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# **Clustering, Logistics, and Spatial Economics**

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# CLUSTERING, LOGISTICS, AND SPATIAL ECONOMICS

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## ABSTRACT

In the last decade, the number of logistic service providers located in clusters across Europe has increased substantially. Because location choice models in logistics studies are not able to give a satisfactory explanation for this phenomenon, various spatial economic concepts are studied in this paper. The main purpose is to provide more insight into the selection of economically attractive locations within these concepts and, more specifically, into the decision of individual firms whether or not to join a cluster. Such insight may lead to an improvement of the existing logistic models. It appears that the spatial economic concepts describe several mechanisms that are relevant to the clustering of logistic service providers. These mechanisms can possibly be incorporated in logistic clustering models.

## INTRODUCTION

In the last decade, the number of logistic service providers located in clusters across Europe increased substantially. Surprisingly, clusters are not only found in regions where they are intuitively expected (namely, nearby sea- and airports), but also at less obvious locations. In the Netherlands, for example, clusters exist in the Rotterdam and Amsterdam region as well as in the neighborhood of Arnhem-Nijmegen, Enschede-Hengelo, Eindhoven, Tilburg and Venlo.

The location choice models in logistics studies are not able to give a satisfactory explanation for this clustering phenomenon. In these models, firms are represented as rational decision-makers who prefer locations where total logistic costs are minimized (Lambert *et al.*, 1993, p. 309/11). It is implicitly assumed that all spatial differences among locations find expression in the costs related to these locations. Many times, such simplification does not affect the explanatory strength of the model. In the present case, however, where firms with different cost structures establish at the same location, the logistic models fail.

In spatial economics the clustering phenomenon has been discussed more extensively. In contrast to the purely quantitative logistic models, most spatial concepts consider location choices to be strategic decisions in which qualitative factors (such as the presence of firms) also influence the location choice. However, the extent to which the location choice is influenced as well as the kind of influence differ from concept to concept.

This paper focuses on a number of spatial economic concepts that are held to be representative for different ways of modeling the clustering of firms. The main purpose is to provide more insight into the selection of economically attractive locations within these concepts and, more specifically, into the decision of individual firms about whether or not to

join a cluster. Such insight may lead to improved location models that are able to describe, or even predict, the clustering of logistic service providers.

Two questions were posed as a starting-point of the study. First, given the set of representative spatial concepts, *why* do firms cluster? Second, given a number of reasons for clustering, *where* do firms cluster? The 'why' question clarifies the criteria that are relevant to firms deciding on joining a cluster and, consequently, enlarges the understanding of the decision-making process. The 'where' question determines whether firms that have different reasons for clustering may establish at the same location.

The organization of the paper is as follows. First, a short survey of different modeling approaches in spatial economics is given in Section 2. The spatial concepts of Porter (1990), Storper (1992), Krugman (1991), Rauch (1993), Scott (1986) and Harrison (1992) are chosen as representatives for three different approaches. The 'why' of clustering is the subject of Section 3. In Section 4, the 'where' of clustering is illustrated by projecting the different concepts on a hypothetical landscape. Finally, Section 5 discusses the main findings.

## **I. MODELING APPROACHES IN SPATIAL ECONOMICS**

In current spatial economic research the description and analysis of clustering takes place at different levels. At macro level, several contributions in the field of economic geography describe the rise and growth of clusters. At micro level, two groups of contributions may be distinguished. The first group describes spatial processes from an organizational point of view. The second group takes the strategy of the firm as the starting-point.

Economic geography concepts are mainly based on the characteristics of the territorial and functional environment of the firm<sup>1</sup>. As a consequence of the macro view, the spatial behavior of individual firms is not modeled explicitly, but should be derived from the general behavior. Although most contributions in this field of study focus on the identification of characteristics (or 'location factors') that influence industrial location choices, a number of contributions can be found in which the clustering of firms is actually modeled. The contributions of Krugman (1991) and Rauch (1993) are considered to be representative for these concepts.

The organizational concepts consider the spatial behavior of the individual firm to be determined by its internal and functional environment. Two completely different concepts are discussed in more detail, namely Scott (1986) and Harrison (1992). In Scott's transaction cost approach the rise and growth of clusters result from a tradeoff between internal and external transaction costs. Harrison's clustering concept, on the contrary, is mainly based on social economic theory.

The strategy of individual firms can be recognized in the strategic concepts. The internal, territorial and functional environment of the firm are also taken into account to some extent. In contrast to the prior types of concepts, the strategic concepts are mainly prescriptive. In other words, the strategic concepts describe where firms should locate and which factors firms should take into account while choosing a location. The concepts described by Porter (1990) and Storper (1992) are chosen as representatives.

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<sup>1</sup> Lambooy (1993) distinguishes between the internal and the external environment of a firm. The latter is split up in a territorial and a functional environment. Strategy is considered to be the link between the internal and external environment.

## II. WHY DO FIRMS CLUSTER?

The six concepts selected above all appear to explain the clustering of firms in a different way. In the following, the various explanations are summarized.

### *Economic geography concepts*

Krugman's concept (1991) distinguishes explicitly between the rise of clusters on the one hand and the growth of clusters on the other hand. In his opinion, the rise and thus the initial distribution of clusters, is determined by history, accident, or even self-fulfilling prophecies. In this respect, Krugman's reasoning is comparable to other contributions on 'path-dependence' and 'endogenous growth' (a.o. Becker (1993) and North (1994)).

Once established, the growth of the cluster depends on the interaction of increasing returns, transportation cost and demand. According to Krugman, the persistence of clusters starts with the existence of economies of scale. When these economies are sufficiently strong, each producer wants to serve his market from a single location. In order to minimize transportation cost, a location is chosen with large local demand. Assuming that the behavior of all producers are the same, demand is concentrated at those locations where the majority of producers is located. "This is a circularity that tends to keep a manufacturing core in existence once it is established" (p. 81).

As Krugman, Rauch (1993) emphasizes the large role that history plays in determining the outcome of location choices. In his opinion, "...the importance of the result that 'history matters' is that there is no assurance that history will choose the most efficient outcome" (p. 844). Rauch argues that this inefficiency may be overcome by discriminatory pricing of land over time.

Rauch's theory assumes that potential clustering economies are expressed in the land prices of industrial parks. In principal, this should lead to an efficient distribution of

clusters. However, firms do not always choose the most efficient location. Therefore, a land pricing policy may be used to persuade firms to relocate. Due to the tradeoff between inefficiency costs at the current location and investment costs at the new location, some firms move to new locations, while others remain at the current site. In this way, both the persistence of old clusters and the rise of new clusters is explained.

### *Organizational concepts*

The transaction cost concept of Scott (1986) also shows how clusters could rise and grow. Within the scope of Williamson (1975), Scott distinguishes between markets and hierarchies. Markets are networks of externalized transactions representing the input-output and information linkages between firms. Firms, on the other hand, are organized as sets of purely internalized transactions within a managerial hierarchy.

According to Scott, clusters are the spatial consequences of vertical disintegration. For when firms disintegrate vertically, the level of external transactional activity in the economy increases. This stimulates those producers with especially intense and costly linkages to one another to cluster. In its turn, the clustering of many producers helps significantly to hold down the spatial costs of external transactions. This has two important side effects. First, further vertical disintegration is encouraged by decreasing search and recontracting costs. Second, vertical disintegration is encouraged among producers whose input demands are quite unstandardized and require much face-to-face contact. "Thus vertical disintegration encourages agglomeration, and agglomeration encourages vertical disintegration" (p. 224).

Harrison (1992) formulated another organizational concept that describes a clustering process based on social economic theory. In his opinion, conventional spatial concepts have an undersocialized conception of human action, because there is no active



role for social relations. Therefore, he argues that concrete personal relations and structures (i.e. networks of interfirm linkages) should be seen as an important factor in the clustering process.

In Harrison's concept, clusters of small, flexible firms are the ideal type of cluster. These firms have specialized in one or more phases of a production process and often cooperate with one another, sharing tools, information, and even skilled personnel. Harrison argues that trust plays a crucial role in such interfirm networks. A redesign of interfirm linkages (possibly including a relocation of firms) should try to improve this trust. "If trust can best be built through learning about the idiosyncrasies of the actors, and if this requires repeated interaction, then such interaction is likely to be facilitated by personal contact, and that contact is in turn enhanced by geographical proximity" (p. 477). In other words, clusters may arise because of 'trust maximization'.

### *Strategic concepts*

Porter's strategic concept (1990) shows how firms may improve their competitiveness by joining clusters of competitive industries. The main assumptions in this concept are that competitiveness depends on the capacity to innovate and upgrade and that firms gain advantage against their competitors because of pressure and challenge.

The idea behind Porter's concept is that in sophisticated industries, firms do not inherit but instead create the most important factors of production. Strong innovative incentives may proceed from supporting, home-based related and competitive industries because of close working relationships. Home-based related industry increases the likelihood that companies embrace new skills. At the same time, it may provide a source of entrants who bring a novel approach to competing. Competitive industries in the territorial environment push firms to further innovation as well.

Storper (1992), on the contrary, suggests that flexible production systems, instead of the innovation itself, are the key to success. In contrast to comparative advantages, the use of flexible production systems is accompanied by productivity gaps that cannot be exceeded by price advantages.

According to Storper, firms are only competitive if they are able to switch from one production technique to another without significant increases of production costs. Such 'technological dynamism' can be realized when firms are organized as a production network (i.e. small, specialized firms acting in a collegial manner). Consequently, clusters are the principal geographic form in which the tradeoff between technological flexibility, cost minimization and a lock-in to old-fashioned skills and knowledge can be managed effectively.

### **III. WHERE DO FIRMS CLUSTER?**

The foregoing shows that the six spatial concepts all adduce different arguments why clustering of firms takes place. These differences, however, do not necessarily imply that locations where firms eventually establish, differ as well. This can be shown best by projecting the various concepts on a fictitious landscape.

In the present case, a landscape is shaped that consists of four independent states: state A in the North-West, state B in the North-East, state C in the South-West and state D in the South-East. A national airport, located in state B, is used for the import and export of goods to and from the four states. Besides certain specific characteristics discussed in the following, state A to D are considered to be identical. The customers' preferences and the firms' technologies do not differ each state.

In state A, there are three small villages with a total population of about 20,000 people. These villages are situated in the Awakening Valley, nearby a bay at Hotelling's

beach. Recently, state government has unfolded plans to deepen this bay and transform it into a national seaport. If these plans are carried out, Awakening Valley will become a high potential logistics area and grow quickly into a mainport for its hinterland. However, the political decision-making process with respect to this project and the juridical dispatch due to the expropriation of land may still take several years.

In state B, Brain Town is the only large town with a population of more than 200,000 people. The three small villages are not of any economic importance. The inhabitants of Brain Town are well skilled and socially straight. Total industry of state B is concentrated around Brain Town and consists of small high-tech firms that act in a cooperative way with each other. The research and development activities of these firms are carried out in cooperation with the technical university of Brain Town.

In state C, Competition Town is the main town. It has a population of more than 500,000 people. The inhabitants of Competition Town are well skilled, but socially tough. The industry of state C is clustered in Competition Town. It consists of a few multinationals producing high quality goods and an underlying network of small suppliers and supporting firms. The multinationals are main competitors of each other. The small firms are providing services to several customers. They are not financially dependent on the orders of a multinational.

In state D, there is no town or area of economic importance yet. However, state government wants to attract new industries and allows industrial park developers to undersell acres of land. Price discounts may rise up to 50 percent. The new industrial area is located in the Discount Fields.

Four areas in this industrial landscape are considered to be potential clustering areas, namely the Awakening Valley, Brain Town, Competition Town and the Discount Fields. It is assumed that the current volume, intensity and costs of transactions are equal

in Brain Town and Competition Town. The distances from the clustering areas to the airport are also equal. Clustering theories are applied *ceteris paribus*.

In the following, the six spatial concepts are projected on this landscape to determine the locations where clustering may take place. The resulting clustering patterns are visualized in Figure 1.

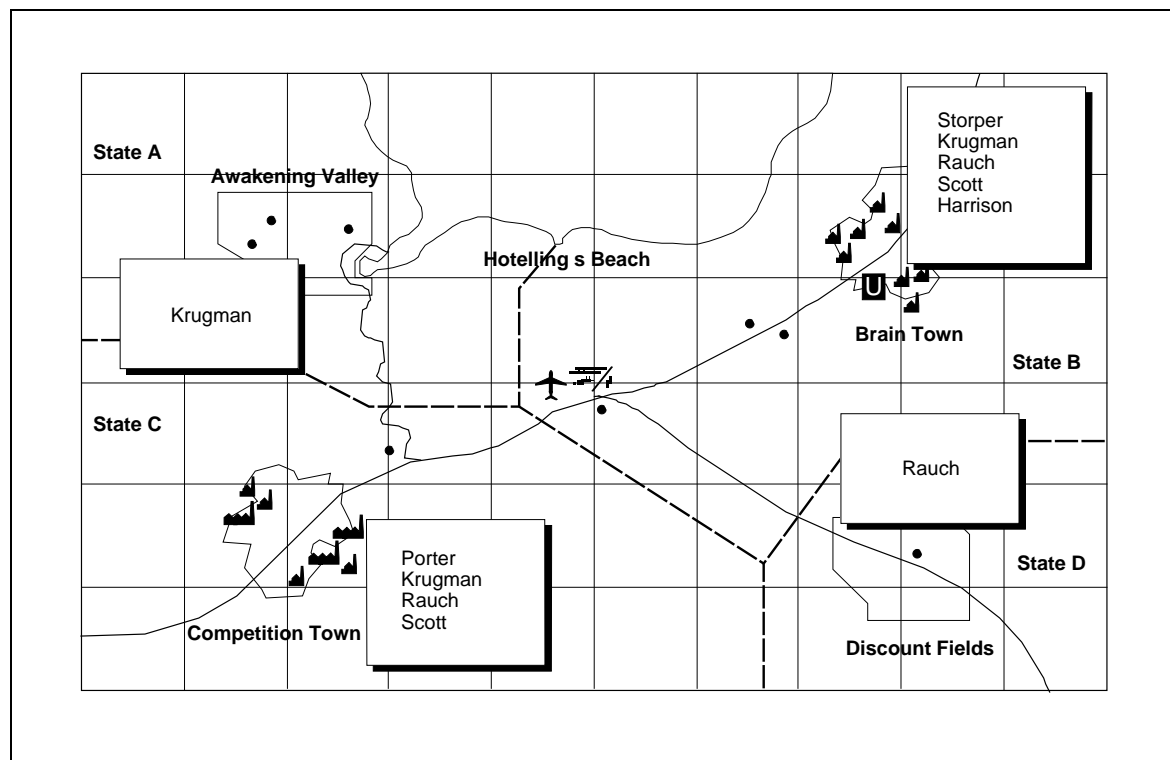


Figure 1. Expected locations of clusters

*Economic geography concepts*

In Krugman's vision, the rise of clusters depends on history, accident and self-fulfilling prophecies. Therefore, prediction of new clustering locations is difficult. In the fictitious landscape, a new cluster is likely to arise in the Awakening Valley as a result of government policy and possibly self-fulfilling prophecy. The rise of a new cluster in the Discount Fields is less likely, but cannot be ruled out. Krugman also shows how clusters tend to be self-sustaining. This implies that the existing clusters in Brain Town and Competition Town will persist.

In Rauch's clustering concept, the (re)location choice of firms depends on the tradeoff between inefficiency costs and investment costs. If first-mover advantages are large enough (i.e. if the discount on land prices is large enough), clusters may arise in new industrial areas. In the fictitious landscape, cheap land is offered in the Discount Fields. Therefore, according to Rauch, some firms move to this new industrial area while others stay in the current clusters in Brain Town and Competition Town.

*Organizational concepts*

Scott's approach describes a spiral of 'vertical disintegration encouraging clustering' and 'clustering encouraging vertical disintegration'. In the fictitious landscape, clusters already exist in Brain Town and Competition Town. In Brain Town, the number of firms is not likely to increase because no further disintegration of industry is possible. In Competition Town, on the other hand, there are still possibilities for industry to reorganize as a network of small, specialized firms. Consequently, the number of firms in this cluster will grow.

The socio-economic approach of Harrison is interesting because it starts from a different point of view. Taking the social interaction between human beings as a starting-

point, Harrison argues that industrial clusters result from a need for personal contact. If this is true, clustering will take place at those locations where these contacts are expected to take place most easily. In the fictitious landscape, only the inhabitants of Brain Town are socially straight. Thus, according to Harrison's concept, clustering will take place in Brain Town.

### *Strategic concepts*

In Porter's opinion, innovation is crucial to the persistence of firms. This innovation is stimulated at most in regions where supporting and competitive industries have located as well. Moreover, firms should even welcome the establishment of more competitors and aggressive suppliers. In the fictitious landscape, Competition Town is a high competitive area. Consequently, firms should cluster or stay clustered in Competition Town.

Storper's concept, on the other hand, stresses that firms should look out for learning opportunities in order to survive. These opportunities are most likely to be found in specialized and disintegrated environments that are supported by 'knowledge centers'. In the fictitious landscape, such environment exists in Brain Town. Thus, in Storper's opinion, firms should cluster or stay clustered in Brain Town.

Table 1

*The 'Where' and 'Why' of Clustering*

	Why?	Where?
Krugman (1991)	<ul style="list-style-type: none"> <li>• Clusters rise by accident or due to self-fulfilling prophecies.</li> <li>• Clusters grow by interaction of increasing returns, transportation cost and demand.</li> </ul>	<ul style="list-style-type: none"> <li>• In principal, clusters may rise at any location.</li> <li>• Existing clusters will grow and persist.</li> </ul>
Rauch (1993)	<ul style="list-style-type: none"> <li>• Clusters rise by accident. Industrial developers may correct inefficiency.</li> <li>• The relocation of firms depends on a tradeoff between investment cost and higher production cost.</li> </ul>	<ul style="list-style-type: none"> <li>• In principal, clusters may rise at any location.</li> <li>• Some firms stay in old clusters. Others locate in new, rising clusters.</li> </ul>
Scott (1986)	<ul style="list-style-type: none"> <li>• Clustering encourages vertical disintegration. Vertical disintegration encourages clustering.</li> </ul>	<ul style="list-style-type: none"> <li>• Existing clusters will grow into clusters of small, specialized firms.</li> </ul>
Harrison (1992)	<ul style="list-style-type: none"> <li>• Clusters of small firms facilitate personal contacts and maximize 'trust'.</li> </ul>	<ul style="list-style-type: none"> <li>• Existing, socially straight clusters will grow into clusters of small, specialized firms.</li> </ul>
Porter (1990)	<ul style="list-style-type: none"> <li>• In clusters of high competitive firms innovation is stimulated. Only innovation creates the necessary competitive advantages to persist.</li> </ul>	<ul style="list-style-type: none"> <li>• Clusters of high competitive firms will persist and may grow due to the entry of new competitors.</li> </ul>
Storper (1992)	<ul style="list-style-type: none"> <li>• Clustering leads to an effective management of the tradeoff between lock-in, technological flexibility and cost minimization.</li> </ul>	<ul style="list-style-type: none"> <li>• Clustering should take place in high innovative areas. Firms within such a cluster must be small, specialized and flexible.</li> </ul>

#### **IV. CONCLUSIONS AND DISCUSSION**

The main findings in this paper with relation to the 'why' and 'where' of clustering are summarized in Table I. It appears that various spatial economic concepts describe the clustering of firms. Although the reasons for joining a cluster differ fundamentally for each concept, the location where clustering is expected to take place may be the same. This implies that in practice the rise, growth, and structure of a cluster can be explained by multiple spatial concepts.

Some of the arguments why firms may join a cluster in general, are also relevant to the clustering of logistic service providers. Krugman, for example, based his concept on the principle of economies of scale. In logistics, the existence of such economies can be proven easily. The discount on land prices, as described by Rauch, may be attractive for firms specialized in warehousing. The relevance of Porter's concept is enlarged as a result of the establishment of a free trade area in Europe, which has led to an increasing competition among transporters. Harrison's concept fits the fact that producers, due to their customer orientation, consider close relationships with their transporters to be of crucial importance. The concepts of Scott and Storper, on the contrary, are less relevant because practice shows that in logistics, there is an increasing tendency towards scale enlargement instead of any form of disintegration.

In conclusion, it appears that a detailed study on the modeling of clustering in spatial economic theory may discover various mechanisms that could be incorporated in logistic clustering models. Although these spatial mechanisms are often non-quantitative, making integration with existing logistic models more difficult, significant improvement in the description of the clustering phenomenon may be expected when such mechanisms are taken into consideration in logistics theory.



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