

Bordering the Area of Spatial Relevance for Schools

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*Eingrenzung von Räumen schulischen Marktgeschehens: Stochastische
Netzwerkmodellierung anhand des Beispiels Hamburg*

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Bordering the area of spatial relevance for schools: a stochastic network approach using the example of Hamburg, Germany

Eingrenzung von Räumen schulischen Marktgeschehens: Stochastische Netzwerkmodellierung anhand des Beispiels Hamburg

Sebastian Leist and Marcus Pietsch

Introduction

- 1 In Germany, the assignment of students to schools was for a long period of time determined by rigid governmental specifications and the clash of interests between parents and schools (Weiß and Steinert, 1996). In those days a more or less strong assertiveness of the protagonists was necessary (Gomolla and Radtke, 2002). Since the turn of the millennium, a sequential movement from input-steering to output-steering was established. This is considered to involve the establishment of quasi-markets. On these quasi-markets, the schools have to perform under the conditions of competition while funding, control and supervision are assigned to the public authority (Bellmann, 2007; Weiß, 2001).
- 2 Quasi-markets in education are, according to Weiß (2001) characterised by free choice of school, funding in relation to performance, autonomy of the schools and internal possibilities for further development of the human resources and organisational structures. Thereby, the economic regulation system needs mechanisms which increase transparency on the market by providing information which enables the participants of the market to compare the institutions, e.g. results of evaluations or systems of quality management. Recent reforms in education aim both at more efficiency and an as

transparent as possible use of the resources. Meanwhile, student achievement is aimed to increase.

- 3 Two premises indicate a perfect schooling-market: competition between the suppliers and freedom of choice of the consumers. Gewirtz, Ball and Bowe (1995, p. 2) focus in this context the following:

“The education market (like all other markets) is intended to be driven by self-interest: first, the self-interest of parents, as consumers, choosing schools that will provide the maximum advantage to their children; second, the self-interest of schools or their senior managers, as producers, in making policy decisions that are based upon ensuring that their institutions thrive, or at least will survive, in the marketplace. The demand for school places is inelastic; that is the number of potential students is fixed. Where there surplus places, the result is meant to be competition, emulation and rivalry: survival can only be assured by attracting consumers away from other schools.”
- 4 The idea of competition between schools based on market structures is comparatively simple: If students and their families can choose from a range of schools, then schools can't take their clientele as granted and must ensure to improve output and achievement to meet the preferences of students and their parents and to persist on the market. Enhanced choice options for students and parents thus still contain the promise of a quality improvement in education by assuming a positive causal relationship of choice options, competition and quality in education: choice options for students and their families generate competition between schools and competition between schools generates quality in education.
- 5 Nonetheless, Altrichter and Rürup (2010, p. 143) notice in their summary of the discourse on school autonomy an increasing awareness about potentially undesired side-effects of the realised configurations of school autonomy. It seems as if occurs, besides the desired differentiation and pluralism in education, the introduction of a hierarchy with the formation of residue classes and schools. Accordingly, they postulate to investigate the criticism that autonomy promotes the disintegration of an educational system more consequent than before (Altrichter and Rürup, 2010, p. 143).
- 6 The following part concludes the current state of research about social segregation on educational markets and turns afterwards towards the difficulty of an adequate bordering of educational markets.

Traditional bordering of schooling-markets

- 7 The present literature about the quantification of effects of competition on public-sector markets mainly deals with two approaches: Either the competitiveness of a market is defined by an index of market concentration or, based on theories about spatial competition, defined by the number of suppliers which are accessible within a given travel time, distance or within given travel costs (Hotelling, 1929). The method used in this article refers to the first approach. Thus, the situation of rivalry within a market is going to be captured by the Herfindahl-Index, which quantifies the supplier concentration on a specific market (Belfield and Levin, 2002). To avoid arbitrary results, it is very important to tackle the difficulty of market definition, i.e. to properly border the area of a market. Mostly, the spatial extent of a market is ambiguous. The scientific literature therefore uses auxiliary approaches which means that market borders are

assumed to be along areas of responsibility of municipal authorities (Bradley and Crouchley; Millington and Taylor, 2000) or even take whole agglomerations as a base (Hoxby, 2000). The validity of analysis based on these approaches anyhow is in dispute; critics mention that at least the consideration of spatial barriers, e.g. rivers, motorways or railways, to classify markets is a reasonable strategy (Rothstein, 2007; Hoxby, 2007). Nevertheless markets bordered via spatial barriers may remain with a too big extension, i.e. that a low market concentration in these cases may not be equal to more choice and competition. The reason is that not all suppliers (= schools) are equally accessible for all customers (= students), because the accessibility of schools, for example by public transport, is likely to vary.

- 8 The disadvantages of these auxiliary approaches may be resolved if an endogenous criterion, which is part of the available data to localise the markets, would be taken into consideration, replacing above mentioned exogenous criteria (area of responsibility etc.). Accessibility of the suppliers is assured and the danger of arbitrary values of indicators is avoided.

Data

- 9 The performed analysis to border the schooling markets is based upon data of transitions between primary and secondary schools after year 4. Primary school in Hamburg finishes after year 4, so every student who completes year 4 leaves towards a secondary school. In considering all transitions made by students as paths (or as lines on a map, to have a visual approach) between primary and secondary schools, a network might be spanned that covers Hamburg. The utilized dataset is generated from the Individual Student Database of the Educational Department of the Federal State of Hamburg which contains all students that attend a school within the jurisdiction, no matter which school type, school maintaining body, year level or place of residence (Freie und Hansestadt Hamburg, 2012a). It contains students who were in year 5 during school year 2011/12 and were the year before in grade 4 and who swapped schools within the federal state of Hamburg. The dataset represents 400 schools and 14,032 students who made transitions between primary and secondary schools on 2,446 different paths (or lines on a map, to stay with the notion as introduced above), often by more than one student. A transition is defined either as a switchover to a different school, or the continuance in a school if year 5 is attended, which is possible in a small number of the comprehensive schools.
- 10 The described data is regarded as “relational” in the sense that schools are interconnected via the transitions of students (paths, resp. lines on a map) and is transformed to a social network by the use of various techniques (Butts, 2008). In technical terms: The social network is directed, because students are only permitted to swap from primary school to secondary school and not the opposite direction, and the network contains loops which means that a student may remain on the same school if she/he stays and attends year 5.

Stochastic modelling of schooling markets

- 11 In opposition to the traditional approaches to border schooling markets, the relational data at hand enables access to an endogenous criterion to define the extension of a

market. Structures of close connection and agile exchange become recognised as cluster (= market) and generate the chance to quantify spatial-temporal phenomena like competition or social segregation. The algorithm projects all schools in a so-called latent social space. Hence, Primary schools are located close together, if they “serve” similar Secondary Schools, and the Primary schools are located close to the Secondary Schools they serve. Considering the perspective of Secondary schools in turn, they are placed in close neighbourhood in the latent social space, if they receive their students in Year 5 from similar Primary Schools. Again, the algorithm assigns coordinates to these Secondary schools which locate them close to these Primary Schools. This is how the assignment to positions in the latent social space takes place for all schools. The cluster procedure subsequently assigns the schools to clusters in considering gaps in the distribution in the latent social space.

- 12 The stochastic modelling of school networks (= educational markets) was carried out by the package “latentnet” for the open-source software “R” (Krivitsky and Handcock, 2008; Krivitsky and Handcock, 2014). Latentnet evaluates “latent position and cluster models for statistical networks” according to Hoff, Raftery and Handcock (2002) and Handcock, Raftery and Tantrum (2007). These are extensions of Generalized Bilinear Mixed-Effects Models (GBME) by a Finite Mixture Model to reveal group structures. Finite Mixture Models are stochastic models which specify the likelihood of observed data as a function of multiple groups (Templin, 2008, p. 325). The probability of a dyad is expressed via a function of distances between two vertices in a latent space as well as with functions of observed dyadic covariates. The probability of a network g for a set of nodes is a product of dyad probabilities. Each is a Generalized Linear Model with following linear component:

$$\eta_{i,j} = \sum_{k=1}^p \beta_k X_{i,j,k} + d(Z_i, Z_j) + \delta_i + \gamma_j$$

$X_{i,j,k}$ is an Array of dyadic covariates, β_k is a vector of coefficients of the covariates. Z_i and Z_j are the positions of the vertices i and j in the latent space. d is a function of 2 positions; either negative Euclidian ($-\|Z_i - Z_j\|$) or bilinear ($Z_i * Z_j$). δ_i and γ_j are vectors of sender- and receiver-effects (Krivitsky; Handcock, 2014).

- 13 The stochastic modelling was conducted in two steps. At first, latent clusters were modelled for the entire network. Therefore, all transitions had to be integrated unweighted into the model, i.e. the number of students actually executing each of the transitions between all Primary and Secondary Schools had to remain unconsidered and only the presence or absence of a connection (= path or line on a map) was considered. The reason for this proceeding is the weak density of the entire network¹. The magnitude of a connection was integrated into the model in the subsequent step. It comprises the subdivision of the regional clusters, identified in the first step of the analysis, into local Subcluster. The density of the regional networks is sufficient enough to model the local networks considered as weighted.
- 14 The proceeding for the calculations for both spatial levels was to set up an increasing number of groups, starting with one group. The procedure is similar to latent class analysis (Lazarsfeld and Henry, 1968). The number of two latent dimensions to model latent cluster is adequate for descriptive purposes according to Hoff (2005). The Markov Chain Monte Carlo runs contained a burnin of 10,000 iterations which were discarded and 40,000 iterations of which one in ten was used for the modelling (Raftery and Lewis, 1995). The Bayes Information Criterion was considered for model selection whose lowest value

indicates which model fits best to the data and therefore should be chosen (Schwarz, 1976).

Results

- 15 The elucidated procedure unveiled regional and, in a subsequent step, local structures of the schooling landscape in the federal state of Hamburg.

Regional schooling markets

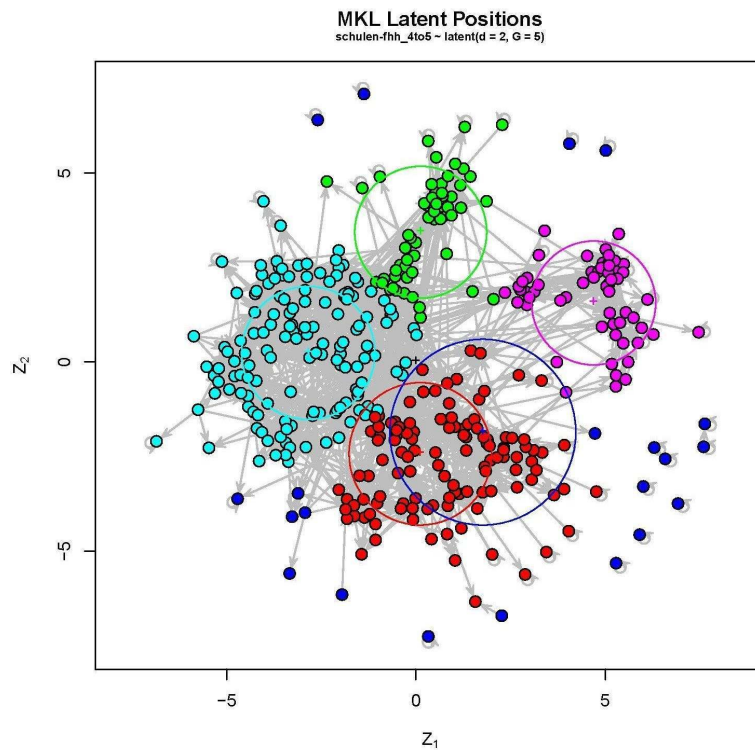
- 16 The stochastic modelling of the entire and, due to the fact of low density, unweighted network resulted in multiple cluster solutions of which the one with the lowest BIC-value was selected.

Table 1. Model selection according to BIC-value for the regional schooling markets.

Cluster-solution	Overall BIC
1	25861,45
2	25869,74
3	26271,3
4	26280,89
5	25771,32
6	25842,18
7	25900,31

- 17 Table 1 suggests that the solution which fits best to the data reveals five regional schooling markets in Hamburg. These markets are subdivided into local markets in the following subsequent step. The distribution of the schools in the latent space is visualized in figure 1.

Figure 1. Distribution of schools in the latent space and assignment to regional schooling markets.



- 18 Both axes represent the latent dimensions. Each circle represents a school. An arrow between two schools indicates a transition of one or more students. An arrow which ends at the same school indicates that one or more students continue attending the same school (in technical terms: loop). Schools which share the same color belong to the same group. Within these groups centroids are placed, which are surrounded by circles in the same color. Their size represents the magnitude of the distribution of each group in latent space. Next to central and close to each other placed schools there are clear gaps between school groups. Furthermore, in the periphery, schools are placed which lack connection to the network. All these schools are united in one outlier-group.

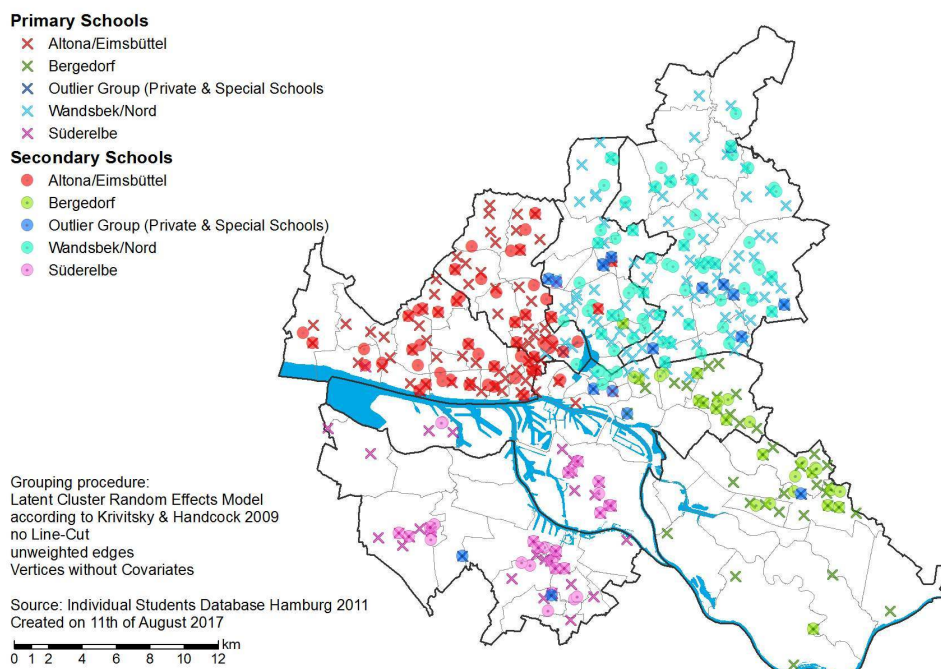
Table 2. Composition of the regional schooling markets.

	primary schools	comprehensive schools	grammar schools	special schools	sum
Facilities in					
Cluster 1 "Altona/Eimsbüttel"	67	20	22	10	119
therefrom public	61	14	19	8	102
Cluster 2 "Bergedorf"	33	12	8	7	60
therefrom public	31	9	7	7	54

Cluster 3 "Outlier-Group"	3	4	2	12	21
<i>therefrom public</i>	0	0	0	10	10
Cluster 4 "Wandsbek/Nord"	82	26	30	5	143
<i>therefrom public</i>	74	21	26	5	126
Cluster 5 "Süderelbe"	29	12	8	8	57
<i>therefrom public</i>	27	9	7	7	50

- 19 This group (cluster 3) consists basically of small private schools and special schools as table 2 shows. The column which contains the sums shows that the group sizes vary. The largest group consists of 143 schools and all groups contain public schools as well as private schools.

Figure 2. Localization of the regional schooling markets in the administrative area of Hamburg, grouped by transitions from primary to secondary schools in Summer 2011.



- 20 Figure 2 points out the spatial positions of the five groups in Hamburg. For the bordering of these groups, spatial barriers apparently are most important. The pink group is clearly bordered by the Elbe River and the harbor. Most of the border between the bright blue group and the green group is a motorway which is difficult to cross as well. The red group and the bright blue group are partly divided by the airport in the north. The group represented by the dark blue color is the outlier-group, as mentioned above.

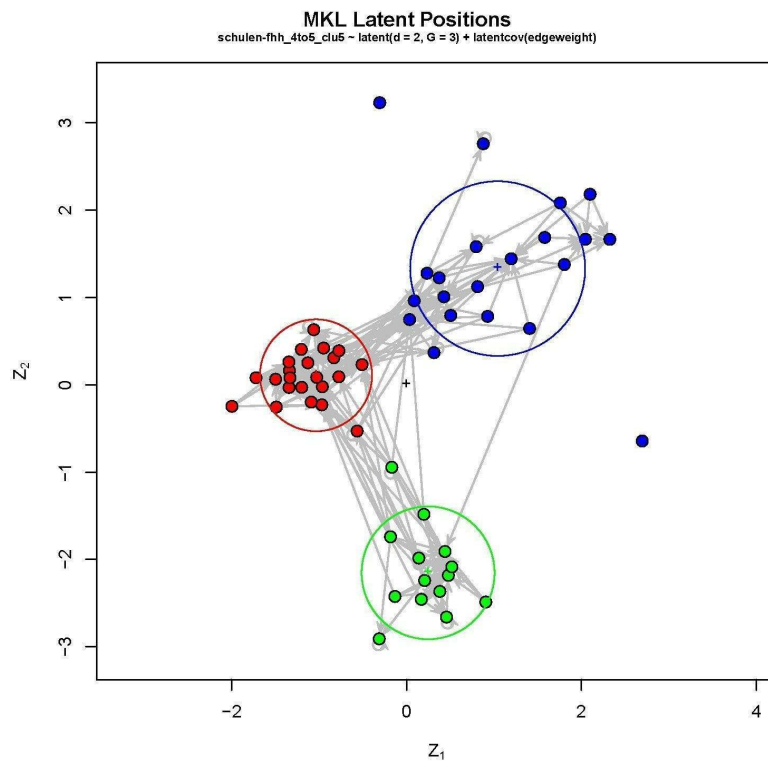
Local schooling markets

- 21 Until now it is not possible to unveil multilevel latent group structures in social networks. This is the reason why the subsequent step is necessary to sub-divide the regional schooling markets. Within the regional schooling markets the connectivity is adequate enough to model the local sub-groups by considering the number of students who swap from primary to secondary school. These function as weights for the transitions, giving transitions of severe students more importance than transitions of only one student. The model is exemplified within one regional cluster which is localized in the south-west of the administrative boundaries of Hamburg and indicated by the pink color (Figure 3). The rationale behind the choice of this particular cluster is firstly, that it appears to be persistent over time due to the clear spatial borders that divide this cluster from the other parts of the city. Borders of clusters within densely populated areas could vary or even disappear due to the transitions made in one particular year, but not taking place the year after. Additionally, the cluster combines sparsely populated, rural parts of Hamburg with densely populated urban parts as well as wealthy neighborhoods whose inhabitants live mostly in single houses with deprived areas characterized by huge multi-storey social housing building clusters. The settlements in this cluster stretch along a railway line that runs south from the city centre and turns westwards after crossing the Elbe river. A highway runs parallel. These are the main transport axes in this part of the city. This cluster seems to be appropriate to show the benefits of the approach at hand.

Table 3. model selection according to BIC-value for the local schooling markets.

Cluster-solution	Overall BIC
1	843,25
2	848,80
3	789,54
4	790,68
5	792,02
6	794,73

Figure 3. Distribution of schools in the latent space and assignment to local schooling markets.



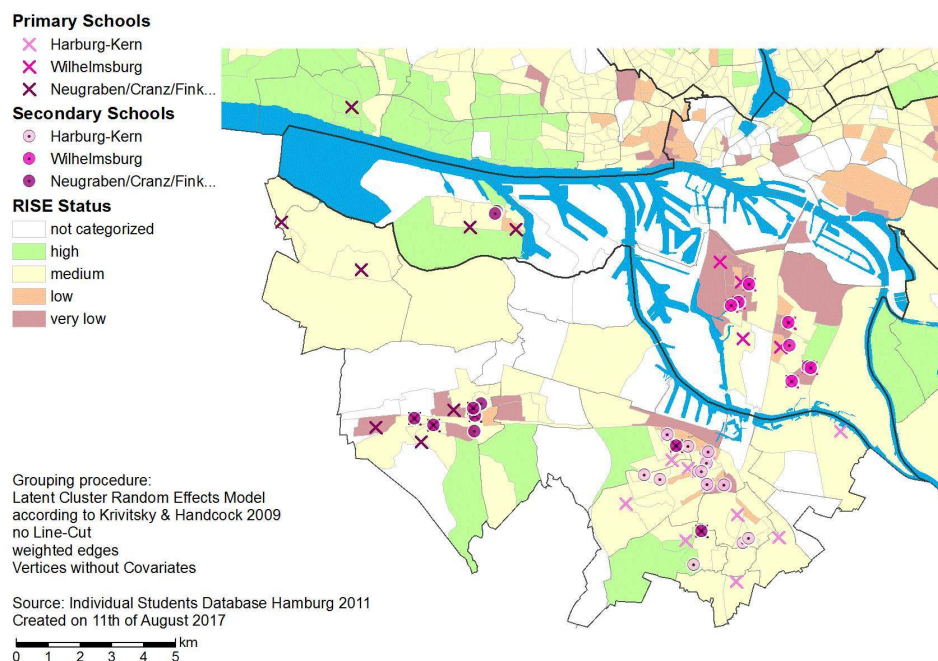
- 22 The distribution of the three sub-groups in the latent space is visualized in Figure 3. The schools are divided in three more-or-less clearly differentiated groups. Additionally, two schools belong to the clusters which don't possess connectivity to the other schools. They are positioned in the periphery². In contrast, the schools in the red cluster are positioned close together, i.e. they seem to have a considerable amount of transitions within the group.

Table 4. Composition of the local schooling markets.

	primary schools	comprehensive schools	grammar schools	special schools	sum
Facilities in					
Sub-cluster "Harburg-Kern"	11	4	5	2	22
therefrom public	11	3	4	2	20
Sub-cluster "Wilhelmsburg"	6	4	1	3	14
therefrom public	6	3	1	3	13
Sub-cluster "Neugraben/Cranz/Finkenwerder"	12	4	2	3	21
therefrom public	10	3	2	2	17

- 23 Table 4 provides a summary of the local sub-clusters which were revealed within the regional schooling market in the south-western part of Hamburg and shows the amount of schools according to school type and school maintaining body. Sub-cluster 1 and 3 contain a similar amount of schools while sub-cluster 2 contains one third less schools. In all sub-clusters approximately half of the schools are primary schools. Comprehensive schools are spread equally throughout the three sub-clusters as well as the special schools. Only grammar schools are bunching in sub-cluster 1 which contains five out of eight grammar schools in the region.

Figure 4. Local schooling markets in the south-western part of Hamburg, grouped by transitions from primary to secondary school in Summer 2011.



- 24 The localization of the schools belonging to the sub-clusters is shown in Figure 4. The primary school in the north, across the Elbe River, is one of the mentioned schools without connectivity. As already pointed out in relation to the formation of the regional clusters, the local clusters are obviously bordered along spatial barriers as well. The islands Veddel and Wilhelmsburg in the Elbe River form one sub-cluster. In the south, the local cluster Harburg-Kern is localized and encompasses the core settlement in this area. To the west there is a spatial gap which marks the border to the sub-cluster Neugraben/Cranz/Finkenwerder, which in turn covers some rural areas. Additionally, the RISE-Index is shown as signature for the areas in which the students live. Brown indicates areas where the risk that a student lives in an environment of multiple discriminatory factors (unemployment, living on welfare, low educational degrees, high rate of migrants, and high rate of single parents) is highest. Orange indicates similar areas where the risk is lower. A significant number of brown and orange areas are on the islands Veddel and Wilhelmsburg and in Neugraben/Cranz/Finkenwerder. Yellow colored areas have medium risk to live in an environment of multiple discriminatory factors. These areas are common and well-spread throughout the considered part of Hamburg. Green colors indicate low risk to live in a deprived environment. The population of these areas is

wealthy by a high chance. Each of the local schooling markets is surrounded by at least one of these areas. It is important here to point out that these areas are sparsely populated because in most cases these areas are covered with single family detached houses and residences, i.e. that not many students live in these areas. By contrast, the brown and orange areas often contain multi-storey buildings in densely populated hotspots with accumulated social disadvantages (Freie und Hansestadt Hamburg, 2011). By far more students live in these areas.

Application of schooling markets on competition: an example

- 25 At first, it will be pointed out, how the exact definition of the schooling markets outperforms a wide-spread traditional, auxiliary approach of market definition. Afterwards, it is shown, how competition may be differentiated depending on the social status of the students.

Herfindahl-index

- 26 The turn towards more autonomy for schools fostered processes of profiling of schools which result in increasing competition between schools (Altrichter and Rürup, 2010). A commonly used measure for competition is the Herfindahl-Index which is applied to the competition of schools for students:

$$HI = \sum_{i=1}^N s_i^2$$

The Herfindahl-Index quantifies competition based on supplier-concentration (Belfield; Levin, 2002). s_i corresponds to the market share of supplier i on the market and N represents the total number of suppliers. The index may have values between $1/N$ and 1 and is interpreted in accordance with the following guidelines:

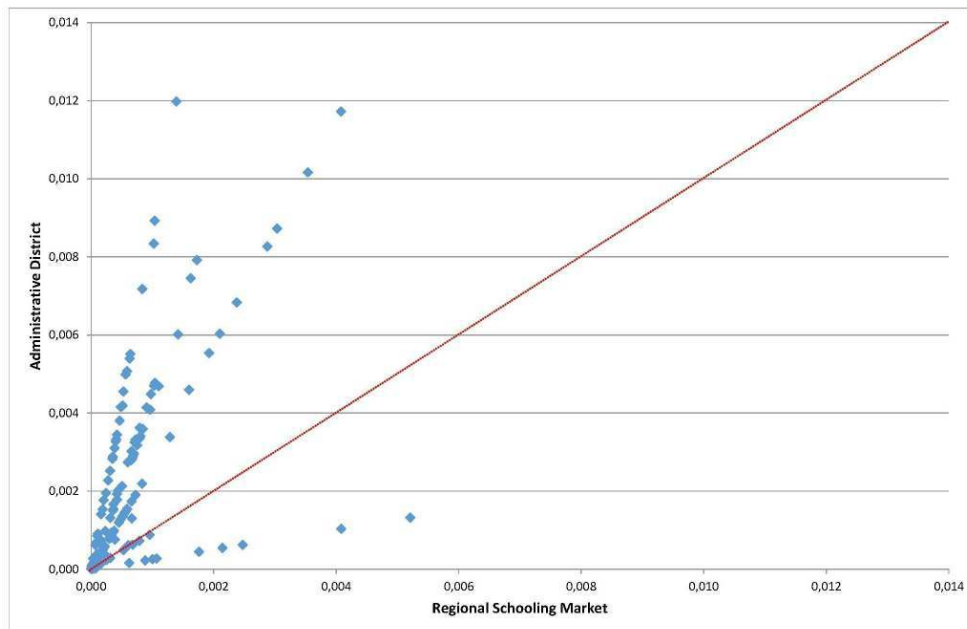
- Values below 0.15 indicate a low market concentration, i.e. a perfect market,
- Values between 0.15 and 0.25 indicate a moderate concentration and indicate an oligopoly,
- Values above 0.25 indicate a strong market concentration, i.e. a monopoly (U.S. Department of Justice and the Federal Trade Commission, 2010).

Regional schooling markets vs. administrative districts

- 27 As mentioned above, traditional approaches are usually used to define the extensions of a market. This might be done via a given travel time, distance or by given travel costs (Hotelling, 1929) and leads to individual markets for each particular school. Another often applied approach is to border markets along areas of responsibility of municipal authorities (Bradley; Crouchley; Millington; Taylor, 2000) or even take whole agglomerations as a basis (Hoxby, 2000). The Federal State of Hamburg consists of seven jurisdictions ("Bezirk") which represent the communal, i.e. local level within the federal hierarchy in Germany. The responsibilities within the School Supervisory Board of Hamburg are spatially shaped along the borders of these jurisdictions. Therefore, competition between individual schools is compared by looking at the values on the market in the sense of an administrative district and by looking at the values for

competition on the Regional Schooling markets (except the outlier-group). Figure 5 shows, how competition between schools is different, depending on the approach to border the market.

Figure 5. Comparison of market shares of schools between administrative districts and regional schooling markets.



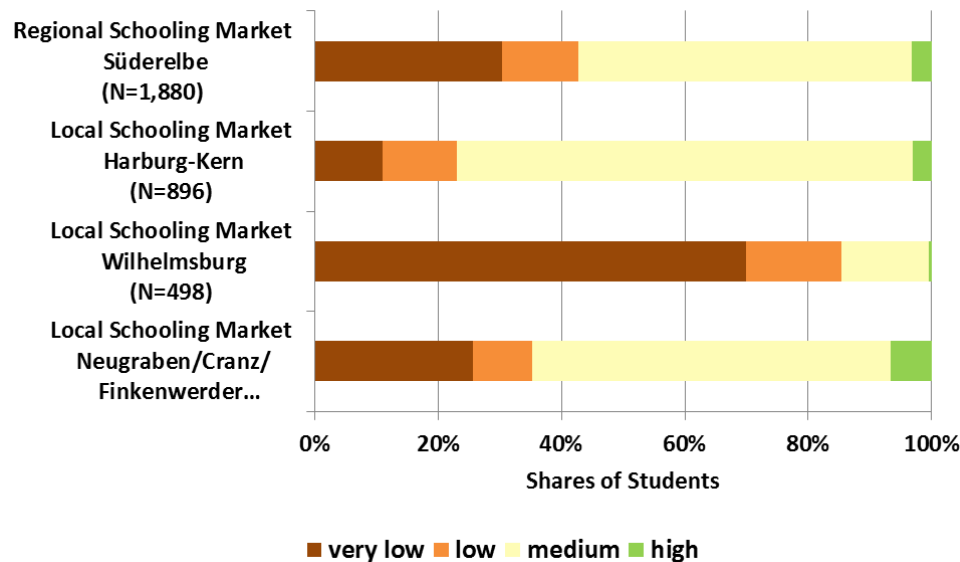
- 28 The red diagonal line indicates perfect correlation of the values for the Administrative districts and the Regional Schooling Markets. Only a handful of schools is located on this line. All the other rhombi indicate that the use of the Administrative boundaries induces incorrect values for competition which are mostly overestimated. The correlation (Pearson's r) between the values is 0.732. Summarized, only the use of as accurate as possible market borders guarantees valid results, otherwise the values depend highly on the fit between administrative boundaries and the unknown market boundaries in real. The risk of arbitrary results then is immense.

Differentiated competition on local schooling markets

- 29 For the reason of quantifying competition, the categorisation of students according to the RISE-Status of the place of residence is made. The categories of the RISE-Status are "very low", "low", "medium" and "high".³ The presumption is, that students who reside in wealthy areas are more likely to have parents with high educational attainment and may be regarded as probably high-performing whereas students out of areas characterised by multiple discriminatory factors are considered to be probably low-performing (Kuhl, Siegle and Lenski, 2013, p. 275ff). A high share of high-performing students is regarded to be an advantage in competition between schools, because this might be seen by the parents, amongst others, as an obvious and easy-to-understand indicator for school quality compared to more abstract indicators like "system-performance" or "gains in student achievement" (Altrichter and Rürup, 2010, p. 140). This suggests that schools strive especially to students from high status residential areas and hence competition takes place preferentially to these students. Figure 6 shows the composition of the

students within the south-west region of Hamburg and its local schooling markets according to the RISE-Index of the students of grade 5 at their place of residence.

Figure 6. Student composition on the regional schooling market Süderelbe and its local schooling markets according to RISE-status (year 5).



- 30 Figure 6 shows discrepancies within the region. Whereas the composition of the local schooling market “Neugraben/Cranz/Finkenwerder” is more or less similar to the one of the whole region, the two remaining markets differ from that. The local schooling market “Harburg-Kern” has a heterogeneous composition and a broad share of medium classified residential areas which indicates a less problematic situation. The situation on the schooling market “Wilhelmsburg” then again is totally different. The students are comparatively homogeneous and 70 per cent reside in areas which are characterised by a high risk of discriminative factors. An additional 15 per cent lives in areas of a bit fewer risks of discriminative factors. In other words, 17 out of 20 students live in deprived circumstances by a high chance. Only two out of all students in year 5 reside in a wealthy area. In relation to the evidence of a high correlation between student achievement and social origin, it can be stated that this local schooling market is cut off from high achieving students in Hamburg.

Table 5. Competition on the regional schooling market and its local schooling markets.

	<i>N</i> (No. of secondary schools)	$H_{i_{min}} (1/n)$	all students	Herfindahl-Index			
				only RISE-Index "very low"	only RISE-Index "low"	only RISE-Index "medium"	only RISE-Index "high"
<u>Regional Schooling Market</u>							

Süderelbe	30	0,03	0,05	0,08	0,07	0,06	0,12
<u>Local Schooling Markets</u>							
Harburg-Kern	13	0,08	0,10	0,12	0,11	0,11	0,28
Wilhelmsburg	8	0,13	0,17	0,17	0,31	0,21	0,50
Neugraben/ Cranz/ Finkenwerder	9	0,11	0,17	0,25	0,20	0,17	0,24

- 31 Table 5 points out the competition both globally for the whole south-west region of Hamburg and the three local markets. The whole region suggests to be a perfect market ($HI < 0.15$). A closer look at the local schooling markets shows the situation more differentiated. The schooling market “Harburg-Kern” may be regarded as a market with low concentration of suppliers, but looking at the student groups according to RISE-Index, there is a remarkable high concentration of students in some schools who live in wealthy areas ($HI = 0.28$). The local schooling market “Wilhelmsburg”, where probably the highest achieving students are absent, has a high concentration of suppliers, especially by considering the social composition of the students. The Herfindahl-Index has values above 0.15, i.e. a moderate or even high social concentration of the students is a characteristic of this market. The HI of 0.5 for the students residing in the wealthy areas has to be interpreted with care due to the fact that only two students in year 5 live in these areas. The local schooling market “Neugraben/Fischbek/Finkenwerder” is again a remarkably concentrated market ($HI = 0.17$). The social differentiation shows tendencies of concentration, especially for the students living in wealthy areas as well as in areas of high risk of cumulative factors of deprivation.

Conclusion, prospects and discussion

- 32 It is possible to tackle the difficulties of bordering regional and local structures. In case of stochastic network approaches, it is a requirement to possess relational data. Then social network analysis tools are able to unveil latent structures and clusters of strong relationships between the actors. In this example, the schooling landscape of Hamburg can be divided into regional and local schooling markets. Mostly, the borders are along spatial gaps in settlement structures, linear barriers (rivers, motorways, railways) or point-shaped barriers (lakes, airport). Hence, if no relative data is available, the use of spatial barriers is a reasonable approach to border markets. Nonetheless, difficulties in bordering persist in areas without spatial barriers. The presented stochastic network approach then shows one of its strengths and still assigns the schools to clusters. The comparison of a traditional approach and the presented approach shows the evidence that the calculated values for socio-spatial phenomena like competition vary between both approaches and shows the risk of arbitrary results. On a small spatial scale, the subdivision of the Regional Schooling Markets into Local Schooling Markets creates options to understand small-scale processes of competition and social segregation. Therefore, the

further analysis of qualitative and quantitative data content is a way to understand the processes which explain the reasons for the attractiveness of a certain school for certain social groups. Further research should also take the questions of persistence of the Regional and Local Markets over time into consideration. Markets may collapse or show continuity over time.

BIBLIOGRAPHY

- ALLEN R., VIGNOLES A. (2007), "What Should an Index of School Segregation Measure?", *Oxford Review of Education*, 33, 5, Oxford, Taylor & Francis, pp. 643-668.
- ALTRICHTER H., RÜRUP M. (2010), "Schulautonomie und die Folgen" ["School autonomy and its consequences"], in ALTRICHTER H., MAAG MERKI K. (eds.), *Handbuch Neue Steuerung im Schulsystem*, Wiesbaden, VS Verlag für Sozialwissenschaften, pp. 111-142.
- BELFIELD C., LEVIN H. (2002), "The Effects of Competition between Schools on Educational Outcomes: A Review for the United States", *Review of Educational Research*, 72, Thousand Oaks, SAGE Publications, pp. 279-341.
- BELLMANN J. (2007), "Das Monopol des Marktes. Wettbewerbssteuerung im Schulsystem" [The monopoly of the market. Competition control in the school system], *Berliner Debatte Initial*, 18, Berlin, WeltTrends, pp. 58-71.
- BELLMANN J., WEIß M. (2009), "Risiken und Nebenwirkungen Neuer Steuerung im Schulsystem. Theoretische Konzeptualisierung und Erklärungsmodelle" [Risks and side effects of the New control in the school system. Theoretical conceptualization and explanatory models], *Zeitschrift für Pädagogik*, 55, 2, Weinheim, Beltz, pp. 286-308.
- BRADLEY S., TAYLOR J. (2002), "The Effect of the Quasi-Market on the Efficiency- Equity Trade-Off in the Secondary School Sector", *Bulletin of Economic Research*, 54, 3, Chichester, Wiley-Blackwell, pp. 295-314.
- BRADLEY S., CROUCHLEY R., MILLINGTON J. & TAYLOR J. (2000), "Testing for Quasi-Market Forces in Secondary Education", *Oxford Bulletin of Economics and Statistics* 62, Oxford, Wiley-Blackwell, pp. 357-390.
- BUCKLEY J., SCHNEIDER M. (2003), "Shopping for Schools: How do Marginal Consumers gather Information about Schools?", *The Policy Studies Journal*, 31, 2, Chichester, Wiley-Blackwell, pp. 121-145.
- BUNDESMINISTERIUM FÜR BILDUNG UND FORSCHUNG (2010), *Der Übergang von der Grundschule in die weiterführende Schule. Leistungsgerechtigkeit und regionale, soziale und ethnisch-kulturelle Disparitäten* [The transition from primary to secondary school. Power justice and regional, social and ethnic-cultural disparities], Bildungsforschung Band 34, Berlin.
- BUTLER T., HAMNETT C. (2007), "The Geography of Education: Introduction", *Urban Studies* 44, 7, Thousand Oaks, SAGE Publications, pp. 1161-1174.
- BUTTS C. (2008), "Social Network Analysis with sna", *Journal of Statistical Software*, 24, 6, Foundation for Open Access Statistics, pp. 1-51.

- DUNCAN O., DUNCAN B. (1955), "A methodical analysis of segregation indexes", *American Sociological Review*, 20, Thousand Oaks, SAGE Publications, pp. 210-217.
- FREIE UND HANSESTADT HAMBURG (2010), *Pilotbericht "Sozialmonitoring im Rahmenprogramm Integrierte Stadtteilentwicklung" (RISE) [Pilot report "Social Monitoring Programme in the Framework of Integrated Urban District Development" (RISE)]*, Hamburg. <http://www.hamburg.de/contentblob/2673088/data/pilotbericht-rise.pdf>, accessed 22. Sep. 2015)
- FREIE UND HANSESTADT HAMBURG (2012a), *Schulstatistiken der Freien und Hansestadt Hamburg [School statistics of the Free and Hanseatic City of Hamburg]*, Hamburg. <http://www.hamburg.de/schulstatistiken>, accessed 18 September 2015.
- FREIE UND HANSESTADT HAMBURG (2012b), *Sozialmonitoring Integrierte Stadtteilentwicklung. Bericht 2011 [Social Monitoring Programme in the Framework of Integrated Urban District Development. Annual Report 2011]*, Hamburg. <http://www.hamburg.de/contentblob/3335496/data/d-sozialmonitoring-bericht-2011.pdf>, accessed 22 September 2015.
- FRIEDMAN M. (1955), "The Role of Government in Education", in SOLO R.A., (eds.), *Economics and the Public Interest*, New Brunswick, Rutgers University Press, pp. 123-144.
- GEWIRTZ S., BALL S. & BOWE R. (1995), *Markets, Choice and Equity in Education*, Buckingham, Open University Press.
- GIBBONS S., SILVA O. (2006), "Competition and accessibility in school markets: empirical analysis using boundary discontinuities", in GRONBERG T., JANSEN D. (eds.), *Improving school accountability: check-ups or choice*, Emerald Group Publishing Limited, pp. 157-187.
- GOMOLLA M., RADTKE F. (2002), *Institutionelle Diskriminierung: Die Herstellung ethnischer Differenz in der Schule [Institutional discrimination: The preparation of ethnic difference in school]*, Wiesbaden, Leske + Budrich.
- GORARD S., TAYLOR C. (2002), "What is segregation? A comparison of measures in terms of 'strong' and 'weak' compositional invariance", *Sociology*, 36, 4, Thousand Oaks, SAGE publications, pp. 875-895.
- GORARD S., TAYLOR C. & FITZ J. (2003), *Schools, Markets and Choice Policies*, London, Routledge Falmer.
- HANDCOCK M., RAFTERY A. & TANTRUM J. (2007), "Model-based clustering for social networks", *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 170, 2, London, Wiley-Blackwell, pp. 301-354.
- HANNEMAN R., RIDDLE M. (2005), *Introduction to social network methods*, Riverside, on-line textbook of the Department of sociology at the University of California. http://faculty.ucr.edu/~hanneman/nettext/Introduction_to_Social_Network_Methods.pdf, accessed 18 September 2015.
- HERBERT D. (2000), "School Choice in the Local Environment: headteachers as gatekeepers in an uneven playing field", *School Leadership & Management*, 20, 1, Oxford, Taylor & Francis, pp. 29-97.
- HOFF P., RAFTERY, A. & HANDCOCK M. (2002), "Latent Space Approaches to Social Network Analysis", *Journal of the American Statistical Association*, 97, Taylor & Francis, pp. 1090-1098.
- HOFF P. (2005), "Bilinear mixed-effects models for dyadic data", *Journal of the American Statistical Association*, 100, Taylor & Francis, pp. 286-295.
- HOTELLING H. (1929), "Stability in Competition", *Economic Journal*, 39, London, Wiley-Blackwell, pp. 41-57.

- HOXBY C. (2000), "Does Competition Among Public Schools Benefit Students and Taxpayers?", *American Economic Review*, 90, Nashville, American Economic Association, pp. 1209-1238.
- HOXBY C. (2007), "Competition Among Public Schools: A reply to Rothstein (2004)", *American Economic Review*, 97, 5, Nashville, American Economic Association, pp. 2038-2055.
- KRIVITSKY P., HANDCOCK M. (2008), "Fitting position latent cluster models for social networks with latentnet", *Journal of Statistical Software*, 24, 5, Foundation for Open Access Statistics, pp. 1-23.
- KRIVITSKY P., HANDCOCK M. (2014), "Latentnet: Latent Position and Cluster Models for Statistical Networks. The Statnet Project", <http://www.statnet.org>, R package version 2.4.2, <https://CRAN.R-project.org/package=latentnet>, accessed 18 September 2015.
- KUHL P., SIEGLE T. & LENSKI A. (2013), "Soziale Disparitäten" [Social disparities], in PANT H.A., STANAT P., SCHROEDERS U., ROPPELT A., SIEGLE T. & PÖHLMANN C. (eds.), *IQB-Ländervergleich 2012: Mathematische und naturwissenschaftliche Kompetenzen am Ende der Sekundarstufe I*, Münster, Waxmann, pp. 275-296.
- LAZARSFELD P., HENRY N. (1968), *Latent Structure Analysis*, Boston, Houghton Mifflin.
- LEIST S., PIETSCH M. (2013), *Modellierung latent-regionaler Schulmärkte [Modelling latent regional education markets]*, Presentation on 1st GEBF in Kiel, 11th to 13th march 2013.
- RAFTERY A., LEWIS S. (1995), "The number of iterations, convergence diagnostics and generic metropolis algorithms", in GILKS W., SPIEGELHALTER D. & RICHARDSON S. (eds.), *Markov chain Monte Carlo in Practice*, London, Chapman and Hall, pp. 115-130.
- ROBERTSON D., SYMONS J. (2003), "Self-selection in the state school system", *Education Economics*, 11, 3, pp. 259-272.
- ROTHSTEIN J. (2007), "Does Competition Among Public Schools Benefit Students and Taxpayers? A Comment on Hoxby (2000)", *American Economic Review* 97, 5, pp. 2026-2037.
- SCHWARZ G. (1976), "Estimating the dimension of a model", *Annals of Statistics*, 6, pp. 461-464.
- TAYLOR C. (2001), "Hierarchies and 'local' Markets: the geography of the 'lived' market place in secondary education provision", *Journal of Education Policy*, 16, 3, pp. 197-214.
- TEMPLIN J. (2008), "Methods for Detecting Subgroups in Social Networks", in CARD N.A., SELIG J.P. & LITTLE T.D. (eds.), *Modeling Dyadic and Interdependent Data in the Developmental and Behavioral Sciences*, Routledge, New York, pp. 309-334.
- TESKE P., FITZPATRICK J. & KAPLAN G. (2006), "The Information Gap?", *Review of Policy Research* 23, 5, pp. 969-981.
- U.S. DEPARTMENT OF JUSTICE AND THE FEDERAL TRADE COMMISSION (2010), *Horizontal Merger Guidelines*, <http://www.justice.gov/atr/horizontal-merger-guidelines-08192010#5c>, accessed 21 September 2015.
- WEIß M., STEINERT B. (1996), "Germany: Competitive Inequality in Educational Quasi-markets", in WALFORD G. (ed.), *School Choice and the Quasi-market*, Wallingford, Triangle Books, pp. 77-94.
- WEIß M. (2001), "Quasi-Märkte im Schulbereich. Eine ökonomische Analyse" [Quasi-markets in education. An economic analysis], *Zeitschrift für Pädagogik*, 43, pp. 6-85.

NOTES

1. The density of an unweighted network is calculated by the share of realized connections in relation to the sum of all possible connections. For weighted networks, the density is defined as the sum of the magnitude of all realized connections divided by the number of all possible connections (Hanneman, Riddle, 2005). The density of this (weighted) network is 0.088.
 2. The assignment of these two schools is artificial. Both are small private schools whose students made one transition after grade 4. Each transition is fulfilled to the same secondary school which belongs to cluster 1. The structure of the transition of both schools has no similarity in relation to the other schools which “deliver” students to this secondary school. Therefore the assignment wasn’t to cluster 1, but instead to another cluster. For the analysis on local level, both schools are considered, but can’t tamper the results.
 3. The RISE-Status is a social index and calculated on a small spatial scale by the authority responsible for urban development in Hamburg. Used indicators for the index are proportions of: Elderly on Welfare, Children on Welfare, Total Population on Welfare, Unemployed, Single Parents, Students with high Graduation (inverted), Migrants (Freie und Hansestadt Hamburg, 2010).
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ABSTRACTS

Most approaches to spatial definitions of schooling markets are based on assumptions which may cause incorrect estimates. This paper presents stochastic network analysis as an alternative approach. Based upon individual student data of the metropolis Hamburg, the results are compared to those of traditional approaches. First, this article gives a short introduction to the current setting of Germany’s educational system, the national efforts for school improvement and the relevance of an adequate spatial definition of a market in this context. Subsequently, the applied method and the essential data structure are described. Following the identification of local and regional schooling markets in Hamburg by applying stochastic network analysis, the authors quantify meso- and small-scale competition amongst schools involved in the transition of students from primary to secondary schools in context of social composition.

Herkömmliche Ansätze zur räumlichen Definition schulischer Märkte fassen auf Annahmen, die fehlerhafte Einschätzungen räumlicher Phänomene verursachen können. Dieser Beitrag stellt die Stochastische Netzwerkanalyse als Alternative zur Eingrenzung des Marktgeschehens vor. Die identifizierten Räume werden auf Grundlage vollständiger Schülerindividualdaten der Freien und Hansestadt Hamburg mit Raumdefinitionen traditioneller Herangehensweisen verglichen. Einleitend werden knapp Deutschlands Schulsystem und rezente Maßnahmen zur Qualitätssteigerung vorgestellt, um die gestiegene Relevanz adäquater räumlicher Definitionen zu verdeutlichen. Nachfolgend wird auf die vorgestellte Methode und die dafür notwendige Datenstruktur eingegangen. Im Anschluss an die Identifizierung lokaler und regionaler Marktgeschehen quantifizieren die Autoren mesoskalig und kleinskalig Wettbewerb zwischen Schulen beim Übergang von der Grundschule zur weiterführenden Schule vor dem Hintergrund sozialer Schülerzusammensetzungen.

INDEX

Keywords: competition, geography of education, school market, segregation, stochastic network analysis

Schlüsselwörter: Bildungsgeographie, Schulmarkt, Segregation, stochastische Netzwerkanalyse, Wettbewerb

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