Knowledge Cluster Development through Connectivity: Examples from Southeast Asia

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Abstract— **Whereas since the 1990s national and regional planners saw the creation of knowledge clusters as a panacea for gaining a competitive advantage to propel a region or country into a higher stage of industrial development, recent research suggests that connectivity (e.g. through broadband penetration or joint research connections with collaborators elsewhere) is one of the enablers for socio-economic development. This paper will draw on the results of studies on knowledge clusters in Southeast Asian countries (Malaysia, Brunei, Singapore) as well as the relevant current literature to ask the question, whether knowledge clusters really contribute to regional development and if yes, under what circumstances. The paper will also draw on lessons learned from knowledge cluster initiatives in Organization for Economic Co-operation and Development (OECD) countries and highlight policy options to enhance connectivity in the context of knowledge cluster development.**

Keywords-knowledge clusters; connectivity; Southeast Asia.

I. INTRODUCTION

Not too long ago, Frances Anne Cairncross, a British economist, journalist, academic and a member of the Council of Economic Advisers for the Scottish Government, announced the "Death of Distance" [1]. She argued that the advances in telecommunications would effectively eliminate distance as a perceptible concept from our lives. This "death of distance," a determinant of the cost of communications, "will become the single most important economic force to reshape society over the next half century". Nothing could be further from the truth. Nobody will today negate the impact of the Internet and of broadband communications on society, culture and the economy, but space still matters. Industrial clusters, knowledge clusters and conceptions of space are still important factors, shaping economy and society. Why does distance still matter?

There are many answers to this intriguing question, but two stand out. The first has been propagated by Harvard Professor Michael Porter [38] [39] [40]. The competitive advantage of nations and regions depends on the formation of industrial clusters. "Clusters are geographic concentrations of interconnected companies, specialized suppliers and service providers, firms in related industries, and associated institutions (e.g. universities, standard agencies, and trade associations) in particular fields that compete but also cooperate. Such clusters are a striking feature of virtually every economy, especially those of more economically advanced areas" (Porter 2000:253). Not only that, the degree of clustering determines the competitiveness of a nation or region. Firms located in a cluster have an enhanced chance of profitability and are more competitive in contrast to firms located outside a cluster in splendid isolation. The main argument of earlier industrial location theory of Alfred Weber is resurrected, namely that transaction costs are lower in clusters than outside [49].

This mantra has been repeated over and over again by Porter and his followers and has led to massive research programmes figuring out the degree of clustering, the location of clusters and the best way to create and manage industrial clusters.

Meanwhile, a great number of studies have been conducted. According to the disciplinary home of the authors, there are coloured results. Geographers have emphasized location and proximity, sociologists emphasized social networks and knowledge sharing, and economists tend to look at economies of scale and transaction costs. At this stage it is extremely difficult to bring together the results of these studies and to draw final conclusions. It has, however, become clear that cluster formation and cluster competitiveness is a good deal more complex and complicated than advocates of Porterian cluster policies would have it. So far, it is not entirely clear whether clusters make firms more productive and thus more competitive, or more productive and competitive firms come together to form a cluster. This poses a dilemma for cluster policies or cluster governance. "Natural" clusters are possibly formed by highly competitive firms, but firms induced by government subsidies or active cluster management may not turn out to be more competitive at all despite being co-located in a cluster.

One finding of Porter type cluster analysis still holds, namely that despite increased broadband penetration and Internet connectivity clusters still emerge. The basic hypothesis that the higher the economic development of a country or region (in terms of the usual measurements), the higher the degree of industrial clustering appears to hold.

The big gap in our understanding of both the clustering process and the outcome of clustering still lies in a precise analysis of the inner workings of a cluster. In short, we need to know more about what makes a cluster tick, before a robust cluster policy can be designed. In Section II we highlight the importance of tacit knowledge in knowledge

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clusters, followed by what it takes in terms of knowledge management for clustering in close proximity to enable higher productivity (Section III+IV). Section V examines Singapore's maritime cluster and discusses the various ingredients for a cluster to become an innovation hub. In the conclusion, we make a case for the importance of governing connectivity as part of knowledge governance.

II. FROM INDUSTRIAL TO KNOWLEDGE CLUSTERS

Current cluster analysis is the foster child of industrial agglomeration theory, as developed by Alfred Weber a century ago [49] [50]. Taking the Ruhr District, the home of German heavy industries, as an example, he could show that the use of raw materials, like coal, water and iron ore, enticed basic industries and metal industries to crowd together to reduce transportation costs. Raw materials were heavier and therefore costlier to transport than finished products to customers. Markets and materials decide location of industries.

This "reduction of transaction cost" argument is still valid for manufacturing industries, but less so for the new and increasingly important raw material called "knowledge" [48]. Data, information and explicit knowledge can be transmitted through the Internet at low cost. Outsourcing data intensive work, like banking, bookkeeping, design and many other tasks has become frequent practice for both the manufacturing and service sectors. It is therefore surprising that in contradiction to the transaction cost argument, knowledge intensive industries still tend to cluster.

Knowledge clusters do not just consist of information and communications technology (ICT) or high-tech production units, but have to be combined with research institutes, R&D divisions of companies (incl. test-beds and labs), institutions of higher education and learning, like colleges and universities, and government support services.

With the rapid development of information and communication technology and the spread of fast Internet connection, knowledge is increasingly seen as the most important driver of development. While reaching the state of an industrial society is seen as the aim of many developing countries, the move towards a knowledge based economy and society has already engulfed the industrial world. The ICT based service sector is expanding and knowledge is regarded as a prime factor of production. Though production chains extend throughout the world, successful knowledge intensive industries are still found primarily in closely-knit knowledge clusters. The Silicon Valley, the Hyderabad ICT cluster or the biotech research cluster in Singapore are just a few of many examples of vibrant knowledge clusters. The cost for producing knowledge may be high, the cost of transferring data, information and knowledge is extremely low. If the venerable transaction cost argument does not hold, what then explains the emergence of knowledge clusters?

One argument refers to Nonaka's distinction between tacit and explicit knowledge [36]. Tacit knowledge is seen as the main ingredient of innovation in the fields of industrial production, marketing and organizational behaviour. While explicit knowledge can be easily transmitted, tacit knowledge or experience needs personal contacts to be disseminated [9] [19]. A concentration of experts and scientists leads to a "knowledge spill-over" between companies and in social networks and face-to-face contacts. This allows the transmission of valuable tacit knowledge, which is hard to pass on through the Internet. Even broadband enabled video conferencing is apparently not able to get tacit knowledge across and replace the stimulating excitement of personal encounters.

Porter and his followers, on the other hand, seem to be skeptical of this argument. Groupthink, for example, can discourage creativity and prevent the process of innovating [42]. Following Granovetter's distinction between strong and weak ties it could, indeed, be argued that weak social ties of pluralistic, open-ended networks are more likely to be innovative than tightly knit networks of like-minded persons [23]. In other words, clusters integrated by social networks are not necessarily more productive and innovative than clusters with broadband Internet communicating units. Empirical evidence is still scarce and a good deal more research will be necessary to draw robust conclusion.

Another still open issue is the scale and regional impact of clusters. As mentioned above, there appears to be a strong correlation between cluster formation and economic growth at the national level. The impact of cluster formation within regions or beyond is less well established.

III. K-CLUSTERS AS DRIVERS OF REGIONAL DEVELOPMENT

One important assumption of the European Cluster Initiative or the U.S. Cluster Mapping Project is that creating or supporting industrial clusters guarantees economic growth [13]. A study of the European Cluster Observatory concluded, "there is plenty of evidence to suggest that innovation and economic growth is heavily geographically concentrated" [47]. As summarized by Mitchell et al. as recently as 2014 "considerable evidence indicates that knowledge plays a key role in the performance and innovation of firms in clusters" (Mitchell et al. 2014:2198). This, they argue, is also true for small and medium-sized enterprises (SMEs), though they often lack the absorptive capacity to assimilate new knowledge, unless there are "knowledge brokers" using their social capital of contacts into their field of expertise (Mitchell et al. 2014:2204).

Another assumption is related to innovations as a driver of growth. Innovations are presumably more likely to occur in clusters rather than elsewhere. A survey of the European Commission (Europe INNOVA / PRO INNO Europe Paper N° 9, Commission Staff Working Document, p. 22) concluded, "cluster firms are more innovative than non-cluster firms. These innovative cluster companies are more than twice more likely to source out research to other firms, universities or public labs than were the average European innovative firms in 2004. This supports the view that clusters

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are encouraging knowledge sharing which may further stimulate innovation. Moreover, cluster firms patent and trademark their innovations more often than other innovative companies" (p. 22-23). The statistical evidence provided in these reports shows that most, if not all, clusters support innovations and regional economic growth [14].

Despite the robust statistical evidence, this assumption has recently come under attack. Clustering may even hinder innovations. As Maskell has pointed out [31], cognitive distance may be small in clusters, but when disparate knowledge is required, strong clustering may even prevent the exchange of necessary knowledge and therefor reduce innovative capacity (p. 924). When disparate knowledge is required, it will just not be available in a narrowly focused knowledge cluster because it might be blocked by a competing or differing school of thought.

In a review of the literature, Wolman and Hincapie draw attention to the fact that "all regions have clusters, but not all clusters produce high growth" [51]. The question is therefore: Why are some clusters and their companies and research institutions more innovative than others? What factors stimulate innovative behaviour and regional economic growth?

These questions have, despite Porterian rhetoric during the past 25 years [37-42], not yet be answered in full. The Porter doctrine can be summarized as follows:

- Cluster participation: (a) increasing the current productivity of constituent firms or industries, (b) increasing innovation and productivity growth, and (c) stimulating new business formation that supports innovation and expands the cluster [42]
- Clusters drive productivity and innovation. Firms that are located within a cluster can transact more efficiently, share technologies and knowledge more readily, operate more flexibly, start new businesses more easily, and perceive and implement innovations more rapidly [41]
- Clusters Drive Regional Performance: Job growth, higher wages, higher patenting rates; greater new business formation, growth and survival; resilience in downturns [37].

By repeating over and over again that clusters stimulate innovations and are a necessary precondition for growth, not all questions are automatically answered. Some doubt remains and many questions have been left open for further research. We will use examples from the existing extensive literature as well as from our own studies on the relatively under-researched areas of clusters in Southeast Asia and point into directions, in which answers may be found or where additional research will be necessary.

IV. BROADBAND AND K-CLUSTERS AS DRIVERS OF REGIONAL DEVELOPMENT

The existence of stable broadband connections is assumed by some authors to act as a driver for cluster formation. Fast Internet connections make video conferencing viable and an immediate exchange of data and information possible. Indeed it could be assumed that the extension of broadband connection makes firms less dependent on proximity externalities, i.e. on cluster formation. From a different perspective broadband connections could also be helpful in spreading the impact of cluster productivity to neighboring regions. The results of empirical studies are, however, not clear-cut. In a recent study, Mack concludes that "in some places, broadband appears to be an essential link that enables knowledge firms to strategically locate in lower cost counties and in close proximity to major knowledge centres. In other places, the availability of broadband Internet connections is unable to mitigate the negative externalities associated with locations in more remote areas of the country. From a policy perspective, this suggests that broadband should be viewed as a key component, but not the only component, of comprehensive local economic development plans" [30]. Her findings are depicted in a map, showing US counties with or without good broadband provision in relation to knowledge intensive industries.

A. Networks and Knowledge Hubs

As various surveys have shown, sharing and dissemination of knowledge within clusters is a major driver of innovations and growth [9] [19] [33] [45]. Several authors see this as a more or less automatic process. Knowledge workers and experts working in proximity in one location easily transmit knowledge, so the argument goes. There is a "knowledge spillover", leading almost automatically to higher productivity [1] [10]. Our studies in Indonesia [44] and Vietnam [6] show otherwise. Though automatic knowledge-spillover may happen, there are knowledge clusters with high kernel density, where knowledge sharing is low or totally absent. This is the case in Hoh Chi Minh City, which has a great number of research institutes and universities in close proximity, but hardly any knowledge exchange takes place [6] [16] [17].

This means that clustering in close proximity is not a sufficient precondition for higher productivity. Knowledge has to be managed, cooperation needs stimulation and appropriate institutions for knowledge sharing, on which productivity rests, have to be formed [9].

The Malaysian government has pursued an active cluster development agenda [20] by declaring several regions as "development corridors" [4] and creating a massive Multimedia Super Corridor next to the newly founded federal capital of Putrajaya [7] [25]. The two other successful knowledge driven industrial clusters are found in Penang and in Johore.

In our studies in Penang we found a high degree of clustering including ICT industry, universities and local and international research institutes and companies. Several companies had relocated to Penang from other countries, because of the availability of high-level manpower and access to services of support companies. Government agencies supported research projects and supported start-up companies [13] [15] [22] [26].

Another interesting case is Brunei Darussalam, a small resource rich country with practically no industrial base [2] [3] [18] [27]. We could identify only one dense knowledge

cluster in the commercial district of the capital Bandar Seri Begawan, but the two major knowledge producing institutions University Brunei Darussalam, including several research institutes and the Institute Technology Brunei are actually located outside the major knowledge cluster [4]. Ongoing research by Purwaningrum (Institute of Asian Studies, UBD) shows that there is very little, if any, knowledge sharing between UBD, industry and government agencies. The so-called "triple helix" is not functioning and urgently needs to be managed.

V. SINGAPORE'S MARITIME CLUSTER (SMC): SUCCESS THROUGH CONNECTIVITY AND COLLABORATIVE RESEARCH & DEVELOPMENT (R&D)

Quite a different story is the development of Singapore's maritime cluster enabled through decisive and visionary knowledge governance by institutions such as Singapore's Economic Development Board (EDB), the Maritime and Port Authority (MPA), Agency of Science, Technology and Research (A*Star) in collaboration with Jurong Town Corporation (JTC) as well as the Urban Redevelopment Authority (URA). JTC, for example, continues to offer future-oriented infrastructure solutions to its cluster customers in order to maintain and improve competitiveness. As far as the offshore sector is concerned, works are under way to increase Singapore's limited water land resource by building new wharves and jetty facilities.

A major corporate actor within the SMC is the Keppel group of companies [46], which employs over 30,000 employees in more than 30 countries (its workforce in Singapore comprises 1,500 people). Keppel Offshore & Marine's companies and yards are situated relatively close to each other within Singapore's SMC, which facilitates knowledge sharing, and creation, arguably key success factors in this business [5]. Incorporated in 2002, Keppel Offshore & Marine has over 300 years of combined experience from the three companies under its wings, namely Keppel Fels, Keppel Shipyard and Keppel Singmarine. With its key competency in the area of offshore engineering, Keppel FELS is the world's leader in offshore oil rig fabrication for international clients such as Petrobras in Brazil.

Keppel Offshore & Marine is well known for its innovative ultra deepwater solutions such as semisubmersibles, drilling tenders, or compact drill ships. Located in the tropics, it built icebreakers for customers in the West and fabricates ice-worthy jack-ups in collaboration with an international business partner. Its innovation capability in designing oil rigs is based on several specialized R&D departments such as the Deepwater Technology Group (DTG).

Keppel has forged R&D linkages with various stakeholders, which helps to create new knowledge and to innovate. Local collaboration partners include A*Star, Ngee Ann Polytechnic (NP), Nanyang Technological University (NTU) and National University of Singapore (NUS). The latter has established an offshore engineering program for young talent at the new Centre for Offshore Research & Engineering (CORE) in the Faculty of Engineering (NUS) together with the endowment of the Keppel Professorship in Ocean, Offshore and Marine Technology. An example of a joint Keppel-CORE project is: 'Improved Guidelines for the Prediction of Geotechnical Performance of Spudcan Foundations during Installation and Removal of Jack-up Units (InSafeJIP)'. To further enhance Singapore's leading role in the global market for oil and gas drilling units and offshore support vessels, Keppel collaborates with several international partners such as the Centre for Offshore Foundation Systems (COFS) at the University of Western Australia. Joint research areas include jack-up spudcan analysis, deep water anchoring systems and the application of geotechnical models in wind farm design.

A. Mapping the Density of the Increasingly Diverse SMC

According to industry observers, Singapore's status as a "dominant force in the offshore marine sector" in conjunction with related services does support the growth of the industry across the region (Indonesia, Malaysia, Philippines), "positioning it as a regional offshore marine hub for the Asia-Pacific" [24]. Like Dubai in the Middle East, Abuja in West Africa or Houston in the USA, Singapore is seen a "natural choice" for Asia driven in-part by a growing demand for oil and gas, the desire across Asia to be self-sufficient in oil and gas, offshore marine capabilities, business incentives and strong support for innovation and the development of R&D talent in key areas.

Over the past few years, Singapore's offshore marine cluster has expanded as evidenced by the emergence of several (complementary) sub-clusters such as oil companies, oilfield and seismic survey services, oil & gas equipment, shipyards and drilling contractors as well as oilfield chemicals. However, increasing diversity does not automatically imply new knowledge creation and collaborative innovation. One way of exploring the collaborative knowledge creation potential of such agglomerations and to delineate a knowledge cluster is to compile directories of firms (incl. research centres and institutions of higher learning). When combined with geospatial coordinates, this method helps to identify potential areas of agglomeration of knowledge transferring and producing organisations, which we define as knowledge clusters [21].

Our studies [33] show that there is a dense clustering of marine firms in the West of Singapore (Tuas) near the sea, which offers certain location advantages with potentially good linkage effects to other related industries in subclusters within the cluster. Proximity can have a positive effect on knowledge sharing which in turn can enhance new knowledge creation [9]. The density of Singapore's offshore marine cluster has been proactively shaped by various planning agencies such as URA, JTC and EDB who are doing their best in anticipating firms' long-term strategic business interests. Good knowledge governance and potential cluster synergies rest on strategic physical and

economic planning approaches adopted by the respective planning agencies driven by Singapore's land scarcity.

The performance of a cluster depends on the extent of innovation related exchanges of knowledge, the quality of relationships to partners within and beyond the cluster as well as intra-organisational knowledge flows within cluster firms. Our findings suggest that firms located in the cluster comprising the central area / old harbour front might be a bit disadvantaged in the mid-term because they might lose their location advantages eventually in case the Tanjung Pagar port facilities will be moved closer to Tuas in the West to free up (valuable) land for expanding the business district further south [33].

B. From Cluster to 'Hub' Status

Increasing diversity does not automatically imply problem-free knowledge flows, new knowledge creation and collaborative innovation. For Singapore's offshore marine sector to become a powerful knowledge hotspot (hub) with regional and global significance, a sustainable local innovation system has to be nurtured characterised by high connectedness and high internal and external networking as well as knowledge creation and sharing capabilities. While empirical studies on the hub status of Singapore's offshore marine cluster are difficult to come by, there is some evidence that policy-makers continue to support and drive innovation in this sector. A key role is performed by the new Singapore Maritime Institute (SMI), a joint effort by MPA, the Agency for Science, Technology and Research (A*STAR) and the Economic Development Board (EDB) in partnership with local institutes of higher learning. SMI is developing strategies and programmes related to the academic, policy and R&D aspects of the maritime industry with an emphasis on shipping, port and maritime services, as well as offshore and marine engineering. It coordinates and aligns the strategic activities of the various maritime institutes at local institutes of higher learning and works to attract renowned academics and researchers to work in Singapore. It grooms local maritime talent and kickstarts more industry R&D projects. Collaborative R&D and capability development in key strategic areas such as subsea systems with local and international partners is seen as a viable strategy to achieve and retain Singapore's role as a global player in the offshore marine industry.

How is Singapore's quest to become a 'real' offshore technology hub progressing? Cluster theory argues that knowledge in form of innovations, patents and research papers as well as close cooperation between relevant knowledge institutions (both locally and internationally) are important to provide evidence for the knowledge hub function, including high knowledge productivity. We tried to shed light on the global standing of Singapore's offshore R&D as well as the external connections of Singapore-based researchers with the help of an output indicator of published journal articles. Only scientific research results in internationally recognized journals are counted. As a result not all projects of cooperation with local and international institutions are measured; only those documented in publications that are recognized, visible and accessible on the Web of Science. In the following, we shall present preliminary results of our analysis to better understand the global offshore R&D landscape.

Using the Web of Science and keywords such as offshore rigs, offshore engineering and dynamic positioning yielded 7,439 journal articles published between 2001-2011 spread over several categories such as Computer Science Information Systems, Electrical Engineering, Applied Mathematics, Automation Control Systems or Ocean Engineering. In terms of journal output, the top 5 countries appear to be the United States, the People's Republic of China, England, Germany and Japan. The top five research institutions are the Chinese Academy of Sciences, Russian Academy of Sciences, University California Berkeley, Indian Institute of Technology and the National University of Singapore (NUS).

In terms of external cooperative science connections (using an output indicator of joint journal articles to which Singapore researchers have contributed) between researchers from Singaporean institutions and elsewhere, India emerged on top of the list (4), followed by the People's Republic of China (2), Australia (2), Norway (2) and the United States (2). Important Singaporean educational institutions include the National University of Singapore (Faculty of Engineering, Department of Electrical & Computer Engineering; Centre for Offshore Research & Engineering; Department of Civil Engineering), Ngee Ann Polytechnic (Centre of Innovation - Marine & Offshore Technology) and corporate institutions such as Keppel Offshore & Marine and KeppelFELS.

A key capacity builder is the Centre for Offshore Research & Engineering (CORE) at the National University of Singapore (NUS) which has helped to enhance offshore geotechnical engineering according to observers. As in other clusters, building a full-time, world class academic group to work on offshore engineering, the transfer of knowledge from visiting experts to local talent and large-scale private sector engagement in terms of R&D funding are seen as important measures to further expand this field. While agencies continue to build up capacities in terms of offshore marine R&D, Keppel already has strong capabilities as indicated by the firm's reputation in the fabrication of jack-ups. Particular strengths with regard to knowledge-intensive technical ingredients/elements of offshore oil rig fabrication include Singapore's project management experience, the ability to deploy systems effectively, steel fabrication know how and availability of motivated manpower at competitive cost. Future (R&D) opportunities may include diversification into areas such as floating production systems and subsea production systems beyond the traditional focus on jack-ups, which bring in the revenues.

Our preliminary analysis suggests that Singapore is working hard towards becoming a global leader in offshore R&D. The ongoing investments into this sector and growing number of companies expanding their presence in the city-state such as Maersk Drilling are a result of turning visionary policy goals with regard to the country's enhanced (global) role in offshore marine R&D into reality. However, there are

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also challenges. As in other sectors, foreign scientists require certain incentives to set up shop in Singapore. While requirements for laboratory space and similar needs are relatively easy to fulfill in sectors such as biotechnology and life sciences, offshore marine scientists require special (at times huge) infrastructural facilities which in turn require space, sea water and land resources etc.

Furthermore one has to acknowledge the necessary organisational readiness in terms of being able to effectively absorb [11] [34] [52] new ideas generated within the organisation or 'externally' by cluster partners, for example through research & development, and to apply them in order to achieve innovation outputs. Key enablers to do so according to the two academics include exposure to relevant knowledge qua relentless networking, the presence of prior related knowledge so as to recognise the value of new knowledge and diversity of experience (the latter increases the scope for acknowledging external ideas and stimuli). Most if not all innovation frameworks propagated by innovation experts around the world have integrated research insights with regard to the power of absorptive capacity into their conceptual structure. Nevertheless, there are still many organisations 'out there' that remain weak or unsuccessful innovators, because they fail to absorb and make use of knowledge, learning opportunities and value networks.

If one translates the theory of absorptive capacity into practical recommendations for managers tasked to making innovation work, for example, qua innovative business models, the following recommendations emerge: Rethink the ways you deliver and capture value as well as how you deliver and monetize it! Leverage on your value networks and (re-)assess how you connect your organization with others (and their know how) to create more value! If innovation gaps are spotted, modify your value networks, e.g. by changing and innovating the supply chain as practiced by Samsung which developed a digital, more efficient operating model in order to better integrate its large and diverse number of logistic service providers (incl. carriers) globally or P&G famous for its continuous replenishment approach. Other 'older' supply chain innovations include the ocean shipping container (1956), the universal product code (1974), Toyota's integrated production system or FedEx' computerised tracking system developed from the mid-1980s onwards which provided near real-time information about package delivery.

VI. CONCLUSION: KNOWLEDGE CLUSTER GOVERNANCE

We have looked critically at basic assumptions of the idea that cluster formation is a precondition for competitiveness, productivity, innovation and ultimately regional development. This position, promoted by Michael Porter, is summarized on the Website of the Harvard Business School as follows (as of November 2014): "Today's economic map of the world is characterized by "clusters." A cluster is a geographic concentration of related companies, organizations, and institutions in a particular field that can be present in a region, state, or nation. Clusters arise because they raise a company's productivity, which is influenced by local assets and the presence of like firms, institutions, and infrastructure that surround it". The basic assumption is that geographic concentration, e.g. clustering increases productivity, innovations and competitiveness. This assumption pervades the business literature. But is this assumption true? Yes and no. Clustering does, indeed, seem to have all these positive aspects, but the degree of clustering does not necessarily correlate with the degree of innovativeness or competitiveness. In other words, clustering is one, but not the only factor in translating clustering into regional economic development. One important aspect is "knowledge". Industrial clusters must contain knowledge clusters, but these knowledge clusters only function if they contain innovative, networked "knowledge hubs", i.e. if knowledge sharing takes place within a cluster and with other knowledge clusters elsewhere. For this to happen, connectivity in form of broadband connections, science cooperation, knowledge flows and so on as well as physical proximity via exchange of information in conducive 'places' such as coffee shops are some of the essential preconditions.

The availability of broadband connections has been identified as one important factor in turning cluster policies into a success [29] [30]. A recent macro study in the US evaluates the relationship between the spatial distribution of broadband providers and the presence of knowledge intensive firm clusters in US counties as "heterogeneous" and "localized": "From a policy perspective, this suggests that broadband should be viewed as a key component, but not the only component, of comprehensive local economic development plans" [29]. Broadband provision is the technological backbone of social networking and knowledge sharing. Proximity within clusters is still an important factor of productivity and regional development, if these conditions are fulfilled. Furthermore, one can not ignore the importance of absorptive capacity of both firms and individuals in recognizing the value of new information generated internally or sourced externally aimed at applying it effectively to value creation in business and society.

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