrading	HKPC		
Financing schemes for enterprises (export and import activities)	TID HKECIC HKMC		
Internship program at start-ups	Cyberport HKMA		
ICT development (for enterprise competitiveness and skill enrichment)	OGCIO HKMA		
Internal overlaps between clusters (Hong Kong) • Research funding for universities • Social innovation and entrepreneurship • Applied R&D and technology innovation • Incubation support for start-ups • Financing schemes for enterprises		*Internal overlaps between clusters (Shenzhen)* • Funding by SZSTI (for applied R&D, S&T-related activities, returnees, and start-up activities) • Enterprise competitiveness	
Differences in innovation policies between the two cities • Research funding: primarily for universities • ICT development: mainly for social welfare • Support for social innovation and entrepreneurship initiatives • No targeted support for specific industries similar to that observed in mainland China • Talent attraction: through visa scheme		• Research funding: primarily for enterprises • ICT development: for firm competitiveness • No explicit support for social innovation and entrepreneurship initiatives • Targeted support for specific industries through 'strategic emerging industries' • Talent attraction: through funding incentive	

(continued)

Table 4. (Continued)

Hong Kong		Shenzhen	
Cluster name	Agencies involved	Cluster name	Agencies involved
Similarities in innovation policies between the two cities			
• Support for applied R&D and technological innovation involving enterprises			
• Incubation and funding support for technology start-ups			
• Policy measures to promote enterprise competitiveness			
Complementarities in innovation policies between the two cities			
• Talent attraction		• Promoting enterprise competitiveness	
• Support for R&D and other S&T activities		• Support for technology start-ups	

Table 5. Opportunities for Policy Collaboration between Hong Kong and Shenzhen.

Common collaboration area	Clusters of innovation policies (HK)	Agencies involved (HK)	Clusters of innovation policies (SZ)	Agencies involved (SZ)
1. Talent recruitment from overseas	Visa schemes to attract talents	ImmD, HKSTP Cyberport	Funding incentives for overseas returnees and talents and start-up activities	SZSTI SZHRSS
2. R&D in science, technology, and innovation	Applied R&D and technological innovation	ITF	Funding and other support for applied R&D- or S&T-related activities	SZSTI
	R&D intermediaries	ASTRI APAS NAMI HKRITA HKPC LSCM		
	Research funding for universities	RGC		
3. Enterprise competitiveness	Enterprise competitiveness and upgrading	HKPC	Enterprise competitiveness (nontechnical, mainly for SMEs)	SZSME SZDRC
	Financing schemes for enterprises	ITF TID HKECIC HKMC	Enterprise competitiveness (technical)	SZETIC
	ICT development (for enterprise competitiveness and skills enrichment)	OGCIO HKMA		
4. Support for start-up development	Incubation support for start-ups	Cyberport HKSTP HKDC HKMC CreateHK	Funding incentives for overseas returnees and talents and start-up activities	SZSTI SZHRSS
	Internship program for start-ups	Cyberport HKMA		

be operational beginning in 2027. Regarding the above talent plan, no further details have been disclosed at this moment.

- *Joint R&D in science, technology, and innovation*: We see considerable potential for Hong Kong and Shenzhen to collaborate, particularly in complementing their comparative advantages.

Areas where collaboration can be further enhanced include cross-border university–industry–research institute linkages, such as collaboration between Hong Kong universities and Shenzhen-based enterprises, and access enabling Hong Kong enterprises to work with research institutes in Shenzhen and vice versa (Wang et al. 2021). Most importantly, the creation of a unified information platform supporting science, technology, and innovation policies in the two cities would be highly beneficial for bridging information gaps relating to science-, technology-, and innovation-related opportunities on both sides of the border.

Having universities as important actors in facilitating CBRIS development would be in line with the findings of scholars such as Cappellano and Makkonen (2019), Van den Broek et al. (2019a), and Van den Broek et al. (2019b), who have demonstrated that universities can contribute to CBRIS development by leveraging their reputations (as teaching and research institutions) and resources (pre-existing scientific and technical capabilities shared with their counterparts or with firms).

Table 6. Status of the Hong Kong–Shenzhen relationship, following the stages-of-integration framework by Lundquist and Trippl (2013).

Stage 1: weakly integrated	Stage 2: semi-integrated	Stage 3: strongly integrated
• Integration is driven primarily by cost differentials (HK factories in SZ are largely on low-value-added sectors) • Very low social acceptance of cross-border regional integration • Persistent wide gaps in institutions, regulatory systems, and socio-cultural values • Actors' strong embeddedness within their innovation system • Lack of mutual trust	• Emergence of regional initiatives to harmonize policies and promote regional integration (GBA initiative) • Growing linkages in scientific and technological areas (presence of HK universities' research institutes and branch campuses in SZ) • Improving physical accessibility (e.g. high-speed rail, cross-border bridges, and connected rail stations)	• None

- *Enterprise competitiveness*: Technology adoption constitutes another promising area for collaboration, which could take the form of government incentives to assist firms in both cities. However, 'border-blocking effects' that can impede interfirm collaboration need to be carefully considered (Van den Broek et al. 2018). Additionally, as explained by Cappellano and Makkonen (2020), cognitive proximity is necessary, but not sufficient, in facilitating closer interactions between firms. Differences in technology standards and regulations may also affect such initiatives. As such, cross-border authorities need to examine social and institutional proximity and find ways of overcoming intercultural and infrastructural gaps between the cities to enhance technology adoption.
- *Support for start-up development*: Hong Kong has initiated several policies designed to promote collaboration with their Mainland counterparts (mostly in Shenzhen) in cross-border start-up development. Hong Kong has been driving collaboration efforts in this area, as shown by policy incentives initiated by government agencies such as Cyberport and HKSTP (e.g. the Cyberport Guangdong–Hong Kong Young Entrepreneur Program and the HKSTP Co-Working Space Mainland Collaboration Program). Similarly, Shenzhen has also been very active in start-up support programs, offering incentives to finance either start-ups or incubators (e.g. the Technology Business Incubator Support Program and the Maker Enterprise Project Funding Program). Hong Kong can also learn from Shenzhen to better coordinate its efforts toward overseas talent recruitment and start-up support policies.

5.2 Challenges to further collaboration

Drawing on Trippl (2010), Lundquist and Trippl (2013), and Makkonen and Rohde (2016), as well as the findings of our cluster analysis, we are able to highlight three main challenges that need to be addressed regarding areas with potential for collaboration. These challenges are significant insofar as the GBA initiative—with respect to innovation policy in Hong Kong and Shenzhen—must overcome some 'teething' issues if it is to succeed.

- *Interagency coordination*: The principal obstacles Hong Kong must address involve not only improving coordination across the 20-plus government agencies involved but also communicating proactively with their counterparts in Shenzhen. As shown in Table 5, in all areas of potential collaboration, Hong Kong has more agencies involved than Shenzhen does. Similarly, the challenge to government agencies in Shenzhen is to communicate with their multitudinous counterparts in Hong Kong, each of which has its own distinct policy agenda. Furthermore, there is a need to promote mutual adaptive coordination across multiple government agencies, as each agency may have its own unique understanding of the government's innovation policy framework, as well as divergent interests in terms of implementing the policies (Flanagan and Uyarra 2016; Edler and Fagerberg 2017), which may create a disconnect between the intended policy objectives and the actual policy outcomes (Del Rio and Howlett 2013). Put another way, agencies may interpret policy frameworks differently and, in so doing, reshape the policy frameworks in a way that affects other agencies.
- *Institutional distance*: Another challenge relates to the prevailing institutional distance, given the complex political configuration that characterizes the relationship between Hong Kong and Mainland China. In addition, there are vast gaps between the two cities with respect to other institution-related factors, such as legal systems, taxation regimes, political–economic systems, treatment of IPR, technology and product standardization and certification processes, and so on. For example, an area for potential collaboration identified earlier—talent recruitment from overseas—faces specific challenges that need to be addressed, such as immigration—what sorts of visas or 'special passes' will be acceptable to both sides?; taxation—which taxation regimes should be adopted for mobile talent?'; scope of support—what types of organizations and/or projects are these talents allowed, or not allowed, to work for?; and so on.
- *Mutual trust*: Reflecting vast differences between the institutional structures and mechanisms that operate in Hong Kong and Mainland China, building mutual trust is challenging. Shen and Luo (2013) and Shen (2014) have argued that Hong Kong has been relaxing its 'fortress' attitude to accommodate policy coordination with Shenzhen since the mid-2000s but, at the same time, remains highly polarized when it comes to accepting the notion of building 'a common cross-border region'. Any efforts to create a thriving CBRIS will require trust-building, which by itself necessitates first addressing the issue of institutional distance (Lundquist and Trippl 2013). Furthermore, creating a mutually trustworthy relationship between cross-border regions also necessitates overcoming existing mental and cultural barriers that have prevented collaboration from taking place in the first place (Trippl 2010). Moreover, the current political turmoil affecting Hong Kong since 2019 has put into question

the long-term viability of STI collaboration with Shenzhen and mainland China more broadly. At present, it is premature to make conclusions, given that Hong Kong universities have been involved in the establishment of branch campuses and research institutes, particularly in Shenzhen (Sharif and Tang 2014). We leave this question to future scholars to explore whether the turmoil does affect long-term collaboration.

5.3 Policy implications for the development of CBRIS

While cross-border cooperation depends on a governance process that reflects the dimensions of trust, learning, partnerships, and flexibility, more often than not it also invokes historical tensions and dynamic, constant reconfiguration of distinct actors with differing views and stakes (Sohn and Giffinger 2015). Reflecting the heterogeneity of interpretations and interests among the agencies and actors whose interactions we included in our study, we find that it is increasingly necessary that governments consider aligning stakeholders' diverse interests and to reform policy incentives to complement, instead of contradict, those stakeholders' interests (Edler and Fagerberg 2017). In this regard, strengthening two-way exchanges between stakeholders will be vital to realizing the benefits of a thriving CBRIS. Such efforts entail long-term investments in building regional social capital and embeddedness among stakeholders on both sides (Rutten and Boekema 2007).

Whether or not successful coordination can take place across agencies identified in separate clusters (and thus defragment the structure of the dendrograms) remains an open question. It is possible that innovation policymaking can be less fragmented when multiple agencies (as identified in the clusters, particularly in the Hong Kong dendrogram) improve their coordination. Indeed, fragmentation may further diminish if the Hong Kong government undertakes bolder steps perhaps to merge some existing government agencies given their overlapping functions and duties.

Theoretically, a particular cluster might lack policy coordination. Any given agency may be responsible for multiple areas of policy implementation and delegate the corresponding responsibilities to multiple divisions, potentially creating communication gaps at an intraorganizational level. Nevertheless, at least in the case of Hong Kong, the government has been taking steps—albeit at a slow pace—to improve the policy coordination process within and between the agencies concerned (cf. Sharif and Baark 2005).

6. Conclusions

This study's detailed analysis of policy documents and its application of HCA methodology contribute several interesting findings to the field of innovation policy. First, we fill an empirical gap in the existing literature on CBRIS by applying the concept to a cross-border region in Asia, namely the Hong Kong/Shenzhen region. Our definition of 'border'—which aligns with Sohn's (2014) and Peck and Mulvey's (2016) definitions—does not in this case denote administrative borders between two nation-states but rather the delineation of distinctive institutions, cultures, and systems that keep societies functioning using their own mechanisms within national administrative boundaries.

Second, to assess the existing status of a CBRIS in Hong Kong and Shenzhen, we analyzed innovation policy frameworks in the two cities and visualized their structures through cluster analysis. The application of cluster analysis to innovation policies in a CBRIS represents the application of an existing methodology to a new empirical setting. We have used the dendrograms generated by our HCA to show that there remain considerable gaps between the innovation policy agendas of Hong Kong and Shenzhen. Regarding Lundquist and Trippl's (2013) stages-of-integration model, we show that the CBRIS between Hong Kong and Shenzhen is at best weakly integrated (i.e. it is a Stage-1 CBRIS).

Third, our cluster analysis enabled us to identify four areas of opportunity for collaboration and three sets of challenges that both governments must address to bring about a thriving CBRIS. Based on all of the above, we are able to discuss the policy implications of CBRIS development in Hong Kong and Shenzhen, based on policy tasks suggested by Coenen et al. (2004), Trippl (2010), and Makkonen and Rohde (2016).

Regarding our two research questions, we find, first, that Hong Kong's and Shenzhen's innovation policies are markedly different from one another. Hong Kong's innovation policies are multitudinous, fragmented, and overlapping, whereas Shenzhen's polices are more specifically targeted and more clearly differentiated. Second, to develop a Hong Kong–Shenzhen CBRIS more expeditiously, we identify four areas where the two cities might achieve innovation policy coherence: talent recruitment, joint R&D activities, enterprise competitiveness, and support for start-ups.

Our study is not, however, without its limitations. First, our analysis does not include within its scope the forging of relationships between cross-border innovation policy governance processes in Hong Kong and Shenzhen. Rather, this study provides a comparative analysis of existing innovation policy frameworks within each of the two cities. Second, the HCA method applied to the existing policies does not capture policy dynamics over time. In this sense, we share Flanagan and Uyarra's (2016) concern with the tendency of innovation scholars to analyze policies in an atemporal manner. Over time, some policies in our datasets may become less relevant owing to various factors, such as electoral cycles, budget constraints, and shifting priorities, while other, newer, government initiatives may substantially reshape the overall policy framework. Third, absent from our work is an in-depth qualitative observation of how agencies shape and/or reshape policy frameworks based on their perceptions and articulations of interests.

Our findings also fail in some ways to capture the bigger picture: even if the two cities were to achieve full alignment of their innovation and technology policies, it remains possible that full regional integration resulting in a CBRIS may not be achieved. Incomplete or ineffectual integration could still exist as a result of underexploited synergies, such as gaps in cognitive/social/institutional proximity, power asymmetries, and uneven commitment to mutual success, as well as discrepancies between views regarding institutions, trust, and governance (Gualini 2003). As such, it is important to remember that regional integration is a highly complex, multidimensional process.

The above limitations notwithstanding, based on our findings, we conclude that the GBA initiative—if analyzed narrowly in terms of innovation policy in Hong Kong and

Shenzhen—may well succeed. This effort would not, however, be free of challenges. The CBRIS concept enables us to frame the empirically grounded GBA initiative theoretically, helping us identify and analyze areas of overlap, opportunities for collaboration, and obstacles to future success. This exercise we have conducted is the first to be completed in the context of the GBA. Our results show that the GBA initiative can be interpreted as either prescient on the part of the Chinese authorities or as a continuation along a road to collaborating on innovation policies between the two cities that they have been traveling with no apparent end in sight for at least two decades.

Funding

The authors gratefully acknowledge funding support from: 1. The Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. HKU C7011-16G); 2. HKUST-NES-SKOLKOVO China-Russia Eurasian Studies Center (CREC) Research Grant 2021; 3. HKUST-Shenzhen Research Institute and Shenzhen Science Technology and Innovation Commission (SZSTI) Research Grant ('Shenzhen Soft Science Funding Scheme', Grant Number RKX20170807173033899).

Conflict of interest statement. The authors declare no conflict of interest involved in the preparation of this manuscript.

Notes

1. Cluster analysis has been utilized in the social sciences in studies ranging from cross-country comparative analyses to citation network analyses to public policy, business management, and innovation studies (cf. Saint-Arnaud and Bernard 2003; Tapio 2003; Kajikawa et al. 2007; Lee and Song 2007; Witt and Redding 2013; Witt et al. 2018).
2. Relying on an extensive list of variables to generate clusters can subject a study to the 'curse of dimensionality' problem (Steinbach et al. 2004). This problem is related to combinatorial explosion—or an exponential increase in the number of possible combinations of a set of variables, particularly with regard to binary variables. Given the massive growth of combinatorial space in the presence of a limited volume of data, the validity of the clustering result may diminish. In other words, if we use precisely all the variables that are mentioned above, we can expect a total of 2^{110} potential combinations in the case of Hong Kong and 2^{113} combinations with regard to Shenzhen. Moreover, a significant proportion of these binary variables are assigned the value of 1 in only a very small number of policies, rendering the clustering analysis futile given the considerably large number of zeros that have been generated.
3. The other algorithm we considered, but did not utilize, was *K*-means (MacQueen 1967), as we have fewer than 500 observations in our dataset (*K*-means is better suited to cases involving 500 or more observations).
4. Our HCA analysis resembled that of Witt et al. (2018) as we used binary variables as our primary units of analysis. While the HCA method has been used in previous studies to analyze binary data (Lee and Song 2007; Witt et al. 2018), concerns have been raised about the validity of the clustering results because HCA is typically conducted only on continuous, instead of discrete, variables. More recent studies, including Tamasauskas et al. (2012), have shown, however, that hierarchical clustering methods can still be useful in analyzing binary data. Rezankova et al. (2011) also found that results obtained from hierarchical clustering and other algorithms were not significantly different from one another.
5. Witt et al. (2018) suggested the Duda–Hart Index because it is more appropriate for determining the optimum number of clusters in large-scale datasets (observations with at least four or more clusters, which is the case with our datasets) rather than the Calinski–Harabasz Index, which is more suitable for smaller datasets with fewer than four clusters.
6. While the default maximum number of clusters that can be optimally generated by the Duda–Hart Index is 15, our observations showed that the 'best' number of clusters represented by this dendrogram is actually 20.
7. To prove that the high number of clusters is not caused solely by the large number of government agencies involved, we performed a robustness check by removing agency dummy variables from both the Hong Kong and Shenzhen datasets and re-ran the cluster analysis using the same methodology. The optimum number of clusters subsequently shrinks to nine for Hong Kong and two for Shenzhen. Despite these considerable declines, the resulting Hong Kong dendrogram still has a higher number of clusters than the dendrogram for Shenzhen. The squared Euclidean distance for the Hong Kong dendrogram, at 4, remains lower than that of the Shenzhen dendrogram, which is nearly 9. In other words, Hong Kong's innovation policy framework remains more fragmented than Shenzhen's.
8. To illustrate our point, we refer to the 'start-up development' clusters. In the dendrogram above, more than two clusters relating to start-up support and development are identified (a cluster solely involving HKSTP, and another cluster not related to this government agency). With regard to this area, five agencies—HKSTP, Cyberport, HKMC, HKDC, and CreateHK—are separately involved in crafting their own implementation plans in terms of start-up creation. Support provided by HKSTP is more sector specific (beneficiaries are entrepreneurs involved in mobile/web app development, biotechnology, or other high-technology products). While the remaining agencies provide support for multiple areas (i.e. Cyberport focuses on IT-related start-ups, with HKDC and CreateHK focusing on creative-industry new firms), their scope of support is constrained to financing support and, to a lesser extent, mentoring. Overall, there appears to be no coherent framework within which to coordinate all these relevant agencies.
9. Again, this finding cannot be interpreted simply as a function of there being fewer agencies in Shenzhen; the municipal government has set clear guidelines specifying what each agency—and its related policy measure(s)—needs to achieve to fulfill the government's policy agenda. As indicated in the previous footnote, our robustness check has shown that the optimal number of innovation policy clusters in Shenzhen—after excluding the agency dummy variables—is still lower than that in Hong Kong. The number of clusters, from the robustness check, is two—namely the cluster consisting of policies designed to support established firms and the cluster comprising policy measures designed to support early-stage businesses (i.e. start-ups), IPR protection, and attracting talent.

References

Asheim, B. T., Boschma, R., and Cooke, P. (2011) 'Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases', *Regional Studies*, 45: 893–904.

—— and Coenen, L. (2006) 'Contextualizing Regional Innovation Systems in a Globalizing Learning Economy: On Knowledge Bases and Institutional Frameworks', *Journal of Technology Transfer*, 31: 163–73.

—— and Gertler, M. (2004) 'The Geography of Innovation: Regional Innovation Systems'. In: J. Fagerberg (ed.) *Oxford Handbook of Innovation*. pp. 291–317. Oxford: Oxford University Press.

—— and Isaksen, A. (2002) 'Regional Innovation Systems: The Integration of Local 'Sticky'and Global 'ubiquitous' Knowledge', *Journal of Technology Transfer*, 27: 77–86.

Baark, E. and So, A. Y. (2006) 'The Political Economy of Hong Kong's Quest for High-Technology Innovation', *Journal of Contemporary Asia*, 36: 102–21.

Bauhinia Foundation Research Centre (BFRC). (2007) *Building a Hong Kong-Shenzhen Metropolis Research Report*. Hong Kong: Bauhinia Foundation Research Centre.

Boschma, R. (2005) 'Proximity and Innovation: A Critical Assessment', *Regional Studies*, 39: 61–74.

Breznitz, D. and Murphree, M. (2011) *Run of the Red Queen: Government, Innovation, Globalization, and Economic Growth in China*. New Haven: Yale University Press.

Cappellano, F. and Makkonen, T. (2020) 'Cross-border Regional Innovation Ecosystems: The Role of Non-profit Organizations in Cross-border Cooperation at the US-Mexico Border', *GeoJournal*, 85: 1515–28.

—— (2020) 'The Proximity Puzzle in Cross-border Regions', *Planning Practice and Research*, 35: 283–301.

Carlsson, B. and Stankiewicz, R. (1991) 'On the Nature, Function and Composition of Technological Systems', *Journal of Evolutionary Economics*, 1: 93–118.

Chen, K. and Kenney, M. (2007) 'Universities/research Institutes and Regional Innovation Systems: The Cases of Beijing and Shenzhen', *World Development*, 35: 1056–74.

Chen, X. and Ogan, T. L. (2017) 'China's Emerging Silicon Valley: How and Why Shenzhen Has Become a Global Innovation Centre', *European Financial Review*, 2017: 55–62.

Church, A. and Reid, P. (1999) 'Cross-border Co-operation, Institutionalization and Political Space across the English Channel', *Regional Studies*, 33: 643–55.

Coenen, L., Moodysson, J., and Asheim, B. T. (2004) 'Nodes, Networks and Proximities: On the Knowledge Dynamics of the Medicon Valley Biotech Cluster', *European Planning Studies*, 12: 1003–18.

Cooke, P. (2005) 'Regionally Asymmetric Knowledge Capabilities and Open Innovation: Exploring 'Globalization 2' – A New Model of Industry Organization', *Research Policy*, 34: 1128–49.

—— Uranga, M. G., and Etxebarria, G. (1997) 'Regional Innovation Systems: Institutional and Organizational Dimensions', *Research Policy*, 26: 475–91.

Crunchbase. *Build Query: Companies*. <https://www.crunchbase.com/search/organization.companies/c20611a556310923f25390456675b935> accessed 28 May 2020.

Del Rio, P. and Howlett, M. P. (2013) 'Beyond the 'Tinbergen rule' in Policy Design: Matching Tools and Goals in Policy Portfolios', *Lee Kuan Yew School of Public Policy Research Paper*, 13–01.

Edler, J. and Fagerberg, J. (2017) 'Innovation Policy: What, Why, and How', *Oxford Review of Economic Policy*, 33: 2–23.

European Parliament. (2016) *EU Innovation Policy – Part II (EU Policies and Instruments Supporting Innovation)*. Brussels: European Union.

Flanagan, K. and Uyarra, E. (2016) 'Four Dangers in Innovation Policy Studies – and How to Avoid Them', *Industry and Innovation*, 23: 177–88.

Freeman, C. (1987) *Technology and Economic Performance: Lessons from Japan*. London: Pinter.

Fuller, D. B. (eds) (2010) *Innovation Policy and the Limits of Laissez-faire: Hong Kong's Policy in Comparative Perspective*. London: Palgrave Macmillan.

Garcia-Alvarez, J. and Trillo-Santamaria, J. (2013) 'Between Regional Spaces and Spaces of Regionalism: Cross-border Region-building in the Spanish 'state of the autonomies'', *Regional Studies*, 47: 104–15.

Gualini, E. (2003) 'Cross-border Governance: Inventing Regions in a Transnational Multi-level Polity', *DisP – The Planning Review*, 39: 43–52.

Hassink, R., Dankbaar, B., and Corvers, F. (1994) *Cross-border Technology Networks in Border Regions? The Case of the Euregion Maas-Rhine*. UNU-MERIT Working Paper No. 2/94-018. Maastricht: UNU-MERIT.

Hong Kong Special Administrative Region Government (HKSARG). (2018), *Hong Kong Annual Digest of Statistics (2018 Edition)*. <https://www.statistics.gov.hk/pub/B10100032018AN18B0100.pdf> accessed 3 Jun 2019.

Kajikawa, Y., Ohno, J., Takeda, Y., et al. (2007) 'Creating an Academic Landscape of Sustainability Science: An Analysis of the Citation Network', *Sustainability Science*, 2: 221–31.

Kiryushin, P., Mulloth, B., and Iakoleva, T. (2013) 'Developing Cross-border Regional Innovation Systems with Clean Technology Entrepreneurship: The Case of Oresund', *International Journal of Innovation and Regional Development*, 5: 179–95.

Koschatzky, K. (2000) 'A River Is a River – Cross-border Networking between Baden and Alsace', *European Planning Studies*, 8: 429–49.

Lee, Y. and Song, Y. (2007) 'Selecting the Key Research Areas in Nanotechnology Field Using Tech Cluster Analysis: A Case Study Based on National R&D Programs in South Korea', *Technovation*, 27: 57–64.

Lens.org. *The Lens Website*. <https://www.lens.org/lens/> accessed 28 May 2020.

Leung, C. K. and Wu, C. T. (1995) 'Innovation Environment, R&D Linkages, and Technology Development in Hong Kong', *Regional Studies*, 29: 533–46.

Liu, C. and Cai, Y. (2017) 'Triple Helix Model and Institutional Logics in Shenzhen Special Economic Zone', *Science and Public Policy*, 45: 221–31.

Lofgren, O. (2008) 'Regionauts: The Transformation of Cross-border Regions in Scandinavia', *European Urban and Regional Studies*, 15: 195–209.

Lundquist, K. and Trippl, M. (2013) 'Distance, Proximity, and Types of Cross-border Innovation Systems: A Conceptual Analysis', *Regional Studies*, 47: 450–60.

Lundvall, B. A., ed. (1992) *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*. London: Anthem Press.

MacQueen, J. B. (1967) 'Some Methods for Classification and Analysis of Multivariate Observations'. In: *Proceedings of 5th Berkeley Symposium on Mathematical Statistics and Probability*, pp. 281–97. Berkeley, CA: University of California Press.

Makkonen, T. and Rohde, S. (2016) 'Cross-border Regional Innovation Systems: Conceptual Backgrounds, Empirical Evidence, and Policy Implications', *European Planning Studies*, 24: 1623–42.

Malerba, F. (2002) 'Sectoral Systems of Innovation and Production', *Research Policy*, 31: 247–64.

Mao, H. and Motohashi, K. (2016) 'A Comparative Study on Tenant Firms in Beijing Tsinghua University Science Park and Shenzhen Research Institute of Tsinghua University', *Asian Journal of Innovation and Policy*, 5: 225–50.

McCann, P. and Ortega-Argiles, R. (2013) 'Modern Regional Innovation Policy', *Cambridge Journal of Regions, Economy and Society*, 6: 187–216.

Milligan, G. W. and Cooper, M. C. (1985) 'An Examination of Procedures for Determining the Number of Clusters in a Data Set', *Psychometrika*, 50: 159–79.

Miorner, J., Zukauskaite, E., Trippl, M., et al. (2017) 'Creating Institutional Preconditions for Knowledge Flows in Cross-border Regions', *Environment and Planning C: Politics and Space*, 36: 201–18.

Mooi, E., Sarstedt, M., and Mooi-Reci, I. (2018) 'Cluster Analysis'. In: E. Mooi, M. Sarstedt, and I. Mooi-Reci (eds). *Market Research (Springer Texts in Business and Economics)*. pp. 313–66. Berlin: Springer.

Nelson, R. R. and Rosenberg, N. (1993) 'Technical Innovation and National Systems'. In: R. R. Nelson (ed). *National Innovation Systems: A Comparative Analysis*. pp. 3–21. New York and Oxford: Oxford University Press.

OECD. (2013) *Regions and Innovation: Collaborating across Borders, OECD Reviews of Regional Innovation*. Paris: OECD Publishing.

Peck, F. and Mulvey, G. (2016) 'Cross-border Collaboration in Economic Development: Institutional Change on the Anglo-Scottish Border', *Journal of Borderlands Studies*, 33: 69–84.
Perkmann, M. (2007) 'Policy Entrepreneurship and Multilevel Governance: A Comparative Study of European Cross-border Regions', *Environment and Planning. C, Government and Policy*, 25: 861–79.
—— and Spicer, A. (2007) 'Healing the Scars of History: Projects, Skills and Field Strategies in Institutional Entrepreneurship', *Organization Studies*, 28: 1101–22.
—— and Sum, N.-L. (2002) *Globalization, Regionalization, and Cross-border Regions*. London: Palgrave MacMillan.
Prud'homme, D. (2016) 'Dynamics of China's Provincial-level Specialization in Strategic Emerging Industries', *Research Policy*, 45: 1586–603.
Rezankova, H., Husek, D., Kudova, P., et al. (2011), *Comparison of Some Approaches to Clustering Categorical Data*. <https://pdfs.semanticscholar.org/d25b/49d3888cef0ea60a8caa0fc80d6b2e44c339.pdf> accessed 28 Feb 2019.
Rutten, R. and Boekema, F. (2007) 'Regional Social Capital: Embeddedness, Innovation Networks, and Regional Economic Development', *Technological Forecasting and Social Change*, 74: 1834–46.
Saint-Arnaud, S. and Bernard, P. (2003) 'Convergence or Resilience? A Hierarchical Cluster Analysis of the Welfare Regimes in Advanced Countries', *Current Sociology*, 51: 499–527.
Sharif, N. (2006) 'An Examination of Recent Developments in Hong Kong's Innovation System: 1990 to the Present', *Science and Public Policy*, 33: 505–18.
—— (2010) 'Rhetoric of Innovation Policy Making in Hong Kong Using the Innovation Systems Conceptual Approach', *Science, Technology and Human Values*, 35: 408–34.
—— and Baark, E. (2005) 'The Tamest of Tigers? Understanding Hong Kong's Innovation System and Innovation Policies', *International Journal of Technology and Globalization*, 1: 462–79.
—— (2008) 'Mobilizing Technology Transfer from University to Industry: The Experience of Hong Kong Universities', *Journal of Technology Management in China*, 3: 47–65.
—— and Tang, H. H. H. (2014) 'New Trends in Innovation Strategy at Chinese Universities in Hong Kong and Shenzhen', *International Journal of Technology Management*, 65: 300–18.
—— and Tseng, M. M. (2011) 'The Role of Hong Kong in Mainland China's Modernization in Manufacturing', *Asian Survey*, 51: 633–58.
Shen, J. (2014) 'Not Quite a Twin City: Cross-boundary Integration in Hong Kong and Shenzhen', *Habitat International*, 42: 138–46.
—— (2017) 'Competition and Cooperation in the Hong Kong-Shenzhen Region'. In: R. Huggins (ed.) *Handbook of Regions and Competitiveness*. pp. 446–62. Cheltenham: Edward Elgar Publishing.
—— and Luo, X. (2013) 'From Fortress Hong Kong to Hong Kong-Shenzhen Metropolis: The Emergence of Government-led Strategy for Regional Integration in Hong Kong', *Journal of Contemporary China*, 22: 944–65.
Shenzhen Municipal Government. (2018), *Shenzhen Statistical Bulletin 2017*. <http://www.sz.gov.cn/zfgb/2018/gb1048/201804/t20180428_11803423.htm> accessed 3 Jun 2019.
Smallbone, D. and Welter, F. (2012) 'Cross-border Entrepreneurship', *Entrepreneurship and Regional Development*, 24: 95–104.
Sohn, C. (2014) 'The Border as A Resource in the Global Urban Space: A Contribution to the Cross-border Metropolis Hypothesis', *International Journal of Urban and Regional Research*, 38: 1697–711.
—— and Giffinger, R. (2015) 'A Policy Network Approach to Cross-border Metropolitan Governance: The Cases of Vienna and Bratislava', *European Planning Studies*, 23: 1187–208.
Steinbach, M., Ertoz, L., and Kumar, V. (2004) 'The Challenges of Clustering High-dimensional Data'. In: L. T. Wille (ed.) *New Directions in Statistical Physics: Econophysics, Bioinformatics, and Pattern Recognition*, pp. 273–309. Berlin: Springer.
Tamasauskas, D., Sakalauskas, V., and Kriksciuniene, D. (2012) 'Evaluation Framework of Hierarchical Clustering Methods for Binary Data'. In: 12th International Conference on Hybrid Intelligent Systems (HIS), pp. 421–26. Pune: IEEE.
Tapio, P. (2003) 'Disaggregative Policy Delphi: Using Cluster Analysis as a Tool for Systematic Scenario Formation', *Technological Forecasting and Social Change*, 70: 83–101.
Tödtling, F. and Trippl, M. (2005) 'One Size Fits All?: Towards a Differentiated Regional Innovation Policy Approach', *Research Policy*, 34: 1203–19.
Trippl, M. (2010) 'Developing Cross-border Regional Innovation Systems: Key Factors and Challenges', *Tijdschrift voor Economische en Sociale Geografie*, 101: 150–60.
Tsui, L., Lun, R., and Cheung, E. (2015) *The Ecosystem of Innovation and Technology in Hong Kong*. Hong Kong: Our Hong Kong Foundation.
United States Patent and Trademark Office (USPTO). *USPTO Patentsview*. <https://patentsview.org/> accessed 28 May 2020.
Van den Broek, J., Benneworth, P., and Rutten, R. (2018) 'Border-blocking Effects in Collaborative Firm Innovation', *European Planning Studies*, 26: 1330–46.
—— (2019a) 'Institutionalization of Cross-border Regional Innovation Systems: The Role of University Institutional Entrepreneurs', *Regional Studies, Regional Science*, 6: 55–69.
—— Eckardt, F., and Benneworth, P. (2019b) 'The Transformative Role of Universities in Regional Innovation Systems: Lessons from University Engagement in Cross-border Regions'. In: A. Varga and K. Erdos (eds) *The Handbook of Universities and Regional Development*. pp. 54–72. Cheltenham: Edward Elgar Publishing.
—— and Smulders, H. (2015) 'Institutional Hindrances in Cross-border Regional Innovation Systems', *Regional Studies, Regional Science*, 2: 116–22.
Wang, J., Chandra, K., Du, C., et al. (2021) 'Assessing the Potential of Cross-border Regional Innovation Systems: A Case Study of the Hong Kong-Shenzhen Region', *Technology in Society*, 65: 101557.
Witt, M. A., Kabbach de Castro, L. R., Amaeshi, K., et al. (2018) 'Mapping the Business Systems of 61 Major Economies: A Taxonomy and Implications for Varieties of Capitalism and Business Systems Research', *Socio-Economic Review*, 16: 5–38.
—— and Redding, G. (2013) 'Asian Business Systems: Institutional Comparison, Clusters, and Implications for Varieties of Capitalism and Business Systems Theory', *Socio-Economic Review*, 11: 265–300.
Wu, W. (1997) 'Proximity and Complementarity in Hong Kong-Shenzhen Industrialization', *Asian Survey*, 37: 771–93.
Yang, C. (2004) 'From Market-led to Institution-based Economic Integration: The Case of the Pearl River Delta and Hong Kong', *Issues and Studies*, 40: 79–118.
—— (2005) 'An Emerging Cross-boundary Metropolis in China: Hong Kong and Shenzhen under 'two systems'', *International Development Planning Review*, 27: 195–225.
—— (2014) 'State-led Technological Innovation of Domestic Firms in Shenzhen, China: Evidence from Liquid Crystal Display (LCD) Industry', *Cities*, 38: 1–10.
—— (2015) 'Government Policy Change and Evolution of Regional Innovation Systems in China: Evidence from Strategic Emerging Industries in Shenzhen', *Environment and Planning. C, Government and Policy*, 33: 661–82.

Appendix

Table A.1. List of government agencies/entities responsible for innovation-related policies in Hong Kong.

Agency or entity	Role related to innovation policies
RGC	* Provide research funding to universities * Arrange for research-related exchanges with nonlocal institutions * Finance PhD fellowships * Provide subsidies for the development of research-related infrastructure in universities
ImmD	* Issue visas for nonlocal talents
ITC	* Provide funding for applied R&D activities * Promote public procurement * Invest in young, high-technology firms * Promote industrial upgrading through courses and training
Cyberport	* Incubate high-technology firms * Provide entrepreneurship-related training * Provide office space for high-tech firms
HKSTP	* Incubate high-technology firms * Provide entrepreneurship-related training * Provide office space for high-tech firms
OGCIO	* Promote ICT applications for social welfare services * Promote ICT through assistance on small businesses and training courses in schools * Regulate data centers in Hong Kong
SIE Fund	* Operate as a platform for social innovation and entrepreneurship * Conduct research on social issues in Hong Kong
ITB	* Main coordinating body on innovation policies in Hong Kong * Parent agency for ITC
ASTRI	* An ITC-designated R&D Center * Conduct applied R&D, mainly in electronics and ICT
LSCM	* An ITC-designated R&D Center * Conduct applied R&D in logistics/supply chain operations * The center is hosted by HKU, CUHK, and HKUST
APAS	* An ITC-designated R&D Center * Conduct applied R&D in automotive parts and accessories * The center is hosted by the HKPC
HKRITA	* An ITC-designated R&D Center * Conduct applied R&D in textiles-related areas * The center is hosted by PolyU
NAMI	* An ITC-designated R&D Center * Conduct applied R&D in material sciences
TID	* Support the development of SMEs in Hong Kong * Provide funding support for nonprofit organizations related to industry associations
HKMA	* Regulate financial technology–related (fintech) matters
HKDC	* Incubate design-related start-ups * Provide funding for design industry–related implementation projects
HKPC	* Conduct applied R&D in high-technology sectors * Assist in technology adoption schemes for local firms * Provide grants relating to patent applications
HKMC	* Provide mortgage support for local firms
HKECIC	* Provide export credit insurance to minimize risks for exporters
CreateHK	* Subsidize projects related to design and creative industries
FHB	* Conduct research in health-related areas
EPD	* Conduct research in environmental protection areas
PICO	* Conduct research in public policy and policy innovation

RGC: Research Grants Council
ImmD: Hong Kong Immigration Department (labeled as 'HKID' here)
ITC: Innovation and Technology Commission
HKSTP: Hong Kong Science & Technology Park Corporation
OGCIO: Office of the Government Chief Information Officer
SIE Fund: Social Innovation & Entrepreneurship Fund
ITB: Innovation and Technology Bureau
ASTRI: Applied Science & Technology Research Institute
LSCM: Logistics and Supply Chain MultiTech R&D Center
APAS: Automotive Parts and Accessory Systems R&D Center
HKRITA: Hong Kong Research Institute of Textiles and Apparel
NAMI: Nanotechnology and Advanced Materials Institute
TID: Trade and Industry Department
HKMA: Hong Kong Monetary Authority
HKDC: Hong Kong Design Center
HKPC: Hong Kong Productivity Council
HKMC: Hong Kong Mortgage Corporation
HKECIC: Hong Kong Export Credit and Insurance Corporation
FHB: Food and Health Bureau
EPD: Environmental Protection Department
PICO: Policy Innovation and Coordination Office

Table A.2. List of government agencies/entities responsible for innovation-related policies in Shenzhen.

Agency	Parent agency	Areas of policy implementation
SZDRC	NDRC, SZGov	* Formulate implementation plans for strategic emerging industries (SEIs) * Implement policy measures on environmental protection and promote green economy
SZSME	SZGov	* Support the development of SMEs
SZETIC	MIIT, SZGov	* Provide market-development support to enterprises * Promote industrial upgrading for non-high-tech firms * Support the development of intermediaries (relating to the internet, product design, and industrial upgrading) * Provide industry-specific support (especially in IT sectors)
SZSIA	Independent, liaising directly with SZGov	* Platform for registration of IPR related to software * Certify software enterprises in Shenzhen
SZIPR	SIPO, SZGov	* Platform for registration of IPR (patents)
SZHRSS	MOHRSS, SZGov	* Provide incentives for high-level talent to move into and work in Shenzhen * Attract talent to science and technology areas as well as others (e.g. artists, corporate executives, and athletes)
SZSTI	MOST, SZGov	* Implement plans for 'mass entrepreneurship and innovation' * Certify high-technology firms in Shenzhen (whether for national-level or municipal-level certification) * Attract talent from S&T disciplines * Administer financing schemes to support applied R&D * Support the development of innovation intermediaries (key state laboratories, public technology service platforms, engineering technology centers, and technology business incubators) * Invest in new high-tech firms

SZDRC: Shenzhen Municipal Development and Reform Commission
SZSME: Shenzhen Municipal Small and Medium Enterprise Service Bureau
SZETIC: Shenzhen Municipal Economic, Trade, and Information Commission
SZSIA: Shenzhen Municipal Software Industry Association
SZIPR: Shenzhen Municipal Intellectual Property Office
SZHRSS: Shenzhen Municipal Human Resources and Social Security Bureau
SZSTI: Shenzhen Municipal Science, Technology, and Innovation Commission
NDRC: National Development and Reform Commission
MIIT: Ministry of Industry and Information Technology
SIPO: State Intellectual Property Office
MOHRSS: Ministry of Human Resources and Social Security
MOST: Ministry of Science and Technology
SZGov: Shenzhen Municipal Government