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European Planning Studies, 23(2015)4:828-845

DOI: 10.1080/09654313.2014.984661

Publisher's version available at
http://dx.doi.org/10.1080/09654313.2014.984661

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ABSTRACT Many papers on economic geography have analysed industrial clusters, but few have addressed the relations among clusters. This paper discusses three types of relations among clusters to better understand why they occur and the roles that human resources, capital, knowledge and markets play in such relations. It provides theoretical ideas, empirical illustrations and suggestions for future research on the relations among clusters in a globalized economy.

1. Introduction: What Is New in Cluster Theory?

Economic geographers frequently study cluster phenomena as a topic. Since Marshall (1890) pointed out the importance of industrial agglomerations, a new way to explain an economy from the viewpoint of geography was introduced, creating a new branch of economics.

A body of literature exists that sheds light on cluster phenomena from almost all possible angles (such as what, when, where, who, why and how). Scholars certainly still contribute to, and deepen our comprehension of, cluster phenomena. The voice from mainstream cluster scholars is dichotomized (see the Journal of Economic Geography, 2011, special issue 2): geographic economists argue that developing models at the person and the firm levels is interesting. In contrast, economic geographers argue that they are more interested in "fragmented" issues, such as how geography influences people's lives. In addition, discipline crossing is another means that assists in gaining more knowledge about clusters. Combining cluster theory with business theories, such as network theory (e.g. Saxenian, 1990; Giuliani, 2007), innovation theory (e.g. Asheim, 1996) and strategy theory (Porter, 1990), is meaningful for expanding our understanding of clusters.

In this paper, we argue that blanks remain that cluster scholars are not addressing. The main blank is what we call "relations among clusters". At least three reasons exist to

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support our argument. Firstly, from the viewpoint of theoretical development, existing research primarily focused on what happens at the individual cluster level. These studies either treat a cluster as an entire unit or explain cluster phenomena at the individual level (e.g from the viewpoint of the cluster firm). Interestingly, we still lack a theory that covers the relations among clusters. We acknowledge that industrial economics explained how two or more industries interact with one another, in particular in trade theory (e.g. Rowthorn, 1992); however, in terms of cluster theory, such arguments are rare. If we accept that a cluster is a group of firms and institutions co-located in the same region, and if we want to apply cluster theory rather than industrial economics to explain the relations among the clusters, our theoretical "weapon" appears weak. We must highlight two points: (a) some scholars may argue that the theory of so-called global value chains (hereafter GVCs) and global production networks (GPNs) paved the way for discussing the relations among clusters (Grossman & Helpman, 1993; Gereffi, 1999; Humphrey & Schmitz, 2002; Coe et al., 2008). However, we do not completely agree with that statement. For example, GVCs depart from foreign direct investments (FDI) theory and international trade theory rather than cluster theory. GVCs (and, similarly, GPNs) show that clusters are driven by economic imperatives, but do not emphasize the importance of geographic proximity. In other words, the GVC itself can be randomly distributed among different regions. Furthermore, we acknowledge that the discussion of relations among clusters (e.g. the multi-cluster level) is developed from the discussion of relations among cluster firms/entities/individual persons, and others. Drawing on previous studies, we step further by considering why some clusters seek to build relations with certain other clusters. More importantly, we also consider how human resources, capital, knowledge and markets influence the relations among clusters. For example, Li (2014) studied international trade fairs, which he named temporary clusters, and argued that firms in IT clusters may have stable relations with firms in other clusters: many Asian IT cluster firms have established stable relations with IT firms in Silicon Valley (Li, 2014, p. 1015). Our paper seeks to theoretically discuss why and how such a phenomenon occurs.

Secondly, we argue that "relations among clusters" is not an academic term that we fictitiously created. Relations among clusters exist in reality and, therefore, are worth studying. For example, Delgado et al. (2010a, 2010b) employed a longitudinal database on clusters in the US and found that strong clusters in adjoining regions increase the probability of developing similar clusters in these regions. Lu et al. (2013) analysed five types of clusters in six Chinese cities and found results similar to those of Delgado et al. Finally, in a recent issue of the Journal of Economic Geography, Bathelt and Li (2014) studied how clusters build FDI relations worldwide and showed that relations among clusters are quite strong. Thus, in the future, research on relations among clusters is reasonably expected to attract greater attention from cluster scholars.

Thirdly, from a policy perspective and at the industrial level, a body of papers discussed the relations among two or more industries. The classic book by Jacobs (1969), The Economy of Cities, provided such an example and influenced city planners in the US. Abundant papers developed a theory of how to effectively construct a cluster from the local government perspective. For example, scholars from the Stockholm School of Economics, such as Solvell, Ketels and Lindqvist, provided concepts of building cluster initiatives from the viewpoint of the Nordic experience (Solvell et al., 2003; Solvell, 2009; Lindqvist & Solvell, 2011). In addition, economists from the Far East showed how

Asian regions build their special economic zones (e.g. Zeng, 2010) as another way to develop clusters. However, we still lack theories that address a region's simultaneous development of more than one cluster and the types of policies that local governments can adopt to develop clusters. These questions are on the "waiting list" to be answered. Drawing on Yuan et al. (2010), we provide the concrete case of Shenzhen, the first Chinese special economic zone. In the late 1970s, Shenzhen began to develop labour-intensive clusters (such as the footwear cluster and the food processing cluster). After more than 10 years, in the 1990s when labour costs increased, technology-intensive clusters such as the ICT cluster represented by Huawei appeared. Therefore, to think about why and how the Shenzhen local government helped local industries transform into high-tech clusters is valuable for policy-makers in other regions.

In this paper, three types of relations among clusters are analysed: relations among (1) the same type of clusters in geographic proximity (adjoining regions), (2) the same type of clusters in faraway (FA) regions and (3) different clusters in the same region. Before we begin our analysis, we briefly present the intuition of taxonomy.

2. Intuition of Taxonomy

Relations among clusters have many dimensions. Firstly, relations can be knowledge relations, trade relations, policy relations, worker flow relations and others. Secondly, clusters are different from one another and have different characteristics. For example, they may be large or small, knowledge intensive or labour intensive, or constituted of a large number of small firms or of several large firms. Regarding the first concern, this paper only takes into account cluster size relations (such in terms of employees, number of firms or economic size). More concretely, if a cluster enlarges its size in terms of number of employees, amount of innovations and economic output, the question is whether or not the size of other clusters increases or decreases. Frequently, clusters are viewed as competing for the same resources, whereas others view related clusters as reinforcing one another. In regional development, the size relation among clusters is considered a "life and death" issue, thus making the (positive or negative) relations among clusters the core of our paper.

To the second concern, we agree with Asheim et al. (2006) that

> clusters vary considerably in type, size, origin, structure, organization, dynamics, and developmental trajectory. It seems most unlikely that different clusters can all be explained in the same way. We may well need different types of theory and explanations for different clusters. (p. 15)

However, this paper argues that discussing relations among clusters in the two dimensions of industrial relatedness and geographic proximity is reasonable and acceptable. We choose these two dimensions because we believe that they are key to defining a cluster. Further articulation is as follows. We draw on the summary of the definitions of clusters by Martin and Sunley (2003, p. 12), who listed 10 definitions of clusters given by mainstream cluster scholars, including Porter, Enright and Simmie, among others. We argue that nine definitions clearly illustrate that cluster firms should have some relations/interactions with one another. Although all nine definitions do not articulate what they mean by "relations/interactions", cluster scholars agree with the concept that firms in a cluster

are not individual "isolated islands". In terms of geographic proximity, 8 out of the 10 definitions mentioned this issue, thus showing that most cluster scholars agree that cluster firms must be located in geographic proximity. We do not deny that current research highlights the importance of building a global "pipeline" (e.g. Liu et al., 2013; Morrison et al., 2013; Fitjar & Huber, 2014). Scholars are likely to argue in the future that a cluster should be like an "octopus" with numerous "feet" linking it all over the world, and that problems caused by a lack of geographic proximity can be easily overcome. However, we argue that, currently, mainstream cluster scholars still treat geographic proximity as a theoretical "pillar" that constitutes cluster theory.

Next, we elaborate on the meaning of industrial relatedness and geographic proximity. Industrial relatedness represents whether or not clusters are "related" to one another. Clusters can have "intimate" relations. For example, when two labour-intensive manufacturing clusters are co-located in the same region, labour easily flows from one cluster to the other. Therefore, relations in terms of employees are formed. Clusters can also be independent of one another. A typical example is a media cluster that primarily produces for a local region and does not necessarily have relations with another media cluster in a FA region (Bathelt, 2005). Imagine that each cluster is a special chemical element; some "elements" are easily generated from chemical reactions, whereas generating other "elements" is more difficult. Delgado et al. (2013), in one of their latest working papers, advanced a novel algorithm and paved the way for identifying clusters. Delgado et al. (2013) departed from the notion by Porter (2003) that if two industries are related, the correlation coefficient of employment (or the number of establishments and economic outputs) for the pair of regional industries (this coefficient is called cluster relatedness) should be close to 1 or $2 1$, and coined a four-step method that includes building a similarity matrix, calculating broad parameter choices, establishing clustering functions and setting benchmark scores. Moreover, Delgado et al. (2013, p. 15) pointed out that "a cluster's within-cluster relatedness must be greater than among cluster relatedness". This paper employs the merits of the method by Delgado et al. Although Delgado et al. (2013) only applied their algorithm to employment relations, this paper argues that such an algorithm can be used to process data on GDP relations, business relations, technology relations and other types of measurable relations. Relying on the work by Delgado et al. enables us to clearly define a cluster's "industrial boundary"; then we identify the clusters that are, and are not, the same type.

In terms of geographic proximity, the relation among two Chinese textile clusters clearly differs from that among one Italian textile cluster and one Indian textile cluster. Empirical scholars provided valuable hints by considering geographic proximity at the individual cluster level. Schmitz (1992) argued that geographic proximity in cluster theory depends on a cluster's location. A cluster may be less than a square kilometre in size in relation to a medium-sized city or a subregion of a country. May et al. (2001, p. 365) studied the British high-fidelity industry and defined a cluster's geographical boundary as being "up to 50 miles in radius (and even bigger in some cases)". Brown (2000, p. 7) noted that relative regional size is important, as illustrated by the differences among the US and the UK. Thus, the geographic boundary of a cluster in the US is defined as a 1-day round-trip driving distance, whereas in the UK such a distance should be limited to 1 hour of driving. These differences also reflect cultural differences related to space. Drawing on the notion by Brown (2000), we adapt a labour market perspective and define cluster limitations in terms of distance or travel time among a worker's home

and workplace. Certainly, workers can get to work in several ways, some of which are limited by commuting distance. The concept of clusters in geographic proximity indicates that workers in a certain cluster are able to easily and frequently travel to other clusters. Although regions and clusters are not the same, pointing out that clusters are affected by regional policy is necessary. This paper argues that if two or more clusters are affected by the same local government, those clusters are in geographic proximity.

3. Three Types of Relations

3.1. Relations Among the Same Type of Clusters in Geographic Proximity (Adjoining Regions)

The same type of clusters can simultaneously exist in geographic proximity in adjoining regions. One example is The Third Italy, consisting of Veneto, Emilia-Romagna and Tuscany, which all developed good textile and manufacturing clusters (Asheim, 2003).

3.1.1. Reasons leading to the appearance of relations among clusters. In this situation, relations among clusters exist primarily because adjoining regions have uneven economic performance. According to development theory and trade theory, unbalanced economic performance is likely the result—if all regions develop at the same speed, if productivity is not fully used (Gardiner et al., 2011, p. 980). Therefore, if the same type of clusters exists in adjoining regions, such clusters tend to have different economic performance in terms of, for example, employment, entrepreneurship and productivity. According to cluster theory, people, organizations and business activities have strong motivations to agglomerate in certain regions. Such motivations lead regions to specialize in certain industries, but such industrial activities are influenced by regional environments (Malmberg et al., 1996, p. 85). In addition, Krugman (1991) mathematically noted that a core region attracts labour and business activities from periphery regions. If one simply imagines that one cluster is located in a core region and the other is in a periphery region, the essence behind Krugman's argument still makes sense.

3.1.2. The roles of labour, capital, knowledge and markets. Normally, large numbers of people do not simultaneously move to a far distant region. More specifically, consider the case in which two adjoining regions have the same type of cluster. At a given point in time, one cluster has better economic performance than the other. Clusters have relations in terms of labour. Two reasons support our argument. In economic geography, Krugman (1991) argued that a cluster with good economic performance is able to offer higher salaries, a better working environment, better competence development and larger markets. These factors attract talent in the same type of clusters from adjoining regions. In development theory, Fontes et al. (2010, p. 597) made a similar analysis of regions: employees who work in regions with relatively low economic performance are attracted to regions with higher economic performance. Talent that flows among clusters shows that clusters are interrelated.

In addition to labour, relations among clusters are reflected in financial capital flows. When investors are venture capitalists or private equity firms, they follow a high-risk, high-return investment strategy. Venture capital firms investing in local SMEs require good information about investment projects and effectively monitor investment recipients

(Ferrary & Granovetter, 2009; Avnimelech et al., 2010). Geographic proximity provides investors with opportunities to carefully compare their investment decisions. Thus, geographical proximity reduces investor risk.

Knowledge spreads among the same type of clusters in adjoining regions; thus, the same type of clusters in geographic proximity may have different types of knowledge relations. Previous research divided knowledge into tacit knowledge and codified knowledge (Gertler, 2003). Tacit knowledge is strongly linked to local characteristics (Bathelt et al., 2004; Sotarauta et al., 2011) and is difficult to transfer across distances. Local knowledge diffusion is easier than knowledge diffusion over long distances (Breschi & Lissoni, 2001; Owen-Smith et al., 2002). Furthermore, scholars found that geographical proximity benefits knowledge diffusion (Jaffe et al., 1993). Rodriguez-Pose and Crescenzi (2008) argued that

> not only knowledge flowing from adjoining regions improves regional growth performance, but also that spillovers are geographically bounded and that there is a strong distance decay effect, which in the European case expands to more or less a 200 km radius. (p. 63)

To summarize, these papers show that knowledge can be exchanged among clusters in geographic proximity. Knowledge spillover may cause the same type of cluster to use the same or similar means to compete with one another. Knowledge spillover may also create opportunities for clusters to cooperate with one another in terms of marketing channel, technologies and other areas.

The same type of cluster in adjoining regions forms both cooperative and competitive relations when developing markets. For instance, the three counties of The Third Italy have their own textile cluster, respectively, but The Third Italy also rose as an integrated textile and manufacturing cluster (Asheim, 2003). The same type of clusters in adjoining regions compete with one another because such clusters are largely similar and have similar costs, products, target consumers, business models and marketing channels. Competition drives productivity and innovation and is viewed as an upgrading mechanism.

3.1.3. Practical examples. Although Krugman's core – periphery model (hereafter the C – P model) was originally designed to explain how one cluster developed, the model also provides insights into the discussion on the relations among the same type of clusters. Similar to the C – P model, we argue that resources (such as labour, financial capital and knowledge) can flow among clusters in geographic proximity. Unlike the C – P model, we argue that relations among clusters are not always negative. Relations among clusters may be positive development forces, creating effective convergence or integration processes among the same type of clusters in adjoining regions and resulting in a larger and stronger cluster. As previously noted, The Third Italy is such a case. Furthermore, Delgado et al. (2010b, p. 28) pointed out that "while cluster specialization in a region displays convergence, employment growth of a cluster is positively influenced by the presence of strong related clusters in the region and by the specialization of neighbouring regions in the same cluster". Certainly, in real life, relations among clusters may be negative. Lu and Cao (2012) analysed data from the Pearl River Delta (China) and found that the same type of clusters in adjoining "core" cities have negative relations with one another in terms of cluster size and cluster economic output. Hu et al. (2005) studied the IT clusters in Taiwan and provided details about the IT industry there. They divided

clusters into R&D oriented, incubation oriented and Science Park oriented, and found that IT firms in different clusters had to fight for scarce resources, particularly human resources and capital—consistent with what was previously discussed.

3.2. Relations Among the Same Type of Clusters in FA Regions

The same type of clusters in FA regions develops different types of relations from those among clusters in adjoining regions. When clusters are in FA regions, endowments (e.g. labour, capital, R&D and business networks) are absolutely different. "FA" with respect to distance means that clusters are located in different countries or at distances that require long travel times. Recent cluster studies have shown that very few clusters rely solely on local markets. The media cluster in Leipzig (Germany) that produced and sold products locally (Bathelt, 2005) is a rare example today. Clusters must expand their markets both domestically and globally. An increasing number of markets have become global as trade barriers and regulations have been removed.

3.2.1 Reasons leading to the appearance of relations among clusters. One reason is that the same type of clusters in FA regions must build relations in technology to bridge technological and innovation gaps. Note that technology reasons are built on market reasons. Owen-Smith et al. (2002) studied biology clusters in both the US and Europe and found many links among these countries' clusters. Some clusters' relations are combinations of technology and marketing knowledge, whereas others are based purely on technology. In other words, clusters with weak technology skills receive technology from clusters with strong technology capabilities. Strategic alliances among firms in other clusters are frequently employed.

3.2.2 The roles of labour, capital, knowledge and markets. Talents play a special role in the relations among clusters in FA regions. On the one hand, talent—particularly top talent—is scarce, and all clusters are fighting for such talent. In this regard, competitive relations exist among the same type of clusters in FA regions. From the viewpoint of an individual talent, a talent is able to easily travel to many locations; however, talent usually does not settle down very easily in a FA place. In particular, for married talent with children, frequently changing jobs and working in different regions mean that the individual must move the family with him or her or live alone without family members. Both choices are problematic from the individual's point of view. Talent travels frequently but also faces significant barriers to settling down in FA regions (e.g. Ploeg & Poelhekke, 2008). A concrete example is from Power and Lundmark (2004), who showed that talented employees travel to many places but stay only in certain places for the long term. Talented individuals tend to like having their own "team" or working with certain teams, and a stable environment benefits talent in terms of producing innovation outputs. Although clusters fight for talents globally, such "fights" are limited. The volume of top talent (e.g. Nobel Laureate, CEO of Forbes top 500 enterprises) is small, and such individuals have the ability to work in different regions but are not likely to adopt such a strategy (Leibovitz, 2004). To normal workers, the movement of a large number of working immigrants among clusters in FA regions is unrealistic. International rules and regulations do not allow people to move freely from one country to another, limiting large-scale immigration from developing to developed countries. Clusters are also able to develop talent relations in new ways; for example, "through globalization, regions with a strong knowl-

edge infrastructure and high incomes are integrating with other regions with low labour costs, in particular in Asian countries" (Lambooy, 2005, p. 1145). Thus, business outsourcing mechanisms become substitutes for talent migration.

Cluster development often requires large-scale capital investments; however, capital does not play an important role in the relations among the same clusters in FA regions. Capital investment comes from three agents: cluster firms' own capital, local capital and FDI. Cluster firms' own capital and local capital cannot be shared among the same type of clusters in FA regions. Studies on venture capital uncovered that (Avnimelech et al., 2010): (1) venture capital has very high "thresholds", indicating that such capital rejects most applications and only invests in a few projects with the potential to achieve business success and (2) venture capital favours investing in firms that are in geographical proximity given the need to monitor projects. FDI follows the principle of maximizing profits, is indifferent to the same type of clusters in FA regions and pursues clusters with the highest profits. Thus, FDI does not prefer one cluster to another, unless notable differences exist in competences and profitability opportunities.

The same type of clusters in FA regions may have both cooperative and competitive knowledge relations. Owen-Smith et al. (2002) showed that American biological clusters are able to develop cooperative relations with their peers in Europe. In contrast, clusters in FA regions also conduct their own research and compete in knowledge and technology. Maskell (2014) classified four ways of getting remote knowledge, namely global pipeline, listening posts, crowdsourcing, and trade fairs. Maskell primarily considered the capability of firms to aware which knowledge they want and where they can turn for help. Since Maskell gave a general explanation of reasons that how and why firms access remote knowledge, such explanation can apply to understand how cluster firms in FA regions build knowledge relations.

In terms of markets, the same type of clusters in FA regions can compete with one another. For example, the aircraft cluster represented by Boeing in Seattle (Gray et al., 1996) and aviation industries in the Netherlands (Broekel & Boschma, 2011) work hard to produce products using advanced technologies of high quality. Two clusters in two countries compete in the global market. Moreover, competition over global market share is the basic issue for clusters producing similar products in FA regions. Selling products and services to customers and making profits drive cluster development. When faced with such a rivalry, clusters are not likely to build relations with competing clusters. Actually, competing clusters interact in many ways other than pure competition. For example, firms in IT clusters in the US often outsource large parts of their value chains to other countries with an IT industry, such as India or Taiwan. Such outsourcing strengthens the IT cluster around Bangalore and other Asian locations (e.g. Ketels, 2003). Hsu (2005, p. 661) referred to the eastern Asian model as "a triangle connection among Silicon Valley – Taipei (Hsinchu) – Shanghai" that is emerging and creating a pattern of capital and knowledge circulation in the nodes of transnational business networks. Dense social and professional networks foster flows of technology, capital, know-how and information within the triangle, stimulating entrepreneurship in the three regions and providing the foundation for formal interregional business relations, such as consortia, joint ventures and partnerships.

3.2.3. Practical examples. In reality, clusters in FA regions may build cooperative relations in the following ways. The first manner, termed "Argonauts" by Saxenian and

Sabel (2008), is diasporas, or highly educated migrants who connect their home and their adopted countries (p. 382). Taiwan, India, Israel and China are typical examples. The first-generation migrants brought their home-country counterparts not only capital resources and advanced technology, but also the likely more important economic and institutional change. Because economic activities are spatially specialized, Argonauts can more easily build relations at cluster levels rather at the national level. The second way is generally the cooperation among clusters in small countries. A typical example is the close cooperation among the Norwegian maritime cluster and the Singapore maritime cluster (Reve, 2011), or the Norwegian maritime cluster and the South Korean maritime cluster (Shin & Hassink, 2011). In such cases, each maritime cluster specializes in certain activities and benefits through trade, communication and joint R&D activities. The Norwegian, Singaporean and Korean maritime clusters tend to develop complementary roles that strengthen one another's competitive positions. Norway remains a leader in maritime technology and design, advanced maritime equipment and maritime finance. South Korea has taken the lead role in shipbuilding, and Singapore is a leader in maritime commercial operations, including port logistics and maritime services. The third way is investor and supplier relations. Bolo (2008) described the development of the Naivasha flower cluster (Kenya). This region has very good natural conditions, such as abundant water, fertile land and comfortable weather, and a nearby airport. More importantly, this cluster cooperates with other clusters in developed countries, in particular the Dutch flower cluster. Cooperation includes investing in local training and building specialized infrastructure. FDI from other clusters often brings R&D, technologies and new skills, and provides marketing channels and access to global markets. The China – Taiwan case is another version of the Dutch – Kenya case. Chen (2004) provided reasons why an increasing number of R&D activities requires global cooperation by stating that R&D costs increased dramatically, and an increasing number of developing countries provide a good supply of R&D talent and skills (p. 339). Chen further argued that mainland China has abundant IT human resources, an enormous domestic market and strong absorptive capacity because its technology developed in a leapfrog manner. Therefore, concerning IT industries, building R&D cooperation with IT firms in China is the first priority for Taiwanese IT firms (Chen, 2004). Although Chen's study only analysed the IT industries in Taiwan and mainland China, and no cluster-related issues appeared in the paper, it referred to the description in Hsu and Saxenian (2000) by noting that Taiwan's IT industry is primarily located in the Hsinchu science-based industrial park, a very strong IT cluster. The Kunshang IT cluster and the Shenzhen IT cluster in mainland China have intensive relations with Taiwanese IT clusters.

In contrast, the same type of clusters may also compete with one another. Blundel and Thatcher (2005) described how the British yacht building industry on the south coast of England declined as its market was eroded by other yacht manufacturing clusters in France, Sweden and Germany. A more intuitive sense of the British yacht building cluster is that "British yacht building (which was clustered in England) has been in decline for two decades . . . our surviving boat builders find it all but impossible to compete with the deluge of inexpensive imported yachts" (Blundel & Thatcher, 2005, p. 416).

Another example is given by Schmitz (1995), who illustrated that the Sinos Valley shoemaking cluster in Brazil lost its low-end shoe market share in the American market because the Chinese produce even cheaper low-end shoes. Schmitz did not mention that

the Sinos Valley fought against a particular Chinese shoemaking cluster. However, the book by Zeng (2010) on Chinese special economic zones and clusters facilitates the conclusion that most shoes in China were produced in the Guangdong province and the Zhejiang province, which have several shoemaking clusters, potentially making these provinces the main rivals of the Sinos Valley.

Last but not least, in the case of the automobile industry, Detroit is losing ground to Japan, Korea and China because it failed to adapt to the demand for smaller and more energy-efficient cars, whereas Germany remains strong because of its strong technological position. Most other countries, such as the UK, lost their automobile industry entirely or only engage in assembly. Thus, having a cluster is no guarantee that a country will remain competitively strong. Clusters need to be exposed to external competition and need to adapt and transform (Reve, 2011). Shipbuilding disappeared completely from the UK and most other European countries, whereas Norway transformed its shipbuilding industry into developing advanced vessels for the offshore oil and gas industry.

Relations among the same type of clusters in FA regions strike a delicate balance. Building cooperative relations with other clusters in the same industry can benefit the local market. Relations among clusters help enhance a local cluster's competitiveness. New ideas from the outside create incentives for cluster development and cluster transformation. In terms of competition effects that exist in the same type of cluster in FA regions, such competition is both positive and negative. On the one hand, when clusters of the same type compete in the global market, such clusters must explore all measures to help them hold onto market share because competing for market share is a zero-sum game. Therefore, clusters must conduct additional activities more effectively to improve their competitiveness. On the other hand, fierce competition also leads to cluster decline and death. Determining the results that relations bring to the same type of clusters in FA regions is difficult. Will one cluster dominate the other clusters or does a new structure emerge that has complementary cluster roles, such as in the automotive or IT industry? We should not jump to conclusions because clusters enlarge or shrink for different reasons. Clusters sometimes decline because of life cycle reasons, changing market demand or cluster competition (Enright, 2003).

3.3. Relations Among Different Clusters in the Same Region

Any region, in particular cities, regardless of the size of its territory and the scale of its inhabitants, must have several industries to support individuals' basic life, such as a retailing industry and a water supply industry. However, we do not find cluster relations in every city. For example, Norway has only five million inhabitants. In small cities such as Bodo and Narvik in northern Norway, building even a single cluster is difficult because the population is too small. For larger regions with larger populations (e.g. major Asian regions), having several clusters simultaneously located in the same region is normal. Smaller regions often need to have specialized resources to be able to develop clusters, such as fish farming along the Norwegian west coast.

3.3.1. Reasons leading to relations among clusters. Jane Jacobs' two masterpieces, The Death and Life of Great American Cities (Jacobs, 1961) and The Economy of Cities (Jacobs, 1969), have provided us with important clues for discussing the relations among clusters. Jacobs did not deny that specializing in a single industry could bring effi-

cient and effective development of that industry; however, she noted that such development is based on a pure economic viewpoint. All business activities are organized by people, and living in a city with only a single industry often leads to an inconvenient life, which is why people finally "abandon" that city and go to one with a more diverse environment. A prosperous city should have several main industries and several supporting industries. All of these industries together produce economic and social benefits for the people living in the city (see Jacobs, 1961, Chapter 6 and 7). From another book, Jacobs (1969, Chapter 2) advanced her famous "D+A ∗ nD" model that explained how innovation takes place from one activity to other activities. This innovation process is experience based and people act on intuition.

Building on Jacobs' arguments, this paper contends that various clusters are co-located in the same region for two reasons. First, each cluster is a potential contributor to developing other clusters in the same region. When a cluster is established, it may have, for example, factories, workers, suppliers and service providers. All participants belonging to a certain cluster may have relations with other clusters. In Seattle, assume that workers in the IT cluster may also demand services provided by the life science cluster. Second, as Jacobs noted, industries can be divided into primary functions and supporting functions. Industries with a primary function hold the main power for generating economic outcomes. Industries with supporting functions provide services for people's normal lives. Following Jacobs' logic, this paper argues that clusters co-located in the same region expand in size and scope. Thus, a cluster is typically constituted by several related industries. A cluster that increases in size implies more jobs and stronger local consuming power. This duality simulates other clusters to locate in the same region or the same city. Furthermore, when clusters are located in the same region, every cluster has the potential to enjoy so-called urbanization benefits.

Building on Jacobs, Evolutionary Economic Geography (EEG) further argued that the process of spin-off development pushes clusters to emerge (Klepper, 2010). EEG coined the important concept of "related variety". Boschma and Frenken articulated this concept:

> Regarding knowledge spillovers, it has been argued that knowledge is more likely to spill over among agents when their cognitive distance is neither too large, as some degree of cognitive proximity is required to ensure effective learning, nor too small, as agents with the same knowledge will have little to learn from each other. Accordingly, the higher the number of related number of related industries in a region, the more opportunities exist for effective knowledge transfers among sectors. (2011, p. 300)

We also use EEG to consider the relations among clusters. The EEG argument highlights the snowball process of spin-offs, and related varieties play a mixed role in the relations among clusters. On the one hand, following the natural development process of clusters, several clusters that have appropriate "related variety" actually benefited from one another. A typical example is from Liu et al. (2013), who studied the cluster size relations among homogenous clusters. According to Lu et al., when a region consists of homogenous clusters, either labour-intensive clusters or capital-intensive clusters, a cluster that enlarges its size increases the sizes of the other clusters in the same region. On the other hand, we take a conservative attitude towards the EEP's related variety argument because, in reality, sometimes two or more clusters of a closely related variety or that are of a completely unrelated variety may be peacefully located in the same region. In

such situations, relations among clusters are not naturally formed but are created by governments. Cluster creation through government intervention is predominant in developing and emerging countries, particularly in Asia and China. For Western economists to understand that a government has the power to decide on the regions that should build certain clusters is sometimes difficult. One example is the development of special economic zones. In a special economic zone, governments provide the basic infrastructure and preferential business policies. Governments also decide on the industries, and even the firms, located in the zone. Many special economic zones achieved considerable economic success, such as those in China, Malaysia and Thailand (Amirahmadi & Wu, 1995). Again, with respect to relations among clusters, note that such zones are built for certain industries with the explicit goal of becoming clusters. In the 1980s, the Shenzhen special economic zones consisted of several clusters: a textile cluster, a food processing cluster and a shoemaking cluster, among others. Currently, several special economic zones are being developed into knowledge hubs. Ge (1999) showed how China uses special economic zones to develop its economy. Although some economists may not be interested in this kind of government-oriented model, this paper argues that if setting clusters in the same region is dominated by the government, and if such a development model enables economic achievement, as in the Shenzhen special economic zone, such a reality will perfect the argument of "related variety". After all, in this case, the preference policy issued by the local government is stronger than the "related variety" among industries.

3.3.2. The roles of labour, capital, knowledge and market. A region that encompasses labour-intensive clusters, such as in manufacturing, does not have as strong a demand for highly educated employees. In this situation, employees benefit from a large job market and can easily change jobs from one cluster to another—making it easier to get a job than when a region has only one cluster. For example, in Dar-es-Salam, the handicraft and the furniture clusters adopted different technologies, but the threshold of joining such clusters is low because they require no formal education or technology skills. A significant amount of manufacturing in China employs manufacturing lines to produce; therefore, a worker only needs a few hours of training before starting to work (Zeng, 2010). If clusters are knowledge intensive, then for labour to flow from one cluster to another becomes more difficult than among labour-intensive clusters. For example, if an IT cluster and a biological cluster are in the same region, an IT engineer cannot take the job of a biologist. High specialization makes changing jobs difficult; however, well-educated people are able to develop skills for new jobs or use their skills in different jobs. For example, an IT engineer is able to write software for both an IT firm and an aircraft firm, as is shown in the Seattle case. Furthermore, when labour-intensive clusters are co-located with capital-intensive clusters, the former provides convenient lives for the latter, and the latter provides high salaries to the former (Lu et al., 2013).

With respect to capital issues, conservative investors prefer to make local investments. If a region consists of several clusters, conservative investors have more investment opportunities. The same concept applies to investors with a more open attitude towards risk. They are able to find more investment opportunities when several clusters exist in the same region.

Concerning knowledge, according to the Marshall – Arrow – Romer (hereafter the MAR model), the argument should be that for any given cluster, cluster firms—particularly firms with a strong knowledge base—intend to protect their knowledge and do not want to share knowledge with other cluster firms. However, the MAR model also points out that cluster firms cannot fully control knowledge spillover; knowledge is "in the air" and is ready to be shared. In summary, the MAR model argues that cluster firms intend to protect their knowledge to generate monopoly power; however, such knowledge protection is never fully successful because knowledge spreads informally from one firm to another firm. It may be asserted that being in geographic proximity does not necessarily cause knowledge spillover. Breschi and Lissoni (2001), for example, articulated three types of means of showing how knowledge spills over in geographical proximity. The three types are localized knowledge spillovers, the viewpoint of new economic geography, and the viewpoint of new industrial geography. Breschi and Lissoni (2001) devoted much effort to reviewing why geographic proximity and knowledge spillover might be not related. Huber (2012) studied the Cambridge IT cluster, one of the most prominent clusters in Europe, and found that most IT firms in such clusters do not have many intra-cluster interactions. Giuliani (2007), from another angle, pointed out that the business network and the knowledge network are different in terms of diffusing knowledge. This paper, however, argues that although Breschi and Lissoni (2001) and Huber (2012) proved that in some cases the argument that geographic proximity benefits knowledge spillover does not work, what they pointed out is that such an argument is imperfect; rather they totally denied the mechanism of knowledge externality coined by Marshall (1890). Therefore, it is still reasonable to argue that geographic proximity is relevant to knowledge spillover. Acs and Armington's (2004) argument that knowledge spillover follows Jacobs theory, and firms have different capacities to absorb knowledge (in particular, diversity development is helpful for small firms), makes sense.

An individual cluster is able to cultivate its own market. Following the classic argument by Marshall (1890), a cluster is able to create a lot of mediators who provide supporting services for cluster firms. Mediators are linking pins in the cluster, and each cluster firm is so specialized that many functions are "handed out" to mediators. When several clusters are co-located in the same region, mediators serve different clusters. Such mediators offer numerous business and consumer services, such as logistics, IT, legal and retailing. Firms that only serve one cluster receive "indirect" benefits by being located in a region with several clusters. Several clusters that rely on similar resources can help one another develop more marshalling advantages, and then each cluster expands its size and creates additional mediator businesses. Heebels and Boschma (2011) used spin-offs as an example of cluster development. A spin-off may be an employee who previously worked for a firm and then quit her job and started her own firm. A spin-off may also be a new business subsidiary started in geographic proximity of the parent firm. Spin-offs generate at least two advantages. First, they add a new member to the local cluster and, second, they receive routines and resources from parent firms, thus strengthening the knowledge base of the clusters.

When several clusters are co-located in the same region, balancing size and scope is essential. Firstly, the region must address congestion effects from rapid economic development. When several clusters are located together and when people are crowded within the same region, several problems result from such crowding. Housing prices and living

costs increase, traffic congestion causes people to spend more time commuting, and pollution worsens the physical living environment, as evident in many Asian cities today. Secondly, cluster development has controversial aspects: when several clusters are located in the same region, high economic performance clusters squeeze the living space from clusters with lower economic performance. The concentration of banks and financial services in downtown areas increases rents, forcing other firms to move out of the city centre and destroying other centre functions. When small firms and regular-income people cannot stay in downtown areas, banks lose some of their customer base. The financial cluster and, subsequently, several prior existing clusters may then begin to decline. This account is from Jacobs (1961). In contrast, the MAR model argues that any cluster has a life cycle, and when clusters mature, they either transform or die. However, when clusters are co-located in the same region, they may decline at a faster rate than when they are alone. Another possible phenomenon that differs from the decline of a financial cluster is when clusters grow too quickly and decline from overexpansion, as seen in some retailing locations.

3.3.3. Practical examples. Two or more clusters co-located in the same region, particularly in big cities, is quite common (Bathelt & Li, 2014). In Seattle, Washington, three famous clusters are co-located: an IT cluster represented by Microsoft, an aircraft cluster represented by Boeing, and a biological cluster represented by the Fred Hutchinson Cancer Research Center (Gray et al., 1996). In Dar-es-Salam, Tanzania, a handicraft cluster and a furniture cluster are co-located, reinforcing each other though several mechanisms (Musonda et al., 2008). The two clusters rely on the same labour pool, use the same skills and receive their training from apprenticeships. Lu et al. (2013) calculated the location quotients for six cities in the Pearl River Delta (China), and their findings showed that from 1989 to 2009, the period during which mainland China experienced significant economic development, the relations among clusters in the same city were positive. In other words, when a cluster enlarges its size, other clusters in the same city receive a noted influence. However, if the relations are detected, then other clusters also enlarge their size. This finding applies to relations among labour-intensive clusters, relations among technology-intensive clusters, and relations among a labour-intensive cluster and a technology-intensive cluster.

4. Discussion and Concluding Remarks

This paper discusses three types of relations among clusters that are co-located in either geographic proximity or FA regions, and attempts to expand cluster theory from the cluster firm level and individual cluster level to the multi-cluster level. Note that relations among clusters are not a simple large version of “relations among industries”. As discussed by Jacobs (1961, 1969), relations among industries may or may not apply to relations among clusters. The process of forming a cluster is slower than the process of forming an industry. A cluster stimulates specific industry development and advances the development of related and supporting industries. Thus, cluster development is more complex and takes more time than industry development. Clusters may be treated as a combination of primary function industries and supporting industries. Jacobs argued that diversity is an unbalanced act. During the process of diversity, one industry’s growth may cause other industries to decline or leave. Clusters decline for many reasons,

such as lower market demand, competition from other clusters, technological advances and new business models. With respect to relations among clusters, maintaining a balance among industries is not necessary. By upgrading technologies, introducing new business models and finding new markets, a cluster is able to transform and successfully survive. A good example is the transformation of the Norwegian maritime industry into the offshore oil and gas sector that now operates globally (Reve, 2011).

When the same type of cluster is located in geographic proximity, unbalanced development of clusters is the main reason for clusters to build relations with one another. In this situation, resources such as human and financial capital and knowledge have low barriers with respect to flowing within nearby regions. Clusters with high economic performance attract resources from clusters with low economic performance, known as the out-crowding phenomenon. Therefore, high performance clusters perform even better because they obtain resources from adjoining regions. Considering congestion effects, relatively low economic performance clusters do not completely disappear. Some people make personal choices and leave the core areas to live in the periphery given congestion effects.

When clusters of the same type are in FA regions, the situation changes. In this case, cluster relations are developed primarily to gain access to markets and knowledge. Neither Porter's nor Krugman's cluster theory fits this situation because the local environment and the free flow of people are not important. When clusters interact with clusters in FA regions, even when people have access to modern communication technology, a large number of individuals are unlikely to flow freely among FA regions. Capital resources show the same pattern. Local capital prefers to invest in either less-risky projects or those that are easily monitored. For market reasons, clusters compete, yet cluster firms simultaneously have incentives to build cooperative relations to develop new products, new knowledge and new business practices.

Arguably, different clusters located in the same region expand Jacobs' urbanization theory. Different clusters in the same region are the result of economic development, and people require facilities and markets from different clusters. On the one hand, several clusters with primary functions generate economic output to meet local demand, creating new economic activities in other sectors. On the other hand, clusters that play supporting roles may initiate the development of new primary clusters. Cluster development faces two potential dangers. One danger is that the cluster becomes too specialized. The other danger is that the cluster is not able to adapt and transform as markets and technology change.

To generate a theoretical framework for analysing the relations among clusters, numerous empirical studies are required. This paper lists several potential important issues for future research. The fundamental research topic is the evolution of a cluster over time in relation to other clusters. Subtopics may include, for example, the following: (1) Why and how does one cluster develop its relations with a certain other cluster? (2) How do new capital- and technology-intensive clusters influence and interact with traditional labour-intensive clusters? (3) From the geographic perspective, what other reasons impact the relations among FA clusters? (4) At the firm level, how do firms relocate among clusters when markets become global?

In this paper, we provide a brief theoretical argument on the relations among clusters and a modest spur to induce other scholars to make valuable contributions, both theoretically and empirically, to obtain a better understanding of the relations among clusters. These findings are expected to have important policy implications at national, regional and business levels.

Acknowledgements

The first author would like to thank all his colleagues at the Institute of Industrial Economics, Jiangxi University of Finance and Economics, and thank doctorial candidate Wenxi Tang from School of Tongji Medical College, Huazhong University of Science and Technology, for their suggestions for revising the paper. Both authors are indebted to the two referees and chief editor of the EPS Professor Philip Cooke for their comments on the previous draft.

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