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Integration of the scientific community as exemplified by the biotech sector: An analysis based on bibliometric indicators in the Danish-Swedish border region

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The Danish-Swedish border region. Integration of the scientific community, exemplified by the biotech sector. An analysis based on bibliometric indicators.

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Abstract

This paper presents an account of the progress of the integration between the Danish and Swedish parts of the Öresund Region within the world of science, with emphasis on biotech. The paper is based on data from the database Science Citation Index Expanded. The amount of co-authorships produced by agents from each side of the region is analysed for a 12 year period (1994-2005) and used as an indicator to show how the integration is proceeding. Each of the co-authorships is examined to shed light on the nature of the interactions, thereby identifying the agents most involved in collaboration. Furthermore the development in co-authorships within the region is compared to the development in co-authorships between the Öresund Region and four selected reference areas. Our findings indicate that there has been a substantial increase in both the number of co-authorships overall and within biotech solely. The rise in co-authorships between the two parts is proceeding at a faster pace than the rise in co-authorships between the Öresund Region and the reference areas. The overall results of this paper indicate a growing integration of the biotech sector in the Öresund Region.

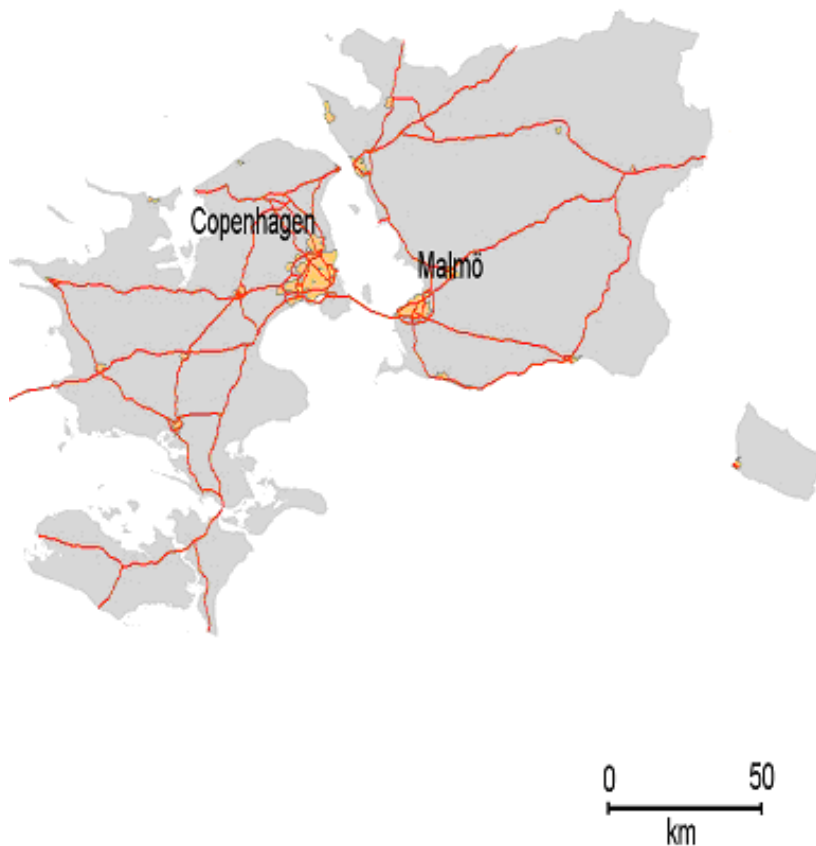
Keywords: Biotech, co-authorships, integration, knowledge, regional growth, the Öresund Region.

Introduction

Within urban- and economic geography today, cities and regions are becoming central to the understanding of economic growth (Asheim & Gertler 2005, Florida 2003, Camagni 2002). At the same time knowledge-creation, innovation and high-tech industries are pointed out by experts and politicians, as sources of continued economic growth within regions. The Öresund Region is a bi-national region, with the greater Copenhagen area on the Danish side, and the Malmö/Lund area on the Swedish side making up its centre in terms of population, economy and culture. Seen in terms of *gross regional product*, Copenhagen ranks 19th of the European cities, but combined with

Malmö/Lund it moves up to an 11th place. Measured in terms of scientific output Copenhagen ranks 21st in Europe, and Malmö/Lund is situated just inside the top 30, but combined the two urban areas rank 5th (Matthiessen 1999 and Matthiessen & Schwarz 1999). Therefore it seems obvious that a functional integrated Öresund Region will be better equipped to handle the challenges posed by the increasing global competition between cities and regions. During the last few decades changing Danish and Swedish national and regional governments have sought to bind the two parts of the Öresund Region closer together, in order to promote regional economic growth and increase competitiveness. In 2000 the opening of the fixed link across Öresund resulted in a significant increase in the number of vehicles and people crossing the Öresund, indicating a speed-up of the integration process. The integration process also spawned several bi-national institutions (both public and private) working to create one functional integrated region both in terms of finance, labour market, education, research and culture. Matthiessen (2004) examines functional integration in the Öresund Region both before and after the construction of the fixed link. Based upon data of the cross-Öresund traffic of people and vehicles as well as migration and commuting, he finds that the fixed link has had a modest positive effect on the integration of the two parts of the region. At the same time he identifies a number of barriers slowing down the integration process e.g. high toll on the bridge and differences in labour market and social laws. Bucken-Knapp (2001) pays attention to the importance of involving the everyday residents of the region in the creation of an integrated Öresund Region. According to Bucken-Knapp it is essential that it is not only the cultural and political elites who commit themselves to the Öresund project. For a full discussion on the border regional problem see Matthiessen (2004) and Knowles (2006).

Figure 1. Map of the Öresund Region



The present paper examines how the integration of the two parts of the Öresund Region is proceeding, but concentrates on the world of science and in particular the biotech industry. Biotech is selected as our area of interest because it is one of the centres of attention in the Öresund Region, when it comes to securing continued economic growth. The analysis identifies the volume of co-authorships between researchers from the Danish and Swedish parts of the Region, and it is carried out for each year in the period 1994-2005. During the analysis three four-year intervals are compared: 1994-1997, 1998-2001 and 2002-2005. Choosing these periods allows for comparison of the integration process both before and after the construction of the fixed link. Analysing the period 1994-2005 also presents an opportunity to examine the effects of one of the high profile bi-national institutions, Medicon Valley Academy¹ (MVA). Established in 1997, MVA is a member-financed, non-profit, network organisation working to strengthen the integration in the Öresund Region.

MVA aims to increase knowledge-sharing, innovation and competitiveness within the biotech and medico sectors in the Öresund Region (Medicon Valley Academy, 2006a). The volume of co-authorships can be seen as an image of the extent of collaboration between researchers in the two parts of the Region. Similarly the extent of collaboration is an indication of how the integration process is proceeding.

Biotech and regional growth

Biotech firms tend to locate in regions where the presence of higher-education institutions, research facilities and other biotech firms is high (Cooke, 2004). Especially important to biotech firms, is the state-of-the-art technology which such regions offer. Another characteristic is that large hospitals e.g. university hospitals play an important role in biotech R&D. Cooke also emphasizes the importance of a well-developed network between the firms and the research institutions. Furthermore McMillan et al. (2000) finds that private biotech firms are highly dependant on public basic research. Indeed publicly funded research plays a greater role within biotech than it does in most other sciences. This is in accordance with Liebeskind et al. (1996), who points to three characteristics within the biotech sector, which makes social networks important. First, the biotech sector is characterized by *hypercompetition*. This is due to rapid technological advances and innovation being an integrate part of the competition between biotech firms. As a consequence new products run the risk of being made obsolete within a relatively short period of time. Second, there is a high degree of *uncertainty* within the biotech sector. It is all but impossible for a biotech firm to predict which research projects will result in products ready for the market. Chances of a biomedical product making it onto the market, is no more than 10-20 %, and it is estimated that the average cost of developing a new product is around 800 million dollars (Medicon Valley Academy, 2005). This underlines the risks taken by firms who engage in biotech research and production. Finally, a large percentage

of the *top scientists* within biotech are employed at universities and university hospitals. As a result of this most of the R&D within biotech is centred in regions with large universities. In a Scandinavian context one such region is The Öresund Region and another is the Stockholm/Uppsala area. In light of this, the substantial agglomeration of around 300 biotech firms in The Öresund Region could in part be ascribed to the fact that the region is home to 12 universities; a relatively large number considering the size of the region.

According to Porter (2001; 2003) such agglomerations of firms into clusters are important if sustainable regional economic growth is to be secured. Inside the cluster the exchange of insights, knowledge and technology is conducted more easily between firms. This form of exchange emerges as a result of the close proximity of firms. Exchange of insights and knowledge between firms is best conducted in an environment dominated by trust, and trust is best created by face-to-face contact. Furthermore a cluster increases a firm's incentive to innovate, due to the fact that it is located in close proximity to other often rival firms. According to Cooke (2001; 958pp) some sort of equilibrium between competition and collaboration in a region is vital to the regions competitiveness, as is a general atmosphere of trust, both among firms and in the public sector. Indeed Cooke finds that regions, where there is a tradition for collaboration among firms, are more successful than regions dominated by intense rivalry.

The regional context has thus a major influence on the development and competitiveness of industries and businesses located in the region. Interactions between agents within the region have a great importance on the possibilities for creating innovative processes. It should however be noted that Audretsch & Stephan (1996) emphasize that biotech is a multidisciplinary science that draws upon knowledge from a wide range of different sources, and it is unlikely that a cluster based firm is able

to source all its inputs from within the cluster. Ties to external research institutions are thus often of great importance for firms inside the biotech sector.

A greater integration between the two parts of The Öresund Region would in all probability increase the biotech cluster's competitive advantages, and thereby help to insure economic growth in the future. The question is whether a new bi-national cluster is being developed on the basis of the two clusters in Greater Copenhagen and Scania?

Method

The analysis is carried out using SCIE. SCIE is part of the Thomson Scientific owned database Web of Science. SCIE contains approximately 5.900 of the worlds leading natural scientific journals within science, medicine and engineering classified into more than 150 disciplines (Thomson Scientific 2006). All contributions are provided with bibliographic descriptions, subject codes and full affiliations for all authors. It is therefore possible to conduct searches after criterions such as author, address, country, subject and year of publication.

The analysis is conducted at the webpage <http://isiknowledge.com>. By using the search function it is possible to extract the papers after the criterions mentioned above. Extraction after year of publication (1994-2005), address of the author (Danish part of the Öresund Region and Swedish part of the Öresund Region²) and subject (biotech³) is used in the analysis. It is thereby possible to observe the development in the number of co-authorships between the two parts of the Öresund Region during the examined period. The extracted publications are afterwards divided into four groups according to the character of the co-authorship. Co-authorships between:

- Danish public and Swedish public agents.

- Danish public and Swedish private agents.
- Danish private and Swedish private agents.
- Danish private and Swedish public agents.

Thereby it is possible to explore whether or not there has been a change in the importance of public and private agents from the beginning of the period to the end. Furthermore the analysis points out the agents who take an active part in the co-operation across the Öresund simply by counting the number of interactions⁴. Finally the observed development will be compared to the development in the number of co-authorships between the Öresund Region and four reference areas. Thereby it will be possible to assess whether or not the development between the Danish and Swedish parts of the Öresund Region is unusual or just part of a general tendency.

It is important to recognize that the use of data from SCIE is not unproblematic as pointed out by Matthiessen & Schwarz (1999). We have identified an additional problem as our research shows that it is not possible to use national specific characters such as the vocals æ, ø (both Danish), ä, ö (both Swedish) and å (used in both countries) in SCIE. This can cause problems in the search process as the English spelling of city names containing these letters may vary. The impact of this circumstance is minimized by searching for all possible combinations. The search will for instance in the case of the Danish place “Risø” both contain the spelling “Riso” and the spelling “Risoe”. Despite of these issues we find that the method is suitable for the current analysis.

The strength of the biotech sector in the Öresund Region

The first analysis carried out is one examining the scope of biotech research in the Öresund Region in an international perspective. The OECD countries⁵ are selected as a frame of reference because of the immense amount of research which is being carried out in these countries. In 2001 the OECD

countries published an estimated 82 % of all papers within science and engineering (OECD n.d.). Even though not directly transferable to biotech, it is assumed that the figures are at the same level. During the two periods, 1994-1997 and 1998-2001, 1,48 % of all biotech publications were produced in the Öresund Region. This amount declined to 1,44 % in the final period, 2002-2005 (Find 2006). The total population for the OECD countries is 1,2 billion people (OECD 2006a). The 3,6 million inhabitants in the Öresund Region (Örestat 2006) thereby constitute 0,3 % of the total OECD population. Compared to the population figures the share of biotech publications in the Öresund Region is approximately five times larger than expected. It can therefore be concluded that the region possesses a stronghold within biotech.

Co-authorships in the Öresund Region within biotech

The increase in the amount of co-authorships between authors from each part of the Öresund Region has been substantial during the investigated periods— both concerning biotech and science overall.

Figure 2. Co-authored papers across the Öresund

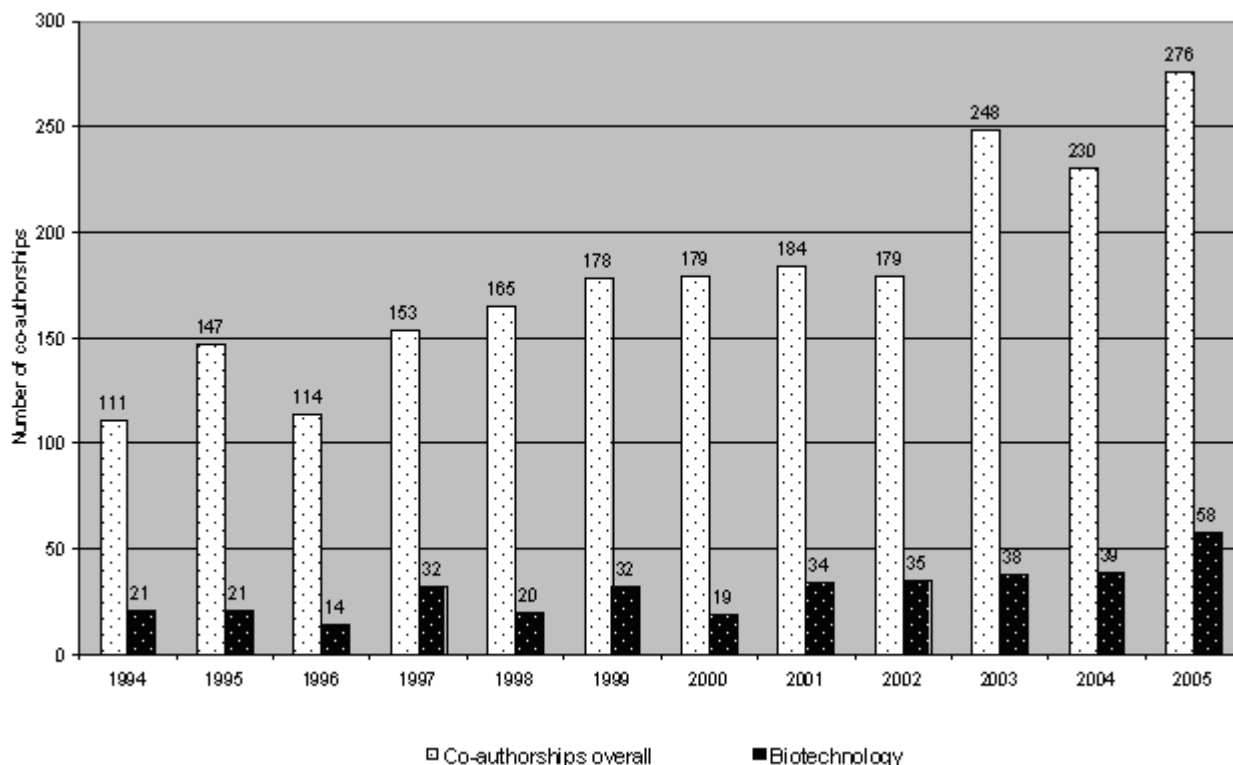


Figure 2 shows the amount of co-authored papers year by year. The trend is obvious as the numbers have more than doubled comparing 1994 with 2005 where biotech has tripled in the same period. The relative increase has been larger in biotech than within science in general when observing the increase over the three periods: 1994-1997, 1998-2001 and 2002-2005. This increase within biotech primarily takes place during the last period. The amount of biotech co-authorships produced during 2002-2005 is 93 % larger compared to the period 1994-1997. The similar percentage for science overall is 78 %.

Table 1. Number of biotech co-authored papers between the Danish and Swedish parts of the Öresund Region compared to the regions total number of biotech papers

	1994-1997	1998-2001	2002-2005
Total number of papers	7.107	8.448	8.935
Co-authored papers	88	105	170
Co-authored papers share of the total number of papers	1,24 %	1,24 %	1,90 %

The figures for the total number of biotech papers are provided by Søren Find.

It is important to notice that the increase in the number of biotech *co-authorships* stretching across the Öresund is not only a result of a growth in the total number of biotech publications. Table 1 demonstrates that the share of co-authorships within biotech was 1,24 % in the first two periods before rising considerably to 1,90 % in the final period.

Characteristics of the co-authorships

The aim of this part of the analysis is to provide a detailed account of the important biotechnological agents in the Öresund Region and their role in producing co-authorships. This will clarify if there is a shift in the importance of private and public institutions.

Table 2. Number of biotech co-authorships classified according to categories

	1994-1997	1998-2001	2002-2005
Danish public – Swedish public	76	87	132
Danish public - Swedish private	2	6	7
Danish private - Swedish private	1	2	7
Danish private - Swedish public	10	16	43
Total number of co-authorships	89	111	189

Table 2 lists the number of co-authorships within the four categories produced during each of the three periods. Several conclusions can be drawn from this table. *First*, the number of co-authorships increases in all four categories during the three periods. *Second*, there is a huge difference in the absolute number of publications. Co-authorships produced by Danish and Swedish public institutions account for a substantial part of the total number of co-authorships. *Third*, an increase in the number of co-authored papers between private agents is seen during all three periods, but the number is still very limited. An important reason for this is probably that firms do not have the same tradition for and incentives to publish results, as for instance universities, due to considerations regarding firm secrets. *Finally*, far more co-authorships are produced by Danish private and Swedish public agents than by Danish public and Swedish private agents. This is in part explained by the fact

that two thirds of the private biotechnological companies in the Öresund Region are located in the Danish part and that these firms on an average are larger than the Swedish measured by the amount of employees (Medicon Valley Academy 2006b).

The following section will analyse the interactions between the individual firms and institutions. This will make it possible to single out the most important agents in the production of biotech co-authorships between the two parts of the Öresund Region.

Interactions across Öresund

Illustrations showing the linkages for each of the three periods have been produced in order to visualize the development in interactions over time (figure 3). Only linkages with a minimum of five interactions have been included to ensure an overview.⁶

Figure 3. Interaction between agents across Öresund⁷



Figure 3.a. Period 1: 1994-1997

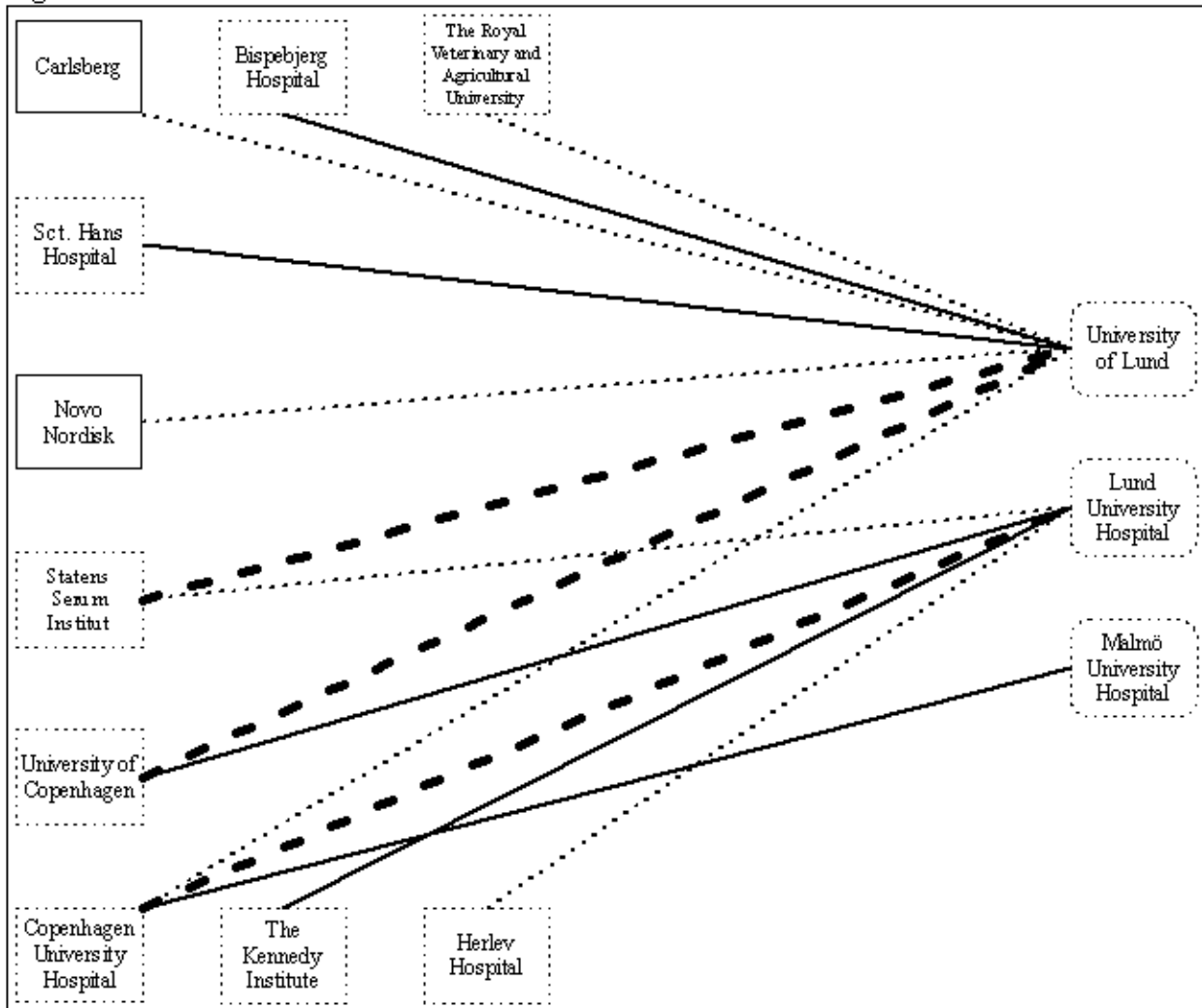


Figure 3.b. Period 2: 1998-2001

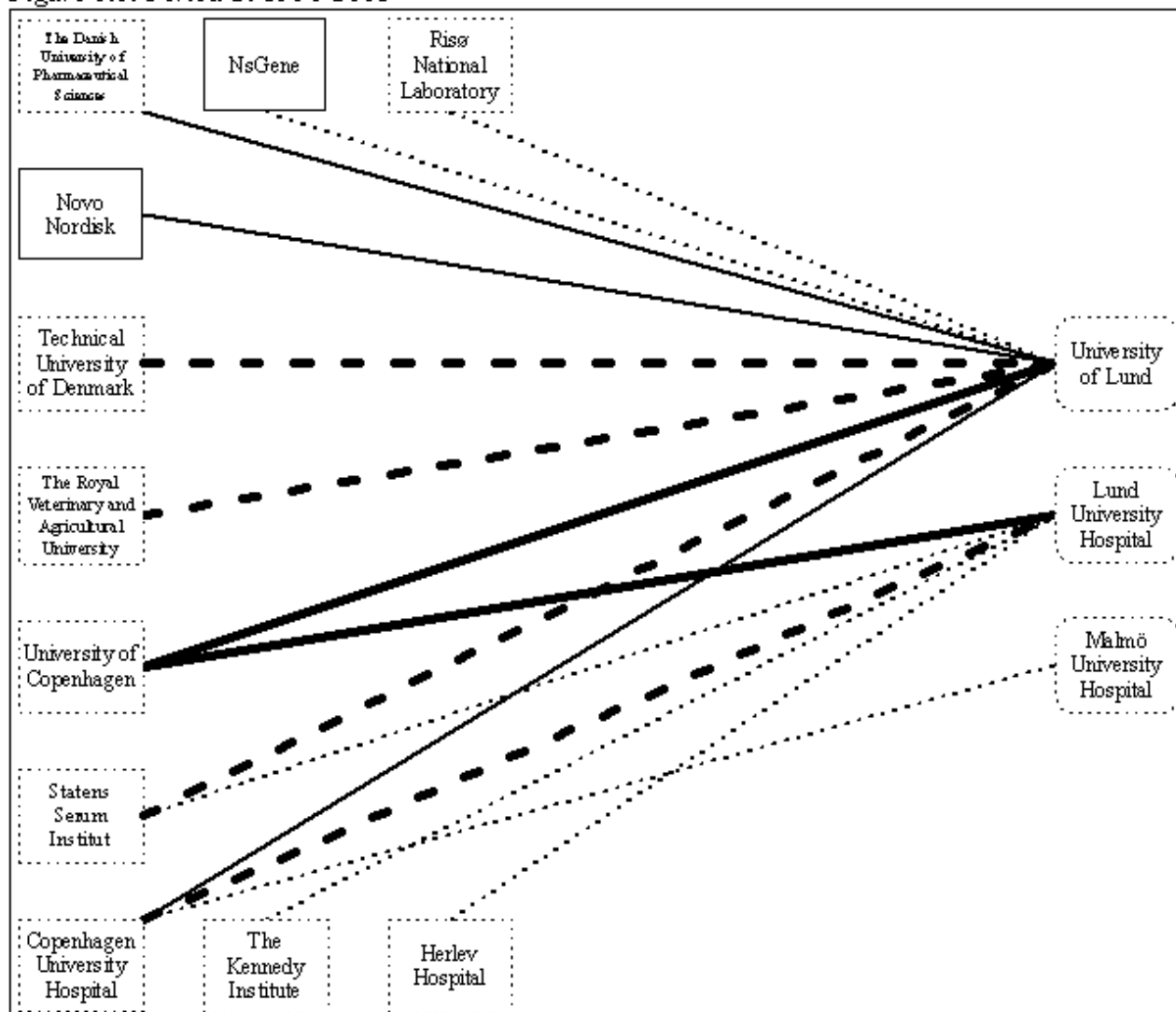
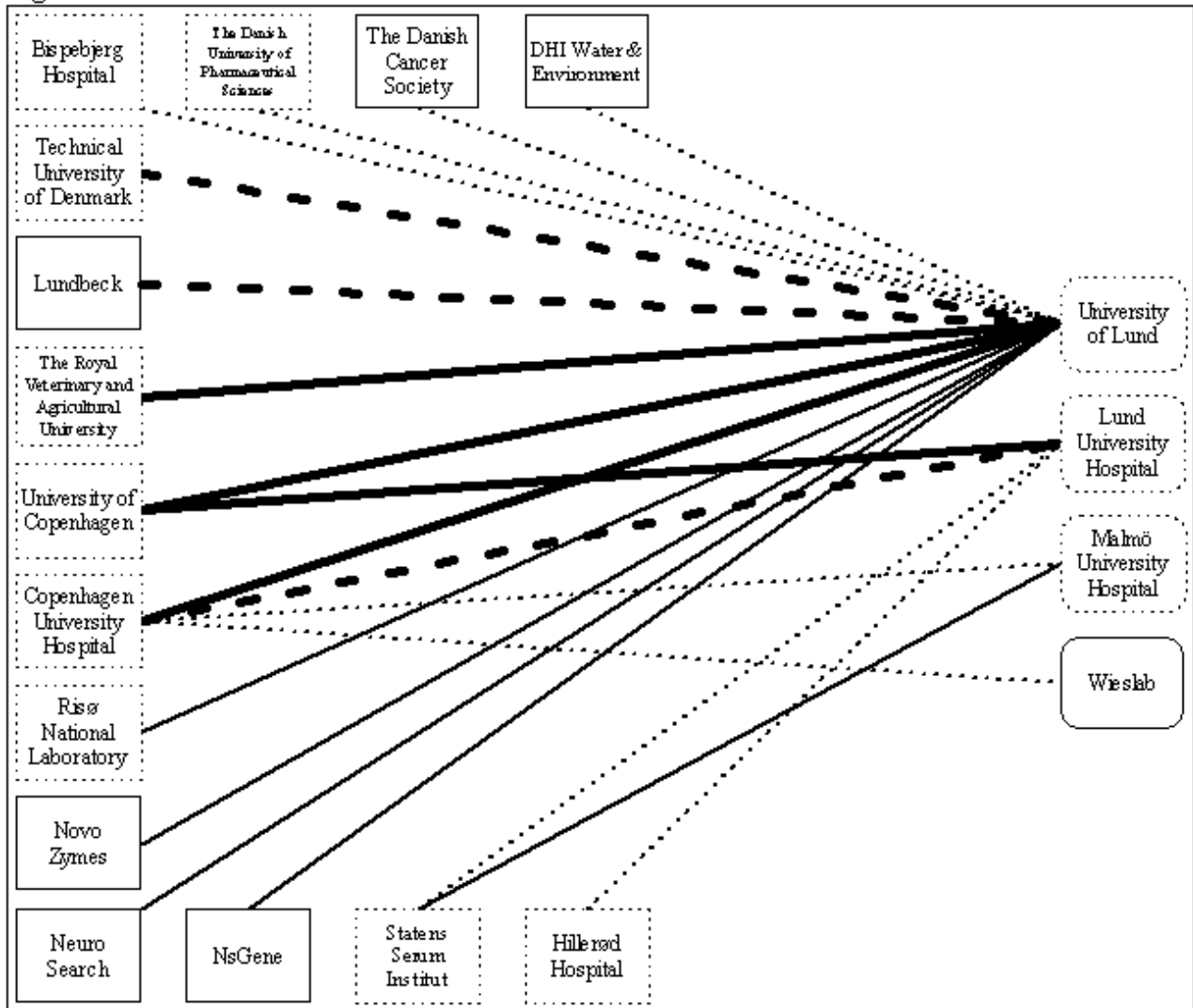


Figure 3.c. Period 3: 2002-2005



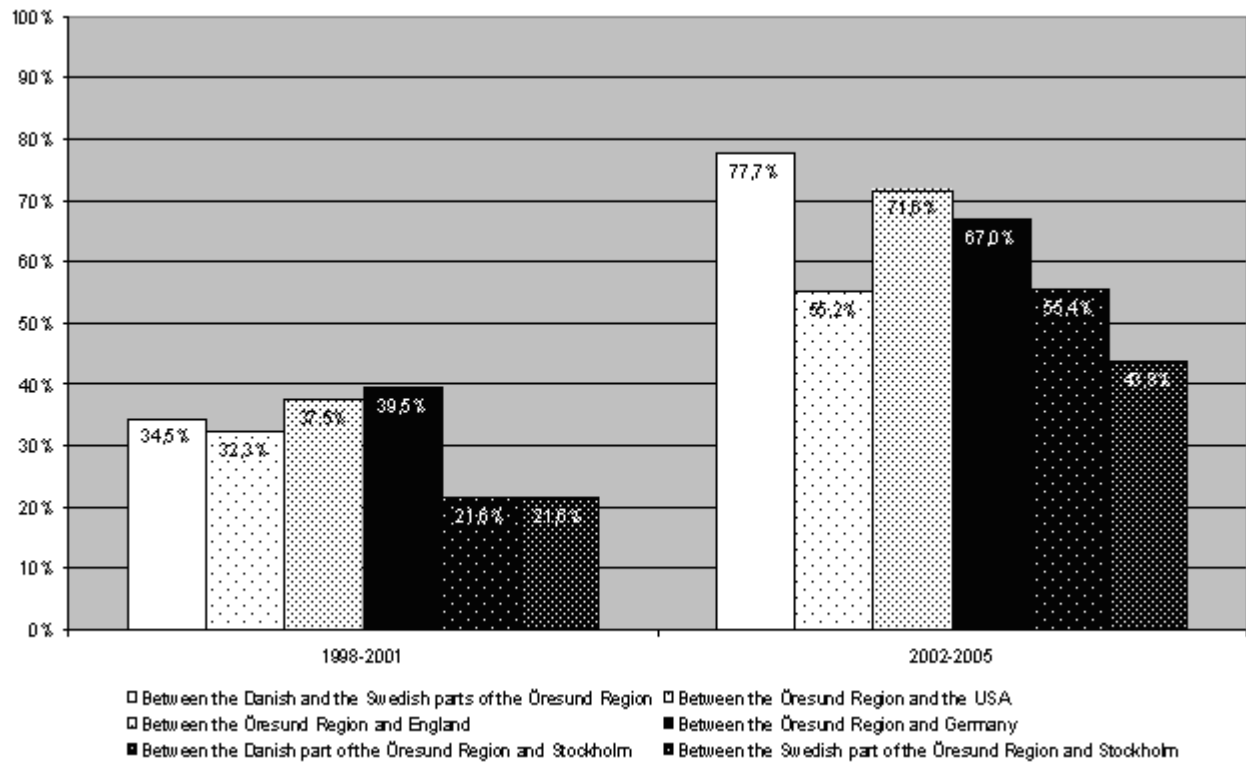
As is seen from figure 3 both the number of agents and the number of interactions increase during the 12 years examined. The increase is most notable in the final three-year period from 2002-2005 where the amount of linkages rises considerably. The figure also shows a clear difference between the Danish and Swedish side in regard to the importance of individual agents. The Swedish side is dominated by three institutions – the University of Lund, Lund University Hospital and Malmö University Hospital – while far more Danish institutions have a considerable importance. Only these three Swedish agents have at least five interactions throughout the 12 years whilst the corresponding number of Danish institutions is 14. The important role of the University of Lund is emphasized by the fact that the institution has 300 interactions during all three periods. This is almost

three times as many as the University of Copenhagen (103 interactions), which is the Danish agent with the highest number of interactions. It should also be noted that only one private Swedish firm (Wieslab) has a sufficient number of interactions to be included in figure 3. All other private agents are Danish and it is interesting to see that the University of Lund is the co-operating partner in each instance.

The Öresund Region compared to other regions with biotech strongholds

The development in co-authorships in the Öresund Region is compared to four selected reference areas in order to analyse if the increased interaction between the Swedish and Danish parts are significant in an international context. The central question is, to put it simply, whether the rise in the number of co-authorships in the Öresund Region is due to an increased integration or just a product of a general tendency towards a growing internationalization. The development internally in the Öresund Region is compared to the development between the Öresund Region and USA, England, Germany and the Stockholm Region. The development between the Öresund Region and Stockholm – which is a competing Scandinavian biotech centre – is analysed individually for the Danish and Swedish part of the Öresund Region with the purpose of uncovering potential internal differences in the collaboration with Stockholm.

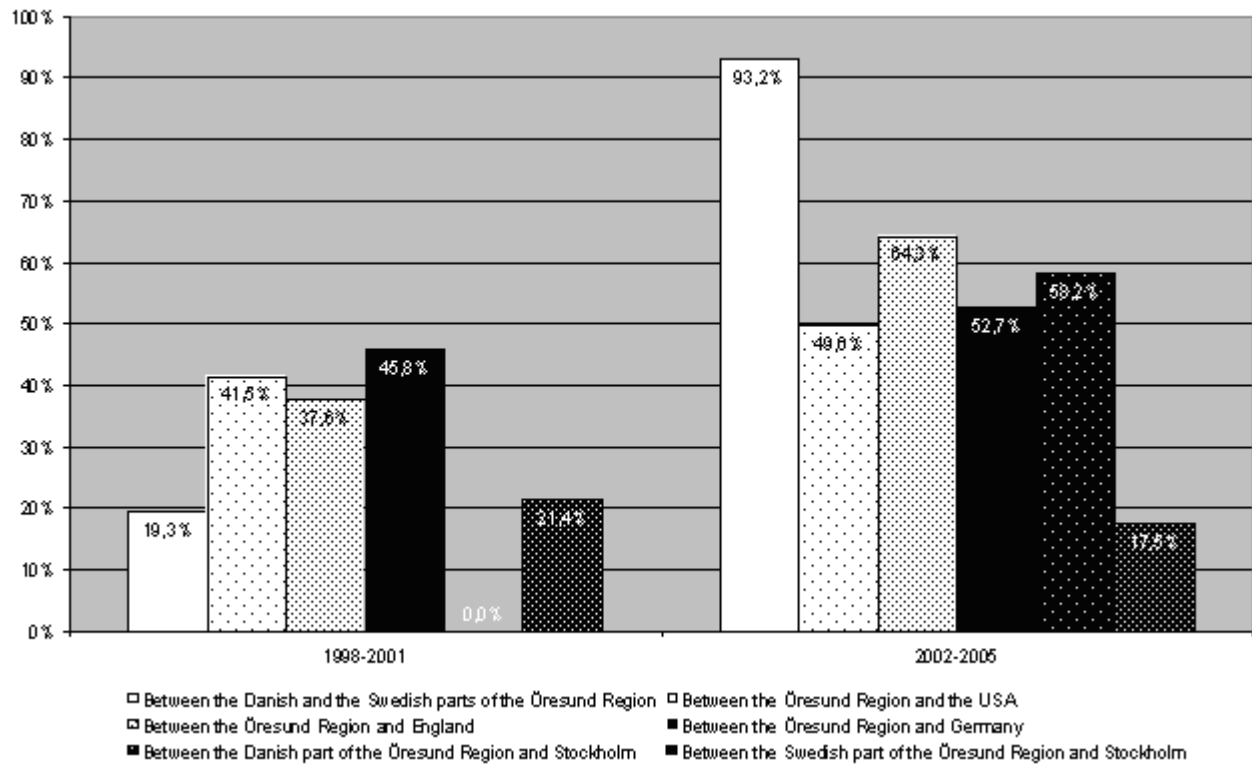
Figure 4. Percentage change in the total number of co-authorships compared to the period 1994-97



See appendix 1 for an overview of the absolute numbers of co-authorships.

Figure 4 displays an increase in the number of co-authorships in relation to all reference areas concerning co-authorships in general. The increase between the Danish and Swedish part of the Öresund Region is roughly the same as the reference areas in the period 1998-2001. In the last period however the increase in co-authorships in the Öresund Region is the largest by some margin. This indicates an increasing integration within the region, but the general increase in co-authorships between the Öresund Region and the four reference areas also shows that there is a tendency towards increasing international collaboration within the world of science.

Figure 5. Percentage change in the number of biotech co-authorships compared to the period 1994-97



See appendix 1 for an overview of the absolute numbers of co-authorships.

With regard to biotech there is also an increasing tendency in the Öresund Region to produce scientific papers with researchers from other regions. Figure 5 shows the number of biotech co-authorships in the last two periods compared to the period 1994-97. When comparing the two periods 1994-1997 and 1998-2001 it is seen that there has generally been a growth in the number of co-authorships. The only exception is the case of the Danish part of the Öresund Region and Stockholm where there were 122 co-authorships in both periods. The increase between the two parts of the Öresund Region is 19,3 % which is moderate compared to the reference areas. The highest increase is 45,8 % and is observed between the Öresund Region and Germany.

There is especially one remarkable observation, looking at the third and final period compared to 1994-1997: There has been a massive increase in the number of co-authorships between the Danish and the Swedish parts of the Öresund Region. The figure has almost doubled from 88 in 1994-1997

to 170 in 2002-2005 corresponding to a growth of some 93,2 %. This is by far larger than any of the four reference areas and it is therefore a strong indication of an increased integration between the two parts of the region. The second largest increase is observed between the Öresund Region and England. Here the number of co-authorships is 64,3 % higher in 2002-2005.

Another interesting conclusion drawn from figure 5 is that the increase in the number of co-authorships between the Swedish part of the Öresund Region and Stockholm has been limited. In fact the number of co-authorships produced between 2002 and 2005 was smaller than during the years 1998 to 2001. Seen in connection with the internal increase in the Öresund Region this may indicate that Scanian agents increasingly orientate themselves towards the Danish part of the Öresund Region at the expense of Stockholm. It should also be noted that at the same time the number of co-authorships between the Danish part of the Öresund region and Stockholm has risen noticeably compared to the first two periods.

Discussion

The observed development in the number of co-authorships between the Danish and Swedish parts of the Öresund Region is by all accounts influenced by the year 2000 opening of the fixed link since the time/distance barrier between Copenhagen and Malmö/Lund has been reduced from 60 minutes to 10 minutes (Matthiessen 2004). As a result the conditions for co-operation across Öresund have been improved remarkably since the travelling time between the Danish and Swedish parts of the region has been reduced significantly. According to Matthiessen the bridge has led to a notable increase in both the number of vehicles and persons crossing Öresund. Face-to-face contact is of great importance for the biotech sector as Audretsch & Stephan (1996) demonstrate and it can therefore be assumed that the construction of the fixed link has led to an increased competitiveness for the

firms of the region within this sector. There is however still room for improvement as a relatively high toll for crossing prevents the region from taking the full advantage of the possibilities offered by the fixed link.

As our study shows both the Danish and the Swedish public research institutions are responsible for the vast majority of co-authorships. This is in line with the findings of McMillan et al. (2000) and Liebeskind et al. (1996) which were discussed previously: They both find that universities and hospitals are usually responsible for a significant part of the research conducted within biotech. There is however reason to believe that the number of co-authorships produced by firms and other private institutions may increase in the future; 59 % of the companies located in the Danish part of the Öresund Region are expecting to intensify activities in the Swedish part within the next 3-5 years, and the corresponding figure for Swedish firms is 54 % according to a survey conducted in April 2005 by The Öresund Chamber of Industry and Commerce (2005). These figures are considerably higher than the results found when the same survey was carried out one year earlier; the figures for the Danish and Swedish companies were respectively 47 % and 38 % in 2004. This indicates a growing attention by firms towards the possibilities offered by the region as a whole.

So far, the firms that do engage in co-authorships are mainly Danish (table 2). As mentioned previously this is in part due to differences in the number of firms. It is however surprising that the disparity is this significant. Part of the explanation may be that the biotech research facilities in Lund have very high standards. Especially the Biomedical Centre (BMC) in Lund is an attractive collaborating partner for Danish firms (Hansen & Hansen 2006). The high standards of BMC could also lower the incentives for Scanian companies to co-operate with Danish institutions. After all, when firms have the demanded inputs nearby it is most often easier to use these instead of inputs localised

outside of the local area. Another possible reason is that Danish biotech firms attract many Swedish employees. This is mainly due to differences in the unemployment rate (Eurostat 2006) and wages (Örestat 2006) between the two countries which for instance has led to a massive advertising for labour by Danish firms in Swedish newspapers (The Öresund Chamber of Industry and Commerce 2005). The implication of this development is that the Danish firms via their Swedish employees strengthen their networks within Scania. Because of the strong ties to Scania the firms are more likely to produce co-authorships – both with public and private Swedish agents.

It is seen from figure 3 that a far greater number of public Danish institutions than Swedish are involved in the writing of co-authorships. This is partly due to the way in which the higher education systems are arranged in the two parts of the region. Almost all scientific disciplines are represented at the University of Lund, whereas the higher education system is more decentralized in the Danish part of the region. In addition to the University of Copenhagen there is a range of other often specialized universities in the Copenhagen area – The Technical University of Denmark and The Royal Veterinary and Agricultural University are examples of such institutions.⁸ Secondly, it can also be argued that Copenhagen as the capital city naturally will have more public institutions located than major provincial towns as Malmö and Lund.

Agents in the Danish part of the Öresund Region are increasingly producing co-authored papers with agents in the Stockholm area as pointed out previously. An explanation may be that the increased co-operation and creation of networks across the Öresund also results in the establishment of connections between the Danish part of the region and Stockholm – when networks to Scania are strengthened it also improves the possibilities of creating relations to the Stockholm area. At the same time there seems to be a tendency for the co-operation between the Swedish part of the region

and Stockholm to be declining. As the bi-national cluster across the Öresund develops, the need and incentives for Scania based researchers to collaborate with researchers in Stockholm may diminish, but as of now co-authorships between the Swedish part of the Öresund Region and Stockholm still far outnumber co-authorships internally in the Öresund Region.

Comparing figures 4 and 5 it is clear that the increase in co-authorships between the two parts of the Öresund Region related to biotech is in excess of 15 % above the increase in co-authorships overall. An important reason for this is probably the efforts made by MVA. MVA has created a strong brand which in turn has increased the possibility to draw attention towards the strength and the quality of the biotech cluster in the region. This is of course important with regard to external agents, but it is also vital in strengthening the internal ties in the region. As MVA furthermore acts as a platform for interaction between agents it is reasonable to assume that the organization has played an important role in the integration process between the two parts of the Öresund Region within the biotech sector.

Conclusion

Our study has provided insight into the current integration process between the Danish and the Swedish part of the Öresund Region within the world of science, more specifically within biotech. This sector has been examined because it is of considerable importance for the economic development of the region. Furthermore the biotech sector requires access to well-developed networks, skilled labour and the most recent scientific results as it is also illustrated by the examined literature. This means that especially this sector will benefit from a more integrated Öresund Region.

By investigating the development in the number of co-authorships from 1994 to 2005, our study has

provided an indication on how the integration in the region is proceeding. A main finding is that there has been a substantial increase in both the number of all co-authorships and co-authorships within the biotech sector. In relative terms the rise is largest with regard to biotech. The increase is mainly due to intensified co-operation between Danish and Swedish public institutions, but a rising importance of the collaboration between public Swedish and private Danish agents can also be observed. The importance of private agents is still modest compared to the public agents, but it is however rising.

When looking at the individual interactions between agents it is seen that a substantial higher number of Danish agents are involved in the writing of co-authorships compared to the number of Swedish agents. There are a few Swedish institutions – most notably the University of Lund – which are heavily involved in co-operation with Danish agents, but the number of private Swedish agents who participate in such collaborations is very limited. This is in part due to the different structures of the university systems in the two parts of the region, where the Swedish system is more centralized than the Danish.

Finally, our study has also shown that the rise in the number of co-authorships within the Öresund region is significant seen from an international perspective – especially concerning the biotech sector. Compared to the four reference areas (USA, England, Germany and the Stockholm Region) it is found that the relative increase within the Öresund Region is the largest with regard to all co-authorships. The relative increase is by far larger than that of any of the reference areas when looking solely at the biotech sector. The figures also indicate that the Swedish part of the region is increasingly orientating itself towards the Danish part of the region at the expense of the Stockholm area. All in all our analysis indicates a growing functional integration within the world of science in

the Öresund Region – and it is a very strong indication of an increasing functional integration within the biotech sector specifically. This suggests that the bi-national biotech cluster in the Öresund Region is on its way to being fully developed thereby helping to ensure the economic growth in the future.

As a concluding remark it must be stressed that the results found in this study is not directly transferable to all other types of industries. Thus this analysis alone does not make it possible to describe the general progress of the integration in the Öresund Region. There may for instance be considerable differences between more and less knowledge intensive industries. A less knowledge intensive industry, e.g. logistics, is also of great importance for the economic development in the Öresund Region and it would therefore be interesting to examine how the integration processes elapses within this sector. The attitudes and actions of everyday residents in the region are also of importance. Bucken-Knapp (2001; 51) notes that “... *in order to study whether the considerable efforts at establishing a cross border metropolitan region will be successful, it becomes necessary to benchmark the attitudes and behaviour of everyday residents in the Øresund*”. Our study has provided conclusions about integration succes within the biotech sector, but in a long term perspective economic growth is dependent on a broad integration, and in-depth studies of other sectors are therefore also needed.

Acknowledgments

This paper is based on a substantial collection of data which can be found in its full form in Hansen & Hansen (2006). We appreciate greatly the data provided by Søren Find (D’ARC, Technical University of Denmark).

Appendix

The development in the number of co-authorships between the different areas

	1994-1997	1998-2001	2002-2005
The Danish and the Swedish part of the Öresund Region			
Total number of co-authorships	525	706	933
Number of co-authorships within biotech	88	105	170
The Öresund Region and the USA			
Total number of co-authorships	3.847	5.089	5.969
Number of co-authorships within biotech	844	1.194	1.263
The Öresund Region and England			
Total number of co-authorships	1.989	2.735	3.414
Number of co-authorships within biotech	428	589	703
The Öresund Region and Germany			
Total number of co-authorships	2.152	3.003	3.593
Number of co-authorships within biotech	461	672	704
The Danish part of the Öresund Region and Stockholm			
Total number of co-authorships	514	625	799
Number of co-authorships within biotech	122	122	193
The Swedish part of the Öresund Region and Stockholm			
Total number of co-authorships	927	1.127	1.333
Number of co-authorships within biotech	206	250	242

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¹ Medicon Valley Academy is one of eight platforms within Öresund Science Region, a trans-national institution that aims to promote the presence of high tech industries and skilled labour in the Öresund Region. The five other platforms are: Öresund Logistics, Nano Öresund, Diginet Öresund, Öresund IT Academy, Öresund Environment Academy, Humanities Öresund and Öresund Food Network (Öresund Science Region 2006).

² Since the Öresund region is neither a city nor a country it is necessary to identify all the cities in the region who has published biotechnological papers in the period 1994-2005. The actual search is then performed by using these city names.

³ Biotech is defined on the basis of the definition used by VINNOVA (The Swedish Governmental Agency for Innovation Systems) in the report "Swedish Biotech – scientific publications, patenting and industrial development". The report singles out the disciplines in SCIE which are considered part of biotech by using OECD's definition of biotech (Sandström & Norgren 2003). The disciplines are the following eleven: Biochemistry & Molecular biology, Biomedical engineering, Biophysics, Biotech & Applied microbiology, Cell biology, Genetics & Heredity, Immunology, Medicinal chemistry, Microbiology, Neurosciences and Virology.

⁴ Interaction is here defined as the co-operation between two or more agents in the writing of scientific papers.

⁵ The OECD-membership countries are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States (OECD 2006b).

⁶ For a detailed account of all interactions please see Hansen & Hansen (2006).

⁷ The Royal Veterinary and Agricultural University and The Danish University of Pharmaceutical Sciences have become part of the University of Copenhagen as of January 1st 2007 and are now respectively called the Faculty of Life Sciences and The Faculty of Pharmaceutical Sciences.

⁸ This decentralized model has changed to some degree due to the reform of the Danish higher education system by January 1st 2007.