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Entrepreneurship: The Role of Clusters Theoretical Perspectives and Empirical Evidence from Germany

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ABSTRACT. This paper is about the impact of clusters on entrepreneurship at the regional level. Defining entrepreneurship as the creation of new organisations and clusters as a geographically proximate group of interconnected firms and associated institutions in related industries, this paper aims to answer three research questions: first, do clusters matter to entrepreneurship at the regional level? Second, if clusters are associated with different levels of entrepreneurship, what explains those differences? Third, what do the answers to the previous questions imply for academics and policy makers? To answer these questions, this paper distinguishes between clusters and industrial agglomerations and advances a theoretical model and empirical research to explain the impact of clusters on entrepreneurship at the regional level. This paper uses the 97 German planning regions as units of analysis to test the hypotheses. Using hypotheses testing and OLS fixed-effects model, this paper finds that clusters do have an impact on entrepreneurship at the regional level, but industrial agglomerations do not. Implications for academics and policy makers and suggestions for future research are given in the concluding section.

KEY WORDS: entrepreneurship, clusters, industrial agglomerations, socioeconomics, neoclassical economics, Germany.

JEL CLASSIFICATION: D62, D63, D23, E24, J23, L16, M13, O10, R11, R12, R30.

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1. Introduction

Both clusters and entrepreneurship are highly visible among academics and policymakers given that similar historical conditions explain their resurgence and supposed impacts on employment would justify their economic importance. However, research on the impact of clusters on entrepreneurship at the regional level is both theoretically and empirically scarce due to conceptual, theoretical, and methodological limitations. In effect, both clusters and entrepreneurship are complex phenomena that defy definition, which in turn undermines theory building and testing. Researchers have studied specific kinds of clusters using as unit of analysis established small and medium sized companies (focus on size) rather than entrepreneurship (focus on new firms). Those studying founding and failure rates have focused on only one industry and one dimension of clusters – i.e. agglomeration of economic activity – and defining entrepreneurship as entry without considering individual level factors (cf. Rocha, 2004 for a review).

This paper contributes to this research agenda, advancing a conceptual and operational definition of clusters and a theoretical model as well as empirical research to explain the impact of clusters on entrepreneurship. Defining entrepreneurship as the creation of new organisations (Gartner, 1989) and a cluster as a geographically proximate group of interconnected firms and associated institutions in related industries (Porter, 1998), this paper aims to answer three research questions: first, do clusters matter to entrepreneurship at the regional level? Second, if clusters are associated with different levels of entrepreneurship, what explains those differences? Third, what do the answers to the previous questions imply for academics and policy makers?

To answer these questions, this paper distinguishes between clusters and industrial agglomerations, broadly defined as clusters without networks. Clusters have been equated to industrial agglomerations in both theoretical (Glassman and Voelzkow, 2001) and empirical studies (Baptista and Swann, 1998), but the lack of distinction among them hides important causal mechanisms that foster entrepreneurship. Based on this distinction, this paper presents hypotheses comparing entrepreneurship within and outside regions with industrial agglomerations, clusters, and clusters with external networks.

This paper uses the 97 German planning regions as units of analysis. Germany is an appropriate country to analyse the impact of clusters on the relationship between entrepreneurship and regional development at least for two reasons: first, both entrepreneurship and clusters are at the top of the policy agenda and it is no surprise that the idea of "entrepreneurship clusters" is an emerging topic for policymakers (cf. Sternberg, 2005 for a review of policies in Germany). Second, primary data from GEM Germany, with exceptionally large sample sizes, can be used together with highly disaggregated secondary regional data from the German Federal Labour Office. The combination of both data sources has never been used before for this purpose.

This paper is organised as follows: the next section reviews the literature, elaborates the theory, and defines the hypotheses explaining the impact of clusters and industrial agglomerations on entrepreneurship at the regional level. Section 4 explains the method and shows the results. This paper ends with contributions and lines for future research.

2. Theory and hypotheses

The conceptual framework and hypotheses to analyse the impact of clusters on entrepreneurship at the regional level is shown in Figure 1. The aim of this paper is to propose and test a model to ascertain whether clusters contribute to entrepreneurship. The argument is that the level of entrepreneurship is higher in regions with industrial agglomerations (H1). When comparing the differential impact of clusters and industrial agglomeration on entrepreneurship at the regional level, the argument is that the combination of the geographical, inter-firm and inter-organisational network dimensions in clusters creates better conditions than industrial agglomerations for the creation of new businesses (H2), although potential cluster blindness, mimetic isomorphism, and inhibiting social capital could impair the clusters' innovation capabilities and ability to change in the face of competitive pressures or changes in demand . This cluster blindness can be overcome whenever a cluster develops external networks, which help cluster actors to identify opportunities, threats, and resources beyond the geographical boundaries of clusters (H3).

This section builds up the conceptual framework shown in Figure 1, defining the variables and elaborating the hypotheses that relate them. The research problem and questions of this study are phenomena driven rather than theory or method driven. That is, the origin of the research topic is reality in itself rather than a new or existing theory or methodology (cf Thietart et al., 2001, p. 41).[1] For this reason, the aim is neither to test a particular theory nor to use a new method to test known phenomena, but to have a richer understanding of the role of clusters in fostering entrepreneurship.

Phenomena driven research coupled with the multidisciplinary character of entrepreneurship and clusters (Porter, 1998) imply there is no unique theory to describe and explain the relationships depicted in the conceptual model. In fact, the lack of cohesive and comprehensive theoretical approaches is highlighted in the entrepreneurship (Swedberg, 2000, p. 24; Busenitz et al., 2003; Shane, 2003) and cluster literatures. Therefore, it would be artificial to set one particular theory against another because there is no unique theory that can encompass either the entrepreneurship or the cluster phenomena.

Therefore, we need an integrative framework upon which formulate the hypotheses to understand and explain the impact of clusters on entrepreneurship. This integration is done using a socio-economic approach (Etzioni, 1988), which was analysed and applied to clusters and entre-

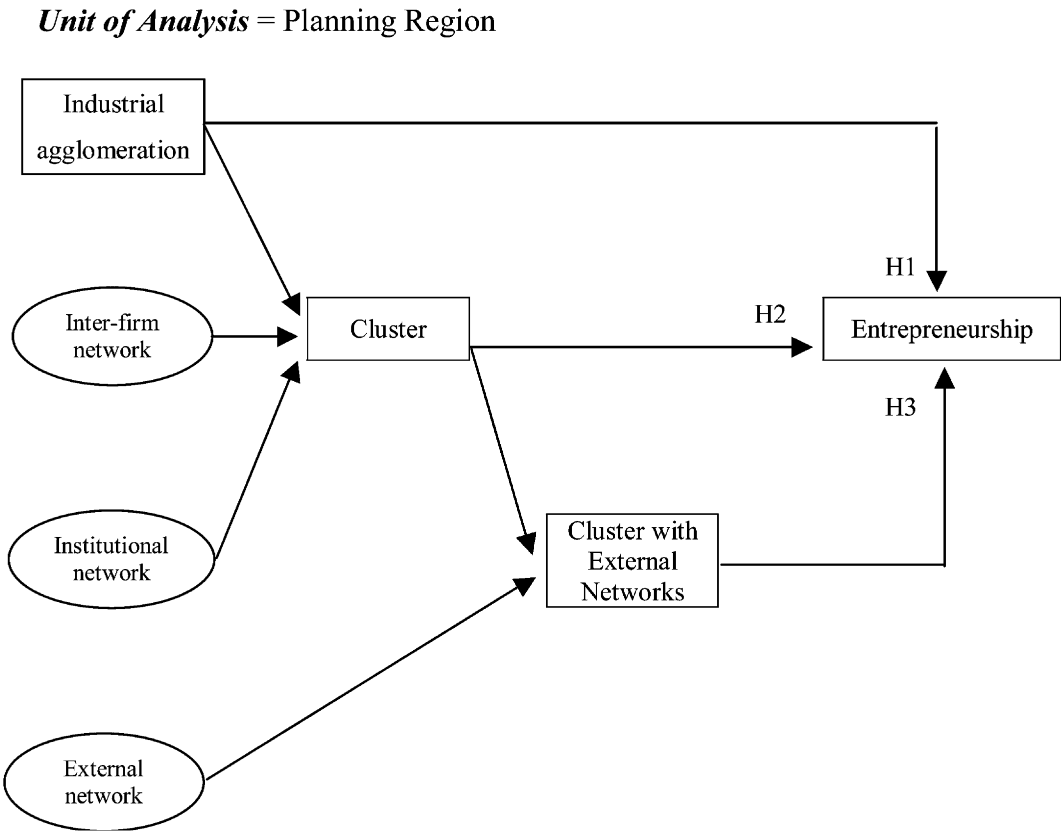


Figure 1. Model and hypotheses.

preneurship elsewhere (Rocha, 2002). A socio-economic approach contributes to explain the integration of economic and social processes within clusters in an integrative way, avoiding the characterisation and explanation of their impacts from either the geographical agglomeration or the social network dimensions alone.

The next two sections review theoretical perspectives and conceptual issues in the entrepreneurship and cluster fields (Sections 2.1 and 2.2). The last three sections state the hypotheses on the effect of clusters and industrial agglomerations on entrepreneurship (Sections 2.3–2.5).

2.1. *Entrepreneurship*

The historical evolution of the concept of entrepreneurship shows its multifaceted reality and explains why this concept has been defined from various perspectives, such as entrepreneurship as a function, especially as innovation either by new firms (Schumpeter, 1934) or large established ones (Nelson and Winter, 1982); entrepreneurship as the discovery, evaluation, and exploitation of future goods and services; and entrepreneurship as the creation of new businesses (Gartner, 1989). Based on this summary review, entrepreneurship could be broadly conceptualised as the discovery of opportunities and the subsequent creation of new economic activity, often resulting in the creation of new organisations (Schumpeter, 1934, p. 66) (cf. Rocha, 2004; for detailed surveys see Sternberg and Wennekers (2005) and Reynolds et al., (2005), this issue).

We define entrepreneurship as the creation of new organisations (Gartner, 1989). It is expected that clusters will show similar impacts on new firms as compared to self-employment, SMEs (Westhead and Storey, 1994) or innovation (Baptista and Swann, 1998) although due to different reasons.[2]

Venture creation has long been an important topic for entrepreneurship researchers (Gartner, 1989) and this creation occurs at multiple levels of analysis. This paper focuses on venture creation at the regional level based on the contextual perspective of entrepreneurship. This perspective acknowledges that the phenomenon involves interaction between the environment and individuals, but it is mainly concerned with rates of start-up at a population level and the cultural, economic or market factors converging to create an environment that enhances or inhibits entrepreneurship (Busenitz et al., 2003). The focus on entrepreneurship at the regional level assumes that entrepreneurship is essentially a regional or local phenomenon, which has been demonstrated both theoretically (Malecki, 1997) and empirically (Reynolds et al., 1994; Wagner and Sternberg, 2004).

2.2. *Clusters and industrial agglomerations*

An extensive historical review of the cluster phenomenon shows a lack of agreement on the definition of clusters. However, the evolution of the cluster phenomenon shows that clusters have three necessary or defining dimensions: geographical proximity, an inter-firm network, and an inter-organisational or institutional network (Rocha, 2004). The geographical dimension of clusters has been studied mainly by economists (Marshall, 1920; Krugman, 1991) and economic geographers (Isard, 1956, Isard et al., 1998) stressing the ideas of sources and benefits of external economies; while the network dimensions of clusters have been analysed by sociologists, organisation theorists, and political scientists stressing the ideas of embeddedness (Polanyi, 1957; Granovetter, 1985), social networks (Nohria and Eccles, 1992), social capital (Coleman, 1990), and un-traded interdependencies (Storper, 1997).

The geographical dimension refers to co-located firms and it has been the only cluster dimension considered in most quantitative studies (cf. Baptista and Swann, 1998).

Inter-firm networks refer to both market-based transaction and untraded or informal relationships (Storper, 1997) between firms within a cluster. Traded interdependencies are production and commercial links as measured by input–output tables and constitute the main dimension to define sectoral clusters (Porter, 1990). Untraded interdependencies "take the form of conventions, informal rules, and habits that coordinate economic actors under conditions of uncertainty" (Storper, 1997, p.5).

Finally, the third cluster dimension – i.e. institutional networks – refers to relationships between firms, non-governmental, and governmental organisations within the cluster (Becattini, 1979; Aydalot, 1986; Saxenian, 1994). As in the case of inter-firm networks, the institutional network dimension of clusters includes both formal – i.e. bridging organisations such as chambers of commerce – and informal – i.e. shared norms, common knowledge, and trust – relationships. Given the public good nature of institutional networks, they are closely related to the concepts of social capital (Coleman, 1990), institutional embeddedness (Van de Ven, 1993) and second and third order networking (Johannisson et al., 2002).

Any conceptual definition of clusters including their three core dimensions – i.e. geographical, inter-firm network, and institutional network – will be highly valid. Based on this premise, the present paper defines clusters as a geographically proximate group of firms and associated institutions in related industries, linked by economic and social interdependences (Rocha, 2002, based on Porter, 1998; Roelandt and Hertog, 1999).

This definition of clusters captures their essential dimensions and therefore allows the inclusion of different types of clusters as well as their distinction from other phenomena (Rocha, 2002, 2004). In effect, clusters are not only agglomerations of firms, but also networks within geographical boundaries. When only the industrial base is present, the phenomenon is called industry; when the industry is relatively concentrated in a specific region, the phenomenon is an industrial agglomeration (Isard, 1956); when only the geographical dimension is present, the phenomenon is a city, a county, or a sub-national state; when only the network dimensions are present, the phenomenon is called business and/or social networks; when only the inter-firm network dimension is present in the form of customer-supply relationships, the phenomenon is a sector, value chain or sectoral cluster (Porter, 1990); when the value chain is integrated in a sub-national geographical space, the phenomenon is a sectoral cluster at the regional level (Feser and Bergman, 2000); finally, when the geographical, inter-firm and inter-organisational networks are present, the phenomenon is a cluster. Then, there are different kinds of clusters within this definition. For example, when only manufacturing SMEs are considered, the phenomenon is traditionally called industrial district (Becattini, 1979); when only high technology SMEs are considered, the phenomenon is called an innovative milieu (Aydalot, 1986).

The distinction between clusters and industrial agglomerations is important in this paper, because it contributes to understand the different impacts of clusters and industrial agglomerations on entrepreneurship.

Industrial agglomerations are proximate groups of firms belonging to the same industry or closely related industries that could potentially, but not necessarily, interact. When interactions occur, they are basically buyer–supplier interactions based on market transactions guided by price considerations rather than social relations or norms, which are seen as frictional matters (Granovetter, 1985, p. 484). The density of firms and/or employment within a geographical area is the main defining feature of industrial agglomerations.

The distinction between clusters and industrial agglomerations is both theoretically and empirically relevant. Theoretically, industrial agglomerations are not considered as entities in themselves because their lack of inter-firm and institutional networks do not provide the necessary glue to bind the different actors within the agglomeration. Contrary to clusters, which are basically regional phenomena given their inter-firm and institutional geographically bounded networks (Becattini, 1979; Porter, 1998), industrial agglomerations are more industrial than regional phenomena (cf. Glaeser et al., 1992, p. 1134 n.1, 1140 n.6). They are economic phenomena resembling Ockham's (1300–1350) assertion that "the only reality is the individual and that supra-individual constructions are only labels without entity" (Rocha and Ghoshal, 2004, p. 12). What is real is the autonomous individual or organisation; societies and intermediate systems are either abstractions or legal fictions without any real entity. Therefore, industrial agglomerations are expressions of the neoclassical economic (Becker, 1976) and transaction cost views of atomistic and competitive behaviour driven by self-interested and profit-maximising agents (Rocha and Ghoshal, 2004).

It might be argued that industrial agglomerations include relationships in the form of external economies such as knowledge spillovers. However, this is a research strategy to measure clusters from its theorised effects – external economies – rather than a definition of clusters in itself. Defining phenomena by their essential dimensions rather than by their effects is advisable whenever there is a device to approximate the real phenomena such as the GEM project to measure entrepreneurship or the attempt to measure the agglomeration and network dimensions of clusters we follow in Section 4.

Empirically, the distinction is important given that several studies have analysed the cluster effect equating it to the concept of localisation economies and compared this cluster effect to that of cities or urbanisation economies (see, for example, Glaeser et al., 1992).[3] Defining clusters as industrial agglomerations leads to different predictions and empirical results as to the impact of clusters on entrepreneurship (Rocha, 2004). In effect, population ecology theory tends to predict an inverted U relationship between density and foundings (cf. Shane, 2003 for a review), arguing that at low levels of density legitimation processes dominate and therefore the founding rate is high, while at high levels of density competition processes over the same resources dominate and therefore the founding rate is low. On the contrary, regional studies on entrepreneurship predict an increase in new firms (Reynolds et al., 1994) based on the localisation economies argument. These different results are the consequence of different conceptual definitions and units of analysis, which in population ecology studies are foundings and industry or industry-region while in regional studies are generally new firms and regions.

The following sections develop the hypotheses that form the model presented in Figure 1.

2.4. *The effect of industrial agglomerations on entrepreneurship*

Industrial agglomerations are particular factors within regions, which help to overcome the "liability of newness" (Stinchcombe, 1965, p. 148) that new firms face due to new roles to be learnt, unknown work force, lack of ties with customers and suppliers, and lack of other resources when compared to established firms (Stinchcombe, 1965, p. 149). The Marshallian and Californian approaches to clusters, industrial organisation economics, and the new economic geography suggest that industrial agglomerations positively affect entrepreneurship, although through different mechanisms.

Marshall argues that geographically proximate firms within the same industry generate external economies of scale available to all the firms that operate in the area. (Marshall, 1966, 225–230, 264). Given the lack of network dimensions within industrial agglomerations, we argue that economies of specialisation, labour supply, and specialised skills are the main factors operating within industrial agglomerations. These external economies are directly connected with the factors underlying the liability of newness of new firms and therefore it could be argued that external economies within industrial agglomerations foster business creation.

Krugman puts forward a similar argument as to external economies but stressing and formalising market size effects of the location of upstream and downstream producers in the same location (Krugman, 1991). The resulting demand effects within industrial agglomerations benefits the creation of new firms because proximate customers not only increases the likelihood of sales but also minimises transportation costs.

The Californian School (Storper, 1997) extends this argument to the whole value chain. In effect, "vertical disintegration increases transactions among firms leading to an increase in transaction costs. To overcome this issue, firms cluster geographically materialising flexible production complexes [that minimise] inter-firm transaction costs" (Rocha, 2004). Vertical disintegration within the same region creates new demands and reduces transactions costs, therefore fostering the creation of businesses.

Finally, industrial organisation economics and competitiveness theory also provide arguments for a positive association between industrial agglomerations and entrepreneurship. In particular, Porter (1990) stresses the importance of the competitive environment within industrial clusters, including not only the typical Marshallian external economies but also lower entry and exit barriers because of reduced uncertainty in terms of prices, costs, and way of doing businesses, which foster the creation of firms.

The combination of resource availability, lower entry and exit barriers, reduced transaction costs and market size within industrial agglomerations positively affects the creation of firms. Alternative, these factors also generate more competition, which lead to the depletion of the common resource base and therefore leading to a decrease in start-ups. This argument seems especially strong at lower levels of analysis, when industry density is analysed at the regional rather than the national level (Lomi, 1995), although results are not conclusive yet (Rocha, 2004; Baum and Amburgey, 2002). However, this argument is based on competition over the same resource-base without considering complementarities with other industries within the same region (cf. Marshall, 1920, pp. 226–227) or the very existence of increasing returns generated by external economies that extends beyond a particular industrial agglomeration to reach the regional level.

Given that resource availability, lower entry and exit barriers, reduced transaction costs and market size foster entrepreneurship and are more likely within industrial agglomerations than not within them, we hypothesise the following:

> *Hypothesis 1: The level of entrepreneurship of regions with industrial agglomerations is higher than that of regions without industrial agglomerations.*

2.5. *The differential contribution to entrepreneurship of clusters vis-à-vis industrial agglomerations*

In addition to the geographical agglomeration dimension, clusters contribute to entrepreneurship with the interaction between the geographical, inter-firm network, and inter-organisational network dimensions (Rocha, 2002). It is argued that the inter-firm and inter-organisational dimensions of clusters embedded in a specific territory create a social structure that provides additional factors to overcome the "liability of newness" described in Hypothesis 1.

In effect, clusters add three important mechanisms to foster entrepreneurship in addition to those mentioned in the previous hypothesis: established relationships, legitimation, and complementary linkages. These three mechanisms contribute to overcome the limitations of new roles to be learnt, unknown work force, lack of ties with customers and suppliers, and lack of resources (Stinchcombe, 1965, p. 149) of potential new firms, which affect their degree of legitimacy before key stakeholders and therefore undermine the motivation of the would-be entrepreneur to start a business . In addition, established relationships, legitimation processes, and complementary linkages increase the perception of opportunities, facilitate the transfer of necessary resources to exploit these opportunities, and encourage the motivation and decision to start a new business due to the higher probability of role models within a cluster. The lack of the network and socio-economic factors within industrial agglomerations put clusters in a better position to foster entrepreneurship than industrial agglomerations.

As to established relationships, which are a form of social capital and relational embeddedness (Granovetter, 1985), people usually start businesses where they were born, have worked (Boswell, 1973) or already reside, which goes some way towards explaining why nascent entrepreneurs are very well established in their careers, life and communities (Reynolds and White, 1997). The network component of clusters is a pivotal factor of this embeddedness of local entrepreneurship, because it facilitates the economic and non-economic resources to start and sustain a new business. In addition, "ties embedded in social relationships enhance collaboration, mitigate competition, and foster information exchange" (Rocha, 2004), which tend to neutralise the potential negative effect on foundings of increased competition in well established clusters due to new entrants . Finally, social capital takes time and needs proximity to develop, and therefore clusters can be seen as geographically bounded forms of social capital (cf. Westlund and Bolton, 2003).

As to legitimation processes, they are intimately related to established relationship such as existing networks of colleagues or relationships from previous works because they provide the credentials to overcome the lack of history of new businesses. Also important are links to formal institutions which enhance legitimacy and provides access to resources, resulting in a positive relationship between links to formal institutions and foundings In addition, entrepreneurship is considered as a collective phenomenon that necessitates both private and public sector roles (Van de Ven, 1993). Given the co-location of firms, governmental agencies, and non-governmental organisations in related industries, clusters create the conditions for this collective entrepreneurship which has been empirically demonstrated as an important condition for the creation of individual businesses (Van de Ven, 1993; cf. Westlund and Bolton, 2003). Finally, other geographically close entrepreneurs starting businesses serve as role models or reference groups, which reduce uncertainty and therefore provide the emotional support to start businesses.

Finally, as to complementary linkages, clusters create the conditions for profiting from the complementarities and spillovers from technology, skills, information, marketing, and customer needs that cut across firms and industries, which are key for the pace of business formation (Porter, 1998). Both the interrelation between firms belonging to related industry bases and the concentration of specific cluster factors, such as the concentration of specialised knowledge, inputs, and institutions (Porter, 1990), explain why clusters generate dynamic external economies compared with the static localisation economies, such as economies of scale and access to inputs and markets generated by industrial agglomerations. In addition, "the differentiation among clustered firms leads to functional complementarities that create mutualistic effects and therefore neutralise the negative effect of sourcing from the same resource pool" (Rocha, 2004).

In addition to these additional benefits, intra-regional displacement effects are less likely to occur in regions with clusters than in regions with industrial agglomerations. In effect, the multi-industry, inter-firm and inter-organisational network dimensions of clusters anchor the cluster structure within a regional context. The multi-industry dimension cuts across industries within the same region while the inter-firm and institutional dimensions provide the necessary structure to disseminate the positive results of clusters across the whole region.

Studies of clusters, especially the industrial district school (Becattini, 1979), and the cultural-institutional (Saxenian, 1994) approaches to clusters highlight the intrinsically socio-economic and institutional nature of clusters. This means that the boundary between business and community tends to blur, implying that economic behaviour, knowledge transfer, and innovation are shaped by community norms, personal and institutional networks, and expectations that in turn produce customary ways of doing business (Sengenberger and Pyke, 1992). For example, knowledge spillovers (...) tend to be spatially restricted (Jaffe, 1989), especially when they are based on informal ties. Knowledge spillovers are a kind of external economies mentioned by Marshall – i.e. innovation diffusion – and given their public nature they enrich the cluster environment with an important resource to start businesses.

Alternatively, it could be argued that the same socio-economic cluster factors that create additional advantages are also clusters' potential weaknesses (Rocha, 2002). In effect, they could create cluster blindness generated by dominant logics or mental models and cluster inertia fostered by mimetic isomorphism. Both negative effects impair the clusters' innovation and ability to change in the face of competitive pressures or changes in demand (Grabher, 1993; Glasmeier, 1994; Pouder and St. John, 1996). In addition to cluster blindness and inertia, a third socio-economic factor that could negatively affect entrepreneurship is inhibiting social capital (Westlund and Bolton, 2003). In effect, social capital could exclude outsiders, put excessive claims on group members, restrict individual freedoms, and downward levelling norms affecting entrepreneurship (Westlund and Bolton, 2003, p.78). In fact, inhibiting social capital could be seen as underlying the restrictions of mimetic behaviour and cases of excessive focus on local networks, entrepreneurship sanctioning cultures, interpersonal trust not linked to institutional trust, and strong ties within the region (Grabher, 1993; cf. Westlund and Bolton, 2003, p. 99). This latter case can be associated to the structural embeddedness perspective, according to which non-redundant ties are key to entrepreneurship. Given that clusters are more likely to provide denser networks than industrial agglomerations, clusters would have fewer possibilities of structural holes within a cluster and therefore fewer opportunities to start businesses.

However, from the empirical standpoint, the impact of the socio-cultural factors on entrepreneurship within clusters seems to be positive in the long run. For example, the microelectronics cluster in Silicon Valley (Saxenian, 1994), the metalworking district in Lombardy, Italy (Morris, 1998), and the shoe cluster in Sinos Valley, Brazil (Schmitz, 1999) are cited as cases in which success is attributed in part to the cluster's socio-cultural layer. On the other hand, the decline of the coal, iron, and steel complex of the Ruhr (Grabher, 1993) is cited as a case in which the institutional and socio-cultural cluster environment has impaired both innovation and the ability to change in the face of competitive pressures. However, in this latter case a reversal of the trend has started few years ago. In the former case the industry took advantage of the local expertise to build a new cluster around environmental technologies, while in the latter case a focus on local competencies aided by institutional support seems to overcome the initial inertia (cf. Glasmeier, 1994). These examples show that clusters, like industries, are able to respond to competitive shocks and new demands.

Therefore, given that in addition to the benefits to foster entrepreneurship provided by industrial agglomerations, clusters provide established relationship, legitimation processes, complementary linkages, and a lower probability of intra-regional displacement effects as compared to industrial agglomerations, we hypothesise the following:

Hypothesis 2: The level of entrepreneurship of regions with clusters is higher than that of regions with industrial agglomerations

2.6. *The differential contribution to entrepreneurship of clusters with external networks vis-à-vis industrial agglomerations*

It is argued that the effect of clusters on entrepreneurship at the regional level is enhanced when clusters develop external networks. In effect, external networks help cluster actors identify opportunities, threats and resources beyond the geographical boundaries of the cluster, thus creating conditions to avoid blindness and inertia.

There are at least two ways in which clusters develop external networks, named the existence of multinational corporations (MNCs) within the cluster and the presence of cluster brokers or institutions that link cluster organisations to external buyers, suppliers or other clusters (Rocha, 2002). First, MNCs generate possibilities for accessing new markets and resources, acquiring new capabilities and developing international competitive advantage (ILO, 1998). MNCs have played a key role in several clusters, not only in traditional industrial regions such as the Southeast of England and Lombardy in Italy, but also in the new area-based partnership formed in Ireland in 1991 (Morris, 1998) and Hong Kong (Enright, 2000).

However, the mere presence of MNCs does not ensure a higher rate of start-ups within the cluster (Rocha, 2005). The degree of embeddedness of the MNCs in the local region plays a key role. The inter-firm and inter-organisational networks within clusters allow a higher degree of embeddedness within clusters than within industrial agglomerations. Two examples, one positive and one negative, illustrate this point. The first case is Ireland. Here, MNCs in the electronic sector have become embedded in the local area due to the existence of public–private partnerships, which included the main stakeholders – i.e. government agencies, firms and business organisations, and the community sector (Morris, 1998). These partnerships have allowed the upgrading of local industry and the participation of all the relevant stakeholders in the distribution of the value created. The second case is Brazil in the 1990s, which shows a lack of MNCs' embeddedness and therefore a negative impact on new businesses formation and wealth in the local area (Rodriguez-Pose and Arbix, 2001). MNCs in the car industry were attracted by economic incentives, i.e., subsidies, tax breaks, building of physical infrastructure, rather than genuine competitive advantages in the selected Brazilian regions. MNCs in this industry are therefore mainly assembly plants, which negatively affect entrepreneurship and local upgrading. In effect, the construction of direct communication links to the plants and tax breaks on the import of spare parts are holding back local R&D and the upgrading and emergence of local suppliers. The Brazilian case shows that external networks within clusters are not enough to foster entrepreneurship; those networks have to be rooted in the local environment to have a positive effect on entrepreneurship.

These two examples show that local entrepreneurship in clusters inserted in global value chains will be a function of the way in which both clustered firms are integrated in the global value chain and MNCs are embedded in the local area (Rocha, 2005). Local embeddedness and global insertion is probably higher in clusters than in industrial agglomeration given the potential for coordination in the former compared to the atomistic composition of the later.

The second case of clusters with external networks is cluster brokers or institutions that link cluster organisations to external buyers, suppliers, or other clusters, such as chambers of commerce and local development agencies. Initial investigations conclude that such commercial and institutional arrangements to establish external links are important for cluster performance and upgrading (ILO, 1998). In particular, linkages with other clusters seem to yield positive results for local clusters. For example, the partnership between the shoe cluster of the Marches region of Italy with that of Leon in Mexico helped to achieve sale and distribution agreements as well as transfers of technology (OECD, 2001). Other examples are the Australia-New Zealand Alliance for Clusters for benchmark and export purposes (OECD, 2001) and the Scooter Suppliers Project that integrates clustered firms situated in Spain, France, and Italy to reinforce the competitiveness of the motorcycle industry in Europe.

The two modes of external networks described above positively moderate the impact of clusters and, therefore, we hypothesise the following:

> *H3: The level of entrepreneurship of regions with clusters with external networks is higher than that of regions without clusters with external networks*

3. Method

The main research question and goal of this paper is to investigate whether clusters have an impact on entrepreneurship. This explains why the hypotheses have been defined in comparative terms, i.e., comparing entrepreneurship within and outside clusters. Therefore, the aim is to investigate whether the creation of firms is higher within clusters, rather than to include all the potential factors that could explain the creation of firms at the regional level.

The testing of comparative hypotheses requires the definition of two methodological issues: first, the unit of analysis of what is going to be compared; and second, the appropriate research approach.

3.1. *Unit of analysis*

Clusters are identified at the level of industry and region including the three cluster components, i.e., industrial agglomeration, inter-firm and inter-organisational networks. Similarly, entrepreneurship is identified at the new firm level. However, both clusters and entrepreneurship are aggregated at the planning region level for analytical purposes. Therefore, the units of observation are the cluster and the new firm, but the unit of analysis is the planning region.

Although clusters are identified in a sectoral-regional sense, four reasons justify using planning regions rather than clusters as a unit of analysis. First, a typical constraint in cluster studies is the lack of information at the cluster level of analysis, given that clusters are multi-industry entities and have no fixed political boundaries. This implies that gathering information at the cluster level is extremely difficult, which is not the case when considering the planning region as a unit of analysis. Second, the sample size at the cluster level is too small to generate representative measures of entrepreneurship. In effect, 237 German clusters have been identified and, although the total sample of individuals is 30000, this yields an average of 125 cases per cluster, which is not enough to compute a representative measure of the number of start-ups over the total population of the cluster. Third, GEM does not provide industry information for those individuals who are not starting a business. Thus, it is necessary to adjust the denominator of the start-up rate using some industry variable from secondary data for each of the 237 clusters, which is not only difficult but also unreliable. Fourth, a review of previous studies on clusters reveals that all of them use political boundaries in order to make comparisons not only within each study but also with other studies. Additionally, all the census-type studies use as a proxy for cluster effect measures of either industry specialisation, such as index of partial specialisation (Costa-Campi and Viladecans, 1999) and specialisation index (Garofoli, 1994), or regional agglomeration such as population density (Reynolds et al., 1994). One of the contributions of the present paper is to use a multiple measure of clusters. Therefore, it is necessary to aggregate the cluster measure at the regional level to compare results with previous regional studies, especially the results concerning the distinction between industrial agglomerations and clusters.

Planning regions are areas below the level of federal states in which the majority of the everyday activities of the population takes place. In most cases the planning region comprises a bigger city and its surroundings. However, the central point is that the definition criterion focuses on commuter distances and central place theory. Planning regions are similar to travel to work areas and therefore encompass the majority of the socio-economic activities that people do (Bundesamt für Bauwesen und Raumordnung, 2000). This means that industry and population share the same spatially bounded locality, producing systems of social and economic interaction.

Figure 2 shows the relationship between German Federal States and Planning Regions together with the entrepreneurship (TEA) rate by region and one example of industrial agglomerations and clusters for the automotive industry. The operational definitions of entrepreneurship, industrial agglomerations and clusters are detailed in Section 3.4.

3.2. *Data*

This paper uses multiple sources of information to measure the variables of the model. The source of data to measure entrepreneurship is a

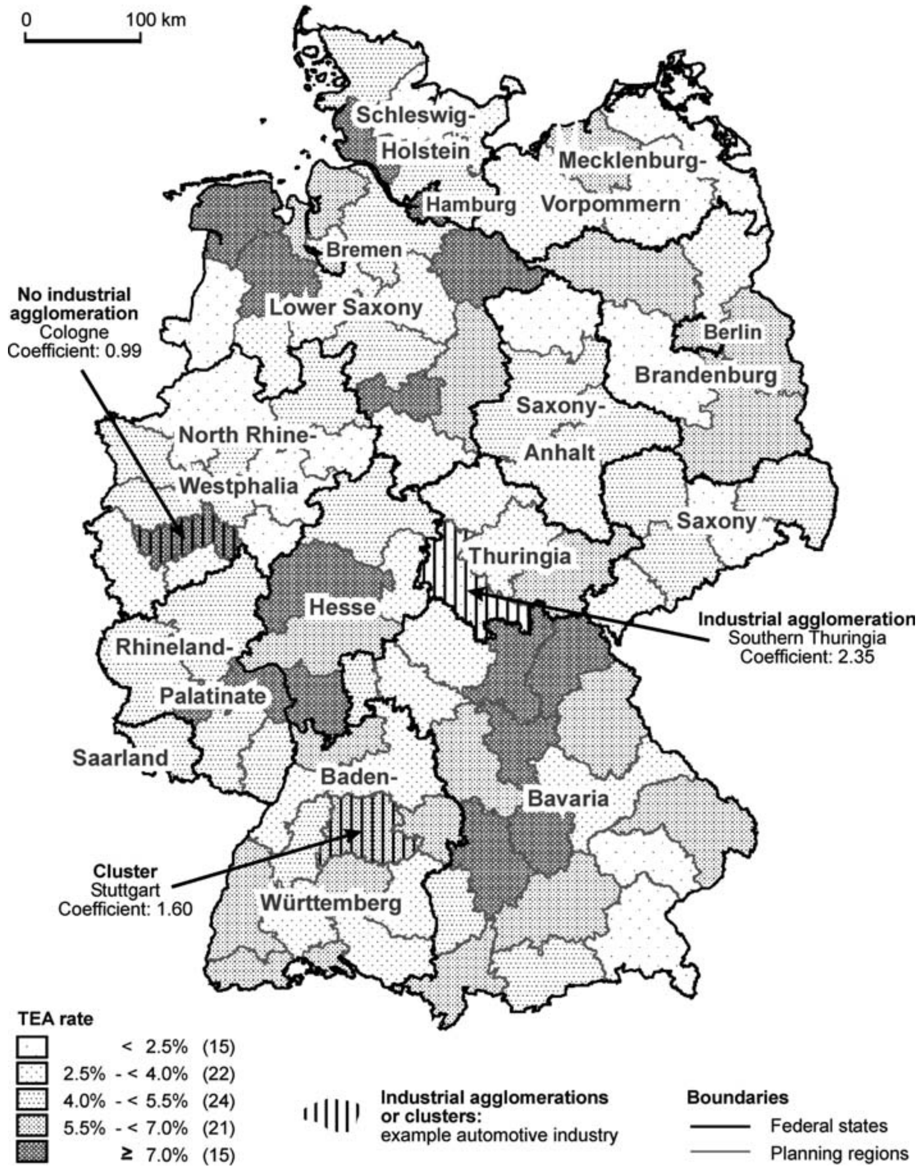


Figure 2. German federal states, planning regions, TEA (2001–2003) and industrial agglomerations versus clusters.

three-year (2001–2003) pooled cross-sectional dataset built up as part of the German participation in GEM (Sternberg et al., 2004). This dataset contains a sample of 29633 individuals interviewed using the same methodology that GEM applies across 40 countries.[4] Given the regional level of analysis of this paper, the individual dataset was aggregated at the planning region level.

Both new and updated quantitative and qualitative data is used to measure the cluster and industrial agglomeration constructs and the control variables used in the model. Quantitative data on establishments, unemployment, and income per capita is taken from the German Federal Labour Office (GFLO) and qualitative data on networks is taken from both existing literature on clusters and a questionnaire sent to a non-random sample of 160 German regional experts in four Länder or one-third of the German Planning Regions.

More than 70 academic papers and policy-oriented publications were reviewed to identify clusters (among the most relevant Glassman and Voelzkow, 2001; Sternberg, 2000). The combination of the quantitative information provided by GFLO on establishments and the qualitative information provided by the literature lead to the identification of 243 clusters. In addition, the cluster network variables were measured with a complementary questionnaire with three seven-point Likert scale questions to measure inter-firm, inter-organisational networks, and external networks.[5] The questionnaire was sent to 160 experts in four Länder: Saxony, Baden-Wurttemberg, North-Rhine Westphalia, and Berlin, which cover one third of the German planning regions. This questionnaire was answered by 62 experts (response rate: 38.5%), and allowed the identification of 94 clusters.

3.3. *Research method*

This paper uses hypothesis testing and multiple regression analysis OLS fixed-effects model to test the hypotheses.

This paper controls for four potential rival explanations: supra regional factors, regional factors different from clusters, sensitivity of results to the aggregation of clusters at the regional level, and spatial autocorrelation. First, supra-regional factors such as East–West Germany differences are controlled using OLS fixed-effects model. Second, other regional factors different from clusters could affect entrepreneurship at the regional level. Therefore, this paper includes control variables suggested by the literature and described in Section 3.5. The inclusion of the relevant regional factors and the use of multiple regression model to isolate the impact of clusters ameliorate the potential existence of other regional rival explanations. Third, results could depend on their sensitivity to the definition of clusters at the regional level. Therefore, this paper runs sensitivity analysis using different aggregation criteria for industrial agglomerations and clusters. Fourth and finally, spatial autocorrelation or dependence (Isard et al., 1998) due to high cross-boundary commuting, typical in cities such as Bremen and Hamburg (cf. Chesire and Malecki, 2004, p. 254), could affect the results. The use of OLS fixed effects and planning region as the geographical level contribute to ameliorate, although not to eliminate, the problem of spatial autocorrelation. In effect, fixed effect controls for all the State factors that could generate spatial dependence between the planning regions included within the State, while the planning region is a self-contained functional geographical unit that include travel to work areas and therefore greatly ameliorate the problem of commuting effects.

3.4. *Operational definitions*

Dependent Variable – Entrepreneurship. Consistent with our definition of entrepreneurship as creation of new businesses, we measure it in terms of nascent and new firms. This paper uses a combination of both measures, which is termed total entrepreneurship activity index (TEA in Figure 2) (Reynolds et al., 2005).

Acknowledging that new businesses do emerge from both people and established firms, the present study chooses the labour market approach for three reasons. First, the present study is interested in independent start-ups rather than in corporate entrepreneurship. Therefore it is not appropriate to use a measure theoretically based on the assumption that established businesses start new ones. Also, the labour market approach assumes that entrepreneurs start their business in the same labour market where the new business operates, which is supported by previous research (Reynolds and White, 1997). Finally, the ecological approach could be misleading in areas with a predominance of a small number of large firms (Garofoli, 1994). In effect, in these cases, few start-ups yield an artificially high start-up rate given the small denominator of the index.

Independent variables – Industrial agglomerations, clusters, and clusters with external networks. A review of literature on clusters shows that both quantitative and qualitative techniques should be employed to identify clusters accurately, which have been analysed elsewhere

(Rocha, 2004). This paper uses location quotients based on plants as quantitative method and more than 70 cluster studies and expert opinion as qualitative methods to gather data to measure clusters.

The unit of analysis of this paper is the planning region and therefore the independent variables are measured at this level. However, an important thesis of this paper is that clusters are different from industrial agglomerations and therefore these variables have to be identified and measured at the industry and planning region level first, and then aggregated at the planning region level in the analysis stage. At the regional level, the independent variables are defined as follows: a planning region is an industrial agglomeration, a cluster, or a cluster with external networks if it contains at least three industrial agglomerations, clusters, or clusters with external networks, respectively.

This paper follows four sequential stages to measure clusters and industrial agglomerations. Figure 3 shows these stages, the associated sources of information and validity criteria. The first stage is the identification of clusters in all the 97 German planning regions using quantitative methods and cluster studies. This process yielded an identification of 176 clusters in Germany. The second stage validates the clusters identified in the previous stage in 31 out of 97 planning regions using expert opinions. This process yielded an identification of 66 clusters in the 31 planning regions where the questionnaire was sent. The third stage is the combination of the previous two stages to obtain the final list of German clusters. This process yielded a total of 171 clusters in Germany. Finally, the fourth stage is the aggregation of the cluster level to the planning region level of analysis in order to test the hypotheses and answer the research questions of the present study. These measurement processes lead to the identification 93 industrial agglomerations, 27 clusters, and 20 clusters with external networks at the planning region level. What follows is an overview of the measurement process, the explanation of the operational definitions at the industry and planning region level and then their aggregation at the planning region level (see Figure 3).

Industrial agglomerations are measured using location quotients based on establishments (LQ). LQ measures the degree of concentration of a single industry in a region and the degree of relative specialisation of a region according to the number of plants in a given year and it is measured as the percentage of an industry in an region over the percentage of that same industry in the nation:

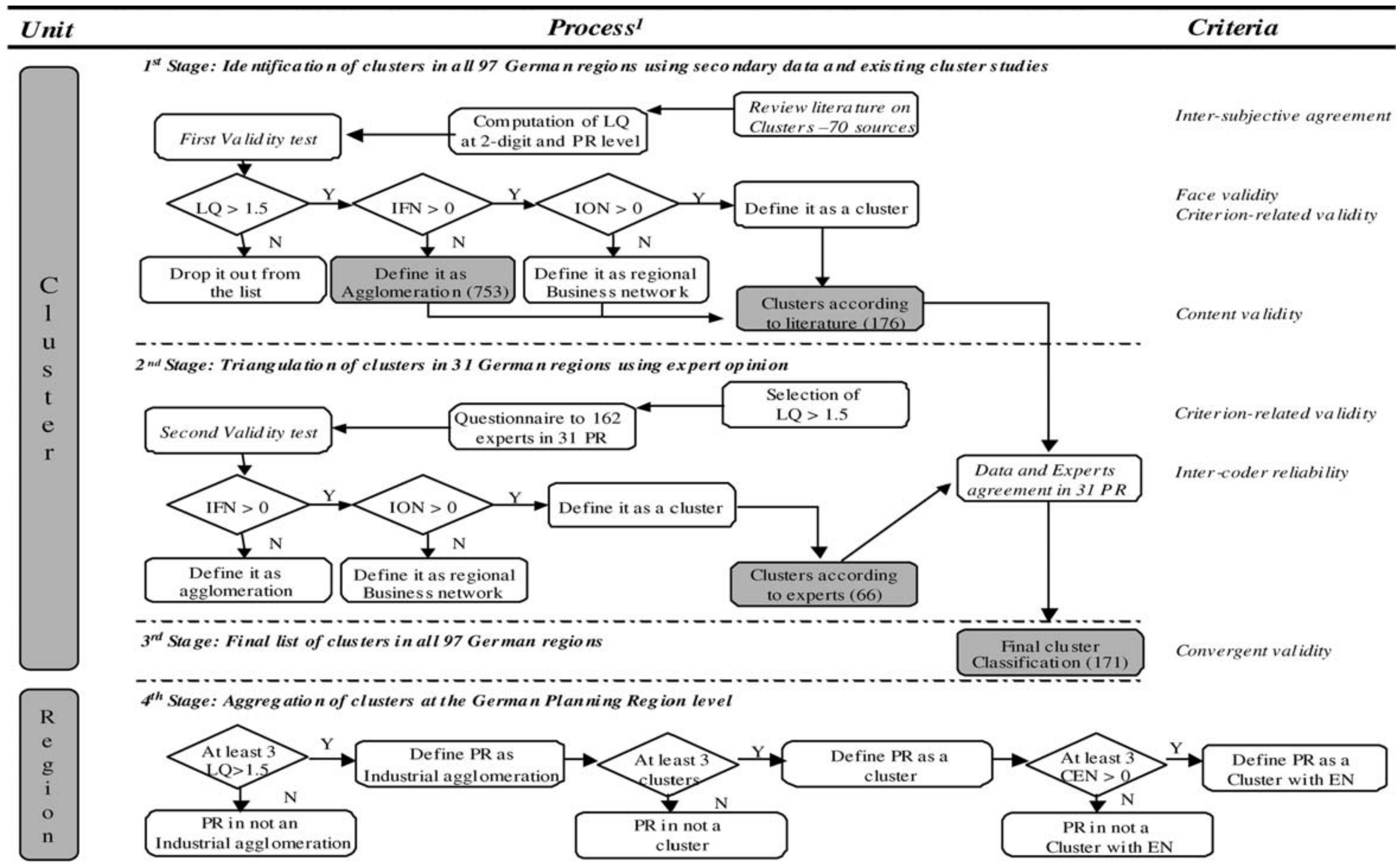
$$\text{LQij} = \left(\sum \text{pij}\right) / \left(\sum \text{pi} / \sum \text{p}\right),$$

where P = plants; i = industry; j = region.

A LQ with value higher than 1 shows that the industry under analysis is relatively concentrated in the focal region. This measure is preferred to that based on employment because it avoids cases of strong influence of big firms in the agglomeration indicator. We define an industrial agglomeration any industry with $LQ > 1.5$ within a specific planning region.

Three key decisions affect the number of industrial agglomerations in a given country: the industry level of aggregation, the geographical level of aggregation, and the cut-off point of the agglomeration indicator. The selection of any specific level should be guided by theoretical arguments and research method considerations rather than by manipulations of any of the previous three quantitative variables. From the theoretical point of view, a key feature of industrial agglomerations and clusters is the generation of external economies. From the research method point of view, a main criterion to progressively build up knowledge on any phenomenon is inter-disciplinary agreement among researchers. Therefore, the combination of industry, geographical, and cut-off point levels chosen by previous studies play a crucial role. Based on these criteria, this paper selects a two-digit industry level of aggregation, a planning region as the regional level of aggregation, and a cut-off point of $LQ > = 1.5$.

Clusters are measured in terms of industrial agglomerations, inter-firm and inter-organisational networks using the sources of information and definitions described in Section 3.3. Table I shows the match between the conceptual and operational definition of clusters, which include the three definitional dimensions of geographical



¹ Keys: LQ = location quotient based on firms; PR = Planning Region; IFN = inter-firm network; ION = inter-organisational network; CEN = clusters with external network

Figure 3. Clusters and industrial agglomerations – Operational definition: Sources of data, criteria, and steps.

TABLE I
Clusters – Conceptual and operational definition

Conceptual definition	1 Geographical proximate group	2 of firms	3 and associated institutions in related industries
		4 linked by economic and social interdependencies	
Main dimensions	Industrial agglomeration (LQ)	Inter-firm network (IFN)	Inter-organisational or Institutional Network (ION)
Operational definition	There is a cluster when the agglomeration, business network, and institutional network dimensions are all present. Technically: Cluster ⇔ LQ * IFN * ION = 1		
1 Source of data	German Federal Labour Office	Empirical studies on clusters Questionnaire to 62 regional experts: Multi-item indicator based on 3 questions	Empirical studies on clusters Questionnaire to 62 regional experts: Multi-item indicator based on 3 questions
2 Computation	Location quotient based on firms (LQf) = % industry in region/% industry in country in terms of firms	1. From Questionnaire (33% of regions) IFN = experts' average value of three items for each cluster 2. From cluster studies IFN = 0 or 1 based on content analysis	1. From Questionnaire (33% of regions) ION = experts' average value of three items for each cluster 2. From cluster studies ION = 0 or 1 based on content analysis
3 cut-off point for categorical (dummy) variable definition	LQ > 1.5 (industrial agglomeration = 1 if LQ > 1.5)	IFN = 1 if IFN > = 0	ION = 1 if ION > = 0
4 Justification	1 A relative concentrated number of firms is necessary to produce external economies (Marshall, 1966 (1890)) 2 Cut-off point close to that chosen by publications that use LQ to measure agglomeration (DTI, 2001: Annex 2 p. 13) 3 LQ based on plants is preferred over LQ based on employment in order to avoid cases of strong influence of big firms in the agglomeration indicator	1. The presence of inter-firm and inter-organisational network dimensions is essential to clusters according to the historical evolution of the concept 2. Application of the inter-subjective agreement criterion in two stages: —review of the empirical literature on clusters —circulation of the same cluster questionnaire to 61 experts 3. Use of questions applied in previous studies whenever was possible)	

agglomeration, inter-firm, and institutional networks.

There is a cluster whenever each one of these dimensions is present for a specific industry within a specific planning region. Presence is defined in terms of cut-off points, which are LQ > 1.5 for the industrial agglomeration dimension and the median value (in the case of questionnaires sent to experts) or dummy variable = 1 (in the case of literature) for the inter-firm and inter-organisational network dimensions (see Table I and Figure 3).The network dimensions were explicitly evaluated by experts in one third of the planning regions; in the rest of the cases, those dimensions were identified and analysed through detailed reading by each author. When either the inter-firm or the institutional networks were non-existent or weak, the agglomeration was not considered a cluster.

Finally, there is a *cluster with an external network* whenever there is the presence of a cluster with external networks for a specific industry within a specific planning region. As in the case of clusters, the presence of external networks is defined in terms of cut-off points, which is the median split (in case of questionnaires sent to experts) or dummy variable = 1 (in case of literature). The same methodology to identify the network dimension of clusters was used to identify the external network dimension.

To increase construct validity, we pursue two strategies (Figure 3). First, any cluster mentioned as such either by the literature or by the experts has to meet the criterion of LQ > 1.5.[6] Otherwise, the phenomenon is a business network rather than a cluster. More than 50 clusters mentioned either by the literature or experts where excluded using this cut-off point, and many of them had LQ < 1 such as pencils in Nuremberg or biotechnology in Berlin, which means that the degree of concentration of the industry in that particular region is less than the national average. These cases could show either the evolution of clusters over time, i.e., what was a cluster 20 years ago is not a current cluster, or the presence of would-be clusters. The latter case does not mean that it will not be a cluster in the future, but it cannot be considered as such in our analysis, which aims to investigate the impact of current clusters on entrepreneurship.

The second strategy is to base the identification of clusters on more than one source of information whenever possible, excluding as multiple sources the evaluations of both authors of this paper. The range of sources of information per cluster is 1–25, with almost 60% of the cases meeting the LQ > 1.5 criterion and considered clusters by more than one source of information, i.e., either multiple experts or articles or both.

To get a measure of agreement between literature and experts, we computed an inter-coder reliability measure for those industrial agglomerations that were both mentioned in the literature and evaluated by experts. This information is available for one third of the planning regions. We used Cohen's kappa coefficient of consistency (Thietart et al., 2001) as the inter-coder reliability measure, considering the literature as the first coder and the experts as the second coder. The kappa measure is relatively high (0.374) and significant. The percentage of agreement is 72%, higher than the expected level (55.5%). This result allows the definition of clusters based only on LQ and the literature for the cases where the questionnaire was not sent. About 40% of these cases have more than one source of information.

The three independent variables are dummy variables because this paper focuses on existence of clusters rather than degree of clustering. In effect, given the current terminological and empirical confusion, it is necessary to isolate the effects of clusters from those of other phenomena. Therefore, established clusters are a better empirical setting than potential or non-well established ones to test hypotheses related to the impact of clusters on entrepreneurship because they are in the best stage to produce such impact. In other words, if clusters matter to entrepreneurship, this effect should be seen in at least well-established clusters.

In addition, using metric variables for each dimension of these constructs could affect construct validity. For example, if clusters are defined as the multiplication of their three dimensions in metrics terms, a planning region with a very high LQ (for instance 10) but very low inter-firm and inter-organisational (for instance 2 each of them) dimensions could have a cluster score equal to 40, which is higher than a score resulting from a planning region with more balanced scores in each dimension (for instance, 1.5, 4 and 4 or a total cluster score equal to 24). This problem is not solved using normalisation of the variables, because it is necessary to have a threshold for each of the cluster dimensions if one is interested in existence rather than degree.

Once the clusters are identified and measured at their own level, then they are aggregated at the regional level to test the hypotheses of this dissertation. As in the case of the measurement of clusters, the units of analysis can be measured in either metric or categorical terms. As noted at the beginning of this section, this paper follows the latter alternative. This decision is not arbitrary but based on ameliorating methodological individualism. In effect, three industrial agglomerations, clusters, and clusters with external networks within a planning region could be considered as a representative number to produce the hypothesised effects on entrepreneurship at the regional level.

Although these reasons, given that different cut-off points could yield different results, other alternative measures, including metric ones, are also used. Therefore, we perform sensitivity analysis using different measures of clusters and industrial agglomerations at the planning region level, and the results are similar to those using a dummy definition.

3.5. *Control variables*

Following previous literature (Reynolds et al., 1994; Storey, 1994), this paper controls for several regional factors such as demand size, urbanisation, unemployment, personal wealth, and human capital that could affect entrepreneurship, using an average two-year lag in all the variables. Demand size accounts for demand of good and services, one of the determinants of entrepreneurship pull, and was measured as population in year 2000. Urbanisation or concentration of people may contribute to entrepreneurship providing entrepreneurial talents and reducing both the cost of access to customers and the access to suppliers, and was measured as population density (inhabitants per square meter). Unemployment is related to necessity entrepreneurship, assuming that many people losing their jobs will start a business, and was measured using the unemployment rate. Personal wealth, measured in terms of gross value added per head of population, provides informal financial resources to start business. Finally, general and specific human capital provide talents, information, and skills for discovering and exploiting opportunities (Storey, 1994, p. 64; Armington and Acs, 2002, p. 43; Shane, 2003, p. 69), and are measured in terms of employees with university or technical college degrees as a percentage of employees covered by social insurance and a specific GEM question on skills to start a business, respectively.

4. Results

Table II shows the correlation matrix and descriptive statistics of all the variables used in testing the impact of industrial agglomerations and clusters on entrepreneurship. The correlation matrix allows a first approximation to testing the hypotheses. Contrary to our prediction, the industrial agglomeration measure shows a very low negative correlation with entrepreneurship, although not significant. However, in line with our predictions, both clusters and clusters with external networks show a positive correlation and both are significant.

After this first approximation, we runt-test comparing entrepreneurship within and outside regions with industrial agglomerations, clusters, and clusters with external networks. We focussed on 1-tailed test ($p < t$) given the directionality of all our hypotheses and obtained similar results to those of the correlation analysis.

In effect, hypotheses testing show that H1 is not supported, while H2, and H3 are supported. In effect, the level of entrepreneurship is lower in regions with industrial agglomerations (H1: $t = -0.01$; $p < t = 0.50$) and higher in regions with clusters (H2: $t = 2.25$; $p < t = 0.013$) as compared to entrepreneurship in regions without industrial agglomerations and clusters, respectively. This means that the level of entrepreneurship in regions with clusters is significantly higher than that of regions with industrial agglomerations. Also, entrepreneurship in regions with clusters with external networks is higher than entrepreneurship in regions without clusters with external networks (H3: 2.67; $p < t = 0.004$). To

TABLE II
Sample statistics and correlations

Variable	Mean	Std. Dev.	Min	Max
Entrepreneurship-TEA	4.680103	2.077702	0.83	11.1
Population density	0.0732448	0.0247693	0.0162371	0.140028
Skills	34.02887	5.294965	20.4	45.3
Income per capita	0.2229703	0.0267547	0.1575829	0.2765006
Unemployment	2.280049	0.4461546	1.515611	3.111335
University degree	0.389324	0.0683627	0.2564946	0.5679619
Population	0.0012318	0.0003164	0.0005436	0.0020277
Industrial Agglomeration	0.9587629	0.1998711	0	1
Cluster	0.2886598	0.4554934	0	1
Cluster with external network	0.2164948	0.4139949	0	1

	TEA	Density	Skills	Income	Unemployed	University	Population	Ind Agglom	Cluster	Cluster EN
Entrepreneurship-TEA	1.0000									
Population density	**−0.1982**	1.0000								
Skills	**0.3763**	**−0.3646**	1.0000							
Income per capita	**−0.2591**	**0.6031**	**−0.4630**	1.0000						
Unemployment	−0.1309	**0.2223**	**−0.4340**	**0.7346**	1.0000					
University degree	−0.0059	**0.4100**	0.0847	0.0194	**−0.3703**	1.0000				
Population	−0.1673	**0.7766**	**−0.2682**	**0.4192**	0.0713	**0.5223**	1.0000			
Industrial Agglomeration	0.0147	0.0436	**0.2788**	0.0138	**−0.1844**	**0.2870**	**0.1932**	1.0000		
Cluster	**0.2219**	**−0.2732**	**0.1066**	**−0.4458**	**−0.4063**	−0.0188	**−0.2375**	0.1972	1.0000	
Cluster with external network	**0.2657**	**−0.3237**	0.1036	**−0.4352**	**−0.2915**	−0.1590	−0.3178	0.0458	0.8252	1.0000

Note: bold type = significant at 0.05 level.

get a sense of stability in our results, we ran sensitivity analyses using nine different measures for industrial agglomerations and clusters at the regional level, obtaining similar results.[7]

Although these results show that there is a statistically significant difference in entrepreneurship at the regional level, there is no information on the role of clusters in explaining such differences vis-à-vis other competing variables. This goal is achieved using multiple regression models.

The nature of the research questions, hypotheses, and measurement process suggests the use of OLS estimators. Before running OLS models, we performed several tests to check some of the assumptions underlying this technique.[8] Given that the plotting of the population, population density, personal wealth, unemployment, and employees with university degree against TEA showed some non-linearity,[9] an appropriate transformation was chosen: log for unemployment and inverse square root for the rest of the variables. After transforming the control variables, we checked for multicollinearity. Table II shows the sample statistics and correlation matrix, which reveals some cases of highly correlated independent variables. Following the rules for inclusion of independent variables in the model (Cohen et al., 2003, p. 143), we decided to keep all the variables until running the regression models and analyse their individual contribution to the explained variance in entrepreneurship. In effect, potential multicollinearity only affects the efficiency of the estimators, while potentially omitted variables affect both bias and efficiency.[10] This decision was confirmed using two alternative test for multicollinearity.

After checking for normality and multicollinearity, and performing the appropriate transformations in the control variables, we ran six OLS models. Table III reports the results of the OLS fixed-effects regressions, explaining the impact of industrial agglomerations and clusters on

TABLE III
Results of OLS fixed-effects: The impact of industrial agglomerations and clusters on entrepreneurship

Model		(1) Base model	(2) Ind. Agglomeration	(3) Cluster	(4) Ind. Agglom versus Cluster	(5) Cluster with ext. networks
Dependent Variable	Entrepreneurship	Entrepreneurship	Entrepreneurship	Entrepreneurship	Entrepreneurship	
Independent variables	Hypothesis		H1	H2	H2	H3
Population density		−25.308	−27.865	−23.192	−24.566	−21.110
		(0.89)	(1.29)	(1.10)	(1.15)	(0.99)
Income per capita		−0.124	1.686	3.676	7.074	6.745
		(0.01)	(0.08)	(0.18)	(0.35)	(0.33)
Unemployment		2.810	2.742	2.668	2.586	2.419
		(2.39)*	(2.37)*	(2.35)*	(2.26)*	(2.09)*
Skills		0.103	0.101	0.113	0.109	0.111
		(1.96)	(2.05)*	(2.41)*	(2.31)*	(2.33)*
University degree		−0.441				
		(0.07)				
Population		−75.623				
		(0.06)				
Industrial agglomeration	H1		−0.730		−0.839	
			(0.81)		(1.02)	
Cluster	H2			1.020	1.041	
				(2.33)*	(2.40)*	
Cluster with external networks	H3					1.194
						(2.46)*
Constant		−3.097	−2.650	−4.650	−4.200	−4.835
		(0.66)	(0.56)	(1.09)	(0.96)	(1.12)
Observations		97	97	97	97	97
R-squared		0.3575	0.3611	0.3876	0.3924	0.3916
Adj R-squared		0.1776	0.1930	0.2265	0.2223	0.2314
Prob > F		0.0007	0.0005	0.0000	0.0000	0.0000
Delta R-squared		-	0.0036	0.0265	0.0048	0.0305

Robust t statistics in parentheses.
* Significant at 5%
** Significant at 1%

entrepreneurship after controlling for all potential factors at the State level. A hierarchical method of entering variables was followed, entering first the control variables, and then the three independent variables according to each one of the five hypotheses (Cohen et al., 2003, p. 158). Also, we report unstandardised regression coefficients, which are more meaningful in case of categorical variables (Cohen et al., 2003, p. 316). All the models are adjusted by the robust standard error option in order to account for potential heteroscedasticity.

Model 1 presents the base model with only the control variables included. As previous research suggests, unemployment and specific human capital are positively related to entrepreneurship; on the contrary, the other four control variables show an opposite sign to what is suggested in the literature, although not all the cases are significant. The variables of population and university degree are not only not significant but also, as Table II shows, highly correlated between them (r = 0.5223) and, in the case of the former, with population density (r = 0.7766). We dropped these two variables and obtained better results in terms of F (F > 0.0001 versus F > 0.0007) with a very low decrease of R-squared (0.3574 versus 0.3575). Therefore, we excluded these two control variables in the following models.[11]

Model 2 includes the control variables and the industrial agglomeration variable. Contrary to H1, the existence of industrial agglomerations is not positively related to entrepreneurship (t = – 0.81), and this result is not statistically significant. Control variables show the same results as in Model 1, with the exception of income per capita, which becomes positive but not significant.

Model 3 includes the control variables and the cluster variable. Results are stable compared to Model 2 and the cluster variable is positive and significant (t = 2.33). There is also a significant increase in the R-squared value (from 0.3611 to 0.3876) and the statistical significance of the overall model (from P > F 0.0005 to P > F 0.0000). From the regression coefficient, the presence of at least three clusters within a planning region is associated with a 1.02% point increase in the entrepreneurship rate for the region compared to regions with fewer than three clusters, leaving all the other factors constant. The size effect is important, because it represents 22% (1.02/4.68) of the average entrepreneurship rate for the whole Germany. This result is similar to that using the t-test, given that the regression coefficient of a dummy-coding variable represents the difference in means between the target group, i.e., clusters, and the control or reference group, i.e., non-clusters, but with the advantage of controlling for other competing factors.

Comparing Model 2 and Model 3 allows testing hypothesis H2, which is supported because the cluster coefficient is positive and significant while the industrial agglomeration coefficient is negative and not significant. Model 4 shows a different way of testing H2, including both industrial agglomerations and clusters within the same model. Given the nested definition of these variables, the interpretation of the coefficient changes (Cohen et al., 2003, p. 320). However, results are stable compared to the previous method given that industrial agglomerations are negative and not significant and clusters are positive and significant (t = 2.40). There is also a significant increase in the R-squared value (from 0.3611 to 0.3924) and the statistical significance of the overall model (from P > F 0.0005 to P > F 0.0000).

Finally, Model 5 includes the control variables and the cluster with external network (CEN) variable to test H3. Results are again very stable compared with the previous models and CEN is positive and significant (t = 2.46). Based on the regression coefficient, the presence of at least three CEN within a planning region is associated with a 1.2% point increase in the entrepreneurship rate for the region compared with regions with fewer than three CEN, leaving all the other factors constant. As in the case of clusters, the size effect is important, because it represents 25.6% (1.2/4.68) of the average entrepreneurship rate for the whole of Germany.

To get a sense of stability of our results, we ran sensitivity analysis using the final model with alternative measures of industrial agglomerations and clusters, while keeping the other variables constant. Table IV shows the results, which are the same as those of Table III, Model 3. In effect, all five models show the same results for the control variables, a negative coefficient for the industrial agglomeration variable and a positive coefficient for the cluster variable. Also, four out of the five models generate a higher R-squared.

Finally, we performed post-regression diagnosis tests using the residuals to double check that the regression coefficients are not biased, that is, that there is not unobserved heterogeneity hidden in the residuals.[12]

In sum, both the chosen operational definition of industrial agglomerations and clusters (Table - III) and the use of alternative measures (Table IV) show the same results. Contrary to hypothesis 1, the existence of industrial agglomerations is not positively related to entrepreneurship and this result is not significant; hypothesis 2 is supported, that is, the level of entrepreneurship in regions with clusters is higher than that of regions with industrial agglomerations; finally, hypothesis 3 is also supported, because the level of entrepreneurship in regions with clusters with external networks is higher than that of regions without such clusters. As to the control variables, consistent with previous studies both specific human capital (Shane, 2003) and unemployment

TABLE 4
Results of OLS fixed-effects: Sensitivity analysis using different industrial agglomeration and cluster measures

Model	Entrepreneurship					
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable						
Control Variables						
Population density	−19.898	−18.246	−17.101	−20.073	−14.345	−24.945
	(0.97)	(0.90)	(0.86)	(0.97)	(0.68)	(1.13)
Income per capita	7.750	5.375	6.296	6.244	3.990	7.683
	(0.40)	(0.29)	(0.32)	(0.31)	(0.20)	(0.37)
Unemployment	2.534	2.472	2.524	2.803	2.567	2.546
	(2.13)*	(2.21)*	(2.22)*	(2.49)*	(2.28)*	(2.23)*
Skills	0.115	0.128	0.115	0.115	0.142	0.098
	(2.37)*	(2.63)*	(2.47)*	(2.39)*	(2.88)**	(1.95)+
Industrial agglomeration measures						
At least one LQ > 3	−0.567					
	(1.14)					
At least two LQ > 3		−0.660				
		(1.37)				
At least one LQ > 2			−1.844			
			(1.92)+			
At least two LQ > 2				−0.588		
				(0.98)		
Average LQ > 1					−0.820	
					(1.64)	
At least three LQ > 1.5						−0.704
						(0.93)
Cluster measures						
At least 3 clusters	1.058	1.141	0.991	0.999	1.231	
	(2.40)*	(2.56)*	(2.24)*	(2.30)*	(2.59)*	
Number of clusters						0.099
						(1.74)+
Constant	−5.231	−5.238	−3.679	−5.377	−5.844	−3.907
	(1.26)	(1.32)	(0.88)	(1.22)	(1.31)	(0.87)
Observations	97	97	97	97	97	97
R-squared	0.40	0.41	0.42	0.40	0.41	0.37
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Robust t statistics in parentheses
significant at 10%
* Significant at 5%
** Significant at 1%

(Storey, 1994, p. 71). However, contrary to previous studies, we do not find population and general human capital as statistically significant. Finally, comparing a fixed-effects to a non-fixed effects model, we find a significant increase in R-squared (R-squared = 0.3924 versus R-squared = 20.49, respectively). Given that the fixed-effect model basically controls for all the factors at the level of Federal States, this means that there is a Länder effect on entrepreneurship.

5. Discussion and conclusions

This paper advances and tests the idea that industrial agglomerations are different phenomenon from clusters and both have a differential impact on entrepreneurship at the regional level. Prior studies have equated industrial agglomerations to clusters (Baptista and Swann, 1998; Glassman and Voelzkow, 2001), but the lack of distinction among them hides important causal mechanisms that foster entrepreneurship. We moved beyond this perspective, theoretically and empirically distinguishing industrial agglomerations from clusters and their differential impact on entrepreneurship at the regional level.

The first research question focuses on the "*what*" and asks whether clusters have an impact on entrepreneurship at the regional level. Defining and measuring clusters as geographically proximate groups of interconnected firms and institutions in related industries and industrial agglomerations as clusters without networks, our results clearly show that clusters do have an impact on entrepreneurship but industrial agglomerations do not.

To find the reasons behind these results, the second research question focuses on the *why* and asks what factors explain the differential positive impact of clusters on entrepreneurship. We frame the answer comparing the nature of industrial agglomerations and clusters and their consequent differential mechanisms to foster entrepreneurship.

A key feature of industrial agglomerations is density of firms and/or employment within a geographical area. Industrial agglomerations are economic phenomena based on atomistic and competitive behaviour. In effect, despite the potential for cooperation among firms, there is no such cooperation beyond what is in their individual interests and interaction is fostered mainly via price signals. According to the economic geography literature, industrial agglomerations generate localisation economies such as economies of scale and access to inputs and markets, which help to start businesses. Previous empirical research found positive effects of regional agglomerations and industry specialisation on entrepreneurship (Reynolds et al., 1994; Armington and Acs, 2002). We add to this literature providing new and updated measures of industrial agglomerations, including population density which we used as control variable, but contrary to previous results our models show a negative, although not significant, impact of industrial agglomerations on entrepreneurship. One interpretation of these different results is that previous studies have not distinguished between industrial agglomerations and clusters and therefore the positive results they show could have been generated by the latter.

Our results suggest that clusters are better than pure market mechanisms to foster entrepreneurship. Firms neither operate in an atomistic fashion nor interact with others based only on business networks considerations. Any business activity is embedded in a broader socio-institutional context and therefore the economic dimensions or relationships cannot be separated from the socio-institutional ones. When these socio-institutional dimensions lack, therefore economic activity resents.

Clusters are a richer industrial dimension than industrial agglomerations, including not only spatial proximity but also inter-organisational relations. Interaction is driven not only by price signals but also by interpersonal and associational relations among people and firms within the cluster. This interaction provides established relationships and complementary linkages, two differential mechanisms to start businesses that are not present in industrial agglomerations. The economic-sociological perspective, the industrial district school, and the innovation and cultural-institutional approaches suggest that cluster effects are based on the intrinsic socio-economic nature of clusters. The scarce previous empirical research on clusters and entrepreneurship was based either on case studies or using different definitions for the cluster construct. We add to this literature, providing a new cluster measure based on all three cluster dimensions rather than only on the industrial agglomeration dimension, showing that cluster positive effects on entrepreneurship are significant from both the statistical and practical standpoint, and more marked than that of industrial agglomerations.

The third research question of this paper focuses on the *what for* and asks about the implications of the previous results and explanations for academics and policy makers. From the academic standpoint, this paper develops and tests the first theoretical model explaining the differential impact of industrial agglomerations and clusters on entrepreneurship, adding to the relatively scarce regional literature on entrepreneurship (Davidsson and Wiklund, 2001). In addition, also it provides both a conceptual and operational definition of clusters and measures and identifies them based on a multiple method approach and unique quantitative and qualitative data.

From the policy-making standpoint, the main contribution of this paper is to clarify what we are talking about when it comes to the cluster phenomenon. In effect, different definitions of clusters lead to different theoretical and empirical impacts on entrepreneurship and therefore to different policy prescriptions. The focus of this paper on both the distinction between industrial agglomerations and clusters and existent rather than potential or would-be clusters allow policy-makers to evaluate whether clusters matter to entrepreneurship and the impact of different industrial configurations on entrepreneurship. A second important policy implication is that given the positive impact of cluster on entrepreneurship, clusters and entrepreneurship policies should be designed together rather than in an isolated fashion. This would be not only more efficient in terms of the use of public funds but also more effective in fostering entrepreneurship.

However, the results of this paper in itself should not be taken as a justification to promote cluster policies before additional analysis. The main reason is that we have not analysed how the existence of clusters in one region affects the outputs of other regions or how the existence of clusters affect the national rate of entrepreneurship. It has been argued that clusters could negatively affect outcomes at the national level, as in the case of creation of regional disparities (cf. Rocha, 2004 for a review). The research questions and results of this paper do not allow analysing this issue.

This paper faces several limitations that represent opportunities for future research. First, although clusters have been empirically defined at the sectoral-regional level, the empirical analysis takes the planning region as the unit of analysis. Future research could focus on clusters as the basic unit of analysis to capture the differences in entrepreneurship within and outside clusters in regions. Using a slightly different definition of clusters and industrial agglomerations, this approach has been applied in a second study (Rocha et al., 2004) and results are fairly similar to those of the present paper. Second, this paper provides an overall conclusion about cluster effects. Further research could focus on analysing clusters' impact on entrepreneurship in different industries. Third, this paper uses an overall measure of entrepreneurship. Future studies could focus on the impact of clusters on different dimensions of entrepreneurship, such as nascent entrepreneurs and new firms, necessity and opportunity-driven entrepreneurship, and innovation and replication entrepreneurship. Fourth and finally, given the current confusion surrounding the cluster phenomenon, this paper focussed on the essential dimensions of clusters. Future research could focus on different types of clusters based on different contingent variables such as degree of cooperation/competition, stage of development, and internal industrial structure.

We invite other scholars and policy makers to continue this new line of research, which may provide novel answers to a key question of the entrepreneurship field: What factors affect the creation and sustainability of new economic activity?

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Notes

[1] Nelson and Winter would define this distinction in terms of formal and appreciative theorising (1982:46). The former is concerned with building theory per se or testing specific aspects of the theory. In contrast, appreciative theorising start with questions that are interesting per se and use existing theory as an organising framework for appreciation.

[2] For a historical evolution of clusters as phenomenon and concept with their antecedents and causes in terms of creation of businesses, SMEs, and innovation see Rocha (2004).

[3] For a review of the concepts of localisation, urbanisation, agglomeration, and external economies, and how they correspond to different conceptualisations of clusters see Rocha (2004, p. 393, n.11). We have avoided including these distinctions and debates given that, as noted above, different conceptualisations of clusters make it unreal to encapsulate them within a single perspective. Important elements of clusters are not only spatial proximity but also inter-organisational relations and the knowledge and social base underlying clusters dynamics.

[4] The complete interview schedule can be downloaded from www.gemconsortium.org.

[5] The questions refer to presence and degree of relationship among firms to measure inter-firm network; relationship among firms, government organisations and not-for profit organisations to measure inter-organisational networks, and relationships between firms and organisation within and not within clusters to measure external networks. The interview schedule can be obtained from the first author under request. More than 50% of the items where selected from previous questionnaires on clusters to increase inter-subjective agreement and reliability.

[6] Clusters can include one or several industries. The starting point to identify clusters used in this paper is that the industry should have $LQ > 1.5$. However, there are industries that include several industry codes at the two-digit level, such as biotechnology, media, logistics and IT. In these cases, we required that at least one of the core industries within the cluster should have $LQ > 1.5$. We have matched the cluster templates of Feser and Bergman (2000) and DTI (2001) with UN definitions of industries used in GEM (version 3) in order to identify the industry codes included in the new industries mentioned above. In the case of the UN, a key-word search was used to identify the SIC codes related to those industries. Given that our definition of LQ is based on 2-digit codes, the codes relating to retail and wholesale were only considered when more than 10 entries at 4-digit level in the UN classification were found (case of computers and microelectronics). The resulting list of industries is as follows (underlined codes denote core industries):

Industry	*SIC Codes*
New materials (polymer fibres, etc)	23, 24, 25, 26
Opto-electronics	26 – glass 30–33, 72-3 -R&D
Computers and microelectronics	22, 24, 30, 32, 33, 51, 52, 72-4, 80
Mining and coal	10, 13, 27 to 29 – value chain
Water	40 and 41
Logistic	60–63
Tourism and entertainment	55, 60, 61, 62, 63, and 92
Environmental and renewable energy	33, 37, 45, 74, 75 (90 – sewage, refuse disposal- is not renewable)
Biotechnology	24, 33 and 73
Media and communications	22, 30, 31, 32, 51, 64, 72, 73, 74, 75 and 92
Aerospace and aviation	33, 51, 62, 73, 74
Satellite navigation	32, 35, 64

[7] Specific results are available from the authors.

[8] For a detailed explanation of these assumptions see Wooldridge (2003), whom we follow in the explanations given in this section. These assumptions are as follows: (1) linearity in parameters; (2) random sampling; (3) zero conditional mean or expected value of the error term equals zero; (4) imperfect relationship between independent variables; (5) homoscedasticity or constant variance of the error term; (6) error term normally distributed; (7) no serial correlation. Assumptions (1)–(5) are called Gauss–Markov assumptions (Wooldridge, 2003, p. 95) and with the addition of assumption (7) assure that OLS produces unbiased estimators of coefficients and their variances. Assumption (6) is not necessary to run OLS but to use a particular sampling distribution to make inferences – the normal distribution. Assumptions (1)–(6) are called classical linear model assumptions (Wooldridge, 2003, p. 116). Finally, there are three additional issues that are not assumptions, but affect the estimators: multicollinearity; outliers and influential observations, and measurement error in the independent variables. The first two issues only affect the efficiency or standard error of the estimators, while the third one affects both the bias and the efficiency of the estimators. We have considered all these assumptions and issues in this paper, either applying the appropriate technique, as in the case of assumptions on linear model and random sampling, or checking that the assumption was not violated, as in the rest of the assumptions. In all the cases we used Stata version 8.2 and the results are reported in the results section. Specific results are available from the authors.

[9] This test is especially for continuous independent variables; the plot of dichotomous variables is not informative about linearity because these variables are qualitative (nominal) variables (Cohen et al., 2003, p. 126). This is the reason why we have not included the three independent variables of the model, which are dummies.

[10] The only exception is the correlation between clusters and clusters with external networks, which, given hypotheses 3–5 of this paper, will be entered in a hierarchical fashion without being part of the same model.

[11] It is customary to drop one instead of two of the highly correlated variables. In this particular case, the

candidate is population. However, we also dropped general education because it also improve the overall significance of the following models and allowed more stability in the result of income per capita, although this latter variable remained not significant. General education turned to be positive but not significant in these models.

[12] The assumptions of homoscedasticity and linearity of independent variables when plotted against the residuals were not violated. Results are available from the authors.

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