Do Clusters Matter?

Empirical Evidence from Germany's Neuer Markt

by

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Abstract

Do clusters matter? There are theoretical arguments from cluster theory suggesting that agglomerations of economic activity have positive performance impacts. In contrast, cluster might attract low performers aiming to profit from external cluster economies like knowledge spillovers. Based on empirical evidence from companies listed at Germany's Neuer Markt we analyze a set of accounting-based and market-based performance measures regarding geographically based performance differentials. We show that for bigger companies clusters matter but tend to have negative performance aspects. By contrast, the performance of smaller companies appears to be less influenced by cluster membership. Our findings can be regarded as tentative evidence for an adverse selection process in which adverse selection effects dominate positive external cluster economies when firms grow.

JEL: G10, M13, R12, R30

Keywords: Cluster, Entrepreneurship, Size and Spatial Distributions of Regional Economic Activity

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1. Introduction

The geographical dimension of corporate activity has long been a neglected field of research.[1] The contributions of von Thünen on the spatial structure of economic activity form a starting point in economic geography research. Newer contributions to this field of research use the term "cluster" to describe the agglomeration of economic activity.[2] Reasons for the formation of clusters are far more often analyzed than the impact of clusters on the performance of firms.

This paper looks at the performance impact of clusters and intends to contribute to the understanding of individual motivations in corporate location choice. In order to understand these motivations we first ask "Do clusters matter?". Our analysis indeed shows that clusters matter. Despite theoretical arguments from cluster theory suggesting that agglomerations of economic activity have a positive performance impact we find negative cluster economies for bigger companies. This supports the view that clusters might attract low performers aiming to profit form external cluster economies. The empirical results also suggest that smaller firms tend to be less influenced by their affiliation to clusters. We believe that the geographically linked performance differentials for bigger companies are not contradictory to the theory emphasizing the dominance of adverse selection effects over positive external cluster economies.

The rest of the paper is organized as follows. Chapter 2 discusses existing theoretical approaches on clusters and economic geography in literature. Chapter 3 reviews the existing empirical evidence on clusters and then describes the research design of the empirical analysis, such as the data set, variables, and methodology. Moreover, we will sum up and interpret our main results. Chapter 4 provides a summary discussion and concluding remarks with regard to further research in the area.

[1] Cf. Krugman (1998), p. 34.
[2] Cf. Porter (1998).

2. Cluster Theory

2.1 Economic Geography

The question where to locate your business has always been crucial for both, new ventures and existing companies aiming to expand on a national or international level. A phenomenon that can be observed is the formation of clusters, i.e. the geographical concentration of firms. The location of value creating activity seems to depend upon historical location choices by other firms. Striking examples in the United States are Boston's mutual funds, Wall Street's investment banks, Hollywood's movie industry, and information technology firms in Silicon Valley. Ellison/Glaeser (1997) found that many US industries are more regionally concentrated then would be supported by chance alone. Cluster theory is closely linked to the economic geography literature which is briefly summarized here.

Von Thünen's (1826, 1850, 1863) theory of land rent & land use can be considered to be the earliest proponent of spatial economics. In contrast to von Thünen, most other economic geography theories link regional agglomeration to increasing returns to scale, e.g. New International Trade Theory.[3] These scale economies can be traced back to imperfections in the market structure. Models in this tradition often use a Chamberlain monopolistic competition world in which markets are competitive but firms have some monopoly power and therefore can benefit from economies of scale.[4] Other models use a transportation cost rationale by emphasizing the location choice trade-off between the inputs a firm needs and its customers, e.g. Weber (1909), Christaller (1968) and Lösch (1944).[5] Despite the highly abstract appearance there is corresponding casual empiricism in support of the suggested interaction of geographical shape and agglomeration of economic activity for the young and innovative firms we analyze.[6] The stream of economic geography called *cumulative causation* focused on market potential as a determinant of corporate location choice. Harris (1954) found that regional growth in terms of firm agglomeration is self-reinforcing: high market potential attracts new firms, enhances the market potential, and thereby induces more firms to move there. Similar results are detected by Pred (1966, 1973).

[3] Traditional international trade theory explains international trade using factor endowments (Heckscher/Ohlin approach) or differences in the production technology (Ricardo model).
[4] Cf. Chamberlain (1933).
[5] Cf. Christaller (1968), p. 27 and Lösch (1944), p. 73.
[6] Cf. Saxenian (1994), p. 30. For example, Silicon Valley might have emerged merely because of the lack of space. The valley is a narrow stretch of land between San Francisco Bay and the Santa Cruz mountains.

A further important stream of location choice theory uses externalities to explain the geographical shape of economic activity. An externality occurs when the production or consumption activity of an economic agent positively or negatively affects the production or consumption activity of another economic agents without being reflected in the price mechanism.[7] Marshall's concept of externalities has its roots in the idea that agglomerations of firms generate a critical mass and an "industrial atmosphere". This critical mass of firms allows businesses to specialize and thereby increase productivity.[8] This idea of local externalities is closest to Porter's cluster concept, which shall be presented in more detail.

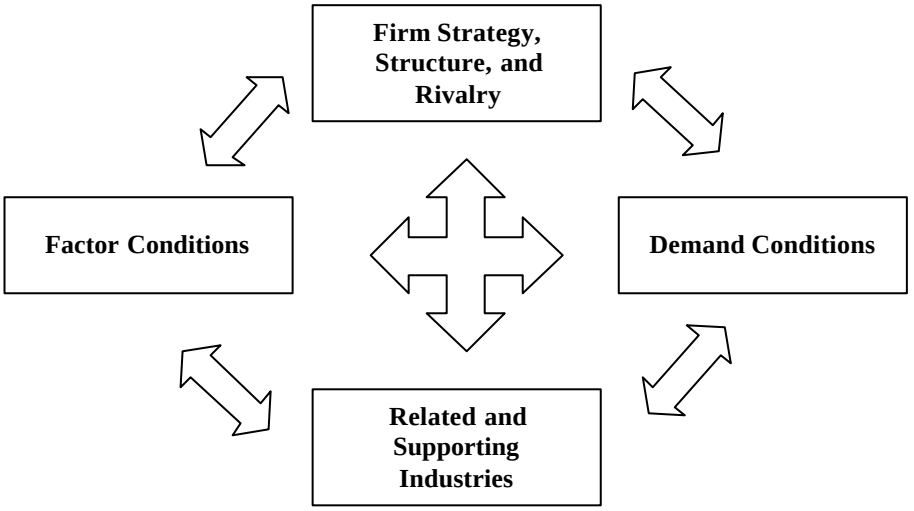
2.2 Porter's Competition View

Porter defines clusters as "*geographic concentrations of interconnected companies and institutions in a particular field.*"[9] The economic activity of a company can be described by a value chain.[10] The value chains of companies in vertical production relationships form the value system.[11] The totality of companies within one value system out of interconnected companies can form a cluster. Within the market-hierarchy paradigm by Williamson (1975) clusters can be classified as a hybrid form.[12] Porter himself argues further that they mitigate the problems inherent in market relationships (lack of trust and coordination) without running into the problems associated with hierarchies (inflexibility, x-inefficiencies[13]). Both, competition and cooperation is spurred by clusters. Rival companies compete intensely and generate innovations as a by-product. At the same time, they cooperate im- or explicitly by sharing input sources in a symbiotical way. Clusters have therefore the potential to transform cooperation and competition into a mixture of both termed co-opetition.[14] The optimal levels of competition and cooperation vary by industry and region.[15]

[7] Building on the findings of Marshall (1986) and Coase (1960), the concept of externalities was introduced by Buchanan/Stubblebine (1962).
[8] Cf. Marshall (1986), p. 25ff.
[9] Cf. Porter (1998), p. 78.
[10] Cf. Porter (1985), p. 36-52.
[11] Cf. Porter (1990), p. 41-43.
[12] Cf. Porter (1998), p. 79. They are an organizational or coordination form in between arm's length markets on the one side and hierarchical structures on the other side.
[13] The term x-inefficiency is a concept that describes organizational slack in hierarchical organization. Cf. Leibenstein (1966).
[14] The concept of co-opetition has been further developed in his game-theoretical dimension by Nalebuff/ Brandenburger (1996).
[15] Cf. Enright (1996), p. 200.

Porter's "diamond of national advantage"[16] is a model that can be used in the analysis of clusters to describe the effect of the business environment on competition via four interrelated influences. These four influences or attributes form the diamond: (i.) factor conditions, (ii.) demand conditions, (iii.) related and supporting industries, and (iv.) firm strategy, structure and rivalry (as shown in exhibit 1). The framework has originally been set at the national level, but Porter argues that it can and has been applied at the regional, state, and city level as well.[17]

Exhibit 1: Porter's diamond



Source: Porter (1990), p. 71.

Factor conditions are all kinds of inputs used as factors of production, e.g. labor, land, natural resources, capital, but also highly skilled human capital, (venture) capital, and efficient infrastructure solutions. According to Porter, sophisticated demand conditions in the home market are a source of competitiveness. Firms that face refined tastes and a high degree of knowledge about a product in the home market are likely to sell superior products in all other markets because their domestic customer base requires high quality products.[18] In addition, the business environment in terms of industry structure is crucial for the competitive advantage. A number of related and supporting industries are important to the competitiveness of firms. Following Porter (1990), the fourth factor, firm strategy, structure, and rivalry, also matters because e.g. rivalry in form of intense domestic competition spurs innovation.

[16] Cf. Porter (1990), p. 71-73.
[17] Cf. ibid., p. xi.

Both economic geography and Porter's cluster theory contribute to our understanding of clusters. However, there is a caveat to both theories. Given that positive cluster effects exist they would be visible in better relative performance of cluster firms. According to cluster theory, these positive spillovers in clusters exist if firms receive more agglomeration economies from a cluster than contributing to their creation. This is not necessarily the case, since also negative cluster externalities exist. A theoretical rationale for varying net effects is given by Shaver/Flyer (2000). They argue that if the cluster members are different, the net benefits are different, too. In a cluster of heterogeneous firms, it could be reasonable to assume that firms with e.g. the weakest technologies or lowest human capital have little to lose and a lot to gain from agglomerating. Thus, agglomeration is expected to be characterized by adverse selection. Shaver/Flyer (2000) support their hypothesis by evidence from US manufacturing industries.

3. The Evidence

3.1 Previous Empirical Research

To assess the literature on empirical cluster research, one can start by diving the literature according to the methodology or according to the main research questions (see exhibit 2).

In accordance with Baudry et al. (1999), there are three main lines of investigation with in cluster research: path dependency theory, new growth theory, and clustering effects approaches. The first line of research looks at historical chance and path dependency in the genesis of clusters.[19] Recent contributions from Athreye (2000) and de Fontenay/Carmel (forthcoming) also fall into this category. New growth theory in the tradition of Romer (1986, 1990) and Grossman/Helpman (1992) are the foundation for the second line of research, which deals with the modeling of knowledge effects as they relate to geographic concentration. The third line of research focuses on the extent and the effects of clustering effects on companies.[20]

Concerning the methodology, Markusen (1994) broadly sketches two main categories in cluster research, the qualitative and the quantitative approach. For example, in qualitative cluster research, case study methodology is frequently used, while in quantitative cluster research, statistical methods are applied.

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[18] An example of this phenomenon can be found in France where local consumers force the French wine industry to produce high quality wine.
[19] Cf. Arthur (1990), David/Rosenbloom (1990), Krugman (1991).
[20] Beaudry et al. (1999) mention authors such as Jaffe (1989), Audretsch (1995), and Breschi (1999).

Exhibit 2: Examples of directions in cluster research

Main Research Question	Methodology	
	Qualitative	Quantitative
Genesis	de Fontenay/Carmel (forthcoming)	-
Growth (Theory)	Athreye (2001)	Beaudry et al. (1999)
Effects	Mytelka/Farinelli (2000)	Beaudry et al. (1999), Isaksen (1996)

Source: own classification

In all lines of research, the object under discussion can be either the cluster itself or individual companies which make up the cluster. In fact, through a micro-macro linkage, firm level effects can result in regional differences and vice versa. Since our paper focuses on the performance differences of companies[21] using quantitative data, the ensuing description of literature will focus on this strand of literature.

Summing up past the empirical research, two main questions have to be clarified: (1) how to operationalize a cluster, and (2) how to operationalize performance?

3.1.1 Operationalizsation of cluster

Operationalization on the basis of Porter's definition of clusters has to take into account three aspects: How is the term "geographic" operationalized? What is meant by "concentration"? How to define which industries belong to "a particular field"?

Geographic concentration, in general, is an aberration from an even distribution of the objects under discussion in space. For practical reasons, space is most commonly divided into administrative units like ZIP codes for data availability reasons.[22] Cross-country differences in spatial measurement techniques can make international comparisons more complex. At least on the European level, the NUTS[23] classification of Eurostat can help to

[21] Rooted in international trade theory, there are also studies which focus on the performance on regions. For example, de Fontenay/Carmel (2001) look at Israel's Silicon Wadi, Isaksen (1996) deals with local Norwegian clusters.

[22] For a further discussion of this measure see point 3.2 of this paper. The main reason for using ZIP codes are that a) they allow to break space down into small parts and b) for our model, we do not need additional data from administrative sources.

[23] Nomenclature des Unités Territoriales Statistiques. For example, in Germany NUTS-1 regions are the "Bundesländer", NUTS-2 regions the "Regierungsbezirke" und NUTS-3 regions "Landkreise" and so-called "kreisfreie Städte".

facilitate comparisons. The main problem resulting from the equation of clusters with regions is that they are usually not the same size. Most clusters are smaller than the NUTS-2 regions (for which most statistical data is available) or even NUTS-3 regions, but there are also clusters which overlap various administrative regions.[24] To visualize the cluster distribution, some studies use mail addresses to plot the geographic distribution of companies.[25] However, this does not help to deal with the integration of secondary statistical data.

In most studies, the operationalization of "concentration" is not well documented. Some studies use a location quotient which compares the relative concentration of a particular industry, measured as employment or number of firms, in a certain region with the industry's concentration in the economy as a whole.[26] A major question is what degree of concentration must be reached for a region, however defined, to be called a cluster. Apparently, each researcher answers this question differently. Some studies even simply state that a certain region is a cluster without giving hard evidence.

Industries are most commonly operationalized according to their SIC or the NACE-CLIO industry codes.[27] The question remains until what depth one can still talk about companies being "in a particular field". On the one hand, there can be spillover effects between industries which do not belong to the same classification, but belong to the same field. On the other hand, a company which is still classified under industry x can have moved to industry y, hence not contributing to the cluster effects (any longer).

[24] For example, Silicon Valley encompasses Santa Clara, San Mateo, southern Alameda, and areas of Santa Cruz County. When the underlying administrative unit is too large or cluster are spanning more than two administrative regions, they might go undetected due to dilution effects. When the administrative regions are chosen too narrow, the results are biased by exaggeration effects.
[25] Cf. Zook (1998).
[26] Cf. e.g. the Employment Concentration Factor as calculated by SANDAG (1998), p. 28.
[27] SIC = Standard Industrial Classification; NACE-CLIO = Nomenclature générale des activités économiques dans les communautés Européennes - Classification and nomenclature of input-output.

3.1.2 Operationalization of performance

Before being able to deal with the question how to operationalize performance, it is important to clarify the *object* whose performance is aimed to be measured. In cluster research, both the performance of the clusters and the performance of each individual company is looked at. Indicators such as the rate of new start-up companies are performance measures of the cluster as a whole, whereas the numbers of patents, the volume of exports or the growth rate (however operationalized) can be measured at the company level as well as on the cluster level.

There is a vast variety of performance measures on the company level in the literature. According to Fritz et al. (1988), performance indicators can be grouped into three main categories: (1) market performance (e.g. market share, turnover), (2) operational performance (e.g. quality, reputation), and (3) financial performance indicators (e.g. profit).[28] In the cluster literature on firm performance, the following performance measures are widely used:

Rate of growth

Beaudry/Swann (1999) construct a firm-level growth model. Their basic regression model contains the trend rate of growth of a certain firm and takes into account that this rate can be influenced by the number of persons employed in similar firms in that region, the number of persons employed in other firms in that region and the science base (number of persons employed in R&D in that region), among other variables.

Beaudry/Swann sum up their results: "Positive clustering effects outweighed negative, but (…) the most common pattern was where clustering with firms in the same sector has a positive effect on growth while clustering from firms in different sectors has a negative effect on growth."[29] Their results can be tentatively interpreted that being located in a industry-specific cluster has a positive impact on firm performance, when performance is equated with growth. However, when using growth as a performance measure, one must not forget about other performance indicators such as sustainability and profitability as well. Using just one measure only shows a part of the picture.

[28] Cf. Fritz e. al (1988), p. 567.
[29] Cf. Beaudry/Swann (1999), p. 29.

Disproportionate share of innovations

Growth rates, as calculated by Beaudry/Swann (1999), are a measure of past performance. Future firm performance is unknown, but a strong base of resources and capabilities can serve as a foundation for future success in all success categories mentioned.[30] Innovations, though risky, can build future resources and capabilities and are thus of huge importance not only on the firm level, but for the economy as a whole. As a consequence, a lot of empirical research has dealt with the question of how clustering can contribute to innovation. One of the most recent papers is Beaudry/Breschi (2002), who derive at similar results than Beaudry/Swann (1999). They note as their central result that firms benefit only from a strong presence of other innovative firms in their industry in the same regional cluster, whereas the presence of non-innovative firms of the same industry in the same region can even lead to congestion effects.

To sum up the short review of previous empirical research, positive and negative cluster effects that are discussed in the literature, are presented below in Exhibit 3.

Exhibit 3: Cluster effects

	Demand Side	**Supply Side**
Advantages	Strong local demand Hotelling Arguments Reduced consumer search costs Information externalities	Technological spillovers Specialized labor Infrastructure benefits Information externalities
Disadvantages	Congestion and competition in output markets	Congestion and competition in input markets

Source: Swann (1998a), as found in Beaudry et al. (1999), p. 3.

The overall direction of cluster effects in terms of performance remains an empirical question. Even though various performance measures have already been discussed in the empirical cluster literature, there is no research using accounting and/or market based valuation measures (e.g. Tobin's *q*) as dependent variables. Hence, we intend to contribute to cluster research by applying such alternative performance measures.

[30] See the rich body of literature on the resource based view of the firm for the relation of resources and capabilities and firm success. Also, there is empirical evidence backing the importance of innovations for firm performance. Cf. Acs/Audretsch (1990).

3.2 Data Description and Empirical Research Design

3.2.1 Dataset

We use a unique database with information from companies listed at Germany's stock market segment Neuer Markt[31] by the end of 2000 to empirically investigate the performance impact of clustering. Since our study is limited to the role of clusters in Germany, companies listed at the Neuer Markt with headquarters abroad are not included in our investigation.[32] The market values of the firms at the end of the fiscal year in 2000 were obtained from the German periodical *Börse Online*. Finally, we use accounting data from the firms listed at Neuer Markt as provided by Küting (2001).[33]

We exclude all companies of the financial services industry from our sample due to their different balance sheet structure.[34] After this adjustment we end up with a sample of 276 firms, as illustrated in appendix 1. The statistics also shows the composition of the sample classified by industry sectors as defined by Deutsche Börse AG. As can be seen, the companies with headquarters in Germany listed at the Neuer Markt by the end of 2000 were not equally distributed among the classified industry sectors. The majority of all companies considered in our analysis belongs to the industry sectors "Internet" and "Technology" which represent nearly one fifth of the sample each.

3.2.2 Variables and Methodology

In the analysis, we focus on the performance of the companies listed at Germany's Neuer Markt, measured by Tobin's *q* and a number of standard accounting ratios. According to Tobin/Brainard (1986) and Tobin (1969), Tobin's *q* is defined as the ratio of the market value of outstanding financial claims to the current replacement cost of the firm's assets.[35] It is assumed that the replacement cost is a logical measure of the alternative use value of the assets. The *q* ratio is often applied as an indicator of intangible value in economic research and has been used by a growing number of empirical studies to categorize firms according to their relative

[31] The Neuer Markt is Germany's trading segment for innovative growth companies and was launched in March 1997 by the Deutsche Börse AG in order to attract small and medium-sized, young technology firms.
[32] One reason for the limitation to German companies is related to the German ZIP code system that we use to determine the location of a firm's headquarter and the existence of a cluster. Moreover, the foreign companies are so widely distributed that they would not constitute a cluster by themselves.
[33] The data has been collected by Küting (2001) from the firms' annual reports of the fiscal year 2000.
[34] The respective firms are ConSors Discount Broker, Direkt Anlage Bank AG, Entrium Direct Bankers AG, and Foris AG. Previous studies on listings on Neuer Markt excluded firms from the financial sector for the same reason. Cf. Fischer (2000); Franzke (2001).
[35] Cf. Lewellen/Badrinath (1997) on the measurement of Tobin's *q*.

performance.[36] The measure is superior to pure accounting-based measures because it is less sensitive to the discretion of managers, e.g. in the form of 'creative accounting'. Not only balance-sheet related information is taken into account but also long-term improvements like growth opportunities and events that do not immediately affect the cash flows of the firm. Although various methods have been proposed for the calculation of the ratio, different measurement approaches tend to yield similar value for Tobin's q.[37] We employ an approximation of Tobin's q by dividing the market value of shareholder's equity by the book value of equity.[38]

While Tobin's q tends to measure the expected performance based on anticipations of the market, accounting measures are based on the historical performance of a company. Therefore, it might be worthwhile to include accounting measures in the analysis and to explore potential differences among the measures. We use the following performance measures based on accounting data: (a) return on equity (ROE); (b) return on assets (ROA); (c) sales per employee; and (d) growth rate of sales.

The ROE reflects the yield on both the retained earnings of a company and the funds invested by shareholders. It also reveals the investment opportunities available for a firm and reflects how well the firm is capitalizing them. The ROA, defined as EBIT divided by total assets, is an efficiency measure on how a firm is being run and provides information on how much profits are generated by each euro of assets. The ratio sales per employee is considered as measure of productivity that provides information about the contribution of each employee to the sales of its company. Finally, we use the growth rate of sales in our analysis as an indicator for the growth of a company.

We include the location of a firm's headquarter, and in particular its affiliation to a predefined cluster, as a dummy variable in our analysis. The dummy variable takes on the value 1 if the firm is located inside a cluster and 0 otherwise. In order to determine the firms' locations of and their concentration in a particular region, we employ a mapping software that is based on the five-digit German ZIP code system. The geographic distribution of the firms in our sample is illustrated in appendix 7. Based on the observed geographic distribution of the firms we then define clusters as the areas which are characterized by a relatively high density of firms. Since it is not always unambiguous to determine the size and the reach of a cluster we define the border of a cluster area

[36] Cf. Lindenberg/Ross (1981); Morck et al. (1988); Lang/Stulz (1994); Lang et al. (1989), Servaes (1991).
[37] Cf. Chung/Pruitt (1994).
[38] The same proxy has been employed in previous studies. Cf. Jain/Kini (1994).

by using circles with different diameters.[39] The use of more than one cluster definition might be helpful to assess the appropriateness of different cluster classifications.

First, we assume firms to be part of a cluster if they are located in the area within a pre-specified radius around a defined cluster center. Specifically, a firm is supposed to belong to a cluster if its headquarter is located inside (10 km radius around the center) or in the metropolitan area (20 km and 30 km radius around the center, respectively) of a cluster. While the first definition might fail to measure the effect of a cluster due to a too narrow focus, the second and the third enlarge the geographic reach of cluster and could thus mitigate this drawback and produce evidence in favor of our conjecture.

Next, we apply different cluster definitions to distinguish between the effects related to the location of a firm inside an important conurbation area and those related to the location in a particular industry belt. While the first definition concentrates on the attractiveness of a conurbation as a location for a firm, it does not consider the importance of a location for a specific industry. Therefore, we introduce a modified cluster classification taking into account whether a firm is located in an area that is of particular importance for its business. In analogy to the first definition of a cluster, we use a more narrow diameter (10 km radius around the center) and wider distances (20 km and 30 km radius around the center, respectively) to codify a firm's affiliation to an industry cluster. For both the conurbation based and industry based definition, we assume the existence of a cluster if the number of firms located the circle exceeds 20 percent of all firm in the same industry. The table in appendix 2 provides an overview of the different cluster definitions applied in our analysis and the shows the number of firms covered by each type of definition.

Finally, in accordance with Fama/French (1993) we assume that that firm size is related to profitability and that small firms tend to have lower earnings on assets than bigger firms.[40] Therefore, we split our sample into smaller and larger firms by using the median of sales as cut-off value. Then, we compare cluster and non cluster firms with respect to their variations in the different performance measures.

[39] The idea of using circles around a center follows model of land use by von Thünen. Cf. also Brake (1986).
[40] In an empirical analysis, Fama and French (1995) show that smaller firms in the US had actually lower earnings.

3.3 Results

The descriptive statistics for the different performance measures of both cluster and non cluster firms are outlined in the appendix. The statistics for larger firms (appendix 3 and 4) reveal that firms located outside a cluster tend to yield higher performance than those located inside a cluster. In particular, three performance measures, i.e. Tobin's *q*, ROE, and ROA, of the non-cluster firms tend to have significant higher means and medians than those of the firms located inside a cluster. Our results are robust for all definitions of clusters we employ in the analysis.[41] However, the results also show that firms located in a cluster tend to grow faster than firms outside a cluster.[42] This finding is significant for our non-industry-related definition of clusters (conurbation cluster). There are no significant differences in the sales per employee ratio between cluster and non-cluster firms but the measure tends to be higher in the case of firms located in cluster.

We interpret our results for larger firms as negative cluster economies. In our opinion, the finding supports the view that cluster might attract low performers aiming to profit from external cluster economies (adverse selection). Thus it seems that negative agglomeration effects dominate positive external cluster economies. For smaller firms (appendix 5 and 6), we do not find any significant results using the different cluster codifications. We think that this empirical finding is not contradictory to theory. We suppose that the positive cluster economies might be offset by congestion costs and adverse selection effects.

[41] To check the robustness of our results we also used "total assets" as a criterion for the size of companies. The division of the sample into larger and smaller firms by using the median in "total assets" as cutoff value confirms our findings that larger companies tend to perform worse than smaller firms although on lower significance levels.

[42] We come to the same results when we use "total assets" as a proxy for firm size.

4. Discussion and Conclusion

In this paper, we focused on the question whether regional clusters matter in order to uncover individual motivations concerning corporate location choice. For this purpose, we empirically investigated the impact of clusters on the performance of companies listed at Germany's Neuer Markt. Our main findings suggest that for bigger firms clusters do matter, but tend to have rather negative effects on the performance. At first sight, these results contradict in some respect the theoretical cluster arguments claiming that (industry) agglomerations might have a positive influence on the performance of firms. The outcome of our analysis supports the view that clusters attract rather low performing firms aiming to derive benefit form external cluster economies such as knowledge spillovers. We also document that the affiliation to a cluster seems to have less net effects on smaller companies. Our empirical picture is not contradictory to an adverse selection process in which negative agglomeration effects dominate positive external cluster economies. For small firms, both countervailing types of cluster economies add up and eliminate a cluster effect in the aggregation. Since lemon firms are net beneficiaries they have competitive advantages compared to firms that are net contributors by producing positive cluster effects, e.g. in the form of knowledge spillovers.

We acknowledge that there might be some limitations to the findings of our study. First, the analysis is restricted to German firms which operate in a particular institutional environment. Therefore, more research is necessary to clarify whether our results hold in other countries as well. Future investigations may extend the scope of analysis by using an international sample of firms. A second objection to our interpretation may be that the unselective high valuation of firms listed at Neuer Markt at the end of the 1990s might have distorted the true value of firm in general, being located in a cluster or not. This should make lemons indistinguishable from good firms. However, despite the bias against our proposition, we could still detects performance differences. Now that the stock valuations have fallen sharply since mid 2000, valuation differences should be even more pronounced.

In a nutshell, we provide new evidence for an important facet of research on clusters by showing the performance impact of agglomeration. We hope that our approach spurs future research refining the link between economic geography and firm performance. There is more research necessary to shed light on the question "Do clusters matter?".

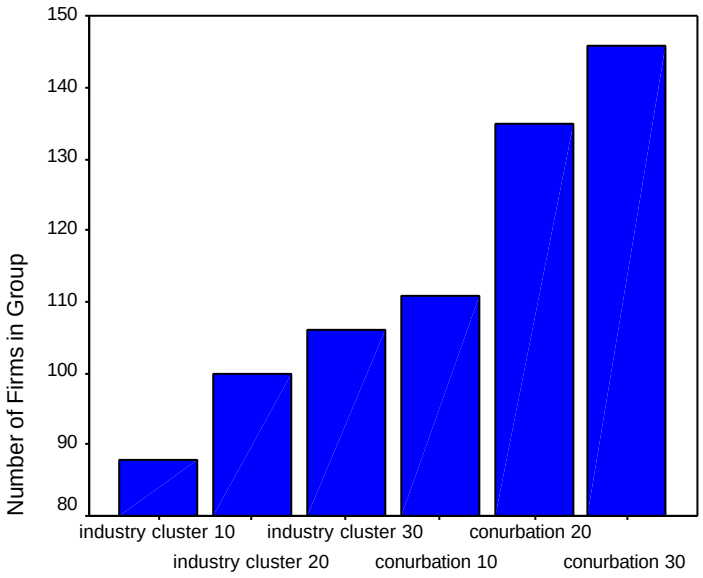
Appendix

Appendix 1: Sectoral composition of the sample

NEMAX-Industry	Number of firms with headquarter in Germany	% of the sample
Biotechnology	13	4,71
Industrials & Industrial Services	14	5,07
Internet	54	19,57
IT Services	34	12,32
Media & Entertainment	39	14,13
Medtech & Health Care	8	2,90
Software	42	15,22
Technology	54	19,57
Telecommunications	18	6,52
Total	**276**	**100,00**

Appendix 2: Variables of different cluster definitions

Cluster definition	narrow definition (radius = 10km)	wide definition (radius = 20km)	wide definition (radius = 30km)
Conurbation-related	*CCL I*	*CCL II*	*CCL III*
Industry-related	*ICL I*	*ICL II*	*ICL III*



Appendix 3: Descriptive statistics for large firms (sales > median) and industry clusters

Panel A: Large Firms - Industry Cluster 10					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	95	4.6365	2.7338	-2.013**
	1	41	3.1856	2.2882	
ROE	0	95	-0.05	0.03	-2.506**
	1	41	-0.29	-0.04	
ROA	0	95	0.03	0.04	-3.009***
	1	41	-0.08	-0.02	
Sales/employee	0	95	0.4606	0.1717	-0.352
(in m€)	1	41	0.3374	0.1826	
Sales growth	0	95	193.24	55.51	-0.832
(in %)	1	41	144.88	66.68	

Panel B: Large Firms - Industry Cluster 20					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	88	4.6847	2.7117	-1.594
	1	48	3.3087	2.6440	
ROE	0	88	-0.05	0.03	-1.967**
	1	48	-0.25	-0.02	
ROA	0	88	0.03	0.04	-2.418**
	1	48	-0.06	0.00	
Sales/employee	0	88	0.4401	0.1651	-0.841
(in m€)	1	48	0.3942	0.1912	
Sales growth	0	88	202.48	55.64	-0.556
(in %)	1	48	135.0	64.64	

Panel C: Large Firms - Industry Cluster 30					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	83	4.7164	2.6902	-1.158
	1	53	3.3889	2.6639	
ROE	0	83	-0.04	0.03	-2.113**
	1	53	-0.24	-0.02	
ROA	0	83	0.03	0.04	-2.363**
	1	53	-0.06	0.01	
Sales/employee	0	83	0.4509	0.1717	-0.588
(in m€)	1	53	0.3812	0.1766	
Sales growth	0	83	208.56	55.43	-0.859
(in %)	1	53	131.84	66.78	

Significance levels are denoted by * for 10%, ** for 5% and *** for 1%

Appendix 4: Descriptive statistics for large firms (sales > median) and conurbation clusters

Panel A: Large Firms – Conurbation Cluster 10					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	82	4.7943	3.1891	-2.909***
	1	54	3.2952	2.1072	
ROE	0	82	-0.04	0.04	-2.944***
	1	54	-0.23	-0.03	
ROA	0	82	0.03	0.05	-3.349***
	1	54	-0.06	-0.02	
Sales/employee	0	82	0.3855	0.1542	-0.964
(in m€)	1	54	0.4838	0.2108	
Sales growth	0	82	75.68	54.42	-2.353**
(in %)	1	54	335.04	71.60	

Panel B: Large Firms – Conurbation Cluster 20					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	88	4.8849	3.0548	-2.354**
	1	48	3.4275	2.4072	
ROE	0	88	-0.04	0.04	-2.851***
	1	48	-0.2	-0.03	
ROA	0	88	0.04	0.05	-3.2***
	1	48	-0.05	-0.01	
Sales/employee	0	88	0.3466	0.1538	-1.253
(in m€)	1	48	0.5128	0.1915	
Sales growth	0	88	69.94	53.07	-2.494**
(in %)	1	48	300.97	71.60	

Panel C: Large Firms - Conurbation Cluster 30					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	83	5.0473	3.2811	-2.276**
	1	53	3.4225	2.5262	
ROE	0	83	-0.03	0.04	-3.396***
	1	53	-0.2	-0.04	
ROA	0	83	0.04	0.05	-3.705***
	1	53	-0.05	-0.01	
Sales/employee	0	83	0.3526	0.1491	-1.083
(in m€)	1	53	0.4905	0.1913	
Sales growth	0	83	70.26	52.27	-2.455**
(in %)	1	53	277.90	71.99	

Significance levels are denoted by * for 10%, ** for 5% and *** for 1%

Appendix 5: Descriptive statistics for small firms (sales < median) and industry clusters

Panel A: Small Firms - Industry Cluster 10					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	90	3.1129	2.1645	-0.856
	1	46	3.6436	2.3821	
ROE	0	90	-0.27	0.07	-0.225
	1	46	-0.49	-0.08	
ROA	0	90	0.2	-0.08	-0.092
	1	46	-0.18	-0.08	
Sales/employee	0	90	0.12	0.0895	-0.497
(in m€)	1	46	0.1287	0.0879	
Sales growth	0	90	128.35	71.16	-1.01
(in %)	1	46	1,594.77	94.39	

Panel B: Small Firms - Industry Cluster 20					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	85	3.1881	2.1795	-0.429
	1	51	3.4661	2.291	
ROE	0	85	-0.27	-0.07	-0.038
	1	51	-0.48	-0.08	
ROA	0	85	-0.21	-0.09	-0.272
	1	51	-0.18	-0.08	
Sales/employee	0	85	0.1109	0.085	-0.056
(in m€)	1	51	0.1430	0.0894	
Sales growth	0	85	134.78	75.22	-0.153
(in %)	1	51	1,430.91	72.14	

Panel C: Small Firms – Industry Cluster 30					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	84	3.2142	2.2076	-0.215
	1	52	3.4186	2.2504	
ROE	0	84	-0.27	-0.07	-0.233
	1	52	-0.47	-0.08	
ROA	0	84	-0.21	-0.08	-0.09
	1	52	-0.18	-0.08	
Sales/employee	0	84	0.1118	0.0861	-0.175
(in m€)	1	52	0.1410	0.0891	
Sales growth	0	84	134.57	74.58	-0.295
(in %)	1	52	1,404.8	72.35	

Significance levels are denoted by * for 10%, ** for 5% and *** for 1%

Appendix 6: Descriptive statistics for small firms (sales < median) and conurbation clusters

Panel A: Small Firms – Conurbation Cluster 10					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	80	2.8466	2.1056	-1.574
	1	56	3.9292	2.3187	
ROE	0	80	-0.26	-0.08	-0.637
	1	56	-0.48	-0.08	
ROA	0	80	-0.21	-0.09	-0.805
	1	56	-0.18	-0.07	
Sales/employee	0	80	0.1226	0.0895	-0.601
(in m€)	1	56	0.1234	0.0879	
Sales growth	0	80	125.71	69.69	-1.393
(in %)	1	56	1,321.98	77.76	

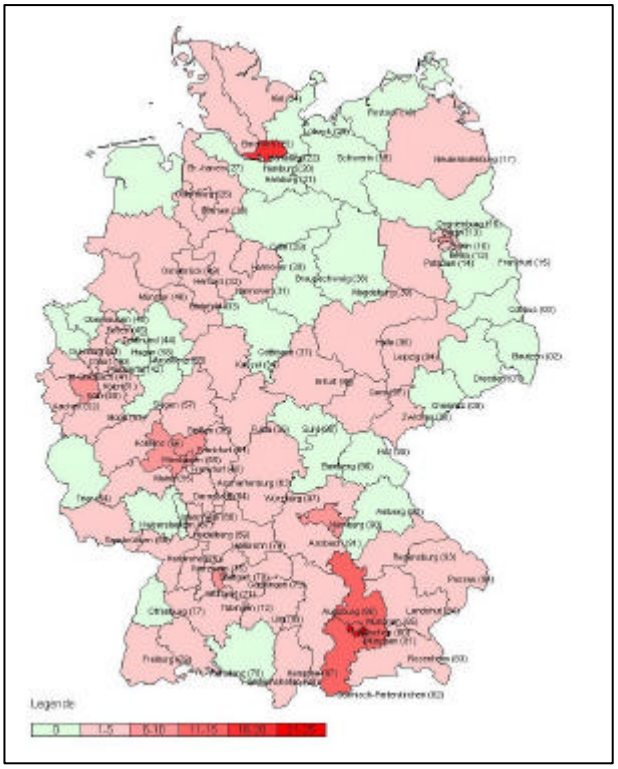
Panel B: Small Firms – Conurbation Cluster 20					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	66	2.8722	2.1927	-1.045
	1	70	3.6885	2.244	
ROE	0	66	-0.22	-0.08	-0.27
	1	70	-0.47	-0.08	
ROA	0	66	-0.21	-0.09	-0.575
	1	70	-0.18	-0.07	
Sales/employee	0	66	0.1164	0.0861	-0.427
(in m€)	1	70	0.1291	0.0891	
Sales growth	0	64	142.29	81.2	-0.014
(in %)	1	67	1,056.17	71.32	

Panel C: Small Firms - Conurbation Cluster 30					
	Cluster	N	Mean	Median	Wilcoxon tests Z-statistics
Tobin's *q*	0	62	2.9375	2.1927	-0.738
	1	74	3.5897	2.237	
ROE	0	62	-0.19	-0.09	-0.118
	1	74	-0.48	-0.07	
ROA	0	62	-0.21	-0.09	-0.472
	1	74	-0.19	-0.07	
Sales/employee	0	62	0.1143	0.0861	-0.157
(in m€)	1	74	0.1302	0.0891	
Sales growth	0	60	145.26	81.2	-0.051
(in %)	1	71	1,002.18	71.32	

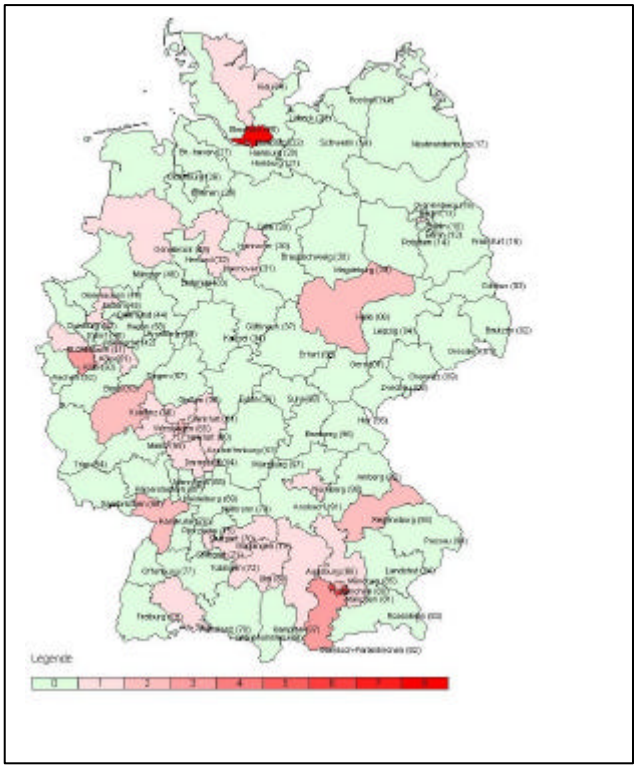
Significance levels are denoted by * for 10%, ** for 5% and *** for 1%

Appendix 7: Spatial Distribution of Selected Companies

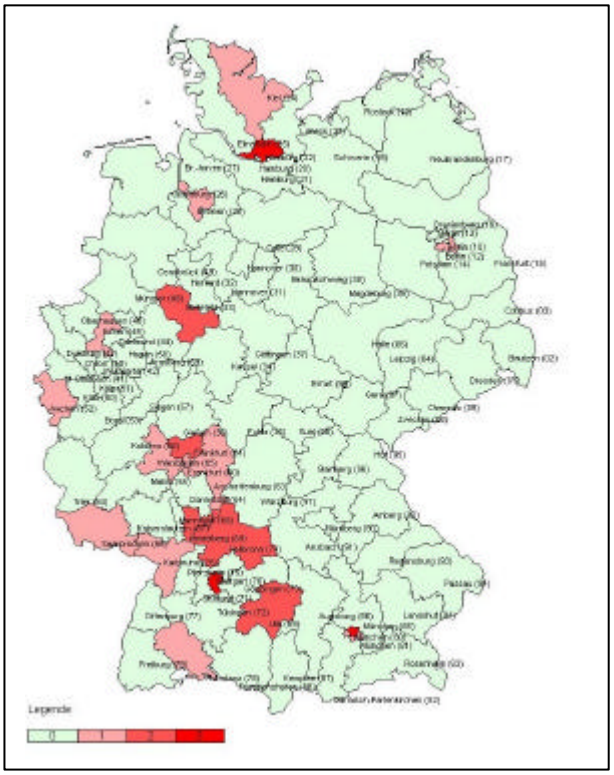
Neuer Markt: Complete



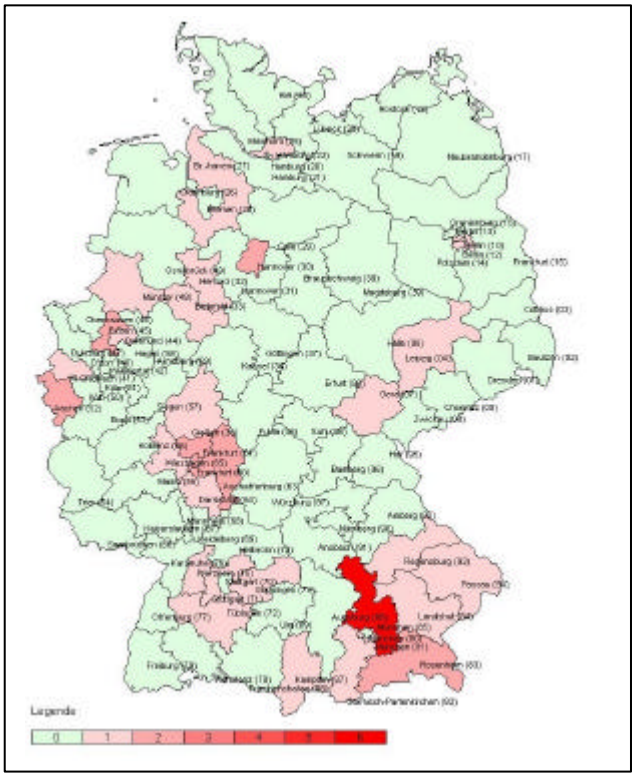
Internet



IT Services



Technology



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