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CONCENTRATION, COAGGLOMERATION AND SPILLOVERS: THE GEOGRAPHY OF NEW MARKET FIRMS IN GERMANY

DIRK DOHSE AND SVEN-CHRISTIAN STEUDE

Kiel Institute For World Economics
Düsternbrooker Weg 120
24105 Kiel, Germany
E-Mail: ddohse@ifw.uni-kiel.de , svensteude@web.de

Abstract

The *Neuer Markt*, launched in 1997 by Deutsche Börse, the German stock exchange, is Europe's closest equivalent to the Nasdaq, the US high-tech oriented stock market. Although the New Economy in Germany is not restricted to Neuer Markt firms one may argue that these firms and their employees form the spearhead of Germany's New Economy.
In the current paper we employ the 'dartboard approach' pioneered by Ellison and Glaeser to analyse the spatial concentration of New Economy employment in Germany, the coagglomeration of firms belonging to different sub-sectors of Neuer Markt and the (intraregional) spillovers between different high tech industries.
We refine the analysis by differentiating between Neuer Markt firms in general and New Economy firms in a more narrow sense, and we compare their spatial distribution with the structure of the 'traditional economy' as well as with the spatial distribution of other innovative activities such as patent applications or R&D.

Key Words: Geographic concentration, New Economy, Neuer Markt, Dartboard Approach

JEL Classification: G19, O30, O18, R11

I. Introduction

The Neuer Markt, launched in 1997 by Deutsche Börse, the German stock exchange, is Europe's closest equivalent to the Nasdaq, the US high-tech oriented stock market. Its short history may be subdivided into three distinct phases: rapid growth (March 1997 – March 2000), deep crisis (March 2000- fall 2002) and beginning consolidation[1] and restructuring (fall 2002 until today).

In only three years (1997 – 2000), Neuer Markt had grown from one to 337 listings and accounted for 80 per cent of the capitalization of all European growth stock markets combined (FT 2001).[2] At its peak in March 2000 the NEMAX All Share Performance Index reached 8583 points compared to a base level of 1000 points in December 1997. Neuer Markt helped to turn a country of bond investors into shareholders (table 1).

Table 1: Share holders and fonds owners in Germany

		1997	1999	1998	2000	2001	2002*
A	Number of shareholders (in thousands)	3920	5005	4515	6211	5694	4679
B	Number of fonds owners (in thousands)	2308	4744	3185	8365	9766	8903
C	Number of people who hold shares and fonds (in thousands)	627	1518	911	2748	2607	2011
D	Shareholders and fonds owners together (A+B-C)	5601	8231	6789	11828	12853	11571
E	D as percentage of population older than 14 years	8.9 %	12.9 %	10.7 %	18.5 %	20.0 %	17.9 %

*1st 6 months
Source: DAI-Factbook (November 2002)

Neuer Markt worked so well "…because it filled a void between a crowded but cash-starved homegrown technology sector and Europe's largest, wealthiest pool of would-be investors"(FT 2001).

However, the rapid rise was followd by a deep fall: The NEMAX All Share Index fell from nearly 8600 points at its peak to less than 1000 points within one and a half year and is currently[3] below 400 points. Not only was Neuer Markt affected more heavily by the burst of the bubble than other growth segments (like Nasdaq or Nouveau Marché), but it has seen its reputation defaced by adverse publicity ranging from spectacular mismanagement to misleading information and causes of fraud and insider trading.

In fall 2002 Neuer Markt entered the third stage of its history, characterized by the endeavor of Deutsche Börse to restore confidence by tighter regulation and listing requirements and the de-listing of penny stocks and insolvent companies. In late 2002 Deutsche Börse announced a new segmentation of the German equity market that will lead to a fundamental restructuring of the whole Frankfurt stock Exchange (FTSE) and particularly of its growth segment Neuer Markt. From 2003 on, FTSE will comprise only two admission standards, called "General

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[1] The term "beginning consolidation" denotes the endeavor of Deutsche Börse to restore confidence by tightening the regulatory framework of Neuer Markt. It does not denote that the slump in prices has come to an end.
[2] Even after the crash the Neuer Markt's $48 billion market capitalization dwarfs the $ 11.4 billion of its main continental competitor, Nasdaq Europe (Business Week, July 2001).
[3] March 2003.

Standard" and "Prime Standard". The "General Standard" segment is oriented towards small and medium-sized companies who seek primarily national investors and a cost-effective stock market listing.[4] The "Prime Standard", by contrast, is introduced to meet the needs of companies that seek to attract the attention of international investors.[5]

In conjunction with the restructuring of the cash market Deutsche Börse has developed a new index system. Deutsche Börse's new selection indices are the DAX, MDAX (Mid-cap), SDAX (Small-cap) and TecDAX. Only companies that fulfill the Prime Standard's transparency requirements can be included in the selection indices. The DAX share index provides coverage for the 30 largest German blue-chip stocks. Below the DAX Deutsche Börse distinguishes between classic (MDAX, SDAX) and technology sectors. For technology companies a new TecDAX index is created, covering the 30 largest technology stocks. This TecDAX will replace the NEMAX50 index[6] as blue chip index for technology stocks. The new benchmark indices, the Classic All Share and the Technology All share (as the successor of the NEMAX all share) will cover classic and technology firms below the DAX level (Deutsche Börse 2002: 3).

Although names are changing and comparability is somewhat aggravated as NEMAX 50 and NEMAX All Share are not transferred in a one-to-one fashion into TecDAX and Technology All Share[7] the restructuring has no impact on the tradability of stocks formerly listed in the Neuer Markt (Deutsche Börse 2002: 3). The firms continue to exist and grow and still form the spearhead of the New Economy in Germany although they are no longer bundled in a single index.

II. The ‚Neuer Markt' as a job machine

In spite of the crash and the restructuring of the German equity market it is worth while to analyse Neuer Markt, not only because "… Germany is Europe's biggest economy and desperately needs a vehicle for risk capital" (Business Week, July 2001), but because Neuer Markt has worked as a job machine, even in its deepest crisis: From the peak of the Neuer Markt index in March 2000 till summer 2001 (when the index fell to a tenth of its peak level) the number of employees in Neuer Markt firms almost doubled from 93.000 to 185.000 (RBSC 2001). This impressive employment performance could not be abided in the subsequent year: Between summer 2001 and summer 2002 there were 58 delistings from Neuer Markt compared to only one IPO such that overall employment decreased from 185.000 to 160.000 (roughly 14 per cent).[8] Viewed in a two-year-perspective (2000 till 2002) the compound annual growth rate of employment for all Neuer Markt firms is 26 per cent. The market segments with the most rapid employment growth were Biotech, Financial Services, Industrials&Industrial Services and Technology, whereas Software and Media&Entertainment were confronted with job losses (table 2).

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[4] These companies are subject to the legal minimum requirements governed by German federal law.
[5] Thus, issuers in the Prime Segment must, in addition to the requirements of the General Standard Segment, fulfill a range of internationally accepted transparency requirements. These include quarterly reports as conforming with stock exchange rules and regulations, financial reporting according to international accounting standards, publication of a corporate calendar, at least one analyst conference per year and ad-hoc disclosure and ongoing reports in English (Deutsche Börse 2002: 2).
[6] In order to provide continuity, Deutsche Börse will continue to calculate the NEMAX 50 index until the end of 2004.
[7] Many Neuer Markt firms will change or have already changed into the SDAX.
[8] Those firms that remained listed at Neuer Markt realized a moderate employment growth in this period.

Table 2: Employment growth by sector

Sector	Employment growth* (March 2000 – July 2002)	Total employment (July 2002)	Number of firms (July 2002)	Average number of employees per firm (July 2002)
Biotech	102%	7281	21	347
Financial Services	77%	8339	5	1668
Industrials&Industrial Services	45%	34882	16	2180
Technology	44%	33572	68	494
IT-Services	22%	19318	34	568
Internet	19%	20727	45	461
Media&Entertainment	11%	6855	30	229
Telecommunications	10%	12427	13	956
Software	-4%	14608	40	365
Medtech&Health	-35%	1698	11	154

* compound annual growth rate (CAGR)
Source: RBSC (2002)

The employment growth in the early years of Neuer Markt (until summer 2000) was primarily due to the listing of new firms ('IPO effect'), whereas since that time there were relatively few new listings[9] and several de-listings such that employment growth since then is primarily due to the expansion of firms already listed (real 'growth effect'). Roland Berger Strategy Consultants (RBSC, for short) expect that the New Economy will continue to be a 'job machine' although consolidation is not completed and employment growth rates are likely to be lower in the future (RBSC 2001). Although the employment growth on Neuer Markt is concentrated on locations in Germany, Neuer Markt has also contributed to employment growth elsewhere, particularly in Germany's neighbor countries the Netherlands, Luxemburg, Austria and Italy (table 3).

Table 3: Employees in Neuer Markt firms in- and outside Germany, July 2002

	Country	Employees	Number of firms with registered office in the country
Germany	D	117336	237
Europe	NL	10362	8
	AT	7366	10
	LUX	9414	1
	IT	4969	1
	FR	1982	1
	CH	1982	6
	GB	724	1
	IRL	1957	2
	IL	1084	7
	HUN	292	1
	DK	135	1
Overseas	USA	2099	7

Source: RBSC 2002

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[9] There were 33 new listings between August 2000 and December 2000. In the whole year 2001 there were only 11 new listings (compared to 132 in 2000).

III. The spatial structure of Neuer Markt firms, employment and capital

A closer look at the spatial structure of Germany-based Neuer Markt firms reveals that they are not equally distributed over space but that there is a clear-cut tendency towards spatial concentration. The location of Neuer Markt firms is focussed on Germany's major cities and their direct hinterland. Nearly 45 per cent of all Neuer Markt firms based in Germany are located in the planning regions München, Rhein-Main (Frankfurt), Berlin and Hamburg. If one also considers those firms which are located in regions neighboring the above named cities the percentage increases from 45 to 56 per cent (table 4). Neuer Markt employment and market capitalization show a similar concentration on the four leading cities.[10]

Table 4: Germany's "top four" Neuer Markt locations, September 2002

Planning Region	Number of NEMAX firms	Employees	Market Capitalization*
München	48	21333	772.4
Rhein Main	20	14696	234.9
Hamburg	19	7092	318.9
Berlin	14	6961	237.3
Top four together	101	50082	1563.4
Top four in %	44.9	45.1	26.8
Top four + neighbors	126	62694	3496.7
Top four + neighbors in %	56.0	56.4	59.9
Germany as a whole	225	111128	5833.0

* in million €
Source: Own survey, supplemented by information from Deutsche Börse AG 2003. Own calculations.

What really strikes the eye is the dominance of München: The planning region München accommodates almost as many Neuer Markt firms as the regions Rhein-Main (Frankfurt), Berlin and Hamburg together. The reasons why München and not the German capital Berlin (which has approximately twice as many inhabitants as München) or Germany's second-largest city (Hamburg) is the center of the new economy are manifold: München is not only an industrial core region but also a high ranking financial center. Sternberg and Tamásy emphasize the role of national and Bavarian technology policies, the impact of F.J. Strauß as former prime minister of Bavaria and national Minister of Defence and the locational choice of Siemens headquarters (Sternberg and Tamásy 1999: 375).[11] Furthermore, München accommodates more venture capital firms than any other German city and there appears to be a close interrelation between the location of venture capital firms and Neuer Markt firms in Germany (Dohse and Schertler 2003).

Even the Rhein-Main region (Frankfurt) accomodates more Neuer Markt firms than Germany's largest cities Berlin and Hamburg which may be due to the fact that Frankfurt is Germany's leading financial center (and one of Europe's financial centers, too) as well as the head office of Deutsche Börse (the German stock exchange) and Neuer Markt. If we also consider neighboring regions the larger Rhein-Main area even outstrips München with respect to market capitalization.

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[10] As can be derived from table 4 firms located in neighboring regions have on average a similar number of employees but a much higher market capitalization than firms located in the agglomeration centers themselves.
[11] The recent decision of General Electric to settle their European headquarters in München underscores the attractiveness of München as a high tech location.

[Map 1: NEMAX firms by planning regions, insert here]

East Germany (with the exception of Berlin) is almost an empty spot on the map of Neuer Markt which may indicate that NEMAX firms hardly grow in East Germany or that Neuer Markt firms shun East Germany (map 1, table 5).

Table 5: NEMAX firms, employment and market capitalization by state, September 2002

State	Firms		Employees		Market Cap.	
	number	%	number	%	amount	%
Baden-Württemberg	33	14,67	16117	14,50	549,60	9,42
Bayern	64	28,44	26060	23,45	1346,46	23,08
Berlin	14	6,22	6961	6,26	237,31	4,07
Brandenburg	1	0,44	41	0,04	2,09	0,04
Bremen	2	0,89	682	0,61	11,32	0,19
Hamburg	19	8,44	7092	6,38	318,87	5,47
Hessen	28	12,44	20483	18,43	1458,82	25,01
Mecklenburg-Vorpommern	1	0,44	208	0,19	9,17	0,16
Niedersachsen	6	2,67	2851	2,57	143,85	2,47
Nordrhein-Westfalen	35	15,56	12505	11,25	1262,61	21,65
Rheinland-Pfalz	3	1,33	1169	1,05	9,13	0,16
Saarland	3	1,33	2497	2,25	78,06	1,34
Sachsen	4	1,78	3478	3,13	117,89	2,02
Sachsen-Anhalt	1	0,44	1420	1,28	0,47	0,01
Schleswig-Holstein	6	2,67	7298	6,57	227,91	3,91
Thüringen	5	2,22	2266	2,04	59,47	1,02
Total	225	100	111128	100	5833,03	100
Old Laender[a]	199	88,44	96754	87,07	5407	92,69
New Laender[a]	12	5,33	7413	6,67	189	3,24

[a] Berlin not included.
Source: same as table 4

Only 12 firms (which is about five per cent of all Neuer Markt firms) are located in the five East German Länder (Brandenburg, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt and Thüringen), and their average size is not much above the German average, whereas their market capitalization is far below average. Nine of these 12 firms are located in the southern parts of east Germany (Sachsen and Thüringen) which indicates that the south-north divide that is well documented for West-Germany may have spilled over to the east German economy.[12]

A broader inspection shows that the former West Germany (Old Laender) accounts for roughly 90 per cent of Neuer Markt firms and employment and an even higher percentage of market capitalization, the leading states within West Germany being Bayern, Hessen, Nordrhein-Westfalen and Baden-Württemberg (table 5). Thus, the new economy in Germany as measured by Neuer Markt firms, employment and market capitalization is clearly overrepresented in the southern and western parts of the country and it is clearly underrepresented in the East.

Making use of a classification introduced by the German Federal Office for Building and Regional Planning (BBR 2001) allows us to subdivide the 97 German planning regions into agglomeration areas, urbanization areas and rural areas. As can be seen from table 6 the large

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[12] Other indicators support this view (see DIW et al. 2002).

majority of all NEMAX establishments and activities is concentrated on the agglomerations and only an evanescent minority of NEMAX firms (employment and capital) is located in rural areas.

Table 6: NEMAX firms, employment and market capitalization by type of region, September 2002

Type of Region	Firms		Employees		Market Cap.	
	number	%	number	%	amount	%
Agglomeration Areas	176	78,2	84232	75,8	4686,16	80,3
Urbanisation Areas	44	19,6	24551	22,1	1139,73	19,6
Rural Areas	5	2,2	2345	2,1	7,14	0,1

Source: Own calculations

Apart from this crude classification the BBR has suggested a more sophisticated classification system consisting of seven types of region which is elucidated in detail in appendix 1. This sophisticated classification reveals that more than 86 per cent of all Neuer Markt firms and 83.5 per cent of Neuer Markt employment is concentrated in densely populated regions with outstanding centers (region types A2, A1 and U2), wheras rural areas with a population density less than 100 inhabitants/km^2 (region type R2) accomodate no Neuer Markt firms at all.

Table 7: NEMAX firms and employment by sophisticated type of region, September 2002

Type of Region	Percentage of Neuer Markt Firms located in this type of region	Percentage of Neuer Markt Employment located in this type of region	Percentage of New Economy Firms located in this type of region	Percentage of New Economy Employment located in this type of region
A1	33,3	36,9	38,8	31,6
A2	44,9	38,8	44,0	41,6
U1	8,4	10,7	6,0	13,1
U2	8,0	7,8	6,0	6,9
U3	3,1	3,6	3,7	4,3
R1	2,2	2,1	1,5	2,5
R2	0,0	0,0	0,0	0,0

Source: Own calculations

It was argued in the introduction that firms listed at Neuer Markt might be viewed as the spearhead of the new economy in Germany. However, a more narrow definition of new economy as information (or virtual) economy would exclude such sectors as Biotech, Financial Services or Industrials&Industrial Services. To check if our previous findings are still valid when using a more narrow definition we define an index "New Economy in a narrow sense" aggregating the NEMAX sub-indices Internet, IT-Services, Media&Entertainment, Software and Telecommunications and excluding the rest (see table A2.1 in appendix 2).
We find that the spatial distribution of firms belonging to the "New Economy in a narrow sense" is rather similar to the pattern revealed by Neuer Markt firms in general (See map 2 and compare it with map 1).

[Map 2, insert here]

There is one noteworthy difference, however: the "New Economy in a narrow sense" appears to be even more spatially concentrated than the Neuer Markt in general (table 8).[13] The preference for urban agglomerations and the shuning of rural areas is obviously more pronounced in firms belonging to the information economy.

Table 8: Spatial concentration of New Economy in a narrow sense and Neuer Markt in general, September 2002

	New Economy firms in a narrow sense	Neuer Markt firms in general
Absolute concentration (Hirshman index)	0,085	0,075
Relative concentration (Lorenz-Münzer index)	0,834	0,769
Firms located in top four cities	48.5%	44.9 %
Firms located in rural areas	1.5 %	2.2 %

Source: Own calculations

We conclude this section with some correlation analysis, comparing the spatial distribution of Neuer Markt activities with the spatial distribution of what may be called the "traditional economy" and the "knowledge economy". As can be seen from table 9 there is a high and statistically significant correlation between the spatial distribution of NEMAX firms, employment and capital and the regional distribution of GDP, income (GDP per head), labor productivity and employment. This indicates that Neuer Markt firms tend to cluster in rich regions with high labor productivity and a high density of economic activities.

Table 9: Correlation between traditional economy variables and Neuer Markt variables

Variable A (traditional economy)	Variable B (Neuer Markt)	Correlation between A and B	Rank-Correlation between A and B
Regional GDP	NEMAX Firms	0.827	0.676
Regional GDP	NEMAX-Employment	0.803	0.637
Regional GDP	NEMAX Capitalization	0.519	0.633
Regional Productivity (GDP/worker)	NEMAX Firms	0.563	0.459
Regional Productivity (GDP/worker)	NEMAX-Employment	0.526	0.392
Regional Productivity (GDP/worker)	NEMAX Capitalization	0.466	0.426
Regional Income (GDP/head)	NEMAX Firms	0.671	0.495
Regional Income (GDP/head)	NEMAX-Employment	0.621	0.418
Regional Income (GDP/head)	NEMAX Capitalization	0.444	0.427
Regional Employment	NEMAX Firms	0.720	0.666
Regional Employment	NEMAX-Employment	0.704	0.645
Regional Employment	NEMAX Capitalization	0.451	0.619

Source: Own calculations

We go one step further now and compare the spatial structure of Neuer Markt activities with the spatial structure of what may be called the "knowledge economy", measured by knowledge or technology indicators such as regional R&D employment and expenditure, or

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[13] See also table 8.

regional patent applications. The high and significant correlation between these regional technology indicators and NEMAX firms, employment and market capitalization (table 10) indicates that technologically strong regions are also strong in terms of the new economy; technologically backward regions are also underrepresented in terms of Neuer Markt employment and market capitalization.

Table 10: Correlation between knowledge economy variables and Neuer Markt variables

Variable A (Knowledge economy)	Variable B (Neuer Markt)	Correlation between A and B	Rank-Correlation between A and B
R&D expenditure	NEMAX Firms	0.728	0.618
R&D expenditure	NEMAX-Employment	0.719	0.571
R&D expenditure	NEMAX Capitalization	0.499	0.561
R&D employment	NEMAX Firms	0.768	0.618
R&D employment	NEMAX-Employment	0.762	0.572
R&D employment	NEMAX Capitalization	0.573	0.561
Patents	NEMAX Firms	0.716	0.613
Patents	NEMAX-Employment	0.696	0.557
Patents	NEMAX Capitalization	0.454	0.574

Source: Own calculations

There is one noteable qualification to this finding, however: the South West (Baden-Württemberg) which may be seen as the technological heartland of Germany (and is leading in terms of patent applications and R&D intensities) is falling behind Bayern (but also behind Hessen and Nordrhein-Westfalen) in terms of new economy firms, employment and, particularly, market capitalization (table 5). If this is the first indication of a permanent shift in the spatial structure of the German economy or just a temporary phenomenon has to be seen in the longer run.

IV. Concentration, Coagglomeration and Spillovers

1. Results based on traditional indicators

It is sometimes argued that in the information economy distance – and thus spatial proximity – loses its meaning. If this is true we should observe that new economy (Neuer Markt) activities are less concentrated in space than activities belonging to the traditional economy (hypothesis 1). On the contrary, one may argue that new economy (Neuer Markt) firms depend more heavily on knowledge spillovers, labor market pooling and spatial proximity to customers than traditional economy firms. In this case we would expect Neuer Markt activities to be more concentrated than variables such as GDP or overall employment (hypothesis 2). Our results on spatial concentration based on traditional indicators such as Hirschman index (absolute concentration) or Lorenz index (relative concentration) presented in table 11 clearly corroborate hypothesis 2, i.e. Neuer Markt activities are obviously more concentrated than population, employment and GDP.[14]

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[14] The Hirshman index can take values between $\frac{1}{N}$ and 1, whereas the Lorenz-Münzer index can take values

between 0 and $\frac{N-1}{N}$. The Hirshman index is suited for comparisons between variables or for the analysis of

Table 11: Indices of spatial concentration

		Absolute Concentration (Hirschman)	Relative Concentration (Lorenz-Münzer)
Neuer Markt	NEMAX firms 2002	0,0750	0,7691
	NEMAX employment 2002	0,0753	0,8003
	NEMAX market cap. 2002	0,0838	0,8507
Knowledge Economy	Patents 2000	0,0282	0,5332
	R&D expenditure 1999	0,0539	0,7072
	R&D employment 1999	0,0453	0,6627
Traditional economy	GDP 2000	0,0215	0,4423
	Employment 2000	0,0168	0,3632
	Population 2000	0,0156	0,3355
Venture Capital	Venture capital firms 2001	0,0719	0,7988
	Independent VC firms 2001	0,1410	0,9048

Source: Own calculations

While this result is not too surprising since it is in line with most of the literature, another result came less expected: concentration of Neuer Markt activities is even clearly higher than patent or R&D concentration (table 11). This indicates that the new economy might aggravate the existing technological divide. Our finding also suggests that it is not just knowledge spillovers that are responsible for the spatial concentration of Neuer Markt activities but that there must be something else behind this finding. Our hypothesis – which is supported by related work[15] – is that the location of Neuer Markt firms (and its excess concentration as compared to patents and R&D) might partly be explained by the location of venture capital firms which show a similar degree of spatial concentration as Neuer Markt firms themselves (table 11).

2. A dartboard approach to Neuer Markt concentration and coagglomeration

One might feel uncomfortable with the concentration measures calculated so far because comparisons of the degree of geographic concentration across industries on the basis of traditional indicators are somewhat ambiguous since these indicators depend on the number and size distribution of firms in the respective industry as well as on the size of the regional observation unit for which data are available. To avoid such problems Ellison and Glaeser (1997) have proposed indices of industry concentration and coagglomeration that control for differences in the size distribution of plants and for differences in the size of the geographic units at hand. The Ellison/Glaeser concentration index γ allows us to test whether observed levels of concentration are greater than would be expected to arise randomly. The index is defined as:

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developments over time. The interpretation of its absolute value as "degree of concentration" is, however, problematic since it is not invariant with respect to monotonous transformations. For this purpose, the Lorenz-Münzer index is the better choice.

[15] Dohse and Schertler (2003) find that the location of venture capital firms in a region has a positive and significant (at the 5 % level) impact on the location of Neuer Markt firms in that region.

$$\gamma_{EG} \equiv \frac{\sum_{i=1}^{M}(s_i - x_i)^2 - \left(1 - \sum_{i=1}^{M} x_i^2\right)^2 H}{\left(1 - \sum_{i=1}^{M} x_i^2\right)(1 - H)} \qquad (1)$$

with $\quad s_i \ (i = 1,..., M) =$ share of an industry's employment in region i

$\quad\quad x_i \ (i = 1,..., M) =$ share of total employment in region i

$\quad\quad H = \sum_{j=1}^{N} z_j^2 =$ Herfindahl/Hirshman index of the plant size distribution

Defining an index of raw geographical concentration as

$$G_{EG} \equiv \frac{\sum_i (s_i - x_i)^2}{1 - \sum_i x_i^2} \qquad (2)$$

We may rewrite (1) as

$$\gamma_{EG} \equiv \frac{G_{EG} - H}{1 - H} \qquad (1')$$

The proposed index has (at least) four desirable properties[16](Ellison/Glaeser 1997: pp. 900):

- It takes on the value of zero not if employment is uniformly spread across space (as is the case in most of the traditional indicators) " … but instead if employment is only as concentrated as it would be expected to be had the plants in the industry chosen locations by throwing darts at a map" (Ellison/Glaeser 1997: 890).

- The index is comparable across industries in which the size distribution of firms differs.

- It allows meaningful comparisons regardless of differences in the level of geographic aggregation at which employment data for the respective industries are available.

- It is relatively easy to compute (given that data are available).

The calculation of the Ellison/Glaeser concentration index is, however, somewhat ad hoc. Maurel and Sedillot (1999) have criticized this and derived an index very similar to that of Ellison/Glaeser from a sequential model of location choice. The Maurel/Sedillot index (γ_{MS}, for short) can be interpreted as the correlation between the location decisions of two business units in the same industry. The Maurel/Sedillot index may be calculated as

$$\gamma_{MS} = \frac{G_{MS} - H}{1 - H} \qquad (3)$$

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[16] Two caveats of the index have to be mentioned: (i) Potential spillovers are only realized when firms choose to locate in the same region, i.e. the index measures only intraregional spillovers and (ii) it is assumed that natural advantages are independent between neighboring geographical areas (Ellison and Glaeser 1997: 901).

It is identical with the Ellison/Glaeser-index except for the term indicating the raw industrial concentration

$$G_{MS} = \frac{\sum_i s_i^2 - \sum_i x_i^2}{1 - \sum_i x_i^2}$$
(4)

"When business units' location choices are independent, the expectation value of γ is zero (E($\hat{\gamma}$)=0). Thus, a value of γ greater than zero in one industry can be interpreted as a geographic concentration in excess of the one that would prevail if the location choices were independent between plants (no spillover) and random among regions (no natural advantage). The industry is therefore regarded as localized." (Maurel and Sedillot 1999: 581).
Ellison/Glaeser as well as Maurel/Sedillot refer to industries with γ's above 0.05 as being highly concentrated, with γ's between 0.02 and 0.05 as moderately concentrated and with γ's below 0.02 as being not very concentrated.

Table 12 shows the values of γ_{EG} and γ_{MS} for all sub-sectors of Neuer Markt, Neuer Markt as a whole and the industry group that may be classified as New Economy in a narrow sense (the IT sector).

Table 12: Concentration indices

Spatial concentration of …	Measure	
	γ_{EG}	γ_{MS}
MedTech&Health sector*	0.133	0.143
Media&Entertainment sector*	0.100	0.135
Software sector*	0.071	0.091
Industrials&Industrial Services*	0.047	0.075
Biotech sector*	0.039	0.052
Internet sector*	0.027	0.045
IT-Services sector*	0.020	0.030
Technology sector*	0.016	0.027
Telecommunications sector*	0.003	0.002
Financial Services sector*	-0.032	-0.017
Neuer Markt as a whole	0.031	0.047
New Economy in a narrow sense*	0.023	0.040

* Only firms listed at Neuer Markt.
Source: Own calculations

A first striking result is that according to γ_MS five (according to γ_EG: three) of the ten NEMAX sub-sectors are highly concentrated. Three subsectors according to γ_MS (four according to γ_EG) are moderately concentrated and only two (three according to γ_EG) show a low degree of concentration or no concentration at all. The industries with the highest degree of concentration (according to both indices) are Medtech&Health, Media&Entertainment, Software, Industrials&Industrial Services and Biotech. Two sectors – Telecommunications and Financial Services – appear to be not geographically concentrated at all. In order to correctly interpret these results it is helpful to have a closer look at the components of γ: As can be seen from equations (1') and (3) the index γ consists of two components that reflect raw geographic concentration (G) and industrial concentration (H). "Broadly, the index represents the difference between these two, and hence the degree of geographic

concentration in excess of that which is due to industrial concentration."(Devereux et al. 2002: 6). As can be seen from table 13, the low γ-values for Telecommunications and Financial Services result from the fact that industry concentration (H) is high relative to geographic concentration (G).

Table 13: Industrial concentration and raw geographic concentration

	Industrial concentration	Raw geographic Concentration	
	H	G_{MS}	G_{EG}
Medtech&Health	0.202	0.311	0.300
Media&Entertainment	0.075	0.197	0.164
Software	0.053	0.137	0.118
Industrials&Industrial Services	0.121	0.185	0.158
Biotechnology	0.105	0.150	0.136
Internet	0.085	0.124	0.106
IT-Services	0.071	0.097	0.087
Technology	0.038	0.063	0.052
Telecommunications	0.307	0.303	0.299
Financial	0.502	0.485	0.470
New Economy in a narrow sense	0.024	0.061	0.046
Neuer Markt as a whole	0.013	0.059	0.043

Source: Own calculations

In the case of Financial Services the result is a pure statistical artefact since the number of observations is extremely low (only two firms, see appendix 2), which leads to an extremely high Herfindahl index.[17] In the case of Telecommunications the Herfindahl index is rather high because the industry structure is dominated by two large enterprises (Mobilcom AG and Telegate AG) that account for more than 74 per cent of overall employment in this sector. Thus, the low γ-values for Telecommunications and Financial Services do not mean that the industry is actually scattered all over the country. It simply means that "… their geographic concentration is largely lower than what could have been expected from the high level of concentration of their production." (Maurel and Sedillot 1999: 586).

The γ-values for Neuer Markt as a whole indicate a degree of concentration in the range between moderate and high. It is striking that the γ-values for Neuer Markt as a whole are somewhat higher than those for the IT-sectors that form the New Economy in a narrow sense (see table 12). At first glance, this result seems inconsistent with the findings for the traditional indicators shown in table 8. It may be explained by the fact that traditional indicators do not differentiate between industrial concentration and geographic concentration. Obviously, industry concentration in the New Economy in a narrow sense is clearly higher than in the Neuer Markt as a whole (indicated by the Herfindahl indices in table 13) whereas raw geographic concentration in the IT-sectors is almost the same as (only slightly higher than) the Neuer Markt average. Thus, traditional indicators find a higher concentration of the New Economy in a narrow sense than of Neuer Markt as a whole, whereas the agglomeration indices γ which measure the excess of raw geographic concentration over industrial concentration are lower for the New Economy in a narrow sense.

Put in a nutshell, concentration of Neuer Markt employment measured by the dartboard approach is considerable. It is particularly high in the sub-sectors Medtech&Health, Media&Entertainment, Software, Industrials&Industrial Services and Biotech. The high level

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[17] Financial Services will thus not be considered in the remainder of this paper.

of concentration in these young and knowledge-intensive industries might indicate that there exist strong current dynamic knowledge spillovers.

Measurement of coagglomeration

The measurement of coagglomeration requires the availability of industry and plant size data for each of r industries belonging to some group. Ellison and Glaeser define an index of the degree to which industries in a group are coagglomerated as

$$\gamma^c \equiv \frac{\left[G / \left(1 - \sum_i x_i^2\right)\right] - H - \sum_{j=1}^r \hat{\gamma}_j w_j^2 \left(1 - H_j\right)}{1 - \sum_{j=1}^r w_j^2} \tag{5}$$

With $G = \sum_{i=1}^M \left(s_i^{group} - x_i\right)^2$

H_j = industry j's plant Herfindahl index

$H = \sum_j w_j^2 H_j$ = the group's plant Herfindahl index

w_j = employment share of the j-th industry

$\hat{\gamma}_j$ = calculated value of the concentration index for the j-th industry.

The index γ^c measures if there is any correlation in the location decisions of firms belonging to different subgroups (indicating inter-industry spillovers), or if the concentration of the industry group is entirely due to the localization within the subgroups (only intra-industry spillovers). The scale of γ^c is the same as that of γ, and Ellison/Glaeser interpret γ^c–values between 0.02 and 0.05 as indicating moderate coagglomeration and values greater than 0.05 as indicating high coagglomeration. "An estimate of $\gamma^c = 0$ may be interpreted as indicating that here is no more agglomeration of plants in the group than that attributable to the tendencies of plants to locate near other plants in the same industry and where aggregate .. employment is high." (Ellison and Glaeser 1997: 905)

From equations (5) and (1) it follows that

$$\gamma = \frac{\sum_{j=1}^r \hat{\gamma}_j w_j^2 \left(1 - H_j\right)}{1 - \sum_{j=1}^r w_j^2 H_j} + \frac{\gamma^c \left(1 - \sum_{j=1}^r w_j^2\right)}{1 - \sum_{j=1}^r w_j^2 H_j} \tag{6}$$

Equation (6) allows us a meaningful decomposition of the industry group's concentration index γ. The first term on the RHS of equation (6) is a weighted average of $\hat{\gamma}_j$ for each of the industry subgroups and may be interpreted as a summary of the *within* industry agglomeration. The second term on the RHS of equation (6) measures the degree to which

there is agglomeration between the industry subgroups (Maurel and Sedillot 1999: 587, Devereux et al. 2002: 17).

Table 14 shows the value of the coagglomeration index γ^c for Neuer Markt as a whole and for the industry group entitled New Economy in a narrow sense. It also shows the proportion of the overall agglomeration accounted for by between industries´ agglomeration (second term on the RHS of (6) as a proportion of γ.)

Table 14: Coagglomeration and proportion of between industry agglomeration

	coagglomeration index γ^c	proportion of overall agglomeration accounted for by between industry agglomeration
Neuer Markt as a whole	0.0311	0.868
New Economy in a narrow sense	0.0210	0.708

Source: Own calculations

Table 14 shows that there is a moderate degree of coagglomeration within Neuer Markt as a whole as well as within the group entitled New Economy in a narrow sense, although the γ^c-value for Neuer Markt as a whole is somewhat higher. The proportion of the overall agglomeration accounted for by between industry agglomeration is 86.8 per cent for Neuer Markt as a whole and roughly 71 per cent for New Economy in a narrow sense.

A simple rescaling of the coagglomeration measure γ^c obtains us an index λ that measures the degree to which spillovers are general (Ellison and Glaeser 1997: 905).

$$\lambda = \frac{\gamma^c}{\sum w_j \hat{\gamma}_j} \qquad (7)$$

λ relates the strength of coagglomerative forces (nominator) to that of agglomerative forces (denominator). "A value of $\lambda = 0$ would indicate that the subindustries exhibit no coagglomeration at all, and a value of $\lambda = 1$ would indicate that the natural advantages and spillovers that exist are .. group-specific rather than .. industry-specific." (Ellison and Glaeser 1997: 915)

We have calculated coagglomeration indices (γ^c) and spillover measures (λ) for all possible pairwise combinations of Neuer Markt industry subgroups[18] (see table 15 for the highly coagglomerated pairs of industries and table A3.1 in appendix 3 for less coagglomerated pairs of industries).

Our results show that there is considerable heterogeneity across industries in the specificity of spillovers. For 12 industry pairs (33.3 per cent) coagglomeration is high ($\gamma^c \geq 0.05$). It is striking that those industries that exhibit a high degree of concentration (Media&Entertainment, Software, Industrials&Industrial Services, Biotech) are overrepresented in table 15, i.e. they tend to generate (and/or to receive) inter-industry spillovers to a considerable extent. Although one has to be careful with political conclusions because of the descriptive nature of the analysis this might indicate that the above named sectors are 'strategic' sectors that could be particularly valuable for regional development.

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[18] Only Financial Services were excluded because of the low number of observations.

Table 15: Industry pairs which are highly coagglomerated

Industry pair		γ^c	λ
Media&Entertainment	Software	0.102	1.275
Industrials and Industrial Services	Media&Entertainment	0.095	1.650
Biotech	Media&Entertainment	0.081	1.065
Biotech	Software	0.078	1.200
Software	Telecommunications	0.071	1.770
Media&Entertainment	Telecommunications	0.068	2.045
IT-Services	Medtech&Health	0.061	1.168
Internet	Medtech&Health	0.060	1.509
Industrials and Industrial Services	Software	0.057	1.004
Biotech	Telecommunications	0.055	4.651
Industrials and Industrial Services	Technology	0.053	1.777
Industrials and Industrial Services	IT-Services	0.050	1.406

Source: Own calculations

V. Conclusions

In this paper we have investigated the geographic distribution of Neuer Markt activities in Germany and we have employed the dartboard approach pioneered by Ellison and Glaeser to analyse concentration and coagglomeration features of Neuer Markt and its subindustries.

We have found that the New Economy in Germany as measured by Neuer Markt firms, employment and market capitalization is clearly overrepresented in the southern and western parts of the country and it is clearly underrepresented in the East. Neuer Markt firms tend to cluster in rich regions with high labor productivity and a high density of economic activities. Technologically strong regions are also strong in terms of the new economy; technologically backward regions are also underrepresented in terms of Neuer Markt employment and market capitalization. However, the German South West (Baden-Württemberg) which may be seen as the technological heartland of Germany (and is leading in terms of patent applications and R&D intensities) is falling behind Bayern (but also behind Hessen and Nordrhein-Westfalen) in terms of new economy firms, employment and, particularly, market capitalization.

Concentration of Neuer Markt employment measured by the dartboard approach is considerable. It is particularly high in the sub-sectors Medtech&Health, Media&Entertainment, Software, Industrials&Industrial Services and Biotech. The high level of concentration in these young and knowledge-intensive industries might indicate that there exist strong current dynamic knowledge spillovers. The analysis of coagglomeration revealed that those industries that exhibit a high degree of concentration (Media&Entertainment, Software, Industrials&Industrial Services, Biotech) tend to generate (and/or to receive) inter-industry spillovers to a considerable extent, which might indicate that they are 'strategic' sectors particularly valuable for regional development.

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Appendix

Appendix 1: Classification of Regions

Germany is subdivided into 440 Kreise and 97 planning regions (Raumordnungsregionen). All analyses in the paper are carried out at the level of planning regions. The following classification schemes apply to planning regions.

Table A1.1: Basic categories of regions in Germany (according to BBR)

Agglomeration areas	Center > 300.000 inhabitants or overall population density $\geq$ 300 inhabitants/km^2
Urbanization areas	Overall population density > 150 inhabitants/km^2 or center > 100.000 inhabitants and overall density > 100 inhabitants/km^2
Rural areas	Overall population density < 150 inhabitants/km^2

Table A1.2: Modified categories

A1	**Agglomeration type 1**: with outstanding center (> 100.000 inhabitants) and densely populated hinterland (> 300 inhabitants/km^2)
A2	**Agglomeration type 2:*** with outstanding center (> 100.000 inhabitants) and hinterland population density < 300 inhabitants/km^2
U1	**Urbanization areas with high population density** (>200 inhabitants/km^2 throughout the whole planning region)
U2	**Urbanization areas with medium density** (100 - 200 inhabitants/km^2) **and an outstanding center** (> 100.000 inhabitants)
U3	**Urbanization areas with density 150 - 200 inhabitants/km^2 and without an outstanding center**
R1	**Rural areas with density 100 - 150 inhabitants/km^2**
R2	**Rural areas with low density** (< 100 inhabitants/km^2)

* Most of the really big cities in Germany (Berlin, Hamburg, München belong to agglomeration type 2)

Appendix 2: New Economy sectors
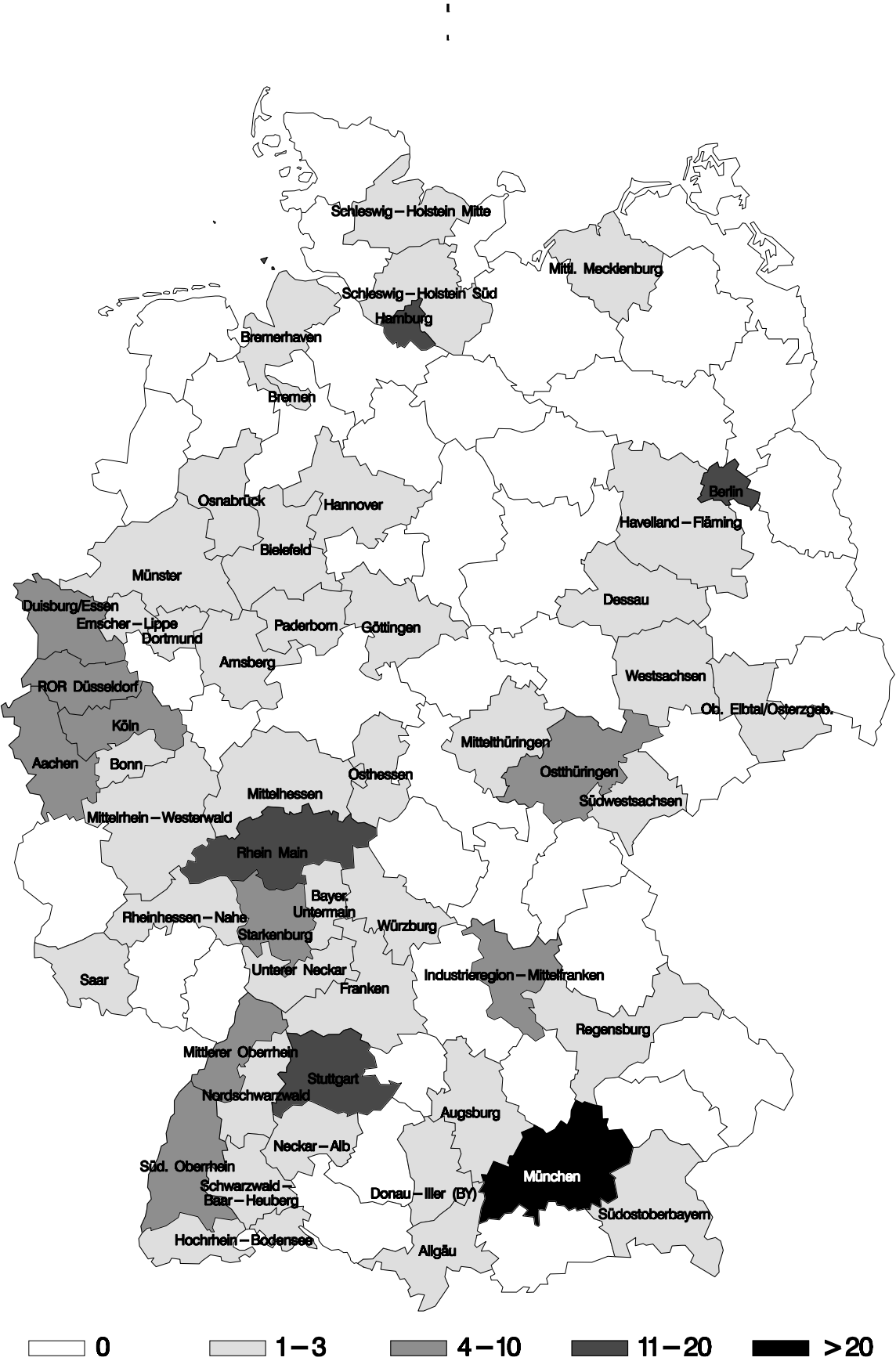
Table A2.1: New Economy in a narrow sense

Sub-indices of NEMAX/AS	Sectors belonging to New Economy in a narrow sense	Number of Firms
Biotech		15
Financial Services		2
Industrials&Industrial Services		14
Internet	X	36
IT-Services	X	27
Media&Entertainment	X	26
MedTech&Health		9
Software	X	33
Technology		51
Telecommunications	X	12

Appendix 3: Coagglomeration indices and Spillover measures

Table A3.1: Coagglomeration indices and Spillover measures for the less coagglomerated pairs of industries

Industry pair		γ^c	λ
Biotech	Technology	0,034	1,800
Industrials&Industrial Services	Telecommunications	0,034	1,048
Biotech	Industrials&Industrial Services	0,032	0,694
Software	Technology	0,031	0,914
Biotech	Medtech&Health	0,030	0,378
Technology	Telecommunications	0,026	2,023
Biotech	IT-Services	0,023	0,966
IT-Services	Software	0,018	0,329
Internet	Software	0,018	0,385
Biotech	Internet	0,017	0,596
Medtech&Health	Software	0,016	0,190
IT-Services	Media&Entertainment	0,014	0,264
Internet	Media&Entertainment	0,014	0,322
Media&Entertainment	Medtech&Health	0,010	0,093
Industrials&Industrial Services	Internet	0,007	0,181
IT-Services	Technology	-0,002	-0,086
Internet	Technology	-0,002	-0,113
Internet	IT-Services	-0,005	-0,215
Medtech&Health	Technology	-0,007	-0,269
IT-Services	Telecommunications	-0,016	-0,608
Internet	Telecommunications	-0,017	-0,906
Medtech&Health	Telecommunications	-0,023	-0,850
Industrials&Industrial Services	Medtech&Health	-0,036	-0,640

Map 1: Neuer Markt firms by planning regions

Map 2: New econonomy firms in a narrow sense by planning regions

Legend: 0   1−2   3−4   5−15   >15