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Reconciling Perspectives on Clusters: An Integrative Review and Research Agenda

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Although our understanding of clusters and their contribution to economic performance has improved over the last three decades, the literature has become host to a wide array of divergent empirical and theoretical claims. We systematically review cluster studies published in top journals, highlighting the lack of integration among prior work. We focus on the ways in which Porter's three cluster dimensions, namely geography, networks, and institutions, have been utilized. None of the studies reviewed fully captured their complex interrelationships, which we argue is an important cause of the key disagreements in the literature. Configurational theorizing and analysis are presented as means by which the different approaches to cluster studies could be reconciled. We discuss how the application of a configurational approach can help explore new scholarly directions that can deepen our understanding of clusters and their performance-enhancing potential. In doing so, we can move beyond an understanding of independent effects to emphasizing combinations of attributes that can generate multiple pathways to cluster performance outcomes.

Introduction

Since Porter's (1990a, 1990b, 1998) cluster concept surfaced almost three decades ago, it has assumed a central role in both the academic and policy discourse on regional economic development (Lazzeretti *et al.* 2014; Martin and Sunley 2003; Wolman and Hincapie 2014). The concept has become a core research topic not only in management (e.g. Arikan 2009) and economics (Golman and Klepper 2016), but also in disciplines such as economic geography (Asheim *et al.* 2008), urban planning (Turok and Bailey 2004), sociology (Jonas and Berner 2010), and political science (den Hertog *et al.* 2001). Although our understanding of clusters and their contribution to economic performance has improved over the last three decades, the literature has become fragmented and confused, with contrasting theoretical claims and contradictory empirical results describing how clusters generate innovation and economic growth (Martin and Sunley 2003; Wolman and Hincapie 2014).

Drawing on the definition of clusters as '*geographic concentrations of interconnected companies and institutions in a particular field*' (Porter 1998, p. 78) we delineated three central dimensions: geography, networks, and institutions. Geographic proximity reduces input costs and may lead to knowledge spillovers and productivity gains (Arikan and Schilling 2011; Krugman 1991; McCann and Folta 2008). Furthermore, knowledge can be transmitted between network partners, spurring innovation (Gordon and McCann 2000; Huggins and Thompson 2013; Knoben and Oerlemans 2012). The cluster concept also incorporates the role of institutions in recognition of the influence that institutional regimes and structures have on organizational capabilities and innovation strategies (Allen 2013; Casper and Whitley 2004; Hotho 2014; Whitley 2007).

Although Porter's (1998) work continues to be influential in shaping cluster research, it is well documented that the research trajectories on clusters are divergent (Cruz and Teixeira 2010; Hervas-Oliver *et al.* 2015; Lazzeretti *et al.* 2014; Martin and Sunley 2003). First, economic geography studies continue to debate whether diverse or specialized

agglomerations drive innovation and economic performance (Beaudry and Schiffauerova 2009). Second, there is contention in the literature on whether sparse or dense interconnectedness supports the innovation efforts of firms (Alguezaui and Filieri 2010). Third, at the intersection between geography and networks, it is uncertain whether value is derived from being located in a cluster (Bathelt *et al.* 2004) or being embedded in extra-local (often global) networks (Fitjar and Rodriguez-Pose 2011). Fourth, in cluster studies focusing on institutions, there is considerable uncertainty regarding whether it is optimal to coordinate clusters through associational communities or formal societal institutions (Rodríguez-Pose and Storper 2006). Although various studies have proposed new contingencies (e.g. Ter Wal *et al.* 2016) and complex interrelationships to address these contentions (Rodríguez-Pose and Storper 2006), the reported findings remain disparate (Funk 2014). For instance, a new line of research is investigating how firm endowments such as the level of internal knowledge impact the effects of agglomeration economies (Hervas-Oliver *et al.* 2018; Knoben *et al.* 2016). However, even here there are considerable disagreements about which types of firms benefit from particular externalities (Frenken *et al.* 2015; Grillitsch and Nilsson 2017, 2019; Rigby and Brown 2015).

Our integrative review begins with a description of our methods, where we outline how we used Porter's (1998) three cluster dimensions as a framework for selecting and analyzing papers. We then systematically unpack the literature and its distinct perspectives, addressing the commonalities and differences between studies. We identify that the long-standing disagreements in the literature are a consequence of the limited attention paid to the complementarity between cluster dimensions, and discuss the reconciliatory potential of a configurational approach. Configurational theorizing emphasizes conjunction, equifinality, and asymmetry. In other words, outcomes are likely to result from combinations of all three cluster dimensions and their interrelations (Fiss 2011). These attributes and their combinations can be either necessary or sufficient for an outcome (Misangyi *et al.* 2017). Moreover, there may be multiple pathways to an outcome, and the inverse of factors leading to its presence do not necessarily cause its absence (Greckhamer *et al.* 2008). We demonstrate how such a theoretical approach can be combined with qualitative comparative analysis (QCA).

Methodology

We adopted a systematic methodology to research the performance implications of clusters found in the literature, taking Porter's (1998) conceptualization as the starting point. We thus followed a fixed framework or 'architecture' with the three cluster dimensions as the building blocks (Adams *et al.* 2016). In line with procedures followed in prior work, we combined methodological rigor and transparency with an in-depth analysis (Boyd and Solarino 2016; Knoben and Oerlemans 2006; Phelps *et al.* 2012; Tranfield *et al.* 2003). This systematic review procedure enabled us to identify divergent empirical claims in the academic literature and point to, what we believe to be, fruitful lines of future research (Rousseau *et al.* 2008).

Figure 1 details our research approach, as well as the number of papers excluded and remaining at every stage. We started by selecting the literature database and relevant archived journals, and then created keywords based on the three cluster dimensions to construct our search queries. Following this, we generated a bibliometric overview of the literature and its use of the different cluster dimensions. We coded papers on whether they were empirical and relevant, and investigated their theoretical and empirical approaches to clusters. This analysis is the foundation of our literature synthesis. In the sections below, our methodology is described at length.

Database

As shown in Figure 1, an important tool for our systematic literature review was the Thomson Reuters Web of Science (2018a) database, which provided us with a wide range of searchable journals, as well as a powerful search engine. Our use of this database is consistent with other reviews on cluster research (e.g. Hervas-Oliver *et al.* 2015; Lazzeretti *et al.* 2014).

To attain a detailed review of state-of-the-art cluster research, we limited ourselves to journals with an Article Influence Score (AIS) in the top 10% of three research fields, grouped into the Web of Science categories of: (1) business and management; (2) economics; and (3) geography, planning & development, public administration, and urban studies. The AIS reflects both the number of citations that papers published in a journal received over a window of 5 years, as well as the prestige of these citations (West *et al.* 2006). Self-citations (within journals) are not counted in this score. The AIS thus has marked

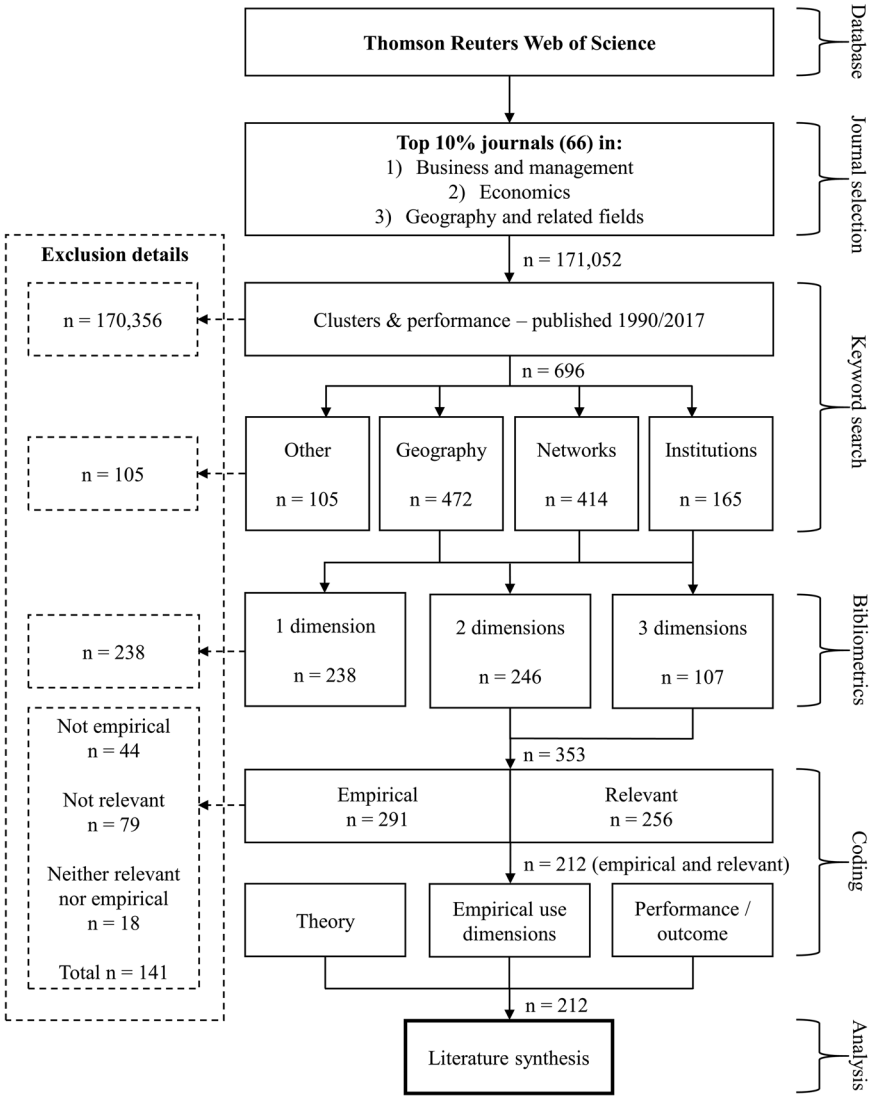

Figure 1. Research approach schema

advantages over the impact factor, which maintains a shorter, 2-year window, and does not consider prestige and self-citation (Kianifar *et al.* 2014). The inclusion of top journals from different fields of research allowed for a more inclusive search beyond hits in business, management, and economics. In our selection of fields, it is notable that, contrary to previous reviews (Hervas-Oliver *et al.* 2015; Lazzeretti *et al.* 2014), we included public administration to account for the increasing number of studies on cluster policies (Ebbekink and Lagendijk 2013).

Our initial selection comprised 77 journals. We removed nine of these (e.g. *Personnel Psychology*) because they do not publish research on clusters or related concepts. A further two (*Academy of Management Review* and *Progress in Human Geography*) were removed because they do not publish empirical studies. The final selection of 66 journals is detailed in Appendix S1 in the Supporting Information.

Keywords

An important step was to identify all relevant literature using keywords. Our first keywords identified any cluster study (keyword: cluster*) that

considered performance (perform* OR develop* OR innov* OR competitiv* OR productiv*). We also created keywords for each of the three dimensions. We developed our search terms iteratively, by updating them until we were confident that our results adequately captured the cluster literature. To inform the keywords we relied on bibliometric reviews on the field's founders and disseminators (Lazzeretti *et al.* 2014) and emerging research interests in the literature (Hervas-Oliver *et al.* 2015). In addition, we consulted 'traditional' literature reviews (Bathelt 2008; Gordon and McCann 2000; Martin and Sunley 2003; Wolman and Hincapie 2014). We investigated the different terms used to denote cluster dimensions and performance with a snowball method, which involved consulting reviews and subsequently examining their references. As most of these reviews focused on geography, we also examined standard works on networks and institutions to further develop these search terms. For example, for networks we perused Wasserman and Faust (1994), Kogut (2000), and Newman (2003). For institutions, examples included Whitley (1999), Hall and Soskice (2001), and Scott (2013). All in all, we aimed to be as inclusive as possible, minimizing our likelihood of missing important literature.

For geography, the keywords captured the most important research traditions on the effects and extent of agglomerations (McCann and Folta 2008), including growth poles, innovative milieux, Marshallian industrial districts, and new industrial spaces (see Moulaert and Sekia 2003 for an extensive overview). Our search terms for networks went beyond interconnectedness between pairs of organization; we also captured network structure and governance, which are increasingly seen as determinants of performance (Huggins and Thompson 2013; Ketels and Memedovic 2008; Provan and Kenis 2008). Finally, our keywords for institutions included insights into the impact of regimes and other structures on the development of firm capabilities and innovation strategies (Casper and Whitley 2004; Hall and Soskice 2001; Hotho 2014; Whitley 2007). As these structures exist at regional and national hierarchies (Allen 2013), our focus was inclusive of both levels. We relied on various institutional approaches, from national business systems (NBS) (Whitley 1999), regional innovation systems (RIS) (Coenen *et al.* 2017), and business ecosystems (Clarysse *et al.* 2014) to industrial ecology (Esty and Porter 1998). A full overview of the keywords for the three dimensions is available in Appendix S2.

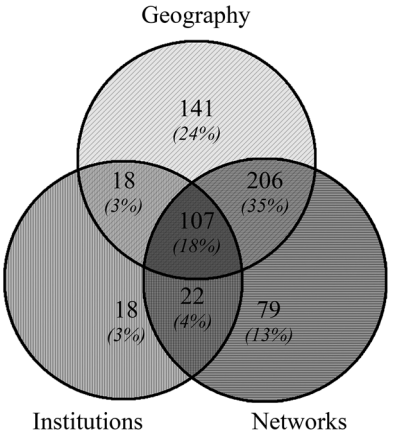

Figure 2. Number of hits (and percentage of total) per cluster dimension; N = 591

Search queries and bibliometric exploration

We searched the selected 66 high-impact journals for papers with the keywords described in the previous sections. For a paper to produce a hit, it had to be published between 1990, when Porter (1990a, 1990b) coined his cluster concept, and December 31, 2017. Furthermore, articles needed to use keywords associated with performance and mention at least one of the cluster dimensions. To arrive at the results, we used Web of Science (2018b) to search the title, abstract, author keywords, and any additional keywords that were available. The full syntax is detailed in Appendix S3.

As Figure 1 reveals, our search resulted in a total of 696 records, of which 591 produced a hit for at least one cluster dimension. We disaggregated the results into groups of keywords, based on the cluster dimensions, to indicate the degree of fragmentation in the literature.

As our purely bibliometric overview in Figure 2 shows, studies most often used keywords that we associated with geography, followed by networks, and finally institutions. A closer inspection of the figure reveals that most studies used multiple dimensions, with the combination of geography and networks found to be most prevalent. This is not to say that either geography or networks were understudied in isolation; they are the second and fourth most populated categories in Figure 2, respectively. Furthermore, the third most populated segment of papers combined all three dimensions, namely geography, networks, and institutions. All in all, this indicates that the different dimensions of the cluster concept are most often combined in a pairwise manner, and that

institutions garnered the least attention, especially in isolation.

Coding

To better understand how the cluster concept has been interpreted, we went beyond bibliometric grouping. One author coded all 353 papers that produced a hit for multiple dimensions (Figure 1) by perusing their abstracts and full texts. The 238 papers focusing solely on either geography, networks, or institutions were not systematically assessed.

To safeguard against false hits (e.g. studies which use a methodological technique such as cluster analysis, but not the cluster concept), the author responsible for the primary coding ascertained whether the selected 353 multidimensional hits were relevant and empirical, removing them from the systematic review if they failed either check (Appendix S4). In this process, and as Figure 1 details, 44 papers were excluded because they were not empirical, and 79 papers were omitted because they were not relevant. A further 18 were discarded because they were neither empirical nor relevant. The 212 papers that passed these initial checks were further examined (Appendix S5). Their theoretical background, empirical use of cluster dimensions, method, and measured outcome were coded. The codes for the empirical use of cluster dimensions were dichotomous (yes and no), whereas the other codes were open. We also kept notes of the broader themes and issues that we identified in our reading. This led us to investigate various topics, such as the conflation of cluster dimensions.

Early in the review process, all authors discussed and cooperatively fine-tuned the coding strategy, for which a consensus for the inclusion criteria had to be reached. For instance, it was agreed that only papers investigating clusters or related concepts such as industrial districts (Moulaert and Sekia 2003) were relevant. Moreover, the authors had to reach a consensus when categorizing papers as empirically investigating each of the cluster dimensions. This was based on an open discussion of a selection of studies, and the flagging of difficult cases by the author responsible for the primary coding. Disagreements were discussed until an agreement was reached. An example was the decision to code the geography dimension as present when there was any spatial element in the empirical analysis.

Upon reaching a consensus on each of the dimensions and the completion of the coding of 353 papers by one author, the other two authors each coded a random sample of 30 papers, giving an indication of coding quality. The lowest interrater agreement percentage was 79% (Appendix S6), indicating strong reliability.

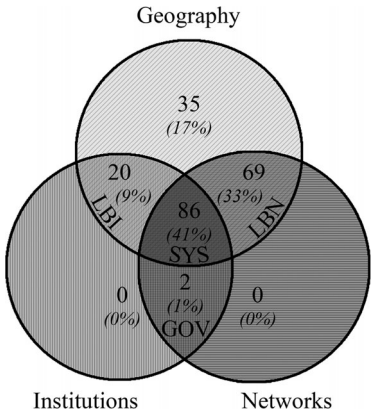

Figure 3. Multidimensional hits' empirical use of dimensions (and percentage of total); N = 212
Note: LBN = location-bound networks, GOV = governed networks, LBI = location-bound institutional arrangements, SYS = system-level perspective

Unpacking perspectives on clusters

The cluster literature is host to various research approaches, each with different emphases on the concept's three dimensions. As indicated in our introduction, previous work has investigated the most popular perspectives and their internal research gaps (e.g. Beaudry and Schiffauerova 2009). However, this research has not reviewed the broader discourse using a systematic framework, finding commonalities and differences between approaches and identifying overarching issues. Using our coding procedure, we uncovered four multidimensional perspectives on clusters, detailed in Figure 3. We also found that a sizeable number of papers (35 in total) hit on multiple dimensions, but only empirically investigated geography. We do not unpack this perspective, as this does not fit our research aims, and past reviews have already comprehensively done so (e.g. Moulaert and Sekia 2003). Instead, we focus on the multidimensional strands of research and their insights, starting with the two-dimensional perspectives and ending with the three-dimensional system-level approach.

Clusters as location-bound networks (LBN)

As Figure 3 shows, the co-dependence between geography and networks is a key avenue of research,

with approximately one-third of all papers falling into this category. These studies conceptually integrate benefits to a firm from geographic proximity (see Wolman and Hincapie 2014) with knowledge benefits from network connections (Huggins and Thompson 2013; Knoben and Oerlemans 2012). As such, these studies view clusters as location-bound networks.

Studies adopting this approach observe that collaborative networks are predominantly spatially proximate (Breschi and Lissoni 2009). Geographic proximity lowers communication costs and being located in a cluster increases the availability of potential collaborative partners. Moreover, co-location facilitates serendipitous, informal knowledge exchanges. This 'local buzz' offers access to knowledge, ranging from gossip to strategic knowledge, and can act as a direct knowledge input, improving firms' innovation capabilities and business processes (Bathelt *et al.* 2004; Storper and Venables 2004; Vang 2007). To illustrate, Dutch architectural firms are often aware of which firms have won contracts in design competitions prior to official announcements (see Kloosterman 2008). Access to this information is facilitated by Dutch architectural workers sharing social circles and living in the same neighborhoods. This knowledge can allow firms to seek and negotiate subcontracts or collaborative efforts before competitors attempt to do the same. Moreover, firms may opt to enter other competitions because they suspect a pivotal player will not, such as a competitor who has already won a major contract.

Organizations also maintain geographically distant, purposeful, formal ties (Ceci and Iubatti 2012; McEvily and Zaheer 1999). These 'global pipelines' provide access to novel knowledge unlike that which is locally available (Fitjar and Rodriguez-Pose 2011). There is strong evidence that this knowledge has innovation-enhancing effects, and particularly enables radical product and process innovation (Fitjar and Huber 2015; Fitjar and Rodriguez-Pose 2011). It is argued that global pipelines facilitate firms and regions to avoid the stagnation of available knowledge and the associated lock-in (Fitjar and Huber 2015). These novel knowledge inputs help firms to avoid lower rates of innovation. For some companies, tapping into global pipelines has become an integral part of their innovation strategy. To give one example, the well-known technology company Intel engages in international collaborative research with corporations and universities (ICRI-CARS 2018; ICRI-SC 2018). These partnerships are aimed at technological challenges such as security for embedded and smart devices (e.g. smartphones).

More recently, the research emphasis has been on the existence of multiple pathways to high innovative performance. The geographic environment imposes constraints and opportunities, which are moderated by firm-internal factors such as the cohesiveness of employee networks (Funk 2014). Firms must therefore focus not only on the balance of local and extra-local connections, but also on their internal networks and practices. Different configurations exist that allow firms to perform well, both in locations with access to industry peers and in regions with fewer potential local collaborators. One example of the latter is the semiconductor company Micron, which is not located in one of the industry's clusters (such as Silicon Valley). Despite its remote location in Boise, Idaho, it is a highly innovative company (Mayer 2011). Funk (2014) suggests that remotely located firms such as Micron benefit from problem-solving teams having low connectivity to other groups in the company, a network inefficiency which facilitates parallel problem solving and the emergence of novel solutions. In contrast, firms located in highly specialized regions benefit from cohesive networks, with a large number of linkages between the different teams within the business. This facilitates processing complex knowledge spillovers from co-located firms (Funk 2014).

Clusters as governed networks (GOV)

The view of clusters as governed networks has been adopted in a small subsection of the literature, and is part of a larger research drive to understand how interorganizational networks are managed, or 'governed' (Mesquita 2007). Most of this attention is directed at the network strategies of individual firms (Mesquita and Lazzarini 2008). However, the perspective of clusters as governed networks demonstrates that these strategies are shaped by the institutional structure. This structure is coordinated at a higher level (e.g. by governments) and can be adjusted to better meet the needs of the firm (Boschma 1999).

In contrast to the predominant thinking in the cluster literature (see Martin and Sunley 2003, p. 26), proponents of the governed networks perspective show that there is no one form of firm-level network governance that always leads to the best outcome. Rather, the way in which firms coordinate their interorganizational linkages should fit a given institutional

context. For example, safeguarding mechanisms such as formal contracts are only efficient when they are enforced by strong formal institutions (Mesquita and Lazzarini 2008). Firms are unlikely to act opportunistically if there is the threat of being taken to court and penalized. However, when formal institutions are weak, the value of such contracts is diminished because their enforcement is questionable or non-existent. Firms can, for instance, choose to freeride and not meet their contractual obligations to invest in collective resources. Under such circumstances, relational (associational) governance via informal rules and codes of conduct is more efficient than a reliance on contracts, and can help to strengthen productivity, innovation, and access to markets (Boschma 2005; Mesquita and Lazzarini 2008; Rodríguez-Pose and Storper 2006). In other words, informal governance can substitute for formal institutions.

The international business literature examining the way in which firms respond to weak formal institutions also provides similar arguments and evidence (cf. Doh *et al.* 2017). Firms may be successful in settings where formal institutions are missing or weak by relying on trust-based collaborative relations (Landa 2016) or developing close business–state relationships to reduce costs and risks (Child *et al.* 2012). The reliance on trust-based relations with other firms is especially likely to yield favorable results if they are not direct competitors. In such situations, partners can create collective efficiencies, for example by sharing experiences on how to adhere to industry standards, jointly investing in infrastructure and lobbying for government support.

This is not to say that higher-level coordination is not of value, or that firms can navigate any institutional context to achieve high performance. The view of clusters as governed networks emphasizes the vital role that governments play in the emergence and development of clusters by shaping and adjusting the institutional structure in which collaborative relations occur (Boschma 1999). Desirable results can best be reached when the needs of firms are taken into account by adjusting the rules and regulations, and providing basic and specialized infrastructure, as well as targeted support. An illustration is provided by the Argentinian Foreign Ministry, who subsidized furniture manufacturers to attend international fairs (Mesquita and Lazzarini 2008). This enabled the sector to engage with global partners and their markets to overcome the issues created by diminishing domestic demand.

Clusters as location-bound institutional arrangements (LBI)

In this third perspective, clusters are conceptualized along the lines of location-bound institutional arrangements. These determine the climate in which organizations operate, and therefore shape economic outcomes in conjunction with firm-internal resources (Barasa *et al.* 2017). Over the past decade, cluster studies have investigated the ways in which firms can navigate and leverage these different innovation contexts through locational strategies (Asmussen *et al.* 2009).

This perspective emphasizes that institutions are geographically embedded, and that spatially bounded inputs such as the availability of skilled workers are a key input for innovation. Different regional endowments and dominant knowledge bases serve to attract and retain particular types of workers with a high level of human capital (Florida 2002). For example, it is intuitively clear that science-based and arts-based clusters require different sets of skills, from codified scientific specializations to tacit arts-based knowledge (Asheim and Hansen 2009).

In addition to access to certain types of workers, the availability and access to capital is key to the innovative performance of a firm. A well-developed regional capital infrastructure is especially important for small and medium-sized enterprises (SMEs) (Klagge and Martin 2005). These firms are often unable to tap into global sources of capital (e.g. global venture capital), and may even have difficulty accessing national sources in centralized capital systems (e.g. in the UK). Rather, SMEs generally benefit from having a decentralized capital system (such as that present in Germany) (Klagge and Martin 2005). This line of research emphasizes that geographical co-location facilitates information gathering and monitoring.

This resonates with claims made in the SME finance literature, which signals that the rating systems that guide credit decisions are often inconclusive (see Flögel 2018). This related literature theorizes that the proximity associated with decentralized capital systems allows creditors to use 'soft' or tacit information in their evaluation. As face-to-face meetings become easier to arrange, SMEs seeking loans gain opportunities to contextualize rating indicators (e.g. a temporarily poor financial balance due to unexpected buyouts), display their competences, integrity, and so on. The associated capital increase for SMEs has led to calls to establish a greater number of regional banks in

centralized capital systems (Flögel 2018; Greenham and Prieg 2015).

Both the overall quality of the labor pool and the availability of capital shape the common innovation infrastructure, along with factors such as technological sophistication and supporting governmental policies (Furman *et al.* 2002). However, it is in clusters and their particular microeconomic environment that this potential for innovation is translated into outputs by firms. Scholarly work has emphasized that the specific environment in clusters and the common infrastructure are interlinked. For example, clusters containing respected universities and an abundance of knowledgeable venture capitalists are better able to fulfill the potential provided by the common innovation infrastructure and achieve greater research and development (R&D) productivity (Furman *et al.* 2002). In such a case, the institutional structures at the national and cluster level are mutually reinforcing; however, if either is weak, suboptimal R&D productivity is likely.

As the above indicates, one of the central tenets of this perspective is the dependence of the firm on its innovation environment. However, some firms are embedded in multiple environments and are able to leverage their positions in various contexts to balance their operations (as suggested by McCann and Folta 2008). Multilocational (and multinational) firms often specialize subsidiaries to benefit from the competitive and comparative advantages of their host environments (Asmussen *et al.* 2009). Their competences are transferred within multilocational firms and contribute to their aggregate capabilities. This also allows them to overcome institutional weaknesses in one location through the acquisition of relevant knowledge and capabilities by subsidiaries located elsewhere (Tanner 2014). Multilocational firms can thus cope with issues such as a lack of technical, managerial, and language skills in a local labor market. One manner in which they do so is by rotating employees between establishments, as is done by the multinational banking and financial services company HSBC (Dewhurst *et al.* 2012).

The view of clusters as location-bound institutional arrangements not only posits that regional endowments act as pools of resources that firms can tap into. It is also argued that regional institutional quality moderates the effects of the resources already available to firms. It has been demonstrated that stronger regional institutions increase the positive innovation impact of the human capital within a firm (Barasa *et al.* 2017). The translation of R&D investment to innovative outputs is similarly improved in environments with strong institutions. This relationship is especially intuitive for developing countries, where issues such as corruption negatively impact human capital and the potential to protect intellectual property (Barasa *et al.* 2017).

Clusters in a system-level perspective (SYS)

The final approach to clusters underlines the importance of geographic, network, and institutional conditions in conjunction, which we therefore labeled the system-level perspective. Studies adopting this perspective have research interests where the three cluster dimensions are intuitively inseparable.

This notably includes the study of how co-located organizations pool their resources to strengthen the innovation infrastructure. Research in this area is both focused on the forms such collective action takes and its effects. It starts from the understanding that these initiatives are contingent on the endeavors of civic entrepreneurs who mobilize and bundle resources (Robinson *et al.* 2007). This is especially important for high-tech activities, which not only require highly skilled and specialized labor, but also high-cost infrastructure (e.g. clean rooms) and access to technologies (Robinson *et al.* 2007). Few organizations can achieve this individually, necessitating the bundling of resources. The resulting infrastructures enable innovation, and may even be a prerequisite for the emergence and proliferation of cutting-edge clusters in industries such as nanotechnology (Robinson *et al.* 2007). Although not much is known in this respect, there are indications that the success of a collaborative initiative depends on its governance structure and fit within the geographical, network, and institutional context (see Battilana *et al.* 2009). Collective action can also center around matters such as regional marketing or government lobbying for various types of funding (Benneworth and Hospers 2007). In addition, organizations frequently come together to develop and enforce industry standards. For example, the French research institute CEA-Leti is working to bring together various research centers and firms to formulate standards for the emerging field of microfluidics (PoC-ID 2018).

Another three-dimensional research focus is territorial lock-in. Although this concept emerges throughout the cluster literature, it is rarely empirically investigated (Crespo *et al.* 2014). The system-level approach contains studies which provide rich, empirical accounts of how territories are affected

(e.g. Sydow *et al.* 2010; Wei *et al.* 2007). This starts from the observation that regions tend to specialize in industries that are related to the historical industrial structure (Zhu *et al.* 2017). This means that successful industries (principally in terms of export) tend to remain important in the long term. However, it also brings the risk of becoming locked into declining activities. This can happen when comparative advantages disappear, or the drivers of a region's initial success become a negative influence. The decline of the Detroit automotive cluster is illustrative (Lazzeretti and Capone 2017; Menzel and Fornahl 2009). The cluster's initial success led to it being dominated by a small number of companies (see Klepper 2007), and the resulting lack of industrial diversity limited the ability of these leading firms to generate new ideas (Lazzeretti and Capone 2017; Menzel and Fornahl 2009).

This is not to say that regions cannot break out of lock-in. A subsection of the literature investigates 'path-breaking' activities and their drivers. For instance, foreign direct investment and its concomitant knowledge spillovers were vital for Chinese cities to develop new, unrelated industrial activities (Zhu *et al.* 2017). This is expected, given that global linkages, or pipelines, can endow firms with novel knowledge dissimilar from that which is locally available (Boschma 2005; Huggins and Thompson 2013). R&D, human capital, and infrastructure investments have a similar path-breaking effect (Zhu *et al.* 2017). There are also indications that tax rebates on exports, as well as liberalized regional economies, aid the creation of path-breaking knowledge.

Contribution to LBN. In addition, the system-level perspective sheds light on research interests from the other three perspectives. For instance, the system-level perspective's inclusion of institutional insights (e.g. Lundvall 1992) enriches our understanding of local buzz and global pipelines. In research that draws on the perspective of clusters as location-bound networks, there is no agreement on the importance of local buzz (Fitjar and Rodriguez-Pose 2011), with some scholars arguing that only global pipelines contribute to the innovation performance of a firm (e.g. Fitjar and Huber 2015). Importantly, system-level studies indicate that, as regulations and industry standards become more stringent and R&D is more formalized, firms become more careful in the selection of their partners (Moodysson 2008). Typical industries in which partner selection tends to be highly selective for these reasons are pharmaceuticals, medical technology, and biotechnology (see Martin and Moodysson 2011). This limits the potential for local buzz to contribute to knowledge creation. In contrast, there are indications that a lack of robust industry standards increases the benefits that firms reap when engaging with local partners. Close collaboration becomes a necessity when design, production, and logistics are subject to the particular demands of a leading firm, instead of established standards (Sturgeon *et al.* 2008).

Contribution to GOV. The system-level approach also adds to the view of clusters as governed networks. It deepens our understanding of how governments can achieve more desirable results in policy interventions when institutional specificities are taken into account. For example, redirecting governmental funds to intermediaries significantly boosted the commercial success and innovativeness of firms in Japan, and is likely to do so in other developed markets as well (Nishimura and Okamuro 2011). These intermediaries can act as brokers and bring partners together both within and across borders. Extant research indicates that this is more cost-efficient than R&D incentives (Nishimura and Okamuro 2011). In developing contexts where the innovation infrastructure is weaker, intermediaries produce better results when they function as direct partners. Their repositories of applied (experiential) knowledge enable firms to upgrade and adapt internal processes, for example to conform to international standards (Corredoira and McDermott 2014). The transfer of this predominantly tacit knowledge is likely facilitated by geographical proximity to recipient firms (Kodama 2008; Perez-Aleman 2011).

Other context-specific institutional factors can also play a role. Strong unions may transfer valuable knowledge and assist other firms in gaining insight into the financial, technological, and strategic prowess of their peers (Rutherford and Holmes 2007). This extends to regional and cluster-level decision-making processes. Labor unions are often a valued partner for collaborative initiatives and governments too. An illustration is provided by the aviation cluster in Hamburg, Germany, where labor unions are part of the advisory board and are informed about the cluster organization's and regional government's activities (Luftfahrtstandort Hamburg 2008).

Contribution to LBI. Building on the arguments of clusters as location-bound institutional arrangements, a system-level perspective highlights the

Table 1. Key multidimensional insights and associated studies

Perspective	Insights	Pivotal empirical papers
Clusters as location-bound networks	• Innovation impact of serendipitous, informal local buzz and purposeful, formal global pipelines	• Fitjar and Huber (2015); Funk (2014); Trippl *et al.* (2009)
	• Multiple pathways to high innovation performance	• Funk (2014)
Clusters as governed networks	• No one optimal form of network governance	• Mesquita and Lazzarini (2008)
	• Role of government in industrial and cluster emergence	• Boschma (1999)
Clusters as location-bound institutional arrangements	• Interdependence among environment, knowledge base, and human capital	• Asheim and Hansen (2009); Florida (2002)
	• Influence of capital infrastructure on performance outcomes	• Klagge and Martin (2005)
	• Embeddedness of cluster and common innovation infrastructures	• Furman *et al.* (2002)
	• Leveraging of regional competence by multilocational firms	• Asmussen *et al.* (2009); Castellani *et al.* (2013)
	• Moderating effect of institutional quality on impact of resources	• Barasa *et al.* (2017)
Clusters in a system-level perspective	• Impact of regulation and industry standards on networks and their localness and serendipity (local buzz–global pipelines)	• Moodysson (2008)
	• Role of universities and intermediaries contingent on institutional context	• Corredoira and McDermott (2014); Nishimura and Okamuro (2011); Sohn and Kenney (2007)
	• Role of civic entrepreneurs in spurring collective action, cluster emergence, and evolution	• Robinson *et al.* (2007)
	• Causes of territorial lock-in, and drivers of path-breaking knowledge	• Sydow *et al.* (2010); Zhu *et al.* (2017)

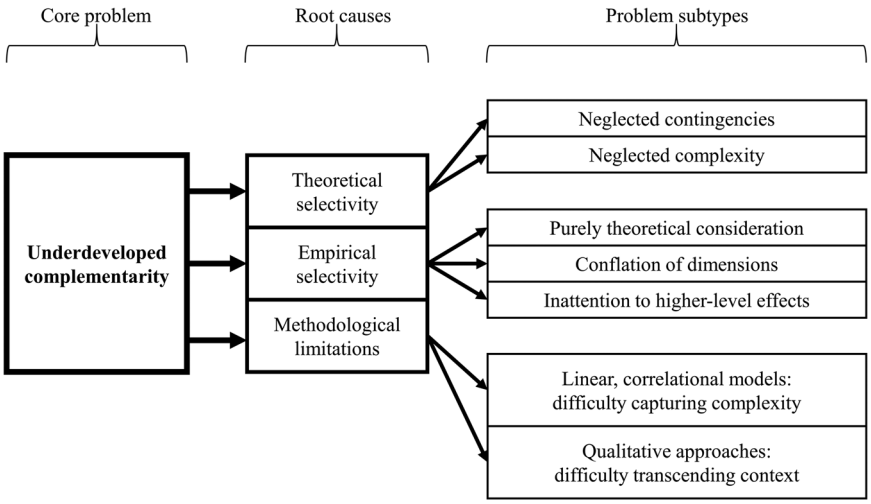

Figure 4. Key shortcomings in the cluster literature

impact of universities and other research-oriented organizations in its analysis of the innovation infrastructure. It identifies two distinct ways in which these organizations can facilitate innovation: through networks and through geography. Regarding the former, it is widely accepted that industry–university collaboration increases the innovativeness of firms by endowing them with specialized knowledge (Hershberg *et al.* 2007). Concerning the latter, the presence of universities in a region improves the quality of the available labor, and thus the innovation infrastructure (Sohn and Kenney 2007).

Unpacking disagreements and inconsistencies

As detailed in the previous section and summarized in Table 1, the different perspectives on clusters have all contributed to our understanding. However, they fall short of considering all three cluster dimensions and their complementarity (Porter 1998, 2000). Below, and as summarized in Figure 4, we explore how this oversight has its roots in theoretical selectivity, empirical selectivity, and methodological limitations.

We highlight how this has limited our understanding of how clusters shape economic outcomes such as innovation.

Theoretical selectivity

The cluster literature suffers from the selective conceptualizations of clusters, with most studies focusing on just one or two of the concept's dimensions (Figure 3). This has created disagreements and confusion, because key contingencies are either not considered at all, or only by a subsection of the literature. Connected to this, the complexity underlying clusters is only hinted at, even by system-level papers.

Neglected contingencies. An example of an area of study hindered by a selective consideration of contingencies is the innovation impact of geographic diversity and specialization (Beaudry and Schiffauerova 2009). Recent studies shed light on the matter by considering how firm-internal knowledge shapes the ability to capture and benefit from geographical externalities (Frenken *et al.* 2015). However, these studies did not include network and institutional conditions. Findings range from the conclusion that the weakest firms benefit the most from agglomeration, through to those reporting the benefits for moderately strong firms or even the strongest firms (Grillitsch and Nilsson 2017, 2019; Hervas-Oliver *et al.* 2018; Knoben *et al.* 2016; Rigby and Brown 2015). An explanation for this can likely be found in neglected contingencies. For instance, institutional factors such as the use and enforcement of non-compete clauses in employment contracts vary between the contexts studied (Kaiser *et al.* 2015). Laws and practices relating to this may reinforce or limit the effects of geographical diversity and specialization by impacting labor mobility between similar firms, an important vehicle for knowledge spillovers (Bathelt *et al.* 2004; Feldman 1999).

Another example of selectivity in adopting cluster dimensions can be found in studies investigating the innovation impact of local, serendipitous knowledge exchange. Institutions alter the effects of this local buzz (Moodysson 2008), but are rarely considered in conjunction with geography and networks, even by recent studies (e.g. Esposito and Rigby 2019). In some contexts, firms are subject to regulations limiting the formation of serendipitous linkages (Moodysson 2008). In certain activities, such as the pharmaceutical industry, externally sourced inputs for innovation need to be rigorously documented. In such cases, purposeful linkages will drive innovation. Due to their specialized nature, these networks will most likely be global. Simply being located in a cluster does not always increase innovation performance, a key research issue that we flagged up in our introduction (Fitjar and Rodriguez-Pose 2011).

Neglected complexity. As our unpacking of the cluster literature shows, performance outcomes result from geographic, network, and institutional contingencies. Crucially, we argue that these three dimensions come together in complex ways, an aspect on which the literature remains underdeveloped. Little is known about how dimensions may complement or substitute one another. It is also unclear which factors are necessary or sufficient, or if there are multiple pathways to an outcome.

There are at least two points of contention that are likely to result from the scant attention paid to whether dimensions complement or substitute for each other. First, this concerns whether sparse or dense interconnectedness drives innovation (Alguezaui and Filieri 2010), and second, whether informal or formal coordination is optimal (Rodríguez-Pose and Storper 2006). When a cluster is considered as a causally complex phenomenon, we can elucidate the way in which its three dimensions interrelate. For example, in a cluster with weak formal institutions and a strong reliance on informal coordination, innovation is likely stimulated by high levels of geographic proximity and network density, that is co-located actors predominantly engaging with partners of their partners (Cassi and Plunket 2015; Phelps *et al.* 2012; Ter Wal *et al.* 2016). Geographic proximity and network density may complement informal modes of coordination by fostering trust (Boschma 2005; Ter Wal *et al.* 2016). It is also possible that geographic proximity serves as a substitute for network density to generate high innovation performance (Cassi and Plunket 2015). In contexts with strong formal institutions, network density may either remain a positive influence, become insignificant, or even adversely affect innovation. In cases where it remains positive, network density could strengthen accommodating informal institutions which reconcile different interests with formal institutional configurations (Helmke and Levitsky 2004). The trust-enhancing effect of network density may also become redundant, and the associated limited access to novel information a detriment (Phelps *et al.* 2012). Our core argument here is that it is very likely that network sparsity and density, as well

as reliance on either formal or informal institutions, have the potential to both positively and negatively influence innovation.

The lack of theoretical attention to cluster complexity also means that relationships between the cluster dimensions have been taken for granted rather than unpacked. For instance, although universities and research-oriented organizations are often found to boost innovation, various assumptions exist on the nature of this effect. The performance benefit is either argued to result from a geographical externality via a labor pool improvement, or is identified as a network effect where firms gain specialized knowledge by engaging directly with universities (Hershberg *et al.* 2007; Sohn and Kenney 2007). The possibility that geographical and network effects may be mutually reinforcing, or act as substitutes (e.g. for firms in regions without local universities) has not been considered.

Empirical selectivity

In addition to the theoretical issues described above, the cluster literature suffers from empirical selectivity. This takes three forms: only theoretically considering certain pertinent cluster dimensions (e.g. ex-post), conflating dimensions, and neglecting to measure or correct for higher-level effects.

Purely theoretical consideration. Studies which empirically capture only some aspects of clusters may be aware of the other dimensions of the construct, but only reflect on these theoretically. This becomes problematic when assumptions on how contingencies shape economic outcomes are untested and taken for granted. To illustrate, the approach considering clusters to be location-bound institutional arrangements posits that a well-developed national innovation infrastructure is of paramount importance to country-, cluster-, and firm-level performance (Furman *et al.* 2002). This line of research hypothesizes that, in the absence of efficiently functioning institutions and thus the low availability of national collaborators, cluster firms will seek global partners. This is assumed to lead to knowledge leakage, diminishing the creation of geographically bounded competitive advantage (Furman *et al.* 2002). The local and global networks have not been measured in this context, however, rendering such conjectures uncertain.

Other interactions between geography and networks are also untested. This includes the assertion made in the perspective of clusters as location-bound institutional arrangements that decentralized capital systems enhance access to capital for SMEs (Klagge and Martin 2005). The assumption is that the monitoring and information gathering of a bank is improved by its co-location to its client (the SME). This is especially expected to benefit smaller firms, which tend to have poorer ratings and would gain the ability to contextualize and explain poor indicators (see Flögel 2018). This has not been demonstrated directly, however, nor has it been compared with other trust-enhancing contingencies (e.g. dense networks, or membership in collaborative cluster organizations).

Another mismatch between theory and empirics is when the impacts of contingencies are considered ex-post. This is most prominent in the perspective of clusters as location-bound networks (e.g. Owen-Smith *et al.* 2002; Tonts *et al.* 2012; Zaheer and Zaheer 2001). Contrary to system-level studies, research performed from this perspective does not empirically account for the impact of institutional factors, limiting the comparability of their results. This is despite the responsible scholars stating that they are aware that institutions matter and have the potential to impact results. This leads to inferences such as banks from the same country competing with one another, because of the 'possibility that country-level institutional and other factors impart some advantage to the supplier banks' (Zaheer and Zaheer 2001, p. 870). Measuring these effects directly, instead of inferring them ex-post, could add to our understanding.

Conflation of dimensions. Another empirical issue relates to the divergent operationalization of cluster dimensions. Although this has the potential to add depth to our understanding of clusters, it also carries the risk of empirical conflation. This most clearly impacts geography-inspired studies, which theoretically adopt the perspective of clusters as location-bound networks (e.g. D'Agostino *et al.* 2013; Delgado *et al.* 2014). These studies are cognizant of the role of both geography and networks, theoretically distinguishing between these dimensions. However, of the 35 papers which empirically only had geographic constructs, 20 inferred network relationships through variables such as location quotients (e.g. Alcacer and Delgado 2016; Bennett *et al.* 1999; D'Agostino *et al.* 2013; Delgado *et al.* 2014; Zaheer *et al.* 2009). Empirically conflating geography and networks is untenable, because co-located firms are not necessarily interconnected and their networks can reach beyond the cluster

(Fitjar and Rodríguez-Pose 2017; Giuliani and Bell 2005). The results of such studies run the risk of being incorrectly interpreted and generating seemingly equivocal findings when compared to studies using more suitable measures.

Inattention to higher-level effects. Higher-level effects are not always measured in the cluster literature, creating further contention. The study of local buzz provides an example. Although the disagreements on its innovation-enhancing impact are elucidated by considering institutions, the implications of local buzz remain equivocal even in the system-level perspective (cf. Hansen 2008; Moodysson 2008). We argue that this is due to the different levels of analysis employed and the empirical neglect of higher-level effects in some of these approaches, which tend to follow disciplinary lines. Geography-inspired research generally finds clear performance effects for local buzz (see Vang 2007). However, economics- and management-oriented studies conclude that only purposeful, global linkages boost innovation (e.g. Fitjar and Huber 2015). Studying this division in more detail reveals that, in the field of geography, the focal unit is typically the region, whereas in economics and management, the focus is on the firm. The latter approach only measures direct linkages between organizations, demonstrating that larger, more successful firms tend to engage more in global connections than do smaller businesses (Fitjar and Rodriguez-Pose 2011). Such a selective empirical approach does not account for the possible beneficial effect of indirect linkages to global knowledge, such as via gatekeepers who disseminate novel knowledge to nearby peers, possibly in a buzz-like manner (Morrison *et al.* 2013). These indirect linkages can only be captured with a regional or network-level view.

Studies including network-level measurements are rare in the cluster literature. This is unexpected, because the impact of different network structures and compositions (e.g. sparsity and density) on innovation is comprehensively theorized (Huggins and Thompson 2013). When studies investigate network-level effects, they tend to be highly descriptive and focus on only one or several clusters (e.g. Sydow *et al.* 2010; Wei *et al.* 2007). Investigating the innovation implications of network structure can provide critical insights on matters such as lock-in (Crespo *et al.* 2014). For instance, studies on overcoming lock-in explore the notion that extra-regional linkages endow firms with novel knowledge (Zhu *et al.* 2017). Network sparsity may have a similar effect, as it increases access to dissimilar knowledge (Phelps *et al.* 2012). It could also reinforce the path-breaking potential of extra-local connections.

As a final note regarding the empirical selectivity of cluster studies, we find that institutions have received little empirical attention (Rodriguez-Pose and Di Cataldo 2015). We know from theoretical work that higher-level institutions such as the quality of laws and regulations shape the environments in which firms operate (Rodríguez-Pose and Storper 2006). However, our knowledge of the impact of institutions on resources in clusters (e.g. geographical and network externalities) is limited. As described in our unpacking of the literature, it has been demonstrated that the innovation-enhancing effects of human capital increase in institutionally strong regions (Barasa *et al.* 2017). However, this research was conducted at the firm level, measuring employee and managerial human capital (Barasa *et al.* 2017). We do not know if the same innovation-boosting effect applies to, for instance, geographical knowledge spillovers. Moreover, to our knowledge, there have been no cluster studies comparing the innovation impacts of different institutional factors such as the types of educational systems and market regulations. This is unfortunate, as these types of study could help to explain performance differences between clusters and perhaps even why the 'Silicon Valley formula' often does not translate well to other contexts (Hospers *et al.* 2009; Ooms *et al.* 2015).

Methodological limitations

Methodological issues spanning all perspectives undermine a deeper understanding of clusters. Both the quantitative and qualitative methods that have been used are insufficient to capture complementarity and transcend contextuality. As a result, selective perspectives have emerged, with limited attention paid to the possibility that complementarity shapes outcomes.

Linear, correlational models. Quantitative methods such as regression analysis and social network analysis measure the isolated, net effects of factors (or more formally, predictors) on an outcome. This means that a predictor is held constant for all others, and its effect is assumed to be similar over all values of the other predictors. With such a methodological basis, it is difficult to capture complementarity between factors, consider the degree of necessity of a variable, or

find multiple causal pathways leading to an outcome (Denk and Lehtinen 2013; Fiss 2007).

To exemplify, firms may become highly innovative when relying on either geographic spillovers or global networks, or both, or neither (i.e. with a standalone strategy) (Funk 2014). However, as our unpacking has demonstrated, the success of any of these strategies depends on the complementarity between many factors. These include the internal capabilities (Frenken *et al.* 2015) and internal networks (Funk 2014) of the firm, the regional geographic diversity and specialization (Beaudry and Schiffauerova 2009), the co-location of firms with global pipelines (Morrison *et al.* 2013), the sparsity or density of collaborative networks (Huggins and Thompson 2013), the informal and formal institutional strength of the environment (Barasa *et al.* 2017; Mesquita and Lazzarini 2008), and so on. We have argued that these factors interact in complex ways, and that the inclusion of the interaction effects between predictors offers a means of capturing some of this complexity in regression analyses. This quickly becomes difficult to interpret, however, especially in relationships exceeding three- or four-way interactions (Greckhamer *et al.* 2013).

Qualitative approaches. Qualitative approaches, including single or multiple case studies, can more easily uncover causal complexity and offer valuable knowledge on how outcomes are generated. These methods allow for an in-depth, rich understanding of a particular context, but are generally non-systematic and non-comparative, and therefore have difficulties transcending contextuality (Denk and Lehtinen 2013).

As qualitative research is also best suited to a limited number of cases, it is difficult to capture generalizable causal complexities. For instance, Evren and Ökten's (2017) qualitative case study of Istanbul's jewelry cluster concludes that agglomeration benefits and diseconomies coincide in one place, and are intrinsically bound to one another. Although this can feed into theory creation, and can inspire similar studies in other contexts, their exploration does not transcend the context. Similar issues impact our knowledge of lock-in processes. We know why specific regions such as Detroit became locked into declining activities (Lazzeretti and Capone 2017; Menzel and Fornahl 2009), but have little knowledge of how lock-in processes compare across different contexts. This is the case for all non-comparative studies, and even when multiple cases are compared, the scale is too limited to draw broader conclusions.

Reconciling cluster research

As we have shown, the cluster literature has become fragmented along different perspectives. We have demonstrated that each interpretation of the cluster concept is valuable and adds to our understanding (see Table 1), but ultimately falls short of fully capturing the complementarity between cluster dimensions (Figure 4). To address the literature's shortcomings, we advocate a configurational approach.

A configurational approach

We have detailed that cluster research suffers from theoretical selectivity, empirical selectivity, and methodological limitations. We have also demonstrated that economic outcomes in clusters are likely the result of all three cluster dimensions coming together in complex ways. It is here that the literature is least developed, with the majority of studies selectively adopting specific cluster dimensions (Figures 2 and 3) and leaving their complex interrelationships undertheorized and untested (Figure 4).

We suggest a break from the dominant approaches for assessing clusters through the adoption of configurational theorizing and analysis. We argue that the key shortcomings in the literature cannot be seen as separate issues. The methods used do not emphasize the likelihood that economic outcomes such as innovation are the result of complex constellations of contingencies, with the potential for multiple pathways to an outcome. Therefore, scholars have not developed such theories. To do so would be problematic, because the predominant methodologies do not allow for their testing.

Configurational theorizing. First and foremost, we argue that it is important to adopt a holistic theoretical approach, where economic outcomes are understood to result from all three cluster dimensions and their interrelationships. Configurational theorizing underlines that outcomes generally result from complementarity between contingencies, rather than from independent factors (Misangyi *et al.* 2017). Moreover, it emphasizes that there can be several ways to reach any given outcome, and the relationships of all pertinent contingencies may vary over these pathways (Ragin 1987). In other words, what is positive in some scenarios may become negative in others. Furthermore, the negation of contingencies does not necessarily cause the absence of the outcome. This approach can fully

accommodate Porter's (1998, 2000) understanding of clusters as a multidimensional constellation of characteristics that occur together and are interdependent (Greckhamer *et al.* 2008; Misangyi *et al.* 2017).

Configurational analysis: QCA. Configurational theorizing has long been used in areas such as management research, although the empirical tools to fully test complex relationships have only recently emerged (Fiss 2007; Fiss *et al.* 2013; Misangyi *et al.* 2017). The method of QCA was first developed by Ragin (1987, 2000, 2008). Over the years, its methodological capabilities have improved considerably, and it has been applied in domains as diverse as the institutional and public network literatures. For example, the institutional literature uses QCA to address the nestedness of institutions and their relation to organizational strategies (Misangyi *et al.* 2017). The public network literature employs QCA to understand stakeholder satisfaction in governance networks (Verweij *et al.* 2013). Despite these diverse applications, none of the cluster studies that we reviewed utilize this methodology.

A full methodological overview of QCA goes beyond the scope of this paper and would overlap with the in-depth overviews provided by Fiss (2007, 2011). However, it is important to outline its key characteristics. At its core, a QCA compares 'complex wholes', or 'sets' of attributes (Misangyi *et al.* 2017). Each case can be a member or non-member of the sets denoting conditions of interest. To illustrate, a firm can either have network linkages (and be a member of this set) or not (a non-member). The outcome, too, is measured by set membership. Set memberships are constructed for each factor and outcome of interest and are plotted in a matrix. This matrix of set relationships can then be simplified using Boolean algebra, uncovering the sets (i.e. conditions) associated with the presence of the outcome of interest. To identify pathways leading to the outcome, the researcher(s) must decide on both a minimum number of cases and the consistency at which a solution can be considered valid. Here, 'consistency' refers to the degree of correspondence between the cases and their sets, and the expressed relationships in a solution (Fiss 2011). Prior to this logical reduction process, it should be ascertained whether any given factor is necessary for the outcome through bivariate calculations of consistency (Schneider and Wagemann 2012). Uncovering necessity is rare, but can serve as an indication that only one factor leads to the outcome of interest, meaning the use of a QCA is not optimal (Ragin 2008).

Because of its reliance on Boolean algebra, a QCA can be used with considerably smaller sample sizes than typical correlational methods (e.g. regressions). It can also be used for large and very large sample sizes. Small-N QCA research typically uses between 12 and 50 cases and 4 to 8 causal conditions (Greckhamer *et al.* 2013). It enables the use of in-depth case knowledge for the calibration or operationalization of sets and the interpretation of findings. Large-N QCAs typically include up to 12 causal conditions and have over 50 cases.

Multiple variations of this technique exist, such as crisp-set (csQCA), multivalue (mvQCA) and fuzzy-set analysis (fsQCA) (Schneider and Wagemann 2012). csQCA utilizes binary sets, and mvQCA can be used to measure discrete, multinomial concepts. fsQCA approaches sets in degrees of membership instead. In addition to detecting pathways to an outcome and the necessity of conditions, other operations can be performed. This includes investigating the degrees of overlap between sets (Fiss 2007). Analyses can also distinguish between core and peripheral factors using different types of assumptions in the simplification process.

How QCA may solve disagreements: a hypothetical study

At the start of our review, we highlighted four pivotal points of contention in the cluster literature regarding the drivers of innovation, which also resurfaced in our unpacking of disagreements and inconsistencies. The first concerns whether diverse or specialized agglomeration externalities are key (Beaudry and Schiffauerova 2009). The second is whether sparse or dense interconnectedness is more beneficial (Alguezaui and Filieri 2010). Third, we posited that it was uncertain whether firms become innovative because of their location in clusters or through their embeddedness in networks (Bathelt *et al.* 2004; Fitjar and Rodriguez-Pose 2011). Fourth and final, there is some debate around whether informal or formal institutions are the best forms of cluster coordination (Rodríguez-Pose and Storper 2006). We briefly explore how a QCA-driven analysis may clarify these four key points of contention.

We take as our example an investigation of the drivers of innovation in a particular industry distributed over several regions, using the firm as the unit of analysis. Our data consist of the geographical externalities to which the firms are subject, their networks and overall network structure, the strength of formal

Table 2. Example QCA: crisp construct operationalization

Dimension (measurement)	Contingency	Examples data source	Set membership cut-off	References
Outcome: innovation (firm level)	• Firm innovation	• European Patent Office (2018); survey	• ≥ 1 patent	Laursen and Salter (2013)
Geography (regional industry structure)	• High diversity	• Eurostat (2018a) population statistics	• Population density (urbanization) > P_{50}	Beaudry and Schiffauerova (2009); Knoben (2008)
	• High specialization	• Eurostat (2018b) structural business statistics	• Location quotient (concentration) > 1	
Networks (N firm-level connections)	• Strong local networks	• Survey; co-patenting	• $N > P_{50}$	Fitjar and Rodriguez-Pose (2011); Pittaway *et al.* (2004)
	• Strong non-local networks	• As above	• $N > P_{50}$	
Networks (network-level structure)	• High sparsity	• Survey; third-party information on specific networks (e.g. associations, clusters)	• Inter-firm collaboration density ≤ 0.25	Alguezaui and Filieri (2010); Ter Wal *et al.* (2016)
	• High density	• As above	• Inter-firm collaboration density ≥ 0.75	
Institutions (institutional strength in home region)	• Strong formal	• Quality of Government Institute of the University of Gothenburg	• Normalized Quality of Government Combined Index ≥ 0.75	Charron *et al.* (2015); Doh *et al.* (2017); Khanna and Palepu (1997, 2000); Rodriguez-Pose and Di Cataldo (2015); Verbeke and Kano (2013)
	• Strong informal	• Survey; expert interviews; content analysis; researcher estimation	• Five-point Likert scale measuring trust towards co-located firms ≥ 3	
Other (firm-level drivers of innovation)	• Strong firm knowledge base	• Survey; annual reports; industry reports	• R&D investment ≥ P_{75}	Cohen and Levinthal (1990); Love and Roper (2015)

Note: N denotes number of cases; P_i denotes the ith percentile.

and informal institutions (the latter proxied through trust), and firms' R&D activities (Table 2). These are all contingencies which are expected to impact the innovation performance of firms. We propose measuring innovation performance as whether or not firms have obtained patents within a particular time frame.

For brevity, and to maintain a degree of simplicity, we envision a crisp-set analysis where firms are either a member or a non-member of a set, despite approaches such as fsQCA allowing for degrees of membership (Schneider and Wagemann 2012). If the value of a contingency meets the cut-off listed in Table 2, it is a full member of the respective set; if it does not, it is a non-member. We did not develop the theoretical grounding of these factors, nor their chosen cut-off points, for which we refer to the references and information in Table 2. Nevertheless, we expect these factors to interact in complex ways, necessitating the use of a QCA.

An example of the types of results that could emerge from this single, crisp-set QCA is presented in Table 3. Of course, this is a simplified example showing how four causal pathways to innovation could shed light on the four points of contention. The pathways are idealized, denoting firms with location-bound and location-spanning networks, as well as location-bound non-networkers and informally coordinated networkers (solutions 1 through 4, respectively). Each achieves innovation through a particular combination of contingencies.

Geographic diversity–specialization contention. Solution 1 shows firms with location-bound networks, which have few internal capabilities. These firms would likely suffer in clusters with high geographical diversity, as the concomitant knowledge spillovers are likely difficult to absorb and process (Cohen and Levinthal 1990). Because the presence of urbanization often coincides with higher land prices and other negative externalities (Beaudry and Schiffauerova 2009), our hypothetical exercise associates its absence with innovation. In contrast, these firms likely would benefit from geographical specialization. In comparison, solution 2 captures firms with location-spanning networks, which have strong internal capabilities and thus benefit from diverse

Table 3. Example QCA: output table with configurations for high innovation performance

Causal conditions		1 Location-bound networkers	2 Location-spanning networkers	3 Location-bound non-networkers	4 Informally coordinated networkers
Geography	High diversity	⊗	●	●	
	High specialization	●	⊗	●	
Networks (firm)	Strong local	●	⊗	⊗	
	Strong non-local	⊗	●	⊗	
Networks (structure)	High sparsity	⊗	●		⊗
	High density	●	⊗		●
Institutions	Strong formal				⊗
	Strong informal				●
	Strong formal OR informal	●			
Internal capabilities	Strong knowledge base	⊗	●		

Note: ● = present condition; ⊗ = absent condition; blank space = causal conditions may be present or absent.

information and its novelty. They also have increased means to engage in distant partnerships (Phelps *et al.* 2012). In this case, specialization creates few benefits, because it does not offer access to novel information. Firms may leak knowledge, however, hindering innovation (Frenken *et al.* 2015). Finally, as shown in solution 3, diversity and specialization may coincide and be at the core of the innovation strategy of a firm, substituting for networks.

Network sparsity–density contention. Firms in solution 1 benefit from network density, creating closer bonds and more familiarity with networked firms (Huggins and Thompson 2013). This enables them to share and process knowledge, compensating for their lack of internal capabilities. Solution 2 shows that a QCA allows for this density to also become detrimental. In this case, the most straightforward explanation would be that firms with sufficient internal capabilities can internalize and utilize external knowledge without external assistance. They can lose out from the overfamiliarity associated with network density.

Location–global networks contention. In much the same way, local linkages give access to knowledge that is more easily processed, but which is less novel (Huggins and Thompson 2013). Firms in solution 1 benefit only from local linkages due to their relatively weaker internal knowledge base. Firms in solution 2 benefit only from global linkages due to their strong internal capabilities. In contrast, solution 3 suggests that firms can also become innovative by relying solely on geographic externalities, if these offer access to knowledge inputs.

Informal–formal institutions contention. Finally, institutions are important in solutions 1 and 4, whereas in other solutions, firms can compensate for the lack of strong institutions by their internal resource strength. In solution 2, this firm-internal capacity to compensate for weak institutions is the clearest, as solution 1 requires either strong formal or informal institutions. Solution 4 shows that firms in regions with weak formal institutions can still become innovative if they rely on informal institutions, as put forward in the literature (Mesquita and Lazzarini 2008). Moreover, sparsity is negative, and density is positive. We chose to highlight this potential relationship, because the familiarity associated with density may strengthen informal modes of governance.

Shared conversations and societal relevance

In addition to providing the means to uncover complementarity, there are two added benefits of a configurational approach worth highlighting. First, adopting this frame of reference will make it easier for different disciplinary communities of scholars to interact and for new, shared conversations to emerge, as it provides a common language and logic (Misangyi *et al.* 2017). The approach can process and integrate both quantitative and qualitative data and can, therefore, form a bridge between these two (often disconnected) 'realms' of research (Misangyi *et al.* 2017). This is important for the cluster literature, which is, in part, fragmented along such lines. Other fields have already started to adopt a configurational approach (e.g. Misangyi *et al.* 2017; Verweij *et al.* 2013), and cluster research could benefit from engaging with these discourses.

Second, in cluster research, a configurational approach holds the potential to offer solutions of societal relevance. Most governments pursue policies to support and create clusters (Martin and Sunley 2003), yet these policies frequently fail to live up to their promise (Duranton 2011). These include attempts to transplant the Silicon Valley model to the electronics and semiconductor industry in New Jersey and Texas (Giest 2017). Numerous studies have already emphasized that such generic endeavors are likely to fail due to contextual differences (Ooms *et al.* 2015; Tödtling and Trippl 2005). Instead, policy approaches should be differentiated and suited to their particular circumstances. If we are able to deepen our understanding of the geographical, network, and institutional conditions of clusters and explore the full depth of complementarity between these dimensions, we may be able to aid policy makers in achieving better outcomes. Utilizing a configurational analysis can even address the necessity and sufficiency of cluster conditions, which could help policy makers to first direct their attention to the preconditions of their desired results.

Discussion

In our systematic review, we have shown that the selective adoption of Porter's (1998, 2000) cluster concept has led to four distinct multidimensional perspectives, each of which neglects the complementarity among the three cluster dimensions. This oversight has been caused by theoretical selectivity, empirical selectivity, and methodological limitations. We argue that the long-standing disagreements that have emerged as a result might be reconciled by applying a configurational approach. We demonstrated this potential in a hypothetical configurational study, in which we combined a holistic, system-level cluster conceptualization with the means to measure complementarity. This exercise shows that research questions such as whether diverse or specialized agglomerations drive innovation are likely misguided, as they assume unifinality and symmetry. Instead, we expect the effects of cluster dimensions to vary within complex constellations of contingencies over multiple pathways.

Because a configurational approach emphasizes conjunction, equifinality, and asymmetry, it provides a foundation from which to elaborate on the existing midrange theories of clusters (Fiss 2011; Misangyi *et al.* 2017). It could, for example, advance the burgeoning literature suggesting that internal capabilities determine the effects of agglomerations on firms, which is host to competing theories (Frenken *et al.* 2015). In their recent study, Grillitsch and Nilsson (2019) contrast the knowledge equilibrium and knowledge competition arguments. The former argument predicts that weak firms benefit from capturing geographically bounded knowledge spillovers and suffer little from knowledge leakage. The latter argument suggests that only strong firms have the necessary absorptive capacity to benefit (Cohen and Levinthal 1990). Researchers consider these divergent postulations incompatible, and the disparate evidence contradicting (Grillitsch and Nilsson 2017, 2019; Hervas-Oliver *et al.* 2018; Knoben *et al.* 2016). However, with a configurational lens, there is no incompatibility or contradiction. Disparate theoretical arguments and empirical findings may represent different pathways to an outcome. There is much promise in rigorously theorizing about such paths and adapting existing theories to a configurational approach.

Although the application of configurational theorizing and analysis to clusters may help researchers to solve long-standing disagreements, we are not suggesting that it is a panacea for all the issues in the literature. Studies must still adopt a holistic, three-dimensional, system-level perspective and include other relevant contingencies. Moreover, concepts should be measured correctly. Conflating network contingencies with geographical proxies is, for instance, problematic, as touched upon earlier. Furthermore, it is important to note that many of the issues raised in the broader field of economic geography also apply to cluster research (e.g. Bathelt and Glückler 2003; Rutten 2014, 2017). For instance, regions are often considered actors, obfuscating the role of firms and the agency of individuals (see Bathelt and Glückler 2003). Related to this, Rutten (2014) points out that micro-level processes are rarely traced. Although networks are built and sustained by individuals who are embedded in social systems, learning in networks is seldom explicitly recognized as resulting from this embeddedness (Rutten 2014, 2017).

We are also not suggesting that quantitative and qualitative methods should be replaced by configurational analysis. Each approach has characteristics that enable it to improve the study of clusters. Rather, it is our suggestion and hope that configurational theorizing and analysis become tools utilized by cluster researchers, which will enable scholars to conceptualize and test the impact of various combinations of cluster dimensions, as well as their necessity and

sufficiency. Configurational analysis can be used in conjunction with quantitative and qualitative methods. To illustrate, qualitative research can feed into the creation and calibration of conditions (Fiss 2011). Similarly, quantitative methods such as regressions can be used to verify the robustness of configurations uncovered in QCA, as is done in public administration, strategic management, and organization research (e.g. Fiss 2011; Torugsa and Arundel 2017).

Our research is not without caveats and limitations. Although our review was extensive, we only systematically perused the literature published in top journals. It is therefore possible that we missed insightful perspectives on clusters presented elsewhere. Moreover, we did not study the 'gray literature' – the body of material outside the academic domain (Adams *et al.* 2017). It would be interesting to review how policy makers and others utilize the cluster concept in future studies, so that the academic discourse can better align with and inform their needs.

We hope that our review encourages cluster researchers to make use of the theoretical and methodological tools afforded by a configurational approach in an attempt to reconcile the differences observed in cluster literature and inform new research directions.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1 – The searched journals, by category
Appendix S2 – Keywords per dimension
Appendix S3 – Search strings
Appendix S4 – Multidimensional coding matrix for paper inclusion
Appendix S5 – Full list of articles subjected to the systematic literature review
Appendix S6 – Intercoder reliability matrix