Internal Draft Summary Report BSR InnoNet WP4

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Content

Preface

This report is a summary of the work done in the analysts' working group (WP4) of the BSR InnoNet on clusters in the Baltic Sea Region since the project's start-up in September 2006 – and a short overview of the coming tasks and ideas.

The report is written by the WP4 core team – Emily Wise, Markus Bjerre and Marie Degn Bertelsen. Parts of the inputs and text are supplied by Copenhagen Economics (represented by Martin Hvidt Thelle, Anne Raaby Olsen, and Mikkel Egede Birkeland). Jørgen Rosted (Director, FORA) and Jens-Erik Lund (Coordinator, BSR InnoNet) have contributed with useful comments and ideas.

The report is structured in the following five chapters and appendices:

Chapter 1 sets the theoretical frame for the analytical work within the BSR InnoNet and outlines the background of the BSR InnoNet project and the analytical work of the working group WP4.

Chapter 2 describes the development and substance of the BSR Cluster Database. It describes the structure and content, as well as the methods and standards used for data collection. The chapter ends with a description of the assessment and adjustment of the cluster code to group industries into clusters in the BSR.

Chapter 3 focuses on analysis of cluster dynamics i.e. clusters' compositions, development, and impact on the development of the regional economy. It starts out by introducing a number of illustrations for analyzing cluster dynamics at a regional level. In addition, an initial overview of cluster dynamics at the national level in the Baltic Sea Region is presented. Lastly, the chapter outlines some preliminary analyses on the important question: *"Do clusters matter for economic performance?"*. The method, some initial results, and scope for further analysis are described.

Chapter 4 introduces the criteria system developed for selecting a cluster for benchmarking cluster-specific framework conditions in the BSR. The criteria used are described in detail, and the explanation for why the Biopharmaceutical cluster is selected is outlined.

Chapter 5 introduces the next step of WP4 activities – the pilot on benchmarking cluster-specific framework conditions. Preliminary ideas on the benchmarking model and data collection are presented.

The appendices provide background information on location analysis of local industries and illustrations of cluster performance at the national level in the BSR.

1. Introduction

The global map of businesses is increasingly dominated by geographically concentrated groups of companies and related economic actors and institutions. These are called industry clusters, clusters of knowledge, or simply just clusters. Companies inside these different kinds of related units are remarkably good at creating jobs, high wages and surplus. The success is attributed to clusters being an effective set-up for spurring innovation and competitiveness.

A range of international studies indicates that something interesting is going on inside these clusters. The actors draw on some advantages from their mutual proximity and connections, and the advantages seem to increase in line with the rise of "the innovative society". As the key competitive factor is no longer the price/quality ratio but the ability to use competencies and knowledge to launch new innovations, the dynamics in clusters are changing, and the need for a competitive environment for innovation is even more important. Today, it is widely accepted that clusters and clustering processes have a positive impact on innovation and economic growth.

In light of this knowledge, a large number of countries and regions have embraced the concept of clusters. All over the world, people and institutions work on developing clusters through specific initiatives[1] and programmes. And it is widely understood that some of the most successful regions/countries understand how to develop competencies and knowledge inside clusters and knowledge units.

This understanding has catalyzed a lot of work on identifying and understanding the mechanisms that spur the success of clusters, and on evaluating the various policies, initiatives, and programmes undertaken to support cluster development.

From the view of public organizations and policy makers, it is crucial first of all to illustrate *if* the public has a role to play in spurring and developing innovative and competitive clusters. And secondly, it is crucial to study how this potential role is addressed most effectively. So the central questions to ask are:

**"What is the actual impact of policy instruments,
initiatives, and programmes related to clusters?"**

**"What does this impact mean for
the national/regional cluster strategies?"**

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[1] "Cluster initiatives" are viewed as activities (e.g. knowledge-sharing or match-making) targeted at a specific cluster or groups of clusters (through a "cluster programme," for example).

1.1. Theoretical frame for cluster analysis[2]

It is important to stress that clusters are not a new phenomenon. Clusters have existed since the rise of civilized activity and are natural entities in which companies develop. This also means that creating clusters from the bare ground is neither an easy nor even a desirable thing for policy makers or public institutions to engage in – all too often, attempts to form new cluster strongholds from the ground have failed.

But even though cluster creation is not a plausible way for policy makers to enhance competitiveness and economic growth, it is generally understood that the positive dynamics in *existing* clusters can be supported by the public – and that initiatives aimed at improving the cluster environment for innovation can catalyze better performance in existing clusters.

Over the last decade, the public sector in many countries has understood the links between clustering processes and innovation. This has led to increasing public investment in cluster development through different types of innovation programmes and cluster support mechanisms.

As a result of the increasing levels of investment in this type of support, there is an increasing demand from policy makers to understand the resulting impact and to be able to fact-base policy formulation. Policy makers pose questions such as:

- How does public support – through what can be called 'cluster policy' – have an impact on cluster performance?
- How does cluster performance impact regional/national economic growth?
- What are the critical framework conditions for cluster development?
- Where should the public sector focus their support?

One way of answering these questions is through systematic international benchmarking. In short, this means testing the link between cluster performance and what can be called cluster-specific framework conditions or "the cluster environment for innovation". If it is possible to find a link between the regions/countries with the most successful cluster(s) and the existence of specific framework conditions in these regions/countries, it gives a unique possibility to learn from the framework conditions applied in the best-performing regions/countries.

To develop a model based on systematic, international benchmarking, it is crucial to discuss the primary assumptions. First, it is important to clarify the used perspective on clusters, and second, it is important to acknowledge the broad range of initiatives that can be taken to support cluster environment. The next two sections address these topics.

[2] Based partly on the Background Paper presented at the BSR InnoNet workshop "Using statistical cluster data", May 2007, Copenhagen.

1.1.1. Perspectives on clusters[3]

There are a number of ways to describe the economic and innovative landscape of a nation. Over the past fifteen years, *clusters* have become an increasingly popular way not only of describing the landscape, but also of structuring the action agenda.

There are many different views on the definition of a cluster. It is perhaps not so important to agree on a common definition of clusters, but rather to understand the perspective from which one is speaking.

Firstly, it is important to stress that clusters are not defined by organizational membership. Clusters are based on relationships between firms and related actors. These relationships can be more or less formalized - ranging from informal knowledge sharing and taking benefit of the same skilled labor force to a cluster organization gathering cluster actors in a formal association.

Secondly, the basis for clusters is some kind of externalities – both hard and soft. The hard externalities being e.g. access to a larger pool of qualified and specialized suppliers, services, potential partners and skilled labor. The soft externalities being more focused on tacit knowledge on technology, consumers, trends etc., access to new networks and aggregated information on interests and needs.

Finally, the core of cluster thinking is related to localization and concentration – this means that clusters are to some extent geographically bound. The range of a cluster can differ, but for actors to get advantage of the "cluster externalities" or "cluster effects", they need to be concentrated in a bounded area.

Box - What is a cluster?

A cluster is a group of companies and related actors within a specialized industry or knowledge area, or actors facing the same challenges. Geographical concentration and mutual relations creates common competencies, dynamics and synergies - spurring quality and innovation. A cluster can be seen as a specialized, regional innovation system with relatively high productivity.

Clusters are often linked in the same value chain or by the same knowledge base – and to some extent share market, technology, demands, and surrounding framework conditions. The geographical concentration spurs formal and informal knowledge exchange and exchange of a common pool of qualified work force.

Clusters can be very different in geographical concentration. Some clusters are located in a very limited area; others cover larger areas. But the geographical concentration is an important component since exchange of both tacit and tangible knowledge and of knowledge workers is closely linked to local people and local knowledge institutions. Also, the interaction between professional and social networks is an essential part of what characterizes and cements the cluster.

Source: REG LAB 2008, www.reglab.dk

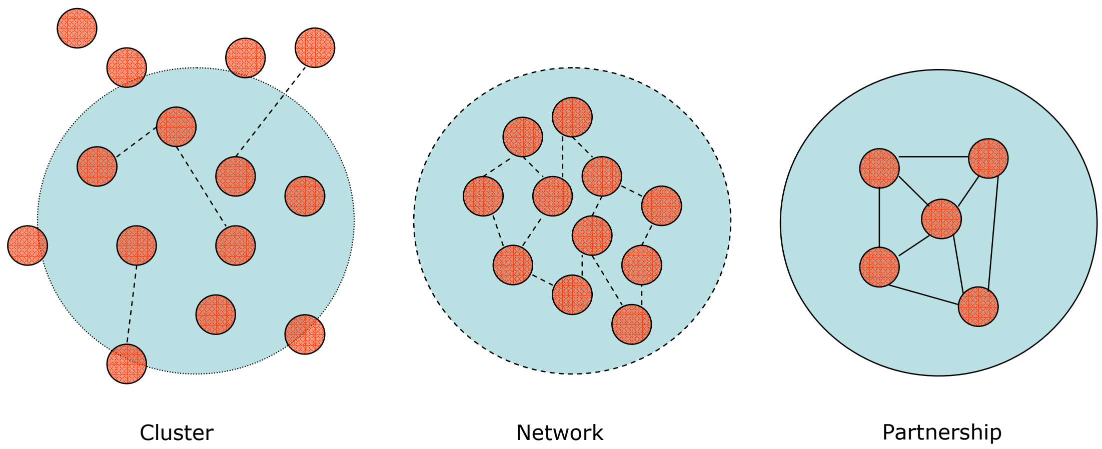
Another way of illustrating the different perspectives of clusters is to distinguish between clusters, networks, and partnerships.[4]

[3] This section builds on inspiration from several cluster experts – among others Stuart Rosenfeld and Alec Hansson.

As mentioned above, clusters are geographical units of co-located companies not bound by formal membership or commitment. In the literature, these units are often named "clutter clusters" to illustrate a pot of more or less unorganized actors. All companies and related actors in a specific area can be seen as a part of the cluster. The actors need not acknowledge the cluster concept themselves but unconsciously take advantage of the business environment surrounding the cluster.

A related concept is networks or membership associations. Networks are more binding than clusters. Networks are often about gathering related actors in meetings and conferences with the aim of building trust, sharing informal knowledge and discussing the challenges and needs of the members.

Companies and related actors can also interact in so-called partnerships - in some connections named "hard networks" or "strategic partnerships". These kinds of networks tend to be binding for the participants and closed for outsiders. Often partnerships focus on concrete collaboration or joint development of new innovative concepts, solutions or products.



Partnerships and networks often originate from a cluster. Network members are often a subset of cluster actors that have acknowledged the need for a more formal cluster concept. And in some cases, a subset of these network members set up more formalized partnerships springing from the informal contacts and recognitions made in the network.

In broad terms, clusters can be viewed from the "top-down" perspective, or from the "bottom-up" perspective. Both perspectives are equally important, but for distinctly different reasons.

The illustration below attempts to describe these two perspectives.

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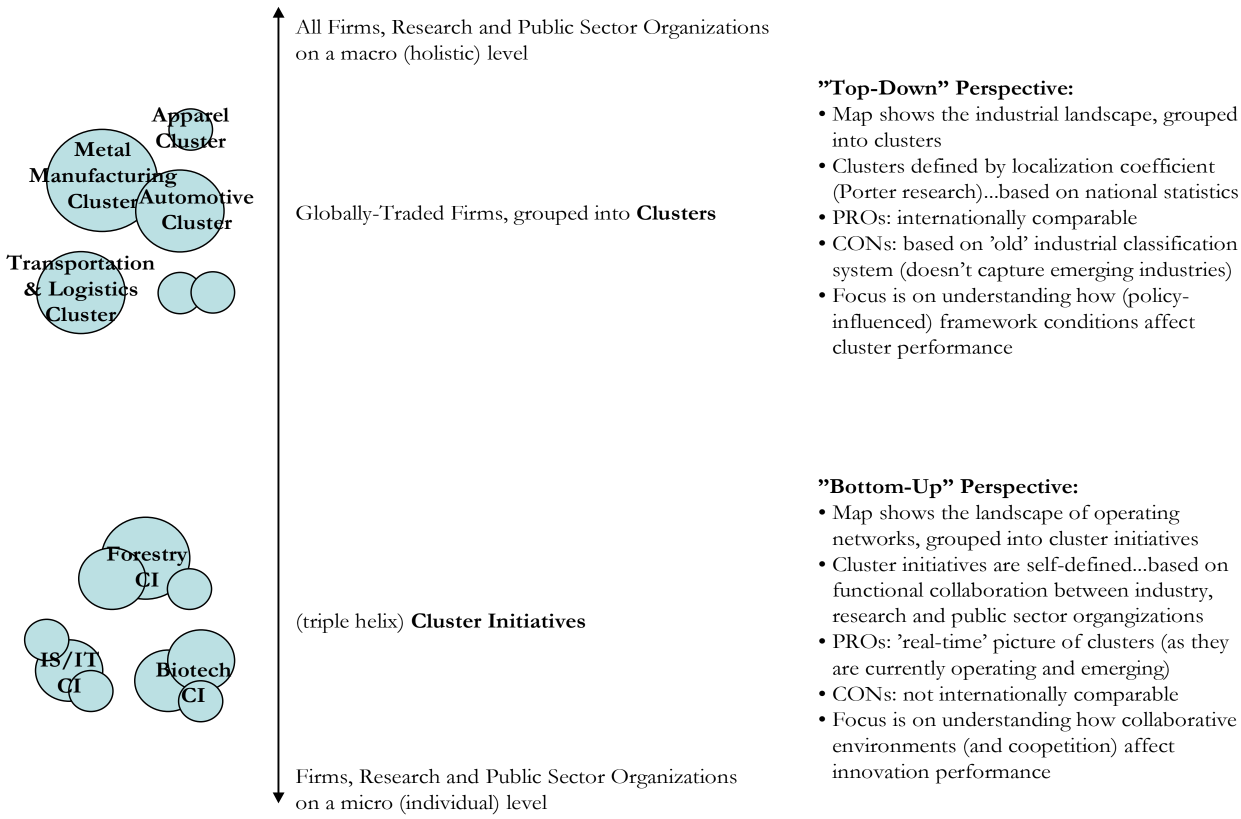
[4] Inspiration from Phil Cooke and Melvin Morgan (1998); rtsinc.org

Illustration – Perspectives on Clusters



A "top-down" perspective of clusters provides a view of specialization patterns within the business environment of a given geography. This perspective can be used to:

> understand the overall composition of the business environment (e.g. which clusters account for what levels of employment and productivity)
> understand the general trends (e.g. what clusters are growing or shrinking)
> have an overall view of how one geography compares to another/international benchmarking (e.g. what drives the economy of one country compared to another, and how has this changed over time)

A "bottom-up" perspective of clusters provides a view of collaboration patterns within the business environment of a given geography. This perspective can be used to:

> better understand a geography's social capital (e.g. labor mobility, the evolution of business networks, etc.)
> provide clues to the future specialization patterns within the business environment (e.g. which types of industries will work together)
> provide input to investments in research and education (e.g. what areas of research are growing in demand; how are research institutes and universities incorporated into the innovation process)

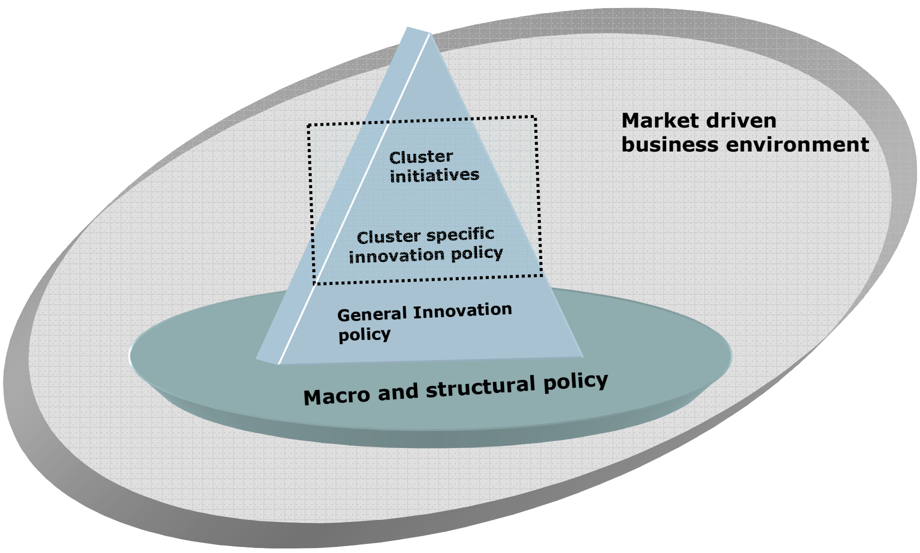
Both perspectives provide useful and important input to policy makers. However, only the first perspective can provide internationally comparable information.

1.1.2. The Cluster Environment

The range of public policies and initiatives for improving the conditions for cluster development is broad - from the establishment of a cluster organization that promotes networking, common branding etc. to strategic national cluster policy aimed at strengthening collaboration for innovation. All of these initiatives are taken to build and support the environment in which clusters develop. It is important to acknowledge that each type of initiative has its own purpose, and that different initiatives are complementary - not contradictory.[5]

Public policies and initiatives aiming at supporting cluster development must however be seen as *part* of an overall environment in which clusters navigate, the so-called "cluster environment" - see illustration below.

Illustration - The cluster environment



The cluster environment consists of three dimensions – the market driven, the basic policy framework, and the innovation policy framework.

The market-driven business environment surrounds the policy framework and includes factors such as suppliers, local competition, inputs, labor market, etc. The market-driven business environment can, from a policy perspective, be seen as a set of "outside" factors that affect the competitive advantages of clusters. These factors are not directly a part of the policy framework but still equally important for the clusters.

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[5] In this paper, we equate cluster initiatives, cluster activities and cluster programmes i.e. initiatives taken to support and develop specific clusters.

The basic policy framework is based on macro and structural policies. These policies are the foundation on which industries operate – macro and structural policies need to be operational and well-functioning for industries and clusters to have the best competitive platform.

On top of these fundamental polices lies what could be called the pyramid of innovation policy. Today's global competition is concentrated on innovation and the ability to handle innovative processes. This puts an increasingly higher weight on the need for well-designed innovation policy.

The bottom layer of the innovative pyramid represents horizontal or general innovation policies – these polices include national and regional innovation programmes and innovation systems.

The middle layer of the pyramid represents cluster-specific innovation policy – these policies are targeted at the innovative competitiveness of clusters.

The top layer of the pyramid represents cluster programmes or cluster initiatives – these policies focus on collaboration between and organization of companies and supporting actors in specific cluster initiatives.

See the box below for further elaboration on the layers of the innovative pyramid.

Illustration - Elements of the innovative pyramid

- **General/horizontal innovation policy**
  - Benefits all companies.
  - E.g. one-stop-shop for entrepreneurs
- **Cluster-specific innovation policy**
  - Benefits all companies in a specific cluster or sector
  - E.g. specialized knowledge institutions or one-stop-shops for entrepreneurs in the textile industry
- **Publicly-funded cluster initiatives or programmes**
  - Benefits companies and related actors in specific cluster initiatives
  - E.g. cluster facilitation/organizations, match-making or cluster programmes (Arena, Vinnväxt).

It is important to stress that all the elements in the policy framework and the market-driven business environment serve as a base for development of clusters. And the initiatives targeted at these elements can be seen as an iterative process over time to improve the cluster environment.

A lot of work has already been done on analyzing and documenting the effect and importance of the general business environment, the macro/structural polices and the general innovation policy (the surroundings and bottom of the pyramid). The main scope of the analytical work in the BSR InnoNet is to develop a tool for analyzing and prioritizing the two upper layers of the innovative pyramid – called the **cluster-specific framework conditions**.

The main objective is to develop a fact-based tool for policy makers to understand how different cluster policies and initiatives affect the innovation capacity (and thus performance) of clusters. With a deeper understanding of these relationships, policy makers would be able to analyze and prioritize among alternative policy actions.

Policy is fact-based when it is derived based on concrete and measurable information or data. This is contrasted with policies that are derived based on opinion, qualitative assessments, or political priorities.

In this regard, there is a clear distinction between descriptions and data. *Descriptions* are useful for understanding details surrounding a particular cluster initiative (for instance), and are a useful method for bench-learning. However, descriptions are rarely systematically defined, and are not analytically comparable. In contrast, *data* or indicators are defined in a systematic way in order to provide data points that can be used for various analyses (e.g. benchmarking, statistical/relationship analysis, sensitivity analysis, etc.).

1.2. The BSR InnoNet and Work Package 4

This section gives a short introduction of the BSR InnoNet project, followed by a description of the analytical work of WP4.

1.2.1. Background[6]

The BSR InnoNet (The Baltic Sea Region Innovation Network) is an INNO Net project under the PRO INNO Europe initiative established by DG Enterprise and Industry at the European Commission. The project runs from September 2006 to August 2009.

The BSR InnoNet project intends to create operational and long-term links between innovation policy makers, implementing agencies and analysts in the Baltic Sea Region. The aim is to help make the Baltic Sea Region a front-runner in creating environments for policy makers and practitioners to establish joint activities, build strong innovation networks in order to link national innovation systems and innovation programmes, and to develop methods to measure and evaluate cluster performance and policy success. The project will take advantage of geographical proximity and policy learning synergies to develop a joint conceptual framework as well as to create a critical mass of joint innovation frameworks and programmes in the Baltic Sea Region.

The project has three broad strategic objectives:

[6] Source: http://www.proinno-europe.eu

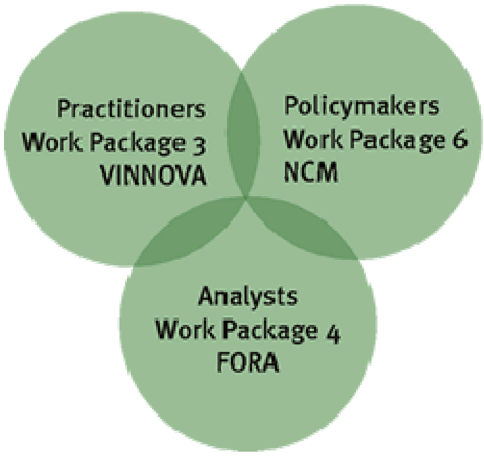
1. To establish a joint conceptual framework for cluster policy formation, evaluation and operational activities across national borders in the Baltic Sea Region

2. To establish one or more joint innovation programmes for cluster development involving partner countries in the Baltic Sea Region

3. To serve as one of Europe's best positive examples for the trans-national development of innovation, thereby helping to meet the targets of the renewed Lisbon Agenda

The BSR InnoNet is structured in three (main) work packages, as shown in the figure below:

Illustration – The three work packages of BSR InnoNet



Two of the most important activities of the project are to create a joint conceptual framework for cluster development and to initiate one or more operational innovative cluster development programmes in the Baltic Sea Region. Furthermore, the BSR InnoNet will participate in and contribute to the PRO INNO Europe Cluster Alliance and the Cluster Memorandum.

The BSR InnoNet project will have a number of results affecting concrete activities as well as the process of formulating an innovation policy that supports cluster development. By producing cluster analyses and benchmarks, the project will attempt to influence the way clusters are understood. Furthermore, its structured policy learning approach, which involves sharing examples of good practice, can inspire and inform innovation policy makers as well as practitioners.

The development of joint strategies and goals for priority policy areas will help to direct the collaborative work of innovation agencies in developing joint programmes. At the same time, the implementation of joint innovation activities and programmes in support of cluster development will lead to concrete regional cooperation in the area of innovation policy.

There will also be a pattern of cooperation with other actors, including InnoNets, the PRO INNO Learning Platform and actors involved in the PRO INNO Europe Cluster Alliance, which will not only affect actors involved in the project, but also those located outside the BSR region.

Finally, by linking the three networks (analysts, practitioners and policy makers), the BSR-InnoNet helps each of these three groups to better understand the roles of the other two. Hopefully, this will improve the competencies of all groups to generate more efficient and effective results. This will, in turn, help the Baltic Sea Region as a whole to maintain its international strength and its innovative capacity.

The BSR InnoNet project is a founding member of the European Cluster Alliance that brings together the four INNO-Net projects dealing with cluster policy development. The European Cluster Alliance will act as the main driver for the further preparation of a strategic agenda on clusters and will be open to other cluster initiatives willing to join the Alliance, share their experiences and develop common actions with other partners.

1.2.2. Content and status of WP4

The main objectives of the analytical work of WP4 in the BSR InnoNet are:

- Illustrating the BSR cluster map – to understand how clusters are located in the region and how their value is created
- Identifying cluster potentials – to find potential cluster improvements and areas for collaboration in the BSR
- Analyzing which policies can make a difference for clusters – to find effective cluster policies in the BSR

In order to target these objectives, five analytical steps are taken[7]:

1. Identifying clusters for benchmarking
2. Assessing key economic indicators in a common standardized database
3. Measuring cluster performance and cluster-specific framework conditions
4. Testing the link between cluster performance and cluster-specific framework conditions
5. Learning from best practice through peer reviews

First, the analytical work provides a picture of clusters in the BSR region. The mapping is based on the Porter-defined clusters, translated into European standards (by Sölvell and Ketels at Stockholm School of Economics), and assessed to fit the BSR context (by FORA and Copenhagen Economics).[8]

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[7] The steps are described in detail in *The Cluster Benchmarking Project – Pilot Project Report*[7], FORA, November 2006.

[8] Documentation of the regional assessments are presented in a technical paper, discussed at the WP4 meeting on the 24th of May, 2007 and described in Chapter 2.

Second and third, the analytical framework and standardized database on cluster employment and real wage will serve as a tool for detecting interesting areas for collaboration in the BSR, and (over time) for monitoring the development of clusters in the region.

Fourth, the standardized database will enable us to identify and map the best-performing clusters in the region thereby gaining valuable insight into the geographical location of top-performing clusters – and then to identify the framework conditions conducive to the creation of top-performing clusters.

Last, peer reviews – the identification and analysis of the conditions used in the areas with the best-performing clusters – can provide a unique basis for evaluation and changes to domestic framework conditions. The methods and conditions used in the best regions may work as useful inspiration.

The benchmark analysis allows countries inside the BSR to draw inspiration from each other and to detect areas for further collaboration. At the same time, the identification of best practice will be a powerful tool in political debate. The continued monitoring and comparison of cluster performance using indicators such as growth, employment and productivity will ensure political attention and commitment. This will facilitate improvements in cluster framework conditions over time.

Following the five steps presented above, the analytical work within the BSR InnoNet has three main deliverables:

1. **Mapping of clusters and cluster performance**
   - To map and measure performance of clusters (employment, specialization, real wage etc.)
   - Output: ***The BSR Cluster Database on performance***

2. **Mapping of cluster-specific framework conditions**
   - To see the presence of cluster-specific framework conditions
   - Output: ***The BSR Cluster Database on cluster policy***

3. **Evaluating cluster policy**
   - To test the impact of cluster policy on cluster performance
   - Output: ***The BSR Cluster Benchmarking Model***

As of the 1st of March 2008, the first deliverable "The BSR Cluster Database on performance" has been launched and has been tested in the member countries and by experts to secure quality and usability. A number of analysis has spurred from this work – including analysis on cluster dynamics, development of a criteria system for picking out interesting and strong BSR clusters for further analysis, and a first look at analysis on the crucial question "Do clusters matter for economic growth?".

The second deliverable – mapping of cluster-specific framework conditions – has been initiated. The work on developing a model for collecting data on cluster-specific framework conditions has begun. In this work, external experts, academics and policy makers are involved to secure the maximum level of usability.

The next three chapters (2-4) illustrate the work done during the first two phases of the project. Chapter 5 gives a short introduction to the next step.

2. The BSR Cluster Database

The purpose of the BSR Cluster Database is to collect outcome data in order to do statistical benchmarking of clusters' performance in the BSR. Data is collected on two key measures of cluster performance: employment and productivity for as many regions and detailed industry codes as possible in the BSR. Data on employment is collected to measure absolute and relative cluster sizes and the clusters' specialization level. Data on productivity (measured by real wages) is collected to measure the value created by each cluster.

To group the industrial data into clusters, we have applied the methodology developed by Professor Michael Porter at Harvard Business School to group detailed branch codes into clusters – referred to in this document as the cluster code.

Section 1 describes the structure of the BSR Cluster Database; Section 2 describes the thoughts behind choosing real wages as a proxy for productivity; Section 3 focuses on how data is harmonized; and Section 4 focuses on the assessment and adjustment of the cluster code to group industries into clusters in the BSR.

2.1. Structure and substance of the database

The BSR Cluster Database contains regional, industrial data for the BSR countries collected on employment and real wages as a proxy for productivity. Employment is collected as Number of Persons Employed, and real wages is calculated by the collection of two data series: Personnel Costs and Number of Employees. All data series are collected according to the common European standards defined by EUROSTAT.

There are two dimensions in the collected data - an industrial and a regional dimension.

Industrial dimension
Data is collected on a 3 or 4-digit NACE level. NACE is the statistical classification of economic activities in the European Community, and ensures statistical comparability between national and community classifications. More disaggregated, internationally comparable business statistics are not officially available. Even at a 3 or 4-digit level, data discretion problems are unavoidable.

Regional dimension
Data is collected on a NUTS2 level. NUTS is a nomenclature of territorial units for statistics defined by EUROSTAT. There are 31 NUTS2 regions in the BSR.

The hierarchical division of the NUTS regions varies from country to country in specific size. NUTS2 regions seem to be the best statistical size for cluster benchmarking.

In the table below, the data coverage for the BSR is summarized. It has been possible to get full data coverage on employment on a NACE3 or NACE4 level for all the 31 regions in the BSR – while the coverage on real wage data is not fully finalized. Data on a level lower than NACE3 is not valid to use in the applied methodology of grouping branch codes into clusters. Three countries have had statistical problems in delivering wage data as this level of detail is too high on a regional level. There is still an ongoing dialogue with the relevant countries trying to solve the data problems. But as for now, these countries are left out of the analysis on cluster productivity.

Table – Coverage of the BSR Cluster Database

	Employment		Real wages	
	Country	Availability	Availability	Nb.of Empl.
1	Denmark	Nace 4	Nace 4	FT eq.
2	Sweden	Nace 4	Nace 4	FT eq.
3	Norway	Nace 4	Nace 4	Converted
4	Finland	Nace 4	Nace 4	FT eq.
5	Estonia	Nace 4	Nace 4	Converted
6	Latvia	Nace 3	Nace 4	Converted
7	Lithuania	Nace 3	Nace 4	Converted
8	Iceland	Nace 4	*Nace1*	
9	Poland - 3 reg.	Nace 3	*Nace1-2*	
10	Germany - 3 reg.	Nace 3	*Nace2*	

2.2. Data on productivity

Data on cluster productivity measures the value created by each cluster, taking into account the resources used to produce this value. By comparing productivity across clusters, it is possible to assess which clusters make best use of scarce resources like capital and labor.

Using productivity as a key indicator means that focus is not necessarily on the largest clusters, neither necessarily the most geographically concentrated clusters. Instead, this approach highlights those clusters which are best apt to use resources efficiently for creating value for their customers.

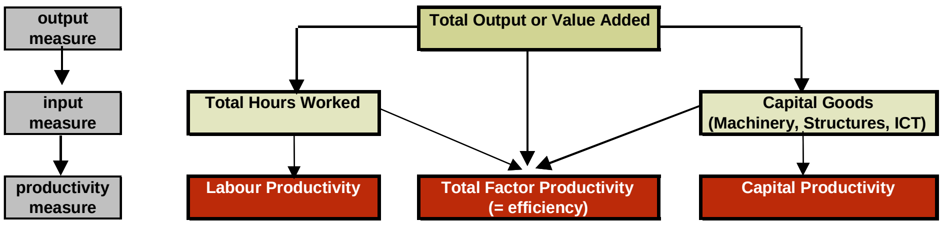
The ideal indicator for cluster productivity should measure the value of the cluster output produced by the cluster (value added), taking the use of inputs (labor and capital) into account. Dividing the value of the output by the value of the inputs will result in the ideal indicator for cluster productivity (total factor productivity).

Unfortunately, the data required for calculating total factor productivity for clusters at a regional level is not available. Measuring regional levels of total factor productivity requires measurement of performance of individual work places in the region, not just the value creation at headquarters or self-standing enterprises without any subsidiaries. But this means that data on value added is problematic to use since value added is reported by headquarter, not by the individual work place.

Therefore, a second-best proxy for productivity is needed. As illustrated below, an alternative to using total factor productivity as indicator could be to use capital productivity. But detailed data on capital use is rarely available. Another alternative is labor productivity.

Here, the value of output is divided by the amount of labor (measured as total hours worked) that were used to produce this output.

Illustration - Measures of Productivity, Input Variables, and Sources of Growth



Labor productivity is most frequently used as a proxy for productivity because better data is available for detailed and robust calculations. Ideally, labor productivity should be calculated as value added divided by labor input (number of hours worked).

As mentioned, data on value added is problematic to use since it is only reported by headquarter. But looking more into the definition of value added, a good proxy for labor productivity can be found in wages, and wages can be measured at the level of individual work places.

Value added is defined as total value of sales (i.e. revenues) minus the cost of the raw materials and intermediate inputs used in the production. For instance, if you are a cement producer, and sand and energy for heating are your main intermediate inputs, then value added is calculated as the value of the cement produced minus the value of the sand and energy used. Of course, in the process of producing cement from sand and energy, you also use labor and some capital invested in the cement machinery. Value added is therefore what is left for remuneration of labor and capital.

Remuneration of labor is also known as wages, and remuneration of capital is also known as return on capital. In capital intensive production like cement, most of the value added goes to pay off the investment in capital (i.e. the machinery). However, in most sectors, and particularly in services and knowledge intensive industries, most of value added is actually wages. In general, wages are around 60 percent of value added, and in many sectors much more (this percentage is also known as the wage quota, i.e. wages as share of total value added).

Furthermore, in industries with well-functioning labor markets and well-functioning capital markets, there will be a strong correlation between labor productivity and wages.

Therefore, wages per unit of labor is a good measure of labor productivity, and for purposes of comparing value creation across regional clusters composed of detailed industry codes, it is just about the only possible indicator that can be used.

2.3. Harmonization

To ensure comparability in data across countries, data on employment, wages and number of employees is collected according to the common European standards defined by EUROSTAT.

Data on employment is defined as "Number of Persons Employed". This includes both full-time and part-time employees and self employed. Real wages are calculated by two data series: Personnel Costs divided by Number of Employees.

The wage variable "Personnel Costs" is the right definition of wages when comparison between nations is desired. All expenditures are included in the variable, so it indicates the total cost for the employer. This is comparable across nations no matter the level of taxes and social security costs.

The employment variable "Number of Employees" needs to be collected in full-time equivalent units in order to calculate the best comparable average wage level. The reason is that the ratio between part-time and full-time employees can be very different across industries and regions. Unfortunately, not all BSR countries collect Number of Employees in full-time equivalent units, and if they do, it might only be for a very few sectors or on a national level. When full-time equivalent units are not available, Number of Employees as full-time and part-time is collected and converted into full-time, which will be described later in this chapter.

Every country in the BSR is asked to deliver data on Number of Persons Employed, Personnel Costs and Number of Employees according to the definitions in the EU regulation on a NACE4 level and on a NUTS2 level for as many branches as possible. Number of Employees is requested as part-time and full-time, as well as in full-time equivalent units when possible. In addition, every country is asked to deliver the data on NACE3 level – which is useful for filling out missing data points at the NACE4 level due to discretionarity.

In order to make the original data comparable across nations, the first step after collecting the data is to harmonize all reported codes to follow the official NACE4 rev.1.1 classification list and fill out missing data by the use of other available data on a less detailed level.

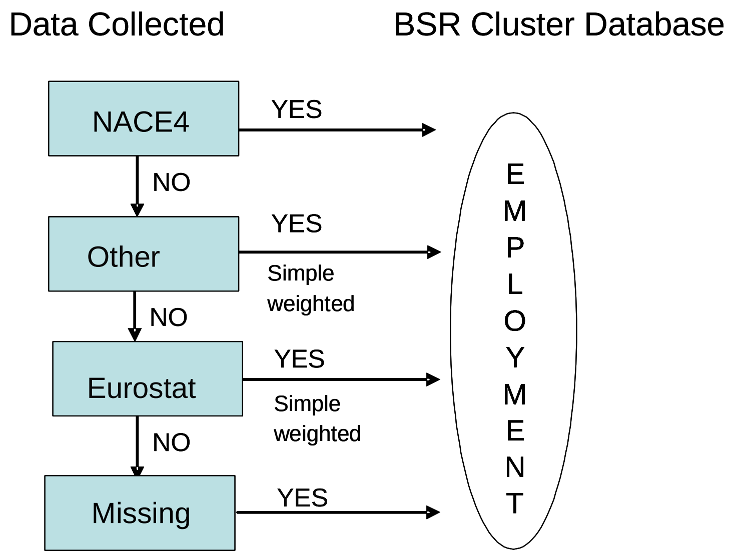
Then, two important steps are performed on the data used for calculating real wages:

1. Conversion to a common currency
2. Conversion to full-time equivalent units

The first step is to translate the data on personnel costs into the same currency (Euro), and the second step is to convert the collected data on Number of Employees into full-time equivalent units.

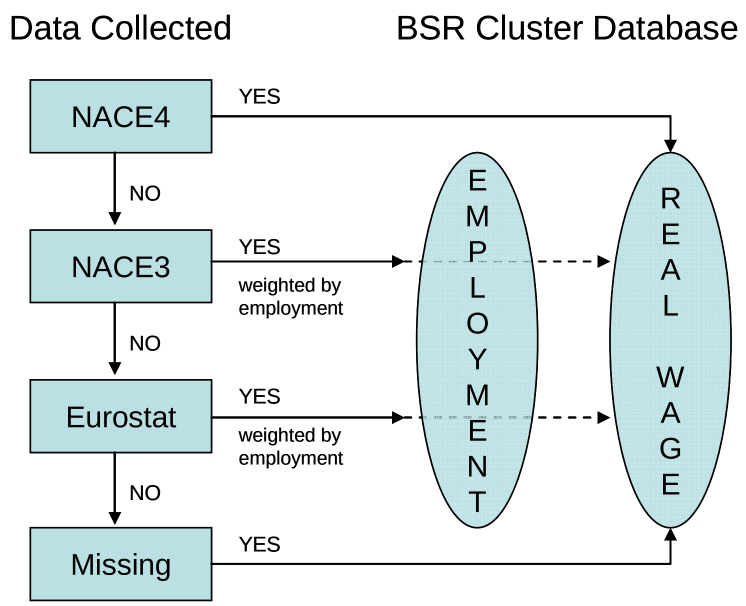
After harmonizing all reported codes to follow the official NACE4 rev.1.1 classification, missing data points on Number of Persons Employed is filled out by the use of available NACE3 data and other data from the EUROSTAT database on different levels of aggregation. This is done by simple weighting using employment data on a less detailed level, which can be illustrated as follows:

Illustration – Filling out missing data points on employment



To fill out missing data points on Personnel Costs and Number of Employees, the data collected on Number of Persons Employed is used for the weighting. This process is illustrated below, and described in more detail in Appendix 1.

Illustration – Filling out missing data points on real wages



Another point to consider is whether the real wage data needs to be corrected for differences in weekly working hours across the BSR countries. But according to research on national differences done by international labor organizations and the OECD, the countries for which real wage data is collected all have a standard working week of approximately 40 hours. Therefore, data is not adjusted in this respect.

After collecting and harmonizing the data, a quality assessment is performed on the data[9].

The two steps for converting the data are described below:

Step 1: Conversion to a common currency
When using wage data across countries as a measure of productivity, the data must be converted into a common currency (Euro), and the conversion is done by the use of foreign exchange rates, not purchasing power parities.

The right way to translate national currencies into Euro depends on what is measured. Normally, wage data is used as a proxy for two indicators: standard of living and productivity (measured as the total cost for the employer).

Different ways of translation are needed for each of the two measures. The translation of wage data as a proxy for standard of living should be done by using purchasing power parity (PPP). A PPP exchange rate equalizes the purchasing power of different currencies in their home countries for a given basket of goods. But here, the intention is to measure the global competitiveness of clusters regardless of the standard of living in the country of the cluster. Therefore, exchange rates are used, not PPP.

Step 2: Full-time equivalent units
Data on Number of Employees has been collected in full-time equivalent units for Denmark, Sweden, and Finland. But for Norway, Estonia, Latvia, and Lithuania, this has not been possible. These data include both full-time and part-time employees. In order to make data comparable across branches and countries, these data need to be converted into full-time equivalent units.

In the Labor Force Survey (LFS) database from EUROSTAT, employment data is estimated according to a quarterly updated large-sample survey in all European countries. The database reports number of employees both as full-time and as part-time separately on a NACE1-2 level and at the national level for all BSR countries.

Consequently, the NACE2 level data from the LFS database is used to calculate a correction factor to convert the collected data (following the definitions of SBS) into full-time equivalent units as illustrated by the following example.

The NACE4 code '64.20' following the definitions of SBS counting both full-time and part-time employment is converted into full-time equivalent units by using the NACE2 code '64' from the LFS reported both at full-time and part-time separately - as illustrated in the box below.

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[9] A few clusters shows to have unrealistically high real wage values when the Number of Employees at the cluster level comes below 50. These observations are ignored in further analyses.

Box – Example of conversion into full-time equivalent

SBS 64.20 (full-time equivalent units)

$$= \frac{\text{LFS 64 (full-time)}}{\text{LFS 64 (full-time) + 64 (part-time)}} * \text{SBS 64.20 (full-time + part-time)}$$

From Statistics Denmark, Number of Employees was collected both as full-time and part-time and in full-time equivalent units. This makes it possible to check how good our correction method is, based on Danish data.

The assessment of fit of using LFS data to convert data on Numbers of Employees into full-time equivalents units gave reasonable results compared to the true full-time series. Therefore, the method for converting to full-time equivalent units can generally be accepted based on Danish data. However, a few NACE codes need special attention.

The NACE2 group 74 covering “Other business activities” is one such sector. The main reason for this is that this group includes the NACE4 industry “Labour recruitment and provision of personnel”, which includes many more part-time workers than the other NACE4 codes under group 74. The productivity numbers of the clusters Financial Services and Business Services are heavily distorted by this problem as they both contain codes belonging to group 74. As a consequence, an exception was made for the country-specific full-time equivalence adjustment so that all NACE4-codes in group 74 for the relevant countries are adjusted according to the Danish NACE4-codes.

2.4. The cluster code

This section documents the assessment of the ability of the translated Porter cluster code to be used to provide policy-relevant cluster benchmarking within the BSR. In the following, the methodology applied in the assessment is explained and how the cluster code is improved to enable a policy-relevant benchmarking analyses of clusters in the BSR region.

2.4.1. Background

Michael Porter (2003)[10] explained in detail how the original cluster codes for the US economy were constructed based on employment data for the year 1996, across 172 economic areas in the US, and for 879 four-digit industries (according to US standard industrial classification, SIC).

The methodology in the original study can be summarized as follows: 1) select the industries that are *resource-depedent industries* (i.e. industries whose location decision is determined primarily by access to natural resources as e.g. coal mining). 2) Analyse the geographical location pattern of remaining industries (not determined by access to natural resources) and

[10] See Porter, Michael E. (2003), “The Economic Performance of Regions”, Regional Studies, vol. 37, aug/oct 2003

divide them into two groups based on objective criteria of geographical concentration[11]. Industries following the general pattern of population concentrations are labelled *local industries*, and industries that are highly concentrated in specific locations (as measured by the objective criteria) are labelled *traded industries*. 3) Then, finally, the co-location patterns amongst the traded industries are analysed, and the information is combined with industry knowledge to form clusters of related industries. As a result, Porter obtains 40 clusters comprised of 590 traded industries. Thus, traded industries are those industries that, in principle, could be located anywhere, but for some reason are highly concentrated in one or more specific locations. Clusters are then, following the analytical construction, groupings of co-located traded industries[12].

2.4.2. Summary of methodology and results

Porter developed his cluster code based on American statistics, which deviate from European statistics. But the American SIC codes were translated into the European NACE codes[13] by Sölvell et al. (2006) to make a European version of Porters cluster code. This translation is used in the project.

The methodology applied for assessing the "fit" of the original US cluster code to European data follows the same three steps as in the original work by Professor Micheal Porter. Thus, two fundamental questions are asked: Is it the right traded industries, and has the grouping of the traded industries into clusters high relevance for policy makers?

To answer these questions, the three steps of the methodology are analyzed systematically, and the main conclusion from each step can be summarized as follows:

First, can the resource dependent industries from the US be regarded as resource dependent industries in the BSR? It is found that six out of 28 resource endowment industries should be moved to traded clusters.

Second, do the industries identified as traded industries in the original US study also display the characteristics of traded industries (i.e. geographical concentration patterns) in the BSR region? In general, the answer is yes, but a few traded industries do not display a high degree of concentration across the BSR region.

It is also found that the larger share of public sector activities in Europe should lead to adjustments of the selection of traded industries. It is concluded that 11 industry codes (mainly in the education sector) originally characterised as traded industries in the US could preferably be considered as public sector activities in the BSR region. As a result, the

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[11] Porter utilizes three measures of the variation of industry employment across geography to separate industries: the share of national employment for all states with LQ ≤ 1; the mean location quotient (LQ) for the top five states ranked by LQ; and the employment GINI coefficient.

[12] The argument is, according to Porter (2003), that "co-location of industries does not guarantee interaction or spillovers but consistent co-location across many regions creates a strong presumption that such interactions are present."

[13] See Örjan Sölvell, Christian Ketels, Göran Lindqvist 2003 and 2006

education and knowledge creation cluster should not be regarded as a separate cluster, but rather as an essential input to build the innovation capacity of all clusters.

Third, and finally, are the adjusted traded industries grouped into meaningful and policy-relevant clusters? The conclusions on this can be summarized in three points:

1. Two clusters are excluded (Prefabricated Enclosures and Motor Driven Products) from further analysis, because these clusters seem irrelevant in Europe and have virtually no employment[14].

2. The Distribution cluster is dissolved. Outsourcing and structural changes have led to re-classification of certain industries since the construction of the original analysis (based on 1996 data). As a consequence, the 8 industries included in the Distribution cluster are reclassified to other, more-related clusters.

3. Finally, the resulting 35 clusters (from now on sub-clusters) are additionally grouped into 13 clusters in Denmark to supplement the analyses with cluster analyses on a more aggregated and policy relevant level.

In addition, the Apparal and the Footwear cluster have been merged into one cluster, because of very low employment level in footwear and since the underlying firms are typically engaged in both businesses.

As a minor note, it is found that some industries seem to have gotten lost in the translation from US SIC codes to European NACE codes. As a consequence, 13 minor changes in the industry translation could improve the fit of the cluster code to European classification standards.

The above-mentioned adjustments lead to an improved cluster code with a higher degree of policy relevance, while still preserving a high degree of comparability with the original code. Only 12 per cent (or 11 percent of employment) of the original cluster industry codes are re-classified, that is, 88 per cent (or 89 percent of employment) of the traded industries in the adjusted cluster code are in the original clusters. Thus, in summary, only a few and relatively obvious and transparent adjustments are needed to the original code in order to improve its policy relevance for the BSR to an acceptable level. The table below provides an overview of the adjustments, and documents how much from the original code is left in the adjusted code.

Table - Changed classifications

	Number of NACE4 codes	Share of NACE4 codes	Share of employment in BSR 2004
Changed classifications	60	12%	11%
Unchanged classifications	456	88%	89%
Total:	516	100%	100%

Source: FORA and Copenhagen Economics

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14 Sölvell and Ketels (2006) also exclude these two clusters in their analysis of clusters in the 10 new EU member states.

2.4.3. Analytical foundation for the adjustments

This section will go more into detail on the background for adjusting the cluster code. Six data-driven analytical steps are used, all supporting the suggestions for the adjustments.

The six analyses are:

1. Assessment of 10 largest firms in each industry
2. Assessment of 100 largest firms across clusters
3. Assessment of individual industries' fit within cluster categories
4. Correlation analysis of co-location patterns across BSR-geography
5. Analysis of labour-mobility between traded industries
6. Application of objective criteria for traded industries

The first two analyses are the nitty-gritty work of firm-level analysis. In order to understand the cluster structure and to test the fit in reality, financial information is analyzed for all Danish companies in traded industries. From the Amadeus database,[15] information is downloaded for all Danish companies and lists of companies are created according to their industry classification.

Comparing the information from the Amadeus database together with the industries included in each cluster reveals detailed information on each cluster to evaluate the composition of individual companies in each cluster by size and by four-digit industry. In addition, the ten largest firms in each of the more than 300 traded industries in the EU-translated cluster code are assessed. Also, the 100 largest companies in Denmark are checked and their placement analysed in the relevant cluster categories.

Regarding the assessment of co-location, the collected data on employment across 25 regions in the BSR-region is used to carry out correlation analyses of the co-location of traded industries. This is largely supporting the original cluster compostions, but also providing results suggesting alternative compositions with a higher degree of co-location. From the same data, it is possible to replicate the original Porter criteria for the selection of traded industries, and to apply it to the BSR-data[16]. This suggests that some industries that are regarded as traded in the original code, actually do not display the characteristics of traded industries and vice versa. This information is taken into account when assessing the necessary adjustments.

Finally, in a few cases, the degree of labour mobility between pairs of industries is analysed and supra-normal mobility rates is used as a supplementary indicator to the co-location indicator[17].

However, the final suggestion for improvements to the cluster code is a result of carefully balancing the pro's and con's in each individual case, and combining statistical knowledge with qualitative knowledge from in-depth discussions with key experts.

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[15] The Amadeus database is a database covering financial and accounting information on virtually all registered companies in Europe.

[16] See Appendix 2

[17] For more information refer to Copenhagen Economics (2006).

A panel of thought leaders[18] of the knowledge economy has been assembled specifically for the project with the aim of stimulating an early discussion of the policy relevance of both the composition of clusters, as well as how succesful policy making in the field could and should be measured. Draft versions of the cluster benchmarking model was discussed with this panel, and the views and comments from the experts proved to be both valuable and stimulating for the development of the model. There was a strong support for the cluster benchmarking model and the thinking and ambition behind it. There was also a broad consensus and acceptance of the proposed methodology and preliminary results. However, the panel should not be held responsible for the final outcome of the exercise.

2.4.4. Translation from US to EU industry codes

By taking a closer look at the Porter code cluster by cluster, some of the NACE4[19] codes seem incorrectly positioned. This is a result of the translation of the US industrial codes (SIC) to the European format (NACE). The translation is not always "one to one" but in some cases "many to one" and in others "one to many" translation.

It is assessed that a few adjustments to the translation will improve the fit to Danish clusters. 13 single industry codes will improve the translation, if moved from one cluster to another,.

An example of a mal-positioned NACE code is 25.22 (plastic packaging) which is moved from forest products to the plastic cluster. All the single NACE4 codes that are moved to other clusters are listed below.

Table - NACE4 codes moved to other clusters

NACE	Name	OLD cluster	NEW cluster
35.12	Building and repairing of pleasure and sporting boats	Hospitality and Tourism	Sporting, Recreational and Children's Goods
32.30	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	Entertainment	Communication equipment
25.22	Manufacture of plastic packing goods	Forest Products	Plastics
26.21	Manufacture of ceramic household and ornamental articles	Building Fixtures, Equipment and Services	Furniture
36.15	Manufacture of mattresses	Building Fixtures, Equipment and	Furniture

[18] The panel consisted of the chairman for the Danish Growth council, the Editor-in-Chief of a leading weekly magazine on political economy, a leading business journalist, a manager from the national venture fund, a partner from a leading international design and innovation consultancy, a national cluster expert and a vice president of a leading Danish multi-national firm deeply involved in a private sector cluster initiative. The panel met twice.

[19] NACE codes are the European industrial format. In our framework, we use the NACE4 rev 1.1. See http://ec.europa.eu/eurostat/ramon/index.cfm?TargetUrl=DSP_PUB_WELC

		Services	
40.30	Steam and hot water supply	Building Fixtures, Equipment and Services	Local
20.51	Manufacture of other products of wood	Furniture	Heavy Construction Services
18.23	Manufacture of underwear	Textiles	Apparel/footwear
17.51	Manufacture of carpets and rugs	Textiles	Furniture
17.52	Manufacture of cordage, rope, twine and netting	Textiles	Fishing and Fishing Products
31.20	Manufacture of electricity distribution and control apparatus	Lighting and Electrical Equipment	Power Generation and Transmission
51.42	Wholesale of clothing and footwear	Distribution Services	Apparel/footwear
51.16	Agents involved in the sale of textiles, clothing, footwear and leather goods	Distribution Services	Apparel/footwear

Source: FORA and Copenhagen Economics

2.4.5. Review of resource-dependent industries

The original code classifies 38 NACE4 industries as resource-dependent industries. By taking a closer look at this group of industries six NACE4 codes are identified to have the potential of being a part of a cluster. All six industries are tested and all of them is found to achieve the criteria for being a traded industry. The changes are listed in the table below.

Table - Resource dependent industries moved to clusters

NACE	Name	New cluster
15.43	Manufacture of margarine and similar edible fats	Processed Food
20.10	Sawmilling and planing of wood; impregnation of wood	Forest Products
24.15	Manufacture of fertilizers and nitrogen compounds	Chemical Products
26.82	Manufacture of other non-metallic mineral products n.e.c.	Heavy Construction Services
51.51	Wholesale of solid, liquid and gaseous fuels and rel. products	Oil and Gas Products and Services
51.52	Wholesale of metals and metal ores	Metal Manufacturing

Source: FORA and Copenhagen Economics

2.4.6. Review of the classification of local industries in the BSR context

All the adjustments discussed until now have not focused on the division of the industries into traded and local. In order to test whether the traded industries in the Porter code should remain as traded industries or be changed to local industries, Porters criteria[20] for being a traded industry are applied on employment data for the BSR-regions.

Four traded industries are found in the original code that should be local industries in the adjusted version of the code due to the criteria. The four codes are listed in the table below.

Not surprisingly, two industry codes are part of the Hospitality cluster (NACE codes 55.10 and 71.10). Hotels will not surprisingly tend to be more concentrated in regions with a large population, not because the inhabitants use the hotels themselves, but because tourists and business people are attracted from abroad. These two clusters will therefore still remain a part of the Hospitality cluster.

The industry 'Other scheduled passenger land transport' (NACE code 60.21) covers mostly public transport in urban areas, and this is an industry that might be geograhically concentrated in the US, but it is very evenly spread out in the BSR geography. This is probably due to the fact that this sector is historically organised as a public sector activity, a perspective which will be discussed more thoroughly in the next section. As a consequence, this industry is moved to local industries.

Finally, the building construction industry (Nace code 45.21) contains large building contractors like NCC, which are multinational companies, but also smaller companies that are of a more local character. It can therefore be argued that it can remain traded or moved to local industries. Examination of the Amadeus database reveals that employment in construction industry across the BSR region is approximately split equally between the two types, thus the industry 45.21 is spilt using equal weights in the database.

Table - Traded industries with BSR location patterns of local industries

NACE	Name	Cluster
55.10	Hotels	Hospitality
71.10	Renting of automobiles	Hospitality
60.21	Other scheduled passenger land transport	Transportation -> Local
45.21	General construction of buildings and civil engineering works	Construction

Source: FORA and Copenhagen Economics

The mirror image of the above analysis is obviously to analyse whether some of the industries categorized as local industries in the US cluster code are actually showing location patterns similar to those of the traded industries. It is found that 54 such industries, which, if catagorized solely on the geographical concentration criteria, should be seen as traded industries. However, no additional information is found allowing a reclassification of these industries; thus, they are kept as local industries, with the suggestion to keep an eye on these industries when analysing specific clusters to see if some of these industries are related to specific clusters. The list of the 54 industries is found in Appendix 2.

[20] One of Porters criteria (top five LQ > 2.0) is changed, since the regional area of BSR covers fewer regions than in the US. Therefore, the criteria is changed to top two LQ>1.25. The rest of the criteria remain unchanged. Please refer to Appendix 1 for details.

2.4.7. Differences in public and private sector division

The larger share of private sector activities in the US economy compared to many European economies, and in particular the Scandinavian economies, has implications for the way the US-based cluster compositions should be interpreted. For example, activities like health care and education are private sector activities in the US, but public in Europe.

One of the central elements in statistical cluster mapping is to use the co-location pattern of firms and industries across the geography to reveal important information about the competitiveness of certain locations over others (and learn why these locations have become more competitive). Therefore, it is relevant to ask what kind of competitiveness-related information is revealed by the location of traditional public sector activities. This should lead to prudence in directly translating clusters composed primarily of industry codes that are private in the US, but public in Europe.

It is found that the public sector share of the original clusters has importance for two cluster compositions: 1) Education and Knowledge Creation and 2) Transportation. Education and Knowledge Creation is a cluster in the original US code. This cluster is composed of universities and research institutions. It makes perfect sense to analyse US universities as a traded industry because many universities are private, and students pay to attend the best schools.

In Europe, or at least in Scandinavia, universities are publicly-funded, and students have free or limited payment for admission. The industries in the cluster are almost entirely categorized as public sector activities.

Therefore, while universities and knowledge institutions can be seen as an integral part of the many knowledge-based clusters, it is questionable whether the location pattern of universities is based on the competitiveness of different locations in supporting that cluster. In Europe, other considerations dominate that decision. Therefore, while public sector activities may constitute important parts of clusters, using their location patterns to assess competitiveness must be done with carefulness.

However, universities and research institutions are vital for the growth and competitiveness of many clusters in the BSR, and the triple-helix approach to cluster policies should be incorporated. It is chosen to dissolve the cluster as an isolated cluster and include the NACE4 codes as a part of the public sector, following the argument that education and knowledge creation should not be regarded as a separate cluster, but rather as an essential input to build the innovation capacity of all clusters.

The Transportation and Logistics cluster in the original cluster composition appears as one of the largest clusters in all BSR countries measured by employment. Taking a closer look at the cluster, it incorporates some industries that are publicly-owned local industries. For instance, the cluster includes metros and local busses, which are not traded industries.

These public sector industries are removed from the specific clusters based on standard classifications. The table below shows the exact list of traded industries which are taken out of the analysis of traded industries.

Table - Industries classified as public

NACE4	Definition
65.11	Central banking
73.10	Research and experimental development on natural sciences and engineering
73.20	Research and experimental development on social sciences and humanities
75.30	Compulsory social security activities
80.30	Higher education
92.31	Artistic and literary creation and interpretation
92.32	Operation of arts facilities
92.51	Library and archives activities
92.52	Museums activities and preservation of historical sites and buildings
92.53	Botanical and zoological gardens and nature reserves activities
92.61	Operation of sports arenas and stadiums

Source: FORA and Copenhagen Economics

Note: This classification is based on the division of private and public sector in the Danish macro model ADAM, and on information on wages by industry split into public and private sector.

2.4.8. Exclusion of two clusters

Two US clusters are excluded from the analysis: *Prefabricated Enclosures* and *Motor Driven Products*. Sölvell et al. (2006)[21] reached a similar conclusion: "The clusters of Prefabricated Enclosures and Motor Driven Products are affected by the translation in a way that their relevance can be questioned".

In the original US cluster analyses, the cluster "Prefabricated Enclosures" comprised products like mobile homes and trailer homes. The cluster "Motor Driven Products" comprised industries producing specialized vehicles like fire trucks, motorized staircase trucks for airports and other motorized equipment. The existence or importance of such clusters in Europe can be questioned, and while the products may be important in the US (e.g. the US market for trailer homes is large compared to the European market), it does not seem to capture important industry clusters in Europe, and in fact, very little employment is registered in those industries belonging to the original cluster.

Therefore, the Prefabricated Enclosures and Motor Driven Products clusters are excluded from the analysis, and the corresponding NACE codes are included in a category of "Other traded industries".

[21] Clusters in EU-10 new members countries, Europe Innova, 2006.

2.4.9. Outsourcing and the Distribution cluster

The most significant change to the US and Western European economies since the original cluster code was constructed in 1996 is probably the extent of outsourcing and offshoring. While it is beyond the scope of this project to thoroughly assess the fundamental implications of globalisation for the cluster composition, it is still relevant to assess where the phenomenon of offshoring might warrant caution as to the composition of clusters. The original cluster composition are assesed with an eye towards the fact that, while all industries are affected to some extent by globalisation and offshoring, only a few clusters are identified to be affected by statistical re-classification of firms due to the changes.

By using the information from the list of companies in each NACE code, it is found that caution in this respect is particularly warranted in the case of the Distribution cluster.

In the original US cluster study, this cluster consists of wholesale activities grouped around major US distribution hubs (like e.g. Atlanta). The wholesale industries comprise a range of product groups like food, textiles, tobacco, clothing, and pharmaceutical products. An increased level of outsourcing in western societies has changed the NACE classification for a range of these companies. An example is the Danish shoe company Ecco. Ecco no longer produces shoes in Denmark, but has located all their marketing, sales, and innovation in Denmark. As a consequence, they are classified as a wholesale company in the footwear industry – and if the original cluster code was applied, Ecco would be a part of the distribution cluster, even though their main activity is design and innovation in the footwear industry. Other industries in the original distribution cluster display similar characteristics, namely that key firms and competencies of traditionally strong manufacturing industries are re-classified as wholesalers after outsourcing production.

In order to analyse whether to keep these industries in a distribution cluster or split those industries into other clusters, the correlation of the location coefficients of the Distribution cluster industries and all other traded industries in the BSR is tested. It is found that these particular wholesale industries are more correlated with other related clusters (Footwear in the Ecco case) than with the Distribution cluster. Therefore, the Distribution cluster is split up in the adjusted code and the NACE4 code placed in the related clusters: Food, Apparel/footwear, Tobacco, and Biopharmaceuticals.

Table - The dissolved distribution cluster

NACE	Name	NEW cluster
51.16	Agents involved in the sale of textiles, clothing, footwear and leather goods	Apparel/footwear
51.25	Wholesale of unmanufactured tobacco	Tobacco
51.31	Wholesale of fruit and vegetables	Processed Food
51.38	Wholesale of other food, including fish, crustaceans and molluscs	Processed Food
51.41	Wholesale of textiles	Apparel/footwear
51.42	Wholesale of clothing and footwear	Apparel/footwear
51.46	Wholesale of pharmaceutical goods	Biopharmaceuticals
52.61	Retail sale via mail order houses	Apparel/footwear

Source: FORA and Copenhagen Economics

The resulting changes are summarized in the table below.

Table - Identical classification of NACE industries after adjustments

	Porters classification	New version	Identical classification
Local industries	152	155	148
Natural endowments industries	38	32	32
Traded industries	313	308	298
Public industries	9	20	9
No classification	4	1	1
Total:	516	516	488

Source: FORA and Copenhagen Economics

With these changes, a cluster composition of 35 clusters is obtained, of which many are as in the original study. A few have been slightly adjusted to capture the major differences between the US and the European economies and to reflect the most vital changes in the economic structures over the ten years that have passed since the original code was constructed. These clusters are believed to present a consistent and policy relevant composition of the BSR economies and in particular of the Danish economy. After consultations with other BSR InnoNet members, further adjustments could be relevant.

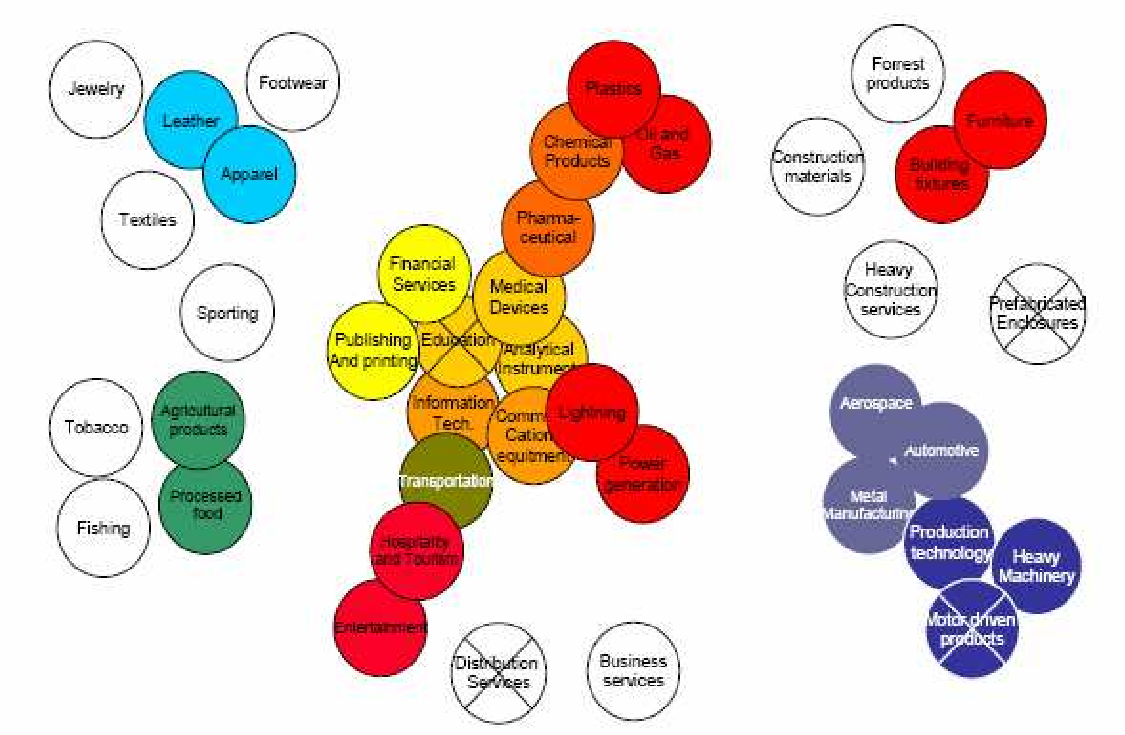
2.4.10. Sub-clusters and clusters

In order to get a better understanding and overview of the Danish clusters, the 35 original Porter clusters or sub-clusters (4 categories are left out) are grouped into 13 larger clusters. Each of the 13 clusters contains of one or more of the original clusters. In the rest of this description, the original cluster categories are named sub-clusters.

By retaining the sub-clusters, even though larger clusters are created, it is still possible to compare the original cluster categories. Thereby, it is possible to compare different compositions that might appear among countries.

The suggestion for grouping the sub-clusters is in line with the finding in the original Porter work regarding the fact that clusters overlap, i.e. some of the industries can belong to more than one cluster. See the figure below.

Illustration - Schematic diagram of cluster overlap in the US economy

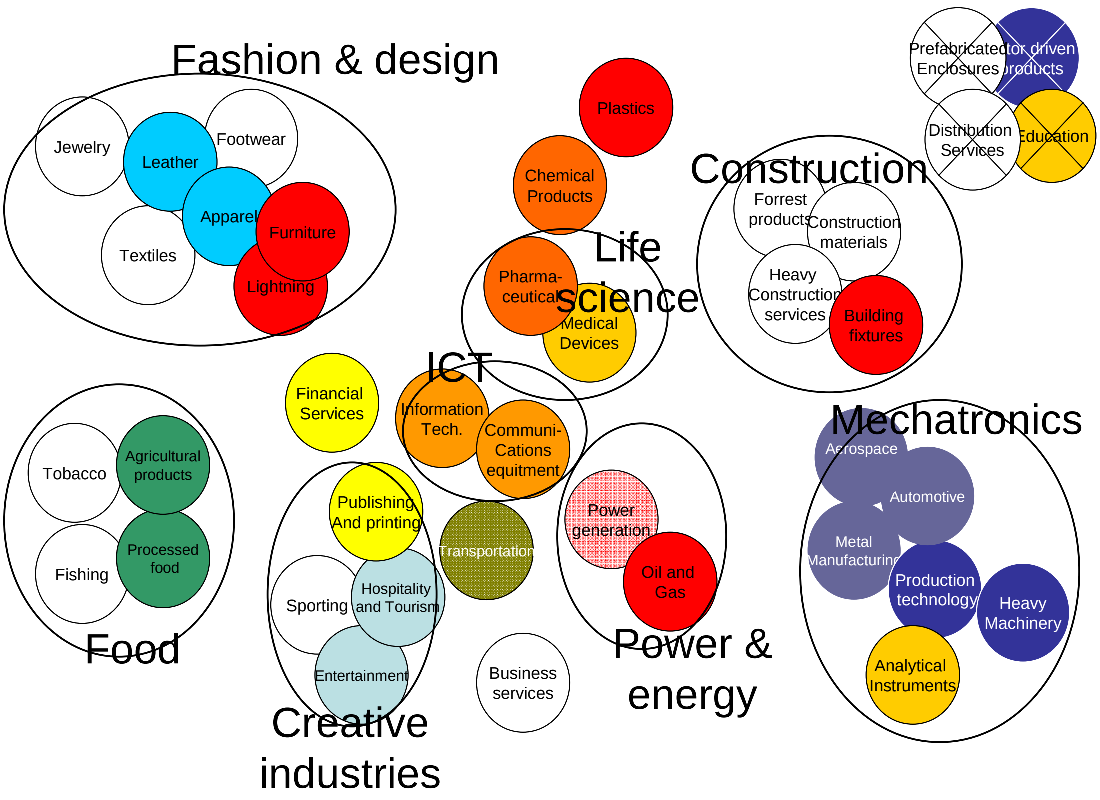


Source: Michael Porter, "The economic performance of the regions", Regional Studies, vol37, aug/sep 2003

Note: Clusters with overlapping borders or identical shading have at least 20 per cent overlap (by number of industries) in both directions.

The figure below shows the Danish groupings and is discussed in detail below. A similar grouping in the other BSR-regions might be different, but still comparable on a sub-cluster level.

Illustration - Schematic diagram of the 13 large Danish clusters



Source: FORA and Copenhagen Economics

For some of the clusters, no further explanation is needed, but some of the clusters need a comment in order to understand the arguments for the sub-cluster grouping shown above. The Fashion and Design cluster is one of them. Today, fashion and design is more a process of design and branding, rather than the actual production of goods. Therefore, it is chosen to group a number of small clusters with the same kind of working processes to the Fashion and Design cluster including: Apparel/footwear, Furniture, Jewelry, Leather and Lighting to one cluster. But it is still possible to see the sub-clusters of interest.

Another cluster worth mentioning is the ICT Cluster, which comprises two clusters: Information Technology and Communication Equipment. These are overlapping, and there might be potential synergies by joining the clusters. Their products are based on the same technologies and are more and more dependent on the innovation in both clusters. E.g. it is important to develop software (IT cluster) that uses the innovation in areas like wireless communication (Communication Equipment cluster).

Finally, it is worth noticing that five clusters are not grouped together with others for several reasons. The Plastics cluster and Chemicals cluster do not fit into any other cluster and are therefore single clusters. The three remaining clusters (the Transportation cluster, the Business Services cluster, and the Financial Services cluster) are supporting almost all clusters and are therefore not grouped.

3. Cluster dynamics in the BSR

This chapter will focus on cluster dynamics in the BSR i.e. the compositions and development of BSR clusters and their impact on economic development in the region.

To understand both the cluster composition and dynamics within a particular geography, answers are needed for questions like:

> What clusters exist in the region/nation/multi-national geography?
> Which clusters drive employment and productivity?
> How are the clusters evolving over time? Which are growing or shrinking (in terms of employment, and in terms of productivity)?

The BSR Cluster Database on performance can be used to conduct analyses in order to answer these types of questions as it includes historical, cluster-level data on both employment and productivity.

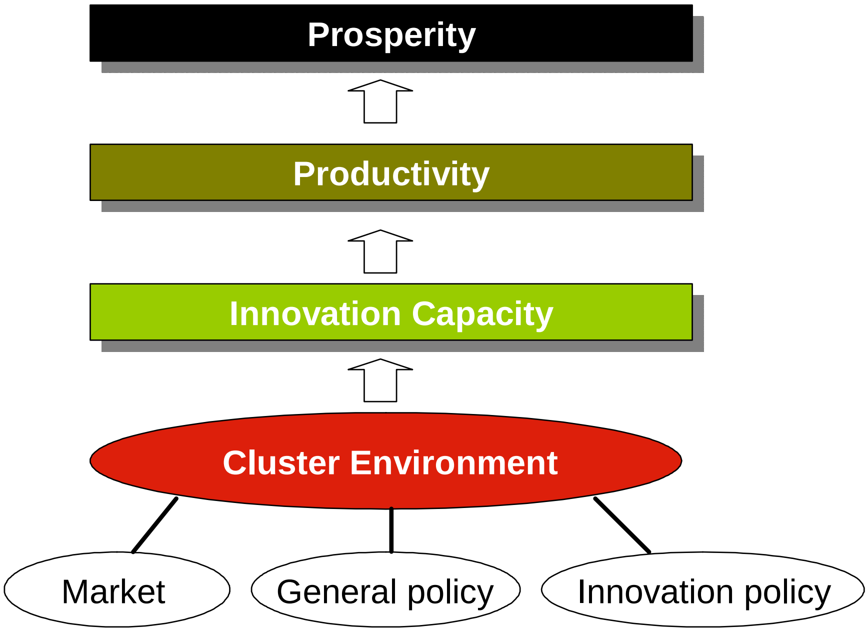
While employment data reveals information about cluster sizes and levels of specialization productivity data reveals information on the value created by each cluster. This can be used in answering the following interesting question:

> Do cluster strongholds create regional prosperity?

The answer to this question will provide policy makers with a clearer justification for formulating cluster-based innovation policies.

The illustration below provides a general perspective on cluster dynamics. A number of studies (e.g. Porter 2003) point at the existence of a positive correlation between clusters' productivity and regional prosperity. It is also believed (although not yet proven) that there is a positive relationship between the internal innovative capacity of a cluster and its productivity.

Illustration – Cluster dynamics



Source: FORA

Thus, the link between cluster performance and regional/national prosperity is two-fold.

First, there is a strong belief that companies within globally-traded industries are positively affected by spillovers from related companies in their surrounding area. Thus they form industry-specific clusters. Strong clusters are often associated with a high level of knowledge sharing, cooperation and a highly-specialized workforce. This helps companies to remain on the competitive edge. The result is that a strong cluster leads to higher productivity levels for companies within the cluster.

Second, it is believed that there are positive repercussions on the rest of the regional economy. As globally-traded industries increase their productivity, wages increase – and this spills over to the rest of the regional economy, catalyzing higher wage levels more broadly. The clusters pull income to the region and thereby increase the region's purchasing power. This means that high-performing clusters may have a positive effect not only on traded industries but also on the total economic performance of a region.

In the following, results are presented based on data from the BSR Cluster Database. Section 1 focuses on how cluster dynamics in the BSR can be illustrated by a set of five illustrations and explanations[22]. These illustrations are made for each of the 31 NUTS2 regions within the BSR and are included in "The background paper on cluster dynamics in the BSR's 31 regions"[23]. The paper was presented to the BSR InnoNet's Steering Committee in early September 2007.

[22] At the BSR InnoNet Workshop on *Using Statistical Data for Policymaking* in May 2007, a preliminary analysis of clusters in Denmark was presented as an example of how the BSR Cluster Database can be used.

[23] This document is currently being updated with revised data, and will be up-loaded to the BSR InnoNet intranet in March.

Section 2, outlines a brief, overview analysis of cluster dynamics at the national level.

In section 3, a preliminary analysis of whether specialization increases productivity levels within clusters confirms that the productivity level of clusters in the BSR seems to be positively related to the degree of specialization.

The question of whether higher productivity levels in traded industries has a positive impact on productivity levels in non-traded industries is treated in section 4, where preliminary indications confirm the hypothesis.

It is important to stress that the results presented in section 3 and 4 are only *preliminary* – a more thorough analysis has been initiated and will be ready during the spring.

3.1. Illustrations on cluster dynamics

To get an overview of the clusters in the BSR, five figures have been used to illustrate the clusters composition, sizes and development on a regional/national (NUTS2) level in the BSR:

1. Absolute Employment
2. Regional Share of Total BSR Cluster Employment
3. Cluster Plot – Employment Specialization
4. Cluster Stairs (productivity)
5. Cluster Plot – Regional Wage and Productivity

The five illustrations are presented below. Denmark is used as an example, but illustrations are available for each of the 31 regions in the BSR[24] and presented in a separate project document: "The background paper on cluster dynamics in the BSR's 31 regions". The 31 regions are listed in the table below.

[24] The first three illustrations are available for all 31 NUTS2 regions of the BSR. The last two illustrations are only available for 24 of the 31 NUTS2 regions (wage data for the three German regions, three Polish regions and Iceland has not been available).

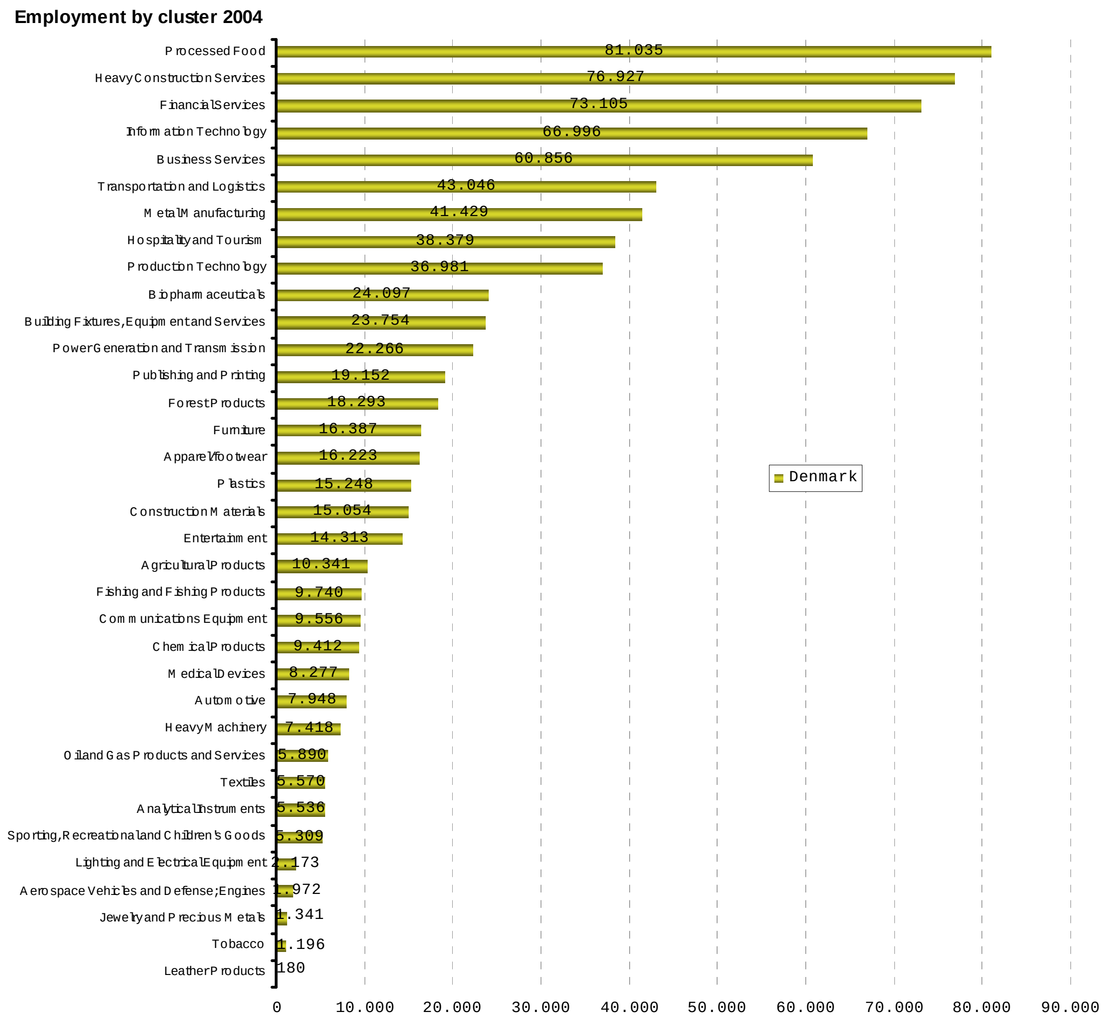
Table - The 31 regions in the BSR InnoNet

Denmark	Denmark - DK00
Sweden	Stockholm – SE01 Central-East Sweden - SE02 South Sweden - SE04 North Sweden - SE06 Central Sweden - SE07 Upper Northland - SE08 Smaaland and Islands - SE09 West Sweden - SE0A
Norway	Oslo and Akershus - NO01 Hedmark and Oppland - NO02 South-East Norway - NO03 Agder and Randaland - NO04 West Norway - NO05 Trøndelag - NO06 North Norway - NO07
Finland	East Finland - FI13 South Finland - FI18 West Finland - FI19 North Finland - FI1A Åland (Finland) - FI20
Estonia	Estonia - EE00
Latvia	Latvia - LV00
Lithuania	Lithuania - LT00
Iceland	Iceland – IS
Poland	Szczecin - PL42 Olsztyn - PL62 Gdansk - PL63
Germany	Hamburg - DE60 Mecklenburg-Vorpommern - DE80 Schleswig-Holstein - DEF0

Source: FORA and Copenhagen Economics

The first illustration, Figure 1, shows the total employment in each of the 35 clusters for the specific region. In the figure, absolute cluster sizes can be compared within the region listed by size in terms of employment (largest to smallest). As an example, the Danish "Processed Food" cluster shows to be the largest cluster (with 81.035 people employed) and the Leather Products cluster is the smallest cluster (with 180 people employed).

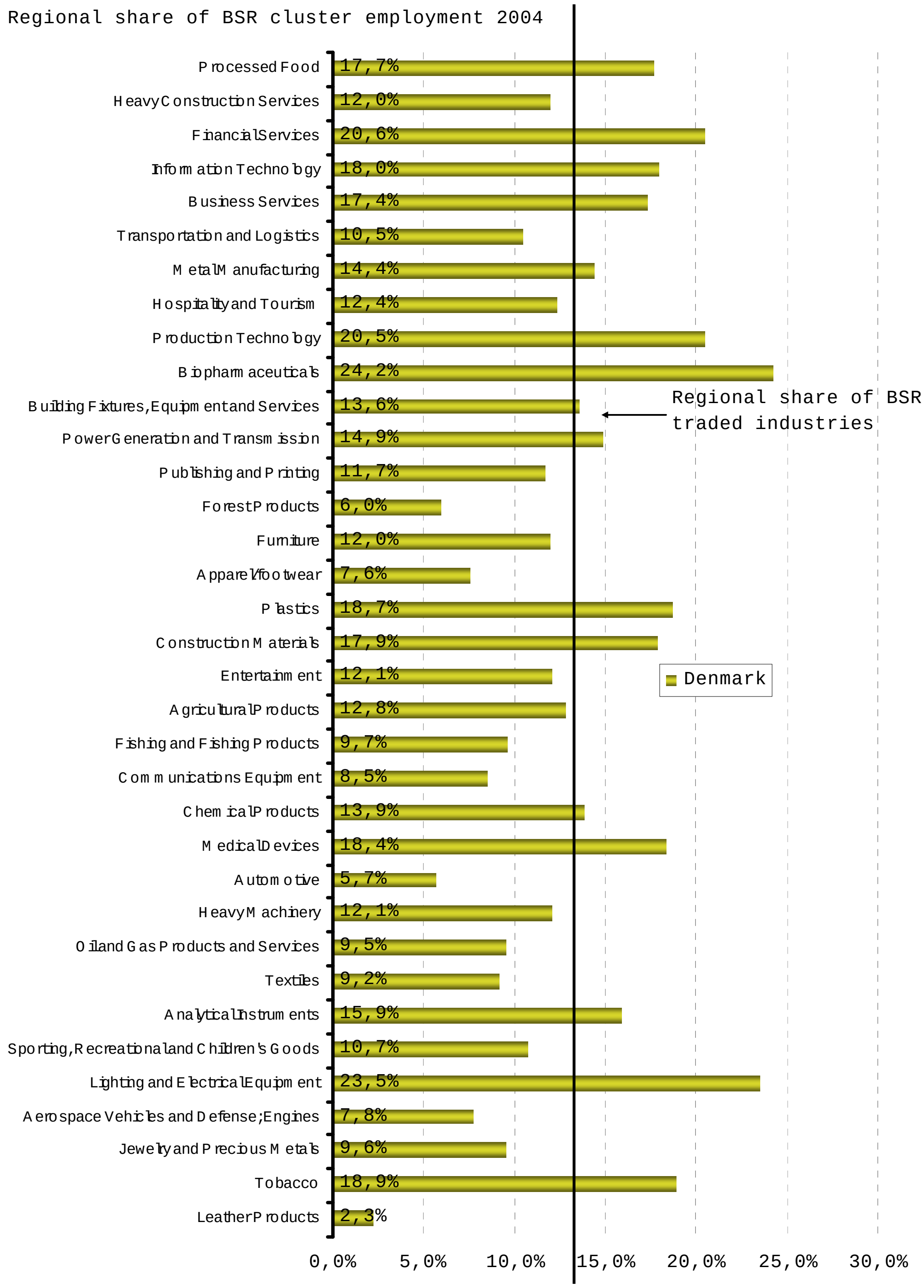
Figure 1 - Absolute employment



Source: FORA and Copenhagen Economics

Figure 2 presents, the region's share of cluster employment relative to the BSR. It illustrates two things: a) the region's average share of cluster employment in the BSR (indicated by the vertical line); and b) each regional cluster's share of total BSR cluster employment. The clusters are listed as in Figure 1 - by size in terms of absolute regional employment. In the figure, the average share of total BSR cluster employment shows to be 13,8 percent in Denmark. This means that 13,8 percent of the BSR's total cluster employment is located in this region. It also illustrates that 17,7 percent of the total BSR employment in "Processed Food" is located in Denmark. This is above the Danish average share of cluster employment, indicating that the region is more specialized in "Processed Food" when compared to the rest of the BSR. In "Heavy Construction Services", however, Denmark is less specialized when compared to the rest of the BSR (with only 12 percent of total BSR employment) – even though this is the cluster with the second largest level of absolute employment in this region.

Figure 2 - Regional share of total BSR cluster employment

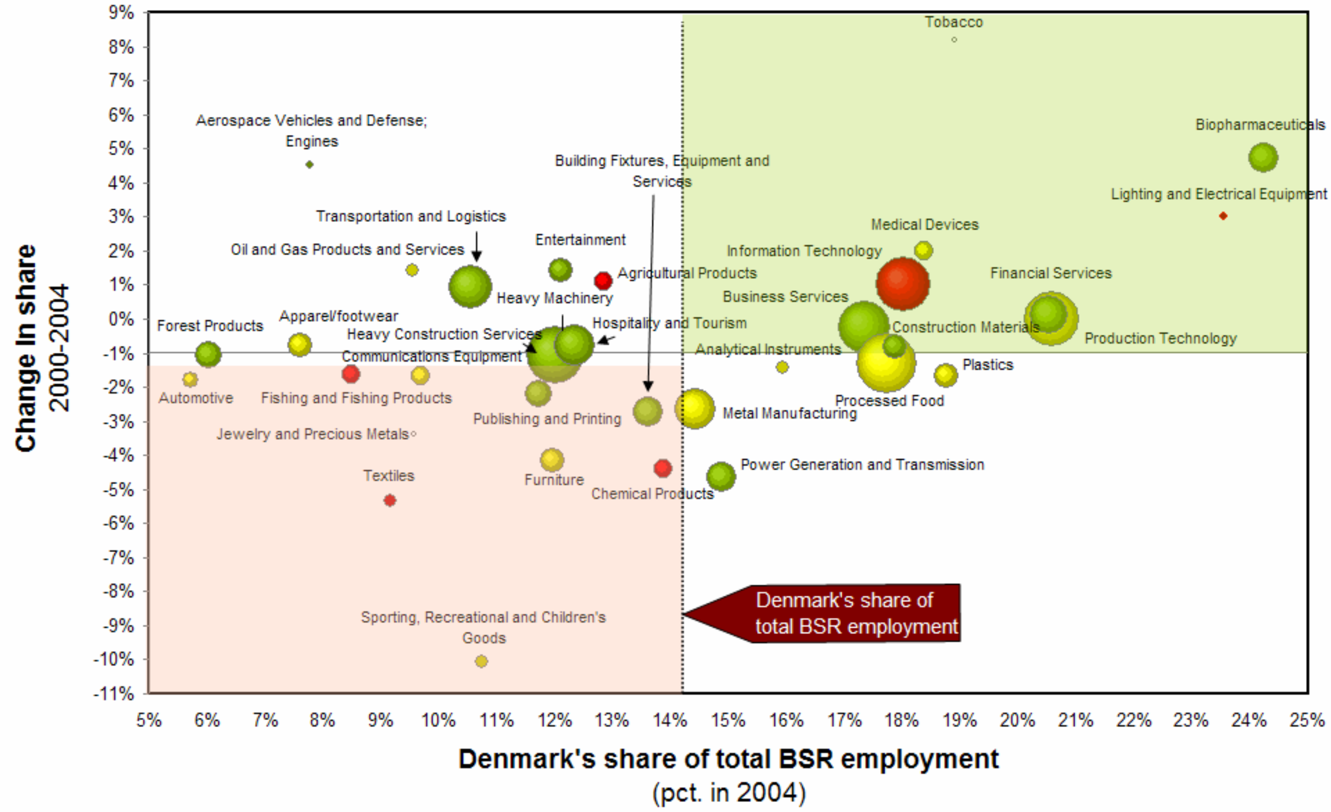


Source: FORA and Copenhagen Economics

The cluster plot in Figure 3 provides a combined picture of: a) the region's current areas of relative strength (measured in terms of employment specialization), and b) the areas where the region has succeeded in increasing employment shares (growth in specialization) in recent years. The plot compares the region with the rest of the BSR.

The horizontal axis shows the region's share of total BSR cluster employment. The dotted line indicates the region's average share of total BSR cluster employment. The region's most specialized clusters are located to the right of this line.

Figure 3 - Cluster plot – specialization



Source: FORA and Copenhagen Economics

In the figure illustrates that Denmark has an average of 14,3 percent of total BSR employment, and the most specialized Danish cluster is Biopharmaceuticals (with 24 percent of total BSR employment).

The vertical axis shows the areas of growth or decline in regional employment (from 2000-2004). The line indicates the change in the region's average cluster employment level relative to total BSR cluster employment. In the example above, the "Information Technology" cluster has grown by 1 percent, while the Danish average cluster employment has declined by 1 percent.

The size of the bubble indicates the absolute employment in the specific cluster. In the above illustration, "Heavy Construction Services" is shown to have a high employment, while "Textiles" is shown to have a low employment.

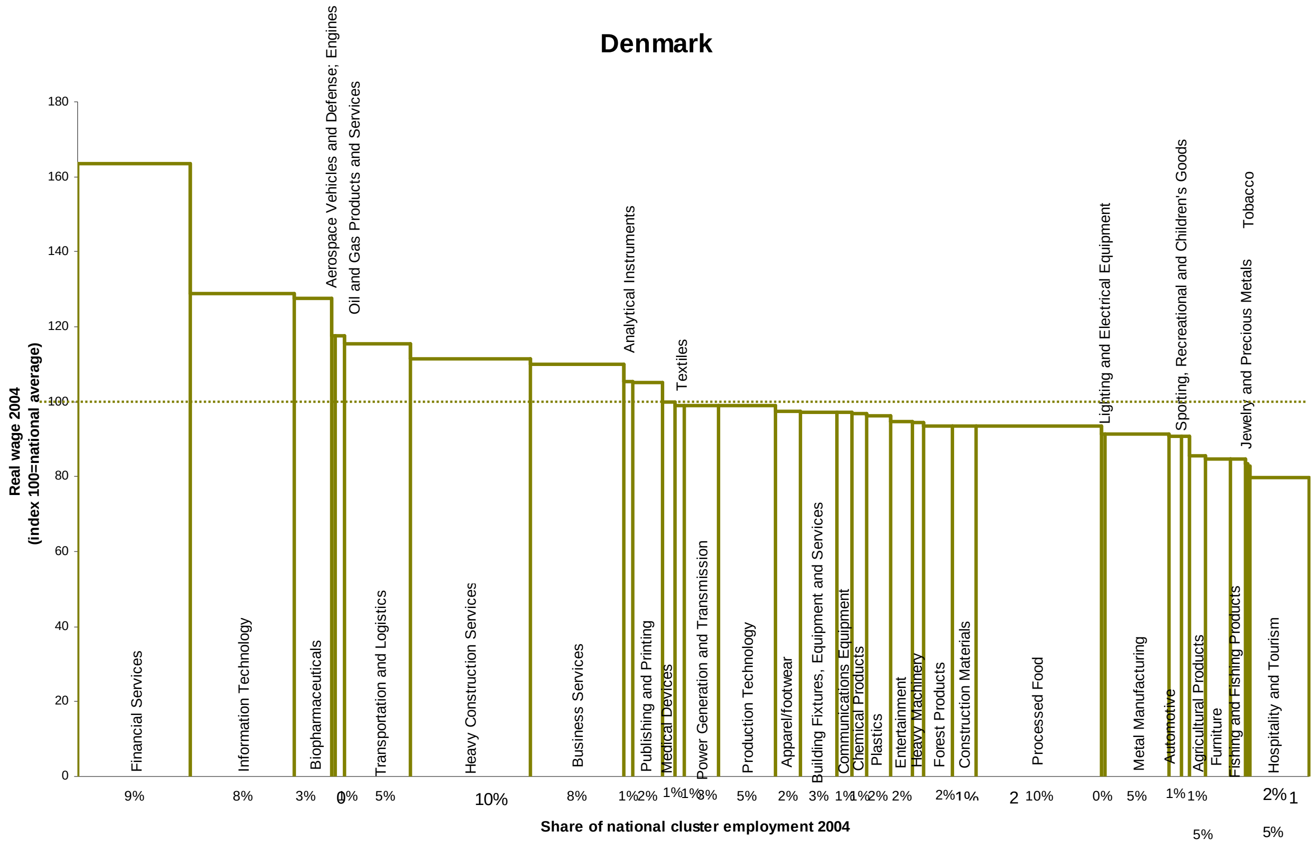
The color of the bubble indicates the change in employment for the BSR as a whole (between 2000-2004). If the level of employment in that cluster has been growing in the BSR, the bubble is green. If it has been falling, the bubble is red. If employment levels have not changed, the bubble is yellow.

On the whole, the most desirable scenario should be to have many green, large bubbles in the upper right quadrant – indicating that the region has managed to strengthen their specialization in areas/clusters that are growing in the BSR. However, having clusters with a decline in employment and specialization is not necessarily a bad thing. These clusters might be in a process of outsourcing part of their production or bringing in new technology to replace man-power in order to make their operations more productive. This is why cluster analysis should be focusing on measures of productivity as well as employment.

The cluster stairs in Figure 4 are illustrating how a region's clusters perform on both employment and productivity measured by real wages. The height of the column indicates the relative real wage of each regional cluster – that is the individual cluster's productivity relative to the general productivity level in the specific region. The width of the column indicates the share of cluster employment in the region. This figure gives a good overview of whether a relatively large cluster also creates high value for its workers and whether a highly productive cluster also has a high impact on the economy.

In the figure, the Danish "Financial Services" cluster has a relative productivity of 163, and accounts for 9 percent of the total cluster employment in the region.

Figure 4 - Cluster Stairs



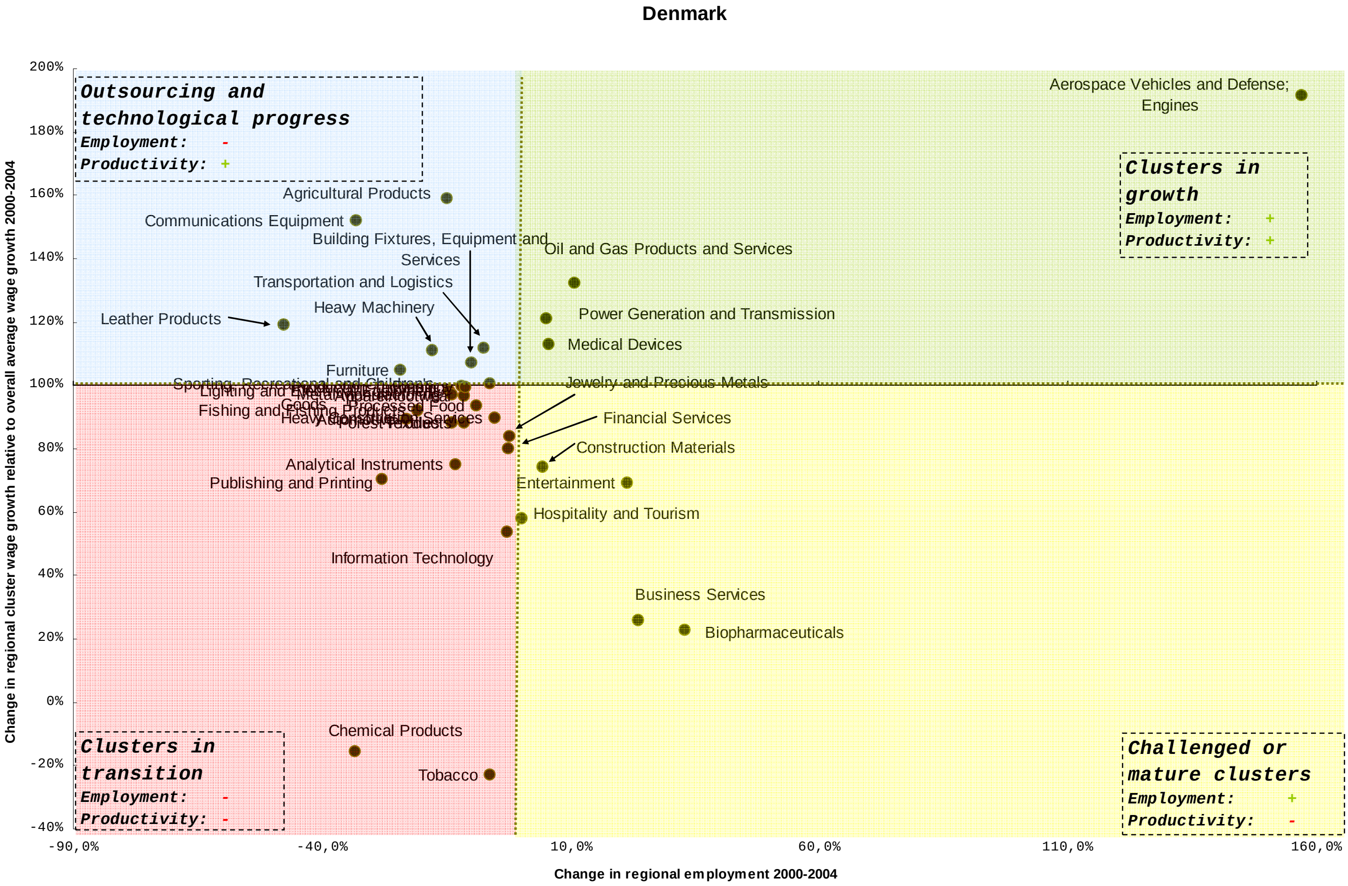
Source: FORA and Copenhagen Economics

The cluster plot in Figure 5 below provides a combined illustration of: a) dynamics of absolute employment levels in the region's clusters (between 2000-2004), and b) dynamics of regional cluster productivity levels – relative to the region's average productivity (between 2000-2004).

The horizontal axis illustrates the employment growth of the region's clusters between 2000 and 2004. If a cluster is situated to the right of the vertical line (that is in the yellow or green quadrants), the employment has risen. If a cluster is situated to the left of the vertical line, the employment has fallen in the given period.

The vertical axis illustrates if the relative productivity in a specific regional cluster has risen or fallen during the given period. If a cluster is situated above the horizontal line (above 100 percent), it indicates that the cluster has had a higher productivity growth than the region as a whole. If a cluster is situated below the line, it indicates that it has had a lower productivity growth than the region as a whole.

Figure 5 - Cluster plot – driver of regional wage/employment



Source: FORA and Copenhagen Economics

In Figure 5 above, the Danish "Communications Equipment" cluster has decreased its level of employment (by almost 30 percent) while increasing its productivity (by around 50 percent more than the region's average productivity).

The upper right corner of the figure (the green quadrant) contains clusters that have had both a growth in employment and a higher growth in productivity than the region has had on average. These clusters can be characterized as *clusters in growth.*

The lower right corner (the yellow quadrant) contains clusters that have had a positive growth in employment, but have not been able to keep up with the general productivity growth in the given period. A cluster can lie in this quadrant for different reasons and are characterized either as *challenged clusters* or *mature clusters*. Challenged clusters are clusters which have attracted more employment but not been able to match the general growth in productivity, while mature clusters are clusters which previously have had a high productivity growth but now have reached a higher level with a lower possibility of maintaining the high level of productivity growth within the period.

The upper left corner (the blue quadrant) contains clusters that have had a decline in employment, but a higher growth in productivity than the region on average. These clusters are typically clusters that have *outsourced* part of their production (during the given period) or brought in *new technology* to replace man-power. A decline in employment need not be a bad thing since the clusters can be in the process of making operations more productive, for instance by keeping their high-end of the value chain and outsourcing the low productive parts of production.

The lower left corner (the red quadrant) contains clusters that have had both a decline in employment and a lower growth in productivity than the region on average. These clusters can be characterized as clusters in transition, that is clusters which may be phasing out or about to transit into new fields of expertise.

3.2. Cluster Dynamics in the Baltic Sea Region

To get a more complete story on the cluster dynamics and the clusters' impact on the economy, cluster analyses need to focus not solely on cluster employment but also on measures of cluster productivity, that is on the value created by each cluster. As seen in the previous section, the largest cluster are not necessarily the most productive clusters, and clusters with decreasing levels of specialization are not necessarily loosing strength but may just be in a process of making their operations more productive by outsourcing or replacing man-power by new technology.

Also, cluster dynamics can be viewed from many levels: local, regional, national and even multi-national. Regional analysis on industrial dynamics can be interesting for regional-level government as an input to regional development or industrial policy. Analysis of higher (national or multi-national) levels can be interesting for national-level government as an input to national industrial or innovation policy. As one 'zooms out', however, detailed information sometimes disappears in the averaging, and different industrial landscapes appear. Therefore, conducting and comparing analyses on the various geographical levels reveals a more complete picture – understanding that the different perspectives may lead to different conclusions and policy recommendations.

This section will provide a brief, overview analysis of cluster dynamics on the national (NUTS1) level in the Baltic Sea Region – except for Northern Poland and Northern Germany, which are composed by the three Northern NUTS2 regions of each country[25].

Table 1 below illustrates the top three clusters measured on absolute employment for each country in the BSR. This overview highlights a number of points:

- "Heavy Construction Services" has the highest level of absolute employment in five countries (Sweden, Finland, Estonia, Norway and Northern Germany), and the second highest level of absolute employment in two countries (Denmark and Lithuania). And this cluster category is among the top three clusters measured on absolute employment in Northern Poland.

[25] In the background paper "Background Paper – *Cluster Dynamics in the BSR's 31 Regions"* cluster dynamics was addressed on a regional (NUTS2) level.

- "Processed Food" has the highest level of absolute employment in three countries (Denmark, Latvia and Northern Poland) and the third highest level of absolute employment in two countries (Lithuania and Estonia)

- In Iceland, the cluster category with the highest absolute employment is "Fishing and Fishing Products"; in Lithuania, it is "Apparel/Footwear".

- Norway, Iceland, Northern Germany, and Northern Poland have the second highest absolute employment in the "Transportation and Logistics" cluster.

- "Forest Products" has the second highest level of absolute employment in Latvia, Finland and Estonia.

Table 1 - Top 3 Cluster Categories measured by absolute employment

N.Germany	Heavy Construction Services 96.733	Transportation and Logistics 87.010	Business Services 63.982
Denmark	Processed Food 81.035	Heavy Construction Services 76.927	Financial Services 73.105
Estonia	Heavy Construction Services 28.529	Forest Products 18.467	Processed Food 17.358
Finland	Heavy Construction Services 109.522	Forest Products 60.780	Information Technology 55.603
Iceland	Fishing and Fishing Products 11.731	Transportation and Logistics 5.564	Financial Services 5.398
Lithuania	Apparel/footwear 62.159	Heavy Construction Services 49.110	Processed Food 38.724
Latvia	Processed Food 27.542	Forest Products 26.219	Apparel/footwear 24.977
Norway	Heavy Construction Services 80.007	Transportation and Logistics 79.023	Information Technology 49.672
N.Poland	Processed Food 62.742	Transportation and Logistics 40.818	Heavy Construction Services 38.824
Sweden	Heavy Construction Services 141.070	Information Technology 115.467	Metal Manufacturing 107.975

Source: FORA

In Table 2 below the top three most productive cluster categories (in terms of real wages) are illustrated. How each cluster category ranks on absolute employment within the given country is indicated in parentheses. The table is based on the illustrations on absolute employment and productivity which can be found in appendix 3 and 4. The overview given in Table 2 highlights a number of additional points:

- There are no positively relationship between the largest clusters with the highest absolute employment and the most productive clusters with the highest real wage.

- "Information Technology" is in the top three of the most productive clusters in five countries; "Oil and Gas Products and Services" in four countries; "Financial Services" in three countries; "Biopharmaceuticals" and "Business Services" in two countries.

Table 2 - Top 3 Cluster Categories measured by real wages (Rank of absolute employment within the country)

Denmark	Financial Services (3)	Information Technology (4)	Biopharmaceuticals (10)
Sweden	Biopharmaceuticals (13)	Information Technology (2)	Oil and Gas Products and Services (29)
Norway	Oil and Gas Products and Services (10)	Business Services (6)	Entertainment (27)
Finland	Oil and Gas Products and Services (29)	Communications Equipment (10)	Aerospace Vehicles and Defence; Engines (30)
Estonia	Business Services (19)	Information Technology (13)	Transportation and Logistics (4)
Latvia	Information Technology (16)	Financial Services (7)	Business Services (11)
Lithuania	Financial Services (12)	Oil and Gas Products and Services (18)	Information Technology (7)

Source: FORA

These very cursory observations point out the importance of looking at different sets of data when analyzing clusters. Both employment and productivity data provide very important and different information for the analysis of cluster dynamics. Excluding either of these data points in cluster analysis would lead to incomplete results and supposedly incorrect conclusions.

These observations also highlight where it might be interesting to look deeper into the data – to confirm what the key economic drivers are, what companies are active in which cluster categories, and what inter-relationships may exist between cluster categories.

A final point that is important to make is that statistical data is only one of several inputs that are important to consider when analyzing industrial/cluster dynamics. The data provides a number of initial "clues" as to where it would be beneficial to focus efforts – both analytical and operational efforts.

3.3. The link between specialization and real wage

For clusters to be a relevant notion to base parts of innovation policy upon there is a need for evidence that shows that companies' success is actually related to the presence of clusters. One way forward is to test if specialization affects productivity i.e. whether companies in highly-specialized clusters have a higher wage level than companies in less-specialized clusters.

3.3.1. What is specialization?

Specialization is often used as a method for identification of clusters. Specialization is defined by the location quotient (LQ), which describes whether or not a region is specialized in a given cluster, but not, however, if there are interactions between the companies in a cluster.

Box - Definition of location quotients

The location quotient is defined as the employment share of a cluster in a given region compared to the employment share in the BSR-region. The location quotient for a cluster in a given region is given as:

$$LQ = \frac{Employment_{reg,cluster} / Employment_{reg}}{Employment_{BSR,cluster} / Employment_{BSR}}$$

If the location quotient is larger than 1, the region has a relatively higher employment share than the BSR-region on average. Often, a region is classified as specialized in a given cluster if the LQ is larger than 1.25. This equals to a 25 percent larger share of employment in a given cluster than the average for the BSR-regions.

Source: FORA and Copenhagen Economics

3.3.2. The econometric model and results

A positive relationship between specialization and productivity measured by real wage is tested by setting up an econometric model.

As the level of productivity differs between clusters and countries, different wage levels will appear. Consequently, the model needs to make sure that it is not these differences which drive the results. Therefore, a fixed-effect model is used.

The fixed-effect model makes it possible to control for differences in wage levels between clusters and countries (unobserved heterogeneity). For instance, it is seen that the Financial Services cluster has a higher wage level than the Hospitality and Tourism cluster in all regions. Also, there are generally higher wages in the Nordic countries than in the Baltic countries, and there are national differences within the two groups of countries.

It is tested whether the location quotient (LQ) can explain the wage level within the same cluster. And therefore, the parameter of interest is the beta coefficient in the model specified in the box below. By taking the logarithm of the real wages, the beta coefficient can be interpreted as the average percentage effect on real wages when the location quotient increases by one.

Box - Specification of the fixed-effect estimation model

$$LN(wage)_{time,cluster,country} = \alpha + \beta\, LQ_{t,c,c} + \mu_{cluster} + \lambda_{country} + T_{time} + \varepsilon_{t,c,c}$$

Source: FORA and Copenhagen Economics
Note: The wages are measured in 1000 euros; LQ is compared to the BSR-regions (excluding the six Polish and German regions)

In the first preliminary analysis a positive and significant relationship is found between the location quotient and the real wage. Thus, there seem to be indications that the real wage within the cluster increases with cluster specialization.

A significant beta coefficient is found in the order of 3 percent. This means that an increase in the location quotient of one will increase the average wage in a given cluster by 3 percent. The box below shows how to interpret this preliminary result.

Box - What does the estimated result mean for a specific cluster?

Below, the Danish Biopharmaceutical cluster is used as an example to illustrate the estimated impact of specialization. The impact is based on an increase in the location quotient of Biopharmaceuticals by 0.1 holding all other cluster location quotients fixed (i.e. that more employment is agglomerated in the Biopharmaceuticals' cluster while employment levels in other cluster remain steady).

In 2000, the Danish Biopharmaceutical cluster employed 18,000 people, and the location quotient of the industry was 1.3. In 2004, employment had increased by 6,000 (to 24,000 people), and the location quotient was almost 1.7 i.e. the location quotient has risen by 0.3.

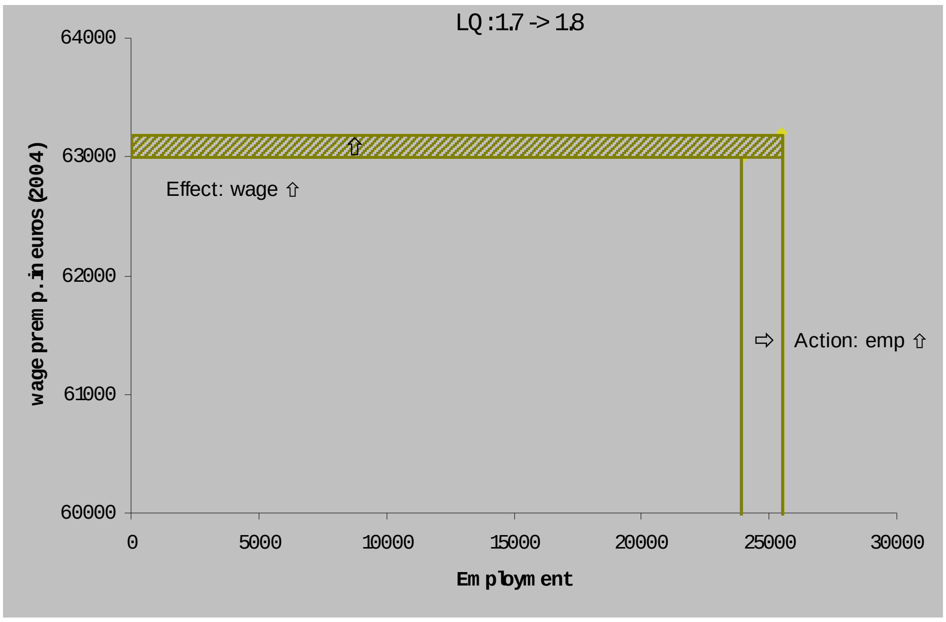
As a hypothetical scenario, imagine that the Biopharmaceutical cluster in Denmark becomes even more specialized – increasing the location quotient from 1.7 to 1.8. - and at the same time the rest of cluster employment is assumed unchanged. The increase of 0.1 in the location quotient in the Danish Biopharmaceutical cluster is equivalent to an increase in employment of 1500 employees (or a 6 percent increase).

The estimated impact of specialization tells us that an increase in the location quotient by 0.1 will, on average, raise the wage level with 0.3 percent for all the employees in the specific cluster. For the Danish Biopharmaceutical cluster this means an increase in the yearly average wage from 63,000 euros (2004) to 63,200. That is, the yearly increase of 200 euros per employee is due to the effect of a 0.1 increase in the location quotient.

In terms of elasticity, for this example, an increase in the cluster employment of 1 percent increases the wages in the cluster by 0.05 percent.

The figure below illustrates how the employment change affects the total earnings in the Danish Biopharmaceutical cluster. If some kind of action (public or private) succeeds in raising employment with 1.500 (the shift of the vertical border), it will create a significant positive effect on earnings (the upward shift of the horizontal border).

The Danish Biopharmaceutical cluster



Source: FORA and Copenhagen Economics

While the model indicates a positive relationship between the localization quotient and wages, the effect is small in magnitude – indicating a positive but limited effect on productivity of strong clusters.

However, it must be stated that the results are preliminary. The limitations of the data used in the analysis may give some explanation to the result.

First, all clusters are included in the analysis, although the positive effects on specialization may be higher in some industries than others. A next step is to define industries where high productivity gains are expected as a result of specialization.

Second, the definition of the relevant region is the same for all clusters. The relevant region for a specific cluster is very likely to vary from cluster to cluster. Here, a definition of the geographical coverage of each cluster is needed.

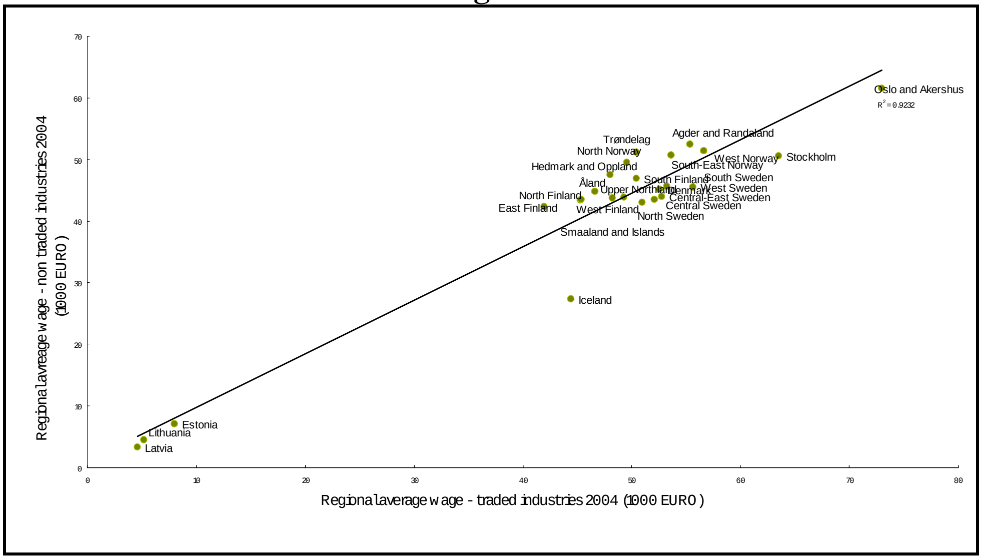
These considerations will be taken into account in further analyses during spring 2008.

3.4. Does the "cluster effect" have an impact on the rest of the economy?

A simple way to illustrate whether strong clusters in a region also affect the rest of the regional economy is to test whether there is a relation between high wages in the traded and non traded industries. The idea is that as globally-traded industries increase their productivity, wages increase – and this spills over to the rest of the regional economy, catalyzing higher wage levels more broadly. High performing clusters may have a positive effect not only on traded industries but also on the total economic performance of a region.

The illustration below includes all the NUTS2 regions in the Nordic and Baltic countries and shows a positive correlation between real wage in traded and non-traded industries (R^2=0,93).

Illustration - Average wages in traded industries versus non-traded industries by region

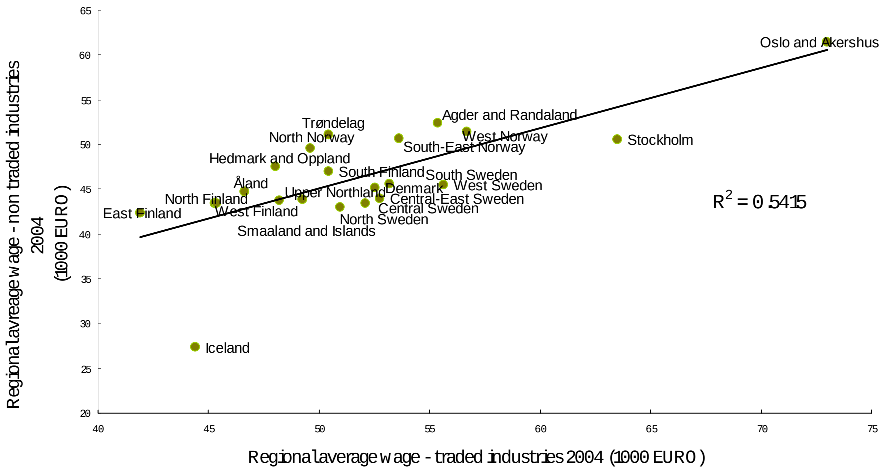


Source: FORA and Copenhagen Economics

Note: For the specific definition of traded and non-traded industries, see the internal project working document: Technical background report on cluster compositions (May 2007).

As the figure shows, there are two groups of regions: the Nordic and the Baltic regions. The Baltic regions are measured on a national level and are therefore represented by three observations only. The next illustration takes a closer look at the Nordic regions by excluding the three Baltic regions. In both illustrations, there is a positive correlation between the average wage in the cluster industries and the average wage in the rest of the regional economy.

Illustration - Average wages in traded industries versus non-traded industries in the Nordic regions



Source: FORA and Copenhagen Economics

Note: For the specific definition of traded and non traded industries see the internal project working document: Technical background report on cluster compositions (May 2007).

The positive correlations may indicate that an effective cluster policy spurring employment and productivity also has a positive effect on the rest of the economy. However, it is important to stress that this is a first step in investigating the importance of cluster specialization, and more work needs to be done to understand the causality of the relation between wages in the traded and non-traded industries. Further analyses will be carried out on this question as well during spring 2008.

4. Picking clusters for benchmarking

The Life Science cluster has been selected as a pilot case for benchmarking cluster-specific performance and framework conditions in the BSR. The decision was taken at the Steering Committee Meeting in Helsinki (September 2007), based on an analysis of criteria developed for prioritizing between the different clusters.

Within the scope of the BSR InnoNet and parallel to the work in WP4, the two other working groups WP3 and WP6 has worked on selecting one or more clusters/sectors/centers of expertise as targets for transnational pilot programmes. This selection was discussed at the joint WP 3&6 meeting on September 3rd in Copenhagen.

The criteria used for selecting clusters for benchmarking and the criteria used for selecting targets for transnational pilot programmes need not be the same. But information and ideas on criteria and selection of clusters in each work package can provide useful information to the other work packages.

This chapter will give a short overview of the ideas developed in WP4 on how to set up these criteria followed by the results of the analysis. Section 1 gives a short outline of the analytical tasks in WP4. Section 2 summarizes which selection criteria have been used, while section 3 describes each of the criteria in detail. The result of the analysis is presented in section 4.

4.1. Background on WP4 tasks

The overall goal of WP4 is to do quantitative cluster analyses that can serve as input and inspiration to the more qualitative work done in the other work packages.

As described in chapter one, WP4 has three main analytical tasks:

1. Mapping the regional clusters in the 31 regions in the BSR starting from the cluster code developed by Michael Porter, Harvard University and translated by Ketels and Sölvell at Stockholm School of Economics
2. Analyzing the dynamics of clusters in the BSR based on indicators such as employment, specialization and productivity
3. Benchmarking innovative performance and framework conditions (cluster policy) across a pilot cluster(s) in the BSR

Task 1 – mapping regional clusters in the BSR

The mapping identifies 35 clusters across the 31 NUTS2 regions of the BSR. The mapping is done on the basis of the Porter cluster code developed at Harvard University. This code is also used in the Europe Innova Cluster Mapping Project lead by Ketels and Sölvell at Stockholm School of Economics. The cluster code used in WP4 has been further qualified to suit European statistics[26].

[26] See the internal project document on "Benchmarking Cluster Performance – A tool for Policy", which was distributed at the conference in Copenhagen May 2007.

Task 2 – analyzing cluster dynamics in the BSR
The analysis gives an all-round picture of clusters in the 31 BSR regions – and the BSR as a whole. The analysis is based on indicators for both the absolute level and growth of employment, specialization, and productivity.

Task 3 – benchmarking performance and framework conditions (cluster policy)
It is interesting to know if the most successful and innovative clusters are situated in regions with specific framework conditions. If this is the case, it could be of interest to look closer at these regions – and see if other regions can learn from their experiences. To get a solid answer, data on both performance (cluster success/innovation) and on the existing framework conditions are collected. To test if the best-performing and most innovative clusters are situated in regions with specific framework conditions, the correlation between performance and framework conditions are tested. The benchmarking will be done as a pilot on one cluster selected from the 35 clusters identified in Task 1.

To meet these three tasks, a collection of data has been initiated. Both employment and real wage data has been collected on a regional and sectoral level. Afterwards, the data has been harmonized, and the highest possible standard for the data has been secured. All data is stored in the BSR Cluster Database – available for all the BSR InnoNet partners. As the project continues, data on cluster performance and cluster-specific framework conditions will be added to the database.

4.2. Criteria for selecting clusters for benchmarking

There are a number of criteria which may be important to consider when trying to prioritize and select clusters for benchmarking cluster-specific performance and framework conditions (task 3 above).

Through various brainstorming sessions, the WP4 team has identified several criteria that could be interesting to consider when deciding which clusters to benchmark. Some of these criteria are quantitative (determined by statistical data), while others are of a more qualitative nature. The sessions concluded in choosing the following six criteria:

1. *Forming a BSR stronghold*
2. *High representation in the BSR*
3. *High learning potential between regions/countries*
4. *Important in the new knowledge economy*
5. *Important driver of regional/national economic performance*
6. *High priority in a regional/national policy context*

The first 4 criteria are directly spurred by the BSR InnoNet's objective to initiate trans-national innovation. The last two are to secure that the participating countries also view the pilot case as nationally interesting and beneficial.

Criteria 1-3 and 5 can be calculated directly from the BSR Cluster Database supplemented with EU data from the Mapping Project. Criterion 4 is based on the European Trend Chart on Innovation 2006. Criterion 6 is of more quantitative character and is based on discussion between the BSR InnoNet partners (in WP6) and at the Steering Committee.

For each of the criteria, the indicators used to apply the criteria and illustrations of their application are presented in detail in the section that follows.

4.3. The criteria and their results

In this section, the first five criteria, their technical formulation and the results from applying the criteria to the data are presented.

4.3.1. Forming a BSR stronghold

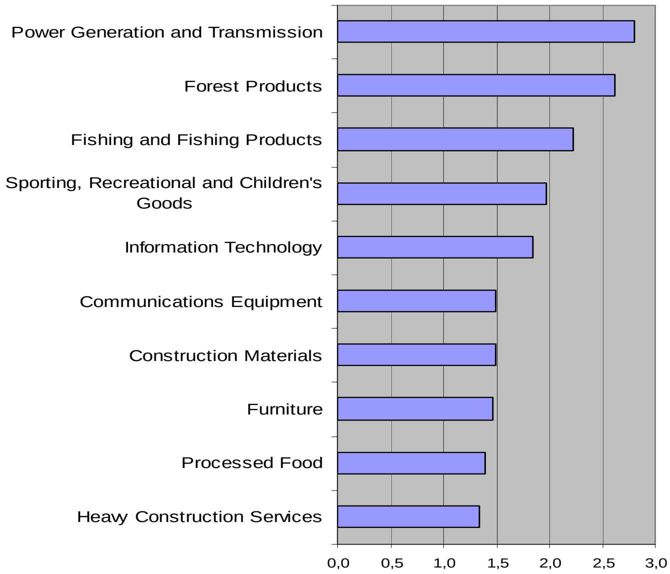
By definition, a cluster in the BSR will form a BSR stronghold compared to the rest of the EU if the cluster is relatively more specialized in the BSR compared to the EU. Clusters where the BSR has particular strengths are interesting for further analysis; consequently, this has been included as one of the criteria.

Specialization of a cluster x in the BSR compared to the EU is measured by the localization quotient which measures the share of total cluster employment of a given cluster in the BSR compared to the share of total cluster employment of the same cluster in the EU as follows:

$$\frac{\left(\frac{\text{Employment in cluster x in BSR}}{\text{Total cluster employment in BSR}}\right)}{\left(\frac{\text{Employment in cluster x in EU}}{\text{Total cluster employment in EU}}\right)}$$

Applying this criterion to the data revealed the following clusters:

Illustration – Top 10 clusters forming a BSR stronghold



Source: FORA and the BSR Cluster Database

4.3.2. High representation in the BSR

Another interesting criterion to consider when selecting a cluster for benchmarking is high representation (measured by employment) across the 31 regions of the BSR. The cluster is highly represented in the BSR if the cluster has a certain size and if it is represented in many of the BSR regions. Therefore, two indicators are considered: critical mass and broad representation.

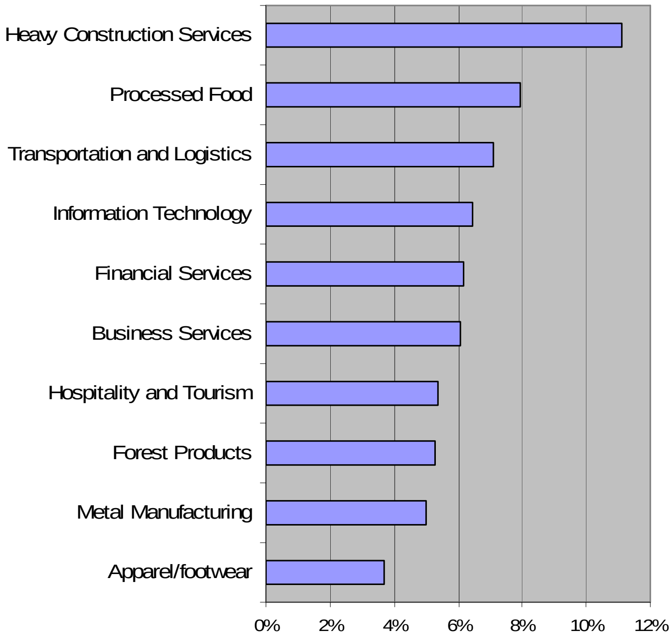
4.3.2.1. Critical mass

A cluster is well-represented in the BSR if it has a certain size across the BSR regions, that is, if the cluster is represented by a significant share of total employment among the clusters in the BSR. The top ten clusters with the highest share of total cluster employment in the BSR have been chosen, measured by:

$$\frac{\text{Employment in cluster x in BSR}}{\text{Total cluster employment in BSR}}$$

Applying this criterion on the data revealed the following clusters:

Illustration – Top 10 clusters with highest share of cluster employment in the BSR



Source: FORA and the BSR Cluster Database

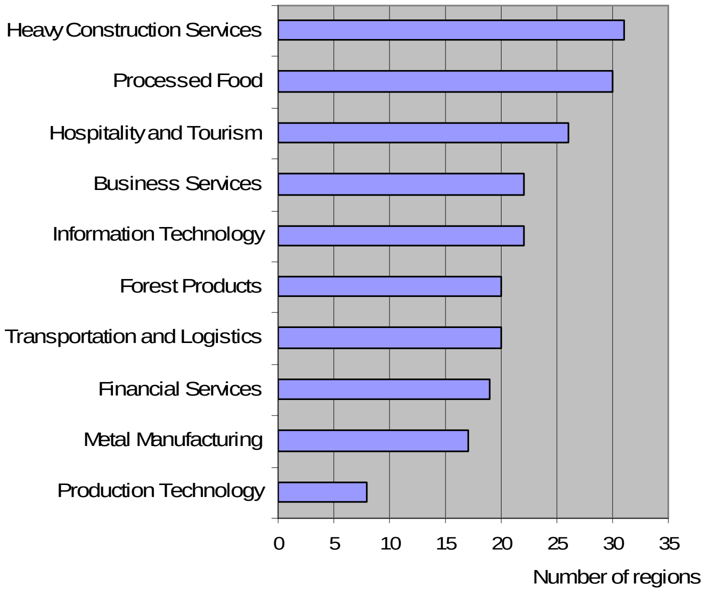
4.3.2.2. Broad representation

Another way of having a high representation in the BSR is if the cluster is broadly represented in the BSR, that is, if it is represented in many of the BSR regions. Therefore, it is interesting to see if the cluster has a relatively high share of cluster employment in many regions, measured by the number of regions in which each cluster has over a certain share of employment (E_0) based on the following subjective criterion:

$$\frac{\text{Employment in cluster x in region i}}{\text{Employment in region i}} > E_0$$

This criterion revealed the following clusters:

Illustration – Top 10 clusters with the broadest representation



Source: FORA and the BSR Cluster Database

4.3.3. Learning potential between regions/countries

Benchmarking is about finding the best-performing regional clusters and testing if other less successful clusters can learn from their experiences. A cluster's learning potential is therefore an interesting criterion to include when selecting a cluster for benchmarking.

A cluster's learning potential can be measured as follows. When regions in the BSR have high differences in the real wage levels of a given cluster, the regions with the lower real wages may have a high potential for learning from the more productive regions which are able to pay a higher real wage within the given cluster. Learning potential between regions of a given cluster is measured as the variation in the relative real wage across regions accounting for national wage effects. The variation is measured by the standard deviation as:

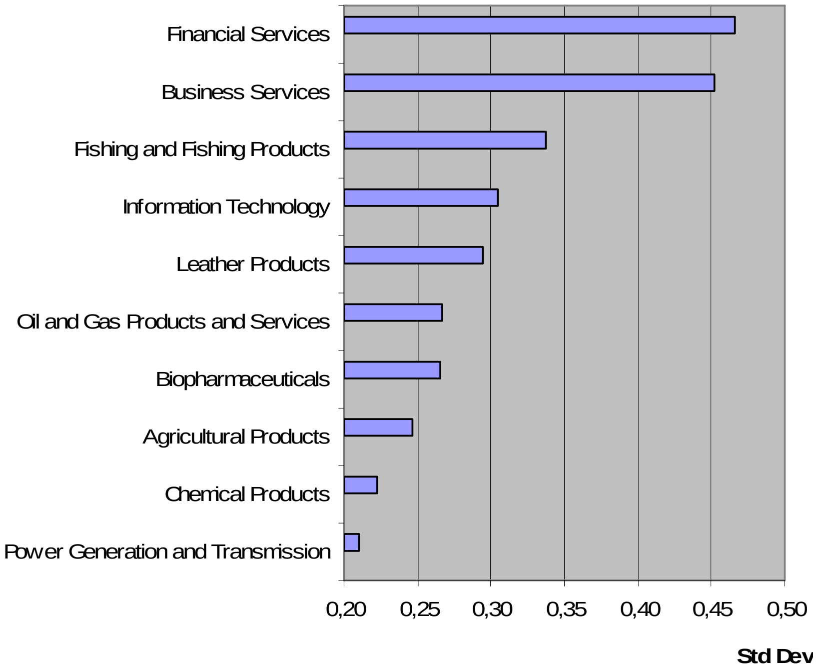
$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

Where

$$x = \frac{\text{Real wage in cluster y in region i}}{\text{Real wage in country z}}$$

This criterion revealed the following clusters:

Illustration – Top 10 clusters with the highest learning potential in the BSR



Source: FORA and the BSR Cluster Database

4.3.4. Important in the new knowledge economy

Benchmarking cluster-specific performance and framework conditions is testing the differences in business conditions related to cluster's specific innovative activities. Therefore, the selection of a cluster for benchmarking in the BSR should also be based on whether the cluster is among the most innovative BSR clusters. This will ensure that the cluster plays an important role in the BSR knowledge economy and that a reasonable amount of innovative activity can be measured in the benchmark analysis.

The criterion for finding the most innovative clusters in the BSR is less scientific and not as the previous criteria based on the BSR Cluster Database.

Numerous studies indicate that innovation is the main driver of growth in the future knowledge economy[27]. The European Trend Chart on Innovation 2006[28] measures innovation in 25 NACE industries which are somewhat comparable with the cluster level.

This criterion revealed the following most innovative clusters:

- Medical devices
- Analytical instruments
- Information technology
- Communication equipment
- Business services
- Pharmaceuticals

[27] EU 2006, OECD 2005

[28] The European Trend Chart on Innovation 2006

- Chemical products
- Automotive
- Lightning and electrical equipment
- Production technology

4.3.5. Important driver of regional/national economic performance

The benchmarking analysis will be of particularly interest if the selected cluster is an important driver of economic performance in the BSR regions. Therefore a fifth criterion is whether a cluster is an important driver of regional/national economic performance in the BSR[29]. Here, two indicators are considered: driver of real wage growth and driver of specialization growth.

4.3.5.1. Driver of real wage growth

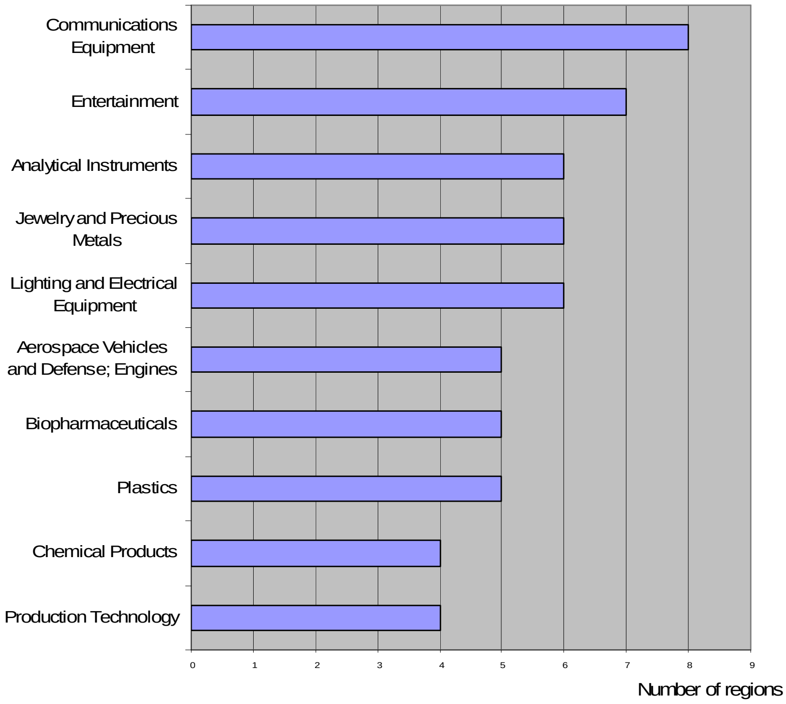
A cluster drives national/regional economic performance in the BSR if it shows to have a high share of relative growth in real wages in many regions of the BSR. This is measured by the given clusters' average growth in average real wages adjusted for regional differences:

$$\frac{\dfrac{\text{Real wages in cluster x in region i (2004)} - \text{Real wages in cluster x in region i (2000)}}{\text{Real wages in cluster x in region i (2000)}}}{\dfrac{\text{Real wages in region i (2004)} - \text{Real wages in region i (2000)}}{\text{Real wages in region i (2000)}}}$$

Applying this criterion on the data revealed the following clusters:

[29] Some regions in the BSR correspond to a nation.

Illustration – Top 10 clusters driving regional real wage growth in the BSR



Source: FORA and the BSR Cluster Database

4.3.5.2. Driver of specialization growth

A cluster drives national/regional economic performance in the BSR if it shows to have a high relative growth in the degree of specialization in many regions in the BSR, measured by the average growth in regional specialization as:

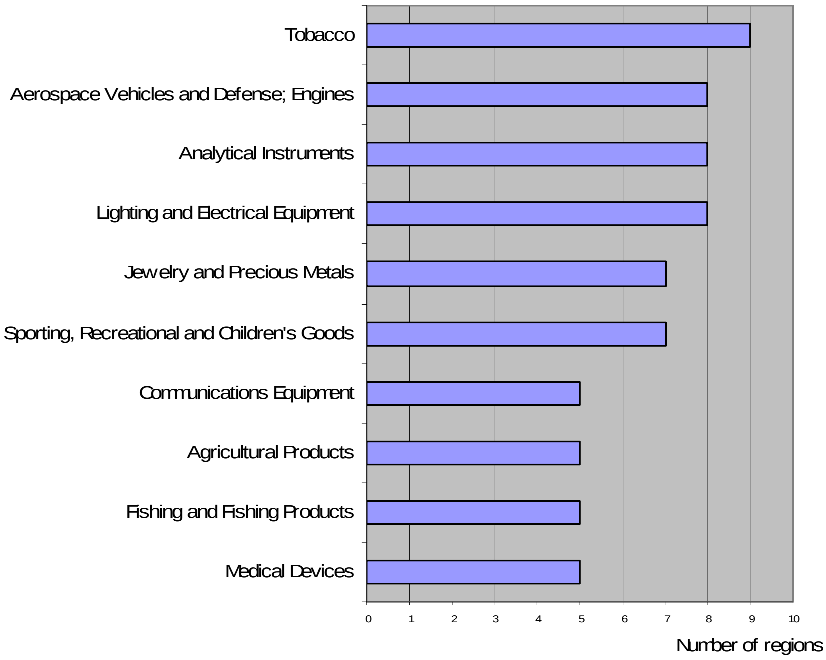
$$\frac{\text{LQ of cluster x in region i (2004) - LQ of cluster x in region i (2000)}}{\text{LQ of cluster x in region i (2000)}}$$

where

$$\text{LQ} = \frac{\dfrac{\text{Employment in cluster x in region i}}{\text{Total cluster employment in region i}}}{\dfrac{\text{Employment in cluster x in BSR}}{\text{Total cluster employment in BSR}}}$$

This criterion revealed the following clusters:

Illustration – Top 10 clusters driving regional specialization growth in the BSR

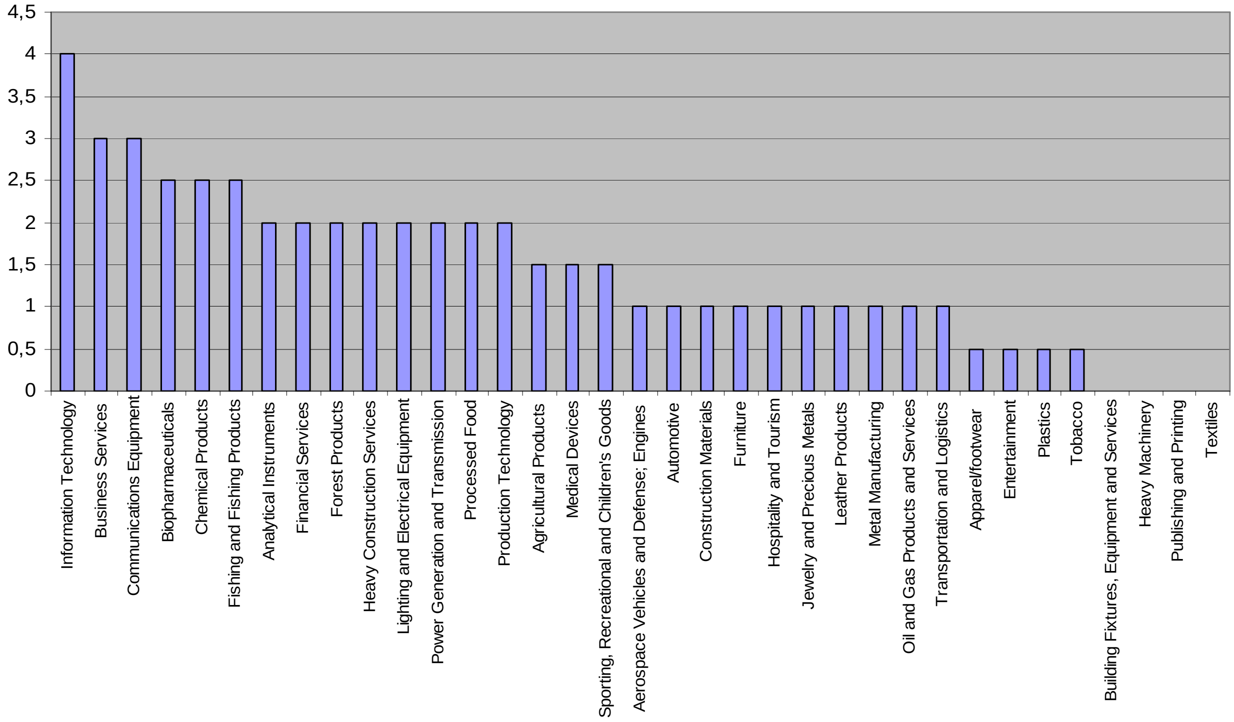


Source: FORA and the BSR Cluster Database

4.4. Picking a cluster for the pilot study

After setting up these five criteria for cluster selection, the criteria are weighted equally which leads to the following ranking of the BSR clusters:

Illustration – Summing up the cluster criteria for BSR



Source: FORA and the BSR Cluster Database

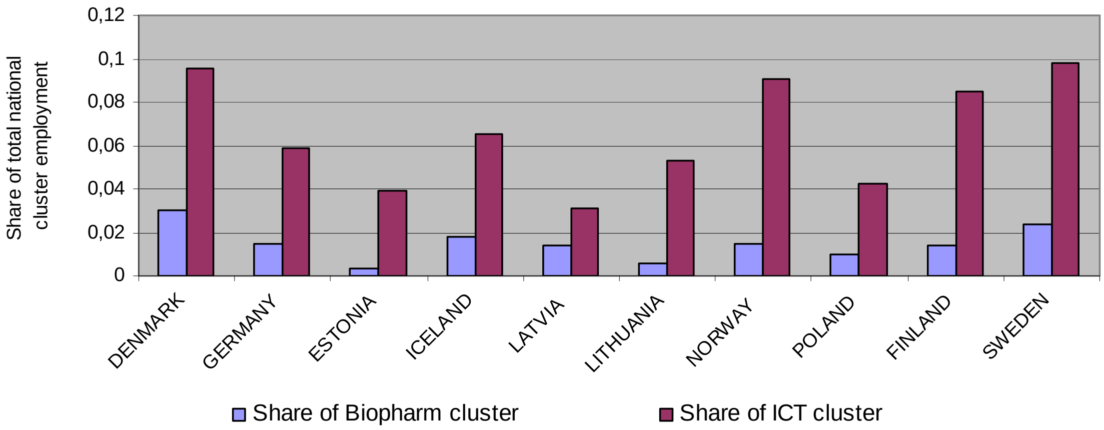
The top four cluster candidates have been considered for the pilot study on benchmarking cluster-specific framework conditions. The four clusters are: *Information Technology, Business Services, Communication Equipment, and Biopharmaceuticals.*

These four clusters have been subject to a discussion on the sixth criterion "High priority in a regional/national policy context". It was agreed that the Business Sector cluster is often seen as a service cluster supporting the other global clusters – it is termed "an internal cluster"– and may not be the most obvious cluster for benchmarking framework conditions.

In broad terms, the IT and Communication Equipment clusters can be seen as spurring the same kind of structure and companies. These clusters are extremely important for all regions and countries in the global economy, but may not be seen as unique for the Baltic Sea region. The Biopharmaceuticals (ranking fourth) was suggested as an interesting cluster for the pilot study on benchmarking cluster-specific framework conditions. The cluster seems to be unique for a number of regions in the BSR, and for the BSR as a whole compared to the rest of EU.

To test if these clusters are actually represented in each of the 10 countries in the BSR, employment shares were calculated for both the ICT and Biopharmaceuticals clusters. The illustration below shows that both clusters are well-represented in the region.

Illustration – Employment share of the Biopharmaceutical and ICT cluster



Source: FORA and the BSR Cluster Database

At the meeting of the Steering Committee of the BSR InnoNet project held in Helsinki, September 2007, it was agreed to pick the Biopharmaceutical cluster as the cluster to be further analyzed in the pilot study. If possible depending on time, financing, etc., it is of the interest of the BSR InnoNet to expand the pilot study to include more clusters.

5. Next step – benchmarking cluster-specific framework conditions

As illustrated in the chapters above, a lot of different analysis on clusters and cluster dynamics in the BSR has been done already. Still, the crucial question that remains to be answered is:

"What are the links between cluster policy and successful clusters?"

The main objective of the analytical work within the BSR InnoNet is to test if the most successful and innovative clusters are situated in regions with specific framework conditions. If this is the case, it could be of interest to look closer at these successful regions – and see if other regions can learn from their experiences.

When comparing cluster performance across regions, it is obvious that there are huge differences – both on the absolute level of employment, specialization and real wage, and of the growth rates. How can these differences be explained? Why are some regions very good at stimulating successful clusters and others not?

Of course, there are some ***historical and cultural*** reasons that some regions/countries have a higher employment in a specific cluster. Differences in ***market driven factors*** can also explain differences – e.g. the existence of a multinational firm spurring entrepreneurs and in time, a cluster environment.

On the policy side, the ***general framework conditions*** may also explain some of the differences in cluster performance. If a country/region has been focusing on supporting universities and setting up well-functioning structures for knowledge sharing between universities and companies, it may influence the general performance of clusters in the region.

Also, the ***cluster-specific framework conditions*** – cluster-focused innovation policy and cluster programmes/initiatives - may explain some of the differences in cluster performance. Regions that are aware of their cluster strengths are able to target the innovation policy to match these strengths – and by that improve the innovative environment for clusters.

Whereas numerous studies have been made on illustrating the importance and on proving the impact of the general framework conditions (e.g. macro/structural policies and innovation policy), there is a lack of tools for illustrating the link between the performance of companies/clusters and the implementation of cluster-specific framework conditions.

The purpose of the BSR benchmarking model on cluster-specific framework conditions is exactly to see if all the different initiatives and cluster polices existing around the region has a demonstrable effect on cluster performance.

It must be stated that all ideas in this section are preliminary and are to be discussed in the coming months.

5.1. Benchmarking cluster policy – preliminary ideas

The work on testing the link between cluster-specific framework conditions (cluster-focused innovation policies and cluster initiatives) and cluster performance consists of four main tasks:

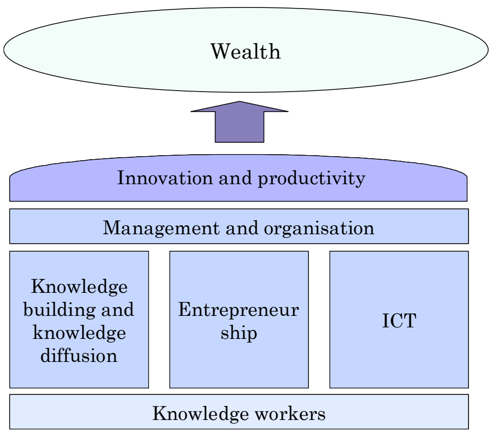
1. Setting up a basic model for cluster-specific framework conditions
2. Setting up a survey for collecting data on cluster-specific framework conditions
3. Collecting data on cluster-specific framework conditions
4. Testing the correlation between cluster performance and cluster-specific framework conditions (adjusting for general national/regional innovation policy)

Task 1 on setting up a basic model for cluster framework conditions has already begun. The idea is to base the model on the extensive work done at the OECD on measuring and benchmarking innovation capacity in the OECD countries.[30]

The OECD studies have pointed out four drivers having key importance for national and regional innovation capacity. As the BSR InnoNet aims at connecting and improving the innovation capacity in the BSR countries, this set of drivers seems very appropriate for the scope of the project.

The thinking behind the OECD model on innovation capacity is illustrated below. The base of the model contains knowledge workers – they are the base of innovative capacity. Through access to knowledge-building and knowledge diffusion, entrepreneurship and ICT, they can spur regional and national innovation and productivity (depending also on management and organizational structures).

Illustration – the OECD framework on innovation capacity

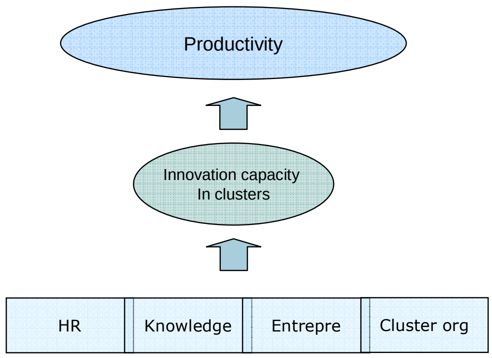


[30] OECD 2001, *The New Economy - Beyond the Hype*, The OECD Growth Project

The model for benchmarking and measuring cluster-specific framework conditions has the same goal as the OECD model to measure the impact of innovation policy. In the BSR model, however, clusters are the focal point – not nations (as in the OECD model). This calls for some minor adjustments to the model.

First, the four drivers are gathered into three drivers for cluster-specific innovation policy: Human Resources, Knowledge and Entrepreneurship – and one cluster-specific driver on cluster programmes/cluster initiatives/cluster organizations. The cluster-specific driver is included to make sure that all the different policy initiatives regarding support to cluster organizations, cluster programmes etc. are also measures by the model (see illustration below).

Illustration – the cluster model



The next step involves setting up a survey for collecting data on cluster-specific framework conditions. The survey is structured according to the four drivers of cluster-specific innovation policy. See the box below for some initial thoughts on indicators.

Box – Framework for collecting cluster-specific framework conditions

HR	Knowledge	Entrepreneurship	Networking
Amount and quality of cluster-specific education	Public resources for cluster-specific knowledge building	Cluster-specific education and support for entrepreneurs	Presence of cluster organization
Amount of leaders with global sight	Access to public knowledge	Amount of cluster-specific venture capital	Public supported cluster initiative
….	…..	…..	….

During the next months, the indicators of cluster-specific framework conditions are to be discussed among WP4 members, experts and knowledge persons. When finalized, the data collection will begin.

After collecting data, the analysis on links between successful clusters and the presence of cluster policy will be initiated, based on an econometric model of benchmarking cluster-specific performance and framework conditions. It is the goal of the BSR InnoNet that the results will provide the policy makers throughout the BSR with a unique tool to document the actual effects of cluster policies.

Appendix 1 – Harmonizing the data

Step 1: Adjustment of codes into the official NACE4 rev. 1.1
All reported codes in the collected data are harmonized to follow the official NACE4 rev. 1.1 used in the BSR database. This is done in the following two steps:

The first step is a general adjustment of the codes. In 2002, the NACE4 classification list changed from rev. 1 to rev. 1.1. This is within the observation period of the collected data, so the specific rev. 1 codes are adjusted to rev. 1.1 either by a simple translation of the old code to a new code or by weighting out the old code to several new codes using simple weights.

The second step is country-specific adjustments of the codes. These adjustments are made when the reported NACE4 codes from the specific country are either not included in the official NACE4 rev.1.1 or on a lower or higher level than NACE4.

Some codes are easily translatable to new codes by simple weighting; others require knowledge from the national statistical agencies. In a few cases, the code is evaluated as unique for the given country and therefore deleted from the database.

Step 2: Interpolation of missing data
The collected data includes many missing values due to discretionarity and also some blank cells. By using additional data collected from each country on NACE3 level and using official data from EUROSTAT, some of the missing data points are estimated by interpolation. Employment data is used to calculate weights. The interpolation is done in steps, starting by the most robust method. When as many cells as possible are interpolated, the interpolation continued by using the second most robust method, and so on. The four possible steps of interpolation are described below:

a. The first step of interpolation uses collected NACE3, NUTS2 data on Personnel Costs and Number of Employees and weights based on Employment data. Interpolation is done whenever one NACE4 code out of the corresponding NACE3-group has missing data and the corresponding NACE3 code has available data. The missing data is filled out by the residual of the value in the NACE3 code minus the sum of the NACE4 codes with reported data points (under the given NACE3-group). There is no interpolation in this step if the residual is less than zero.

b. The second step of interpolation uses collected NACE3, NUTS2 data on Personnel Costs and Number of Employees and weights based on the Employment data. Interpolation is done whenever more than one NACE4 codes out of the corresponding NACE3-group has missing data and the corresponding NACE3 code is available. The interpolation uses NACE3 weights calculated from Employment data to weight out the NACE3 data for the missing NACE4 codes. This gives a rather precise estimate of Personnel Costs and Number of Employees. The interpolated data is often of quite small significance. This is because the lack of information that this method addresses is often due to discretionarily small NACE4-industries making the estimated interpolations small as well.

c. The third step of interpolation uses official data on Personnel Costs and Number of Persons Employed at NACE level 1-4 and at a national level from EUROSTAT together with weights based on the Employment data. The interpolation uses country-weights by filling out empty cells by the product of the NACE4-weights in respect to the total country and the corresponding available EUROSTAT aggregates. To obtain the most precise estimate, the most disaggregated data is preferred. The procedure is therefore looking for the most disaggregated NACE code available from EUROSTAT, before continuing to a less disaggregated code, and so forth. Unfortunately, the employment data used is not Numbers of Employees but Number of Person Employed, which counts both workers and employers. The estimated numbers of employees will therefore be overvalued depending on the number of self-employed in the given industry. Another backside of this interpolation method is that data on both employment and personnel costs is not available on regions from EUROSTAT.

d. The fourth step of interpolation uses available data on 'Wages and Salaries' and 'Number of Persons Employed' at NACE level 1-3 and at NUTS2 level from EUROSTAT together with weights based on the Employment data. The interpolation is based on aggregate-weights by using weights for the individual NACE4-code in the same NUTS2-region under different NACE-aggregates, and is multiplied on the available EUROSTAT data. To interpolate by this method NUTS2-data is needed, which is only available for 'Wages and Salaries'. The estimates based on this method will therefore deviate. Again, Number of Person Employed is used instead of Numbers of Employees which will overvalue the number of employees depending on the number of self-employed in the given industry. Because of the poor quality, interpolation by this method is **not** used on the data.

Appendix 2 – Location analysis of local industries

The table below lists 54 private sector industries that are classified as local industries in the original US cluster code, but display location patterns similar to traded industries in the BSR geography.

Three measures of the variation of industry employment across the BSR geography are used to analyze whether industries display characteristics of local industries or traded industries. The three criteria are similar to those originally used by Porter (2003), but since a smaller population and a smaller geography is analyzed for the BSR, the cut-off values are adjusted to fit the region. The applied criteria are:

- The share of national employment for all regions with LQ ≥ 1 is larger than 50 percent;
- The mean LQ for the top two regions ranked by LQ is larger than 1.25;
- The employment GINI coefficient is larger than 0.3

The cut-off value for the second are changed since the regional area covers fewer regions than in the US. In the original study, the criteria was that the mean LQ of the top five states should be larger than 2.0. This criterion is changed such that the mean LQ of the two most specialized regions is above 1.25.

Data at the detailed NACE-4 level is used where available (Sweden, Finland, Norway, Denmark, Germany (north) and Iceland).

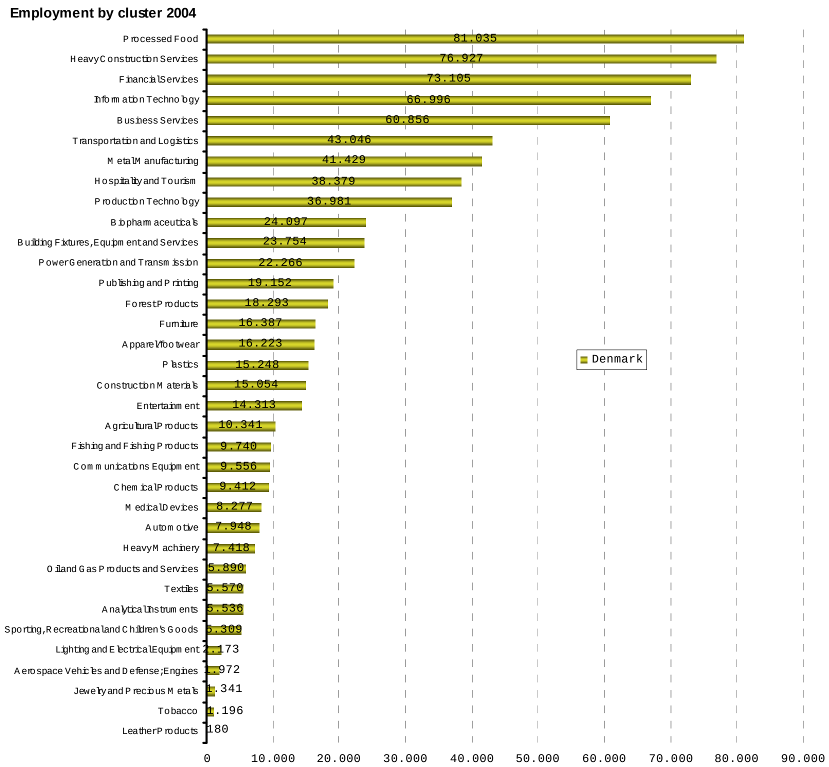
Local industries with location pattern similar to traded industries in the BSR

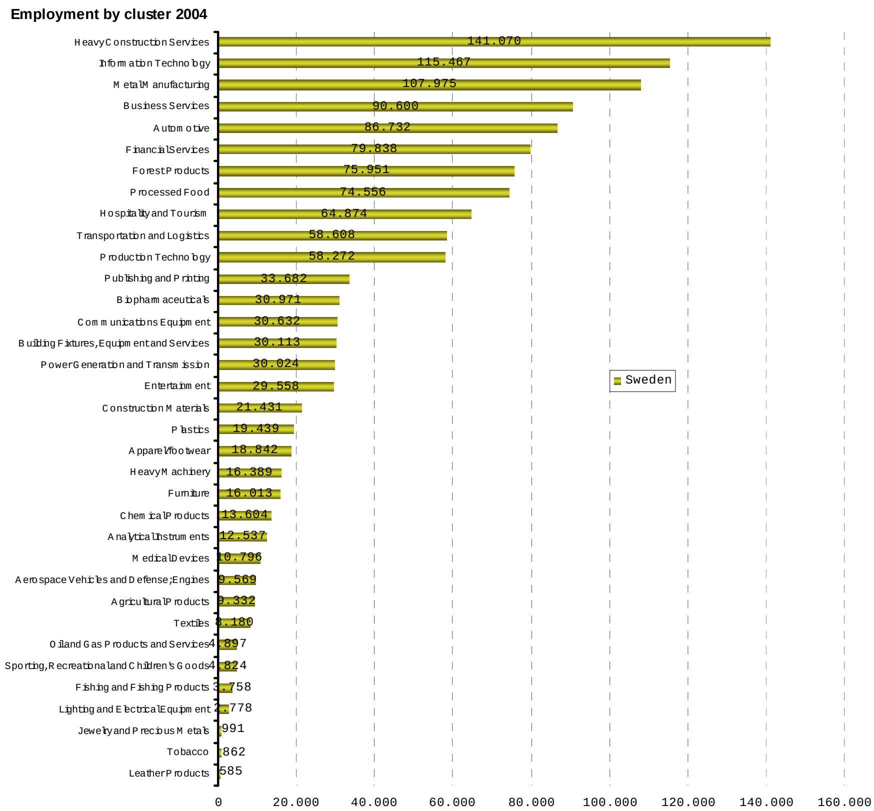
NACE	Name
15.98	Production of mineral waters and soft drinks
22.13	Publishing of journals and periodicals
25.12	Re-treading and re-building of rubber tires
26.62	Manufacture of plaster products for construction purposes
29.72	Manufacture of non-electric domestic appliances
36.63	Other manufacturing n.e.c.
40.21	Manufacture of gas
40.22	Distribution and trade of gaseous fuels through mains
45.12	Test drilling and boring
45.23	Construction of motorways, roads, airfields and sport facilities
45.34	Other building installation
45.42	Joinery installation
45.45	Other building completion
51.13	Agents involved in the sale of timber and building materials
51.14	Agents involved in the sale of machinery, industrial equipment, ships and aircraft
51.15	Agents involved in the sale of furniture, household goods, hardware and ironmongery
51.17	Agents involved in the sale of food, beverages and tobacco
51.18	Agents specializing in the sale of particular products or ranges of products n.e.c.
51.19	Agents involved in the sale of a variety of goods

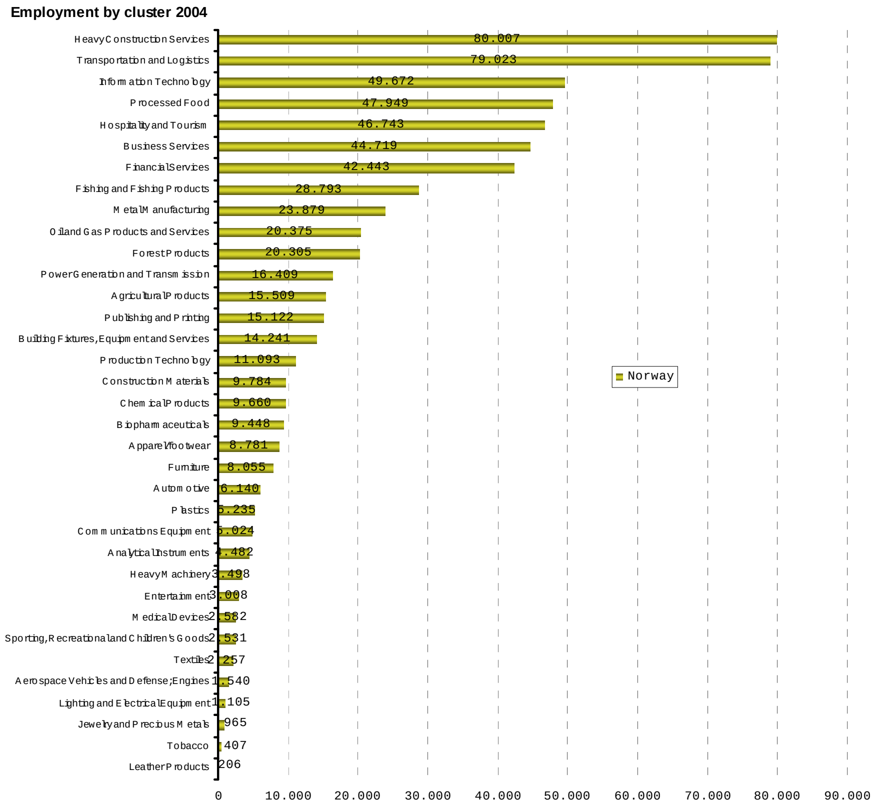
51.22	Wholesale of flowers and plants
51.24	Wholesale of hides, skins and leather
51.32	Wholesale of meat and meat products
51.33	Wholesale of dairy produce, eggs and edible oils and fats
51.34	Wholesale of alcoholic and other beverages
51.35	Wholesale of tobacco products
51.36	Wholesale of sugar and chocolate and sugar confectionery
51.37	Wholesale of coffee, tea, cocoa and spices
51.43	Wholesale of electrical household appliances and radio and television goods
51.45	Wholesale of perfume and cosmetics
51.56	Wholesale of other intermediate products
51.81	Wholesale of machine tools
51.83	Wholesale of machinery for the textile industry and of sewing and knitting machines
51.84	Wholesale of computers, computer peripheral equipment and software
51.86	Wholesale of other electronic parts and equipment
51.90	Other wholesale
52.12	Other retail sale in non-specialized stores
52.21	Retail sale of fruit and vegetables
52.22	Retail sale of meat and meat products
52.26	Retail sale of tobacco products
52.32	Retail sale of medical and orthopedic goods
52.41	Retail sale of textiles
52.62	Retail sale via stalls and markets
52.73	Repair of watches, clocks and jewelry
55.40	Bars
55.51	Canteens
66.02	Pension funding
70.11	Development and selling of real estate
70.12	Buying and selling of own real estate
70.32	Management of real estate on a fee or contract basis
71.23	Renting of air transport equipment
71.31	Renting of agricultural machinery and equipment
74.60	Investigation and security activities
74.82	Packaging activities
74.86	Call centre activities

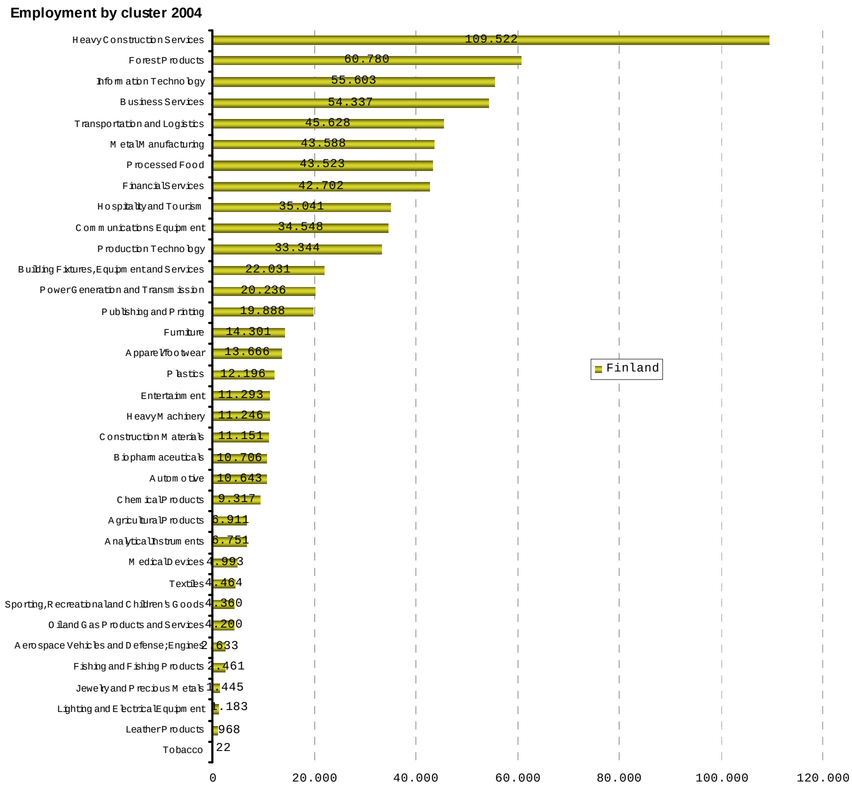
Source: FORA and Copenhagen Economics

Appendix 3 – Absolute Employment in clusters (national level)

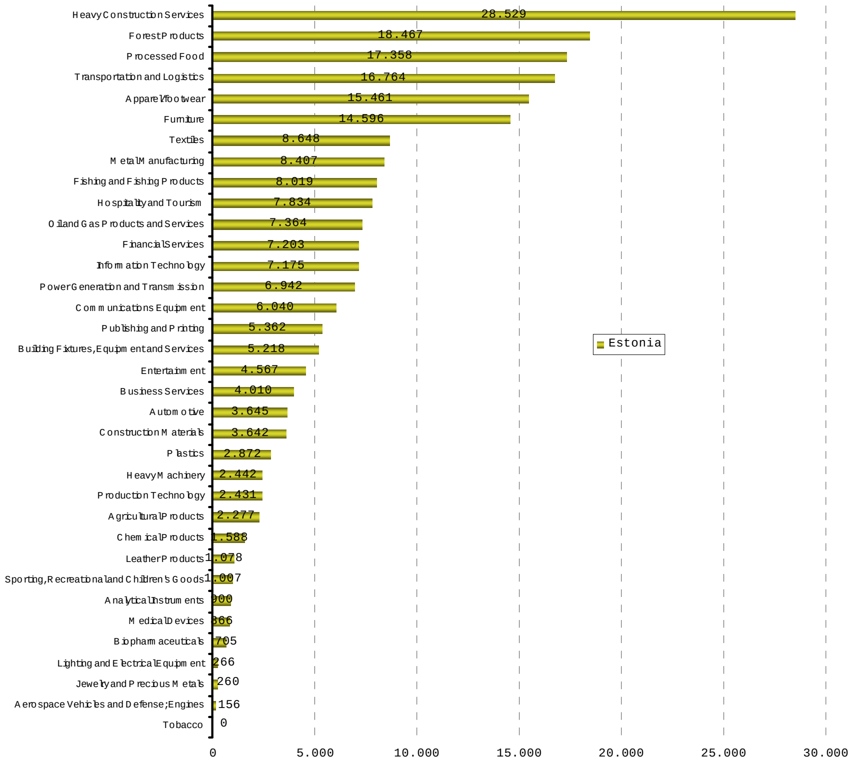




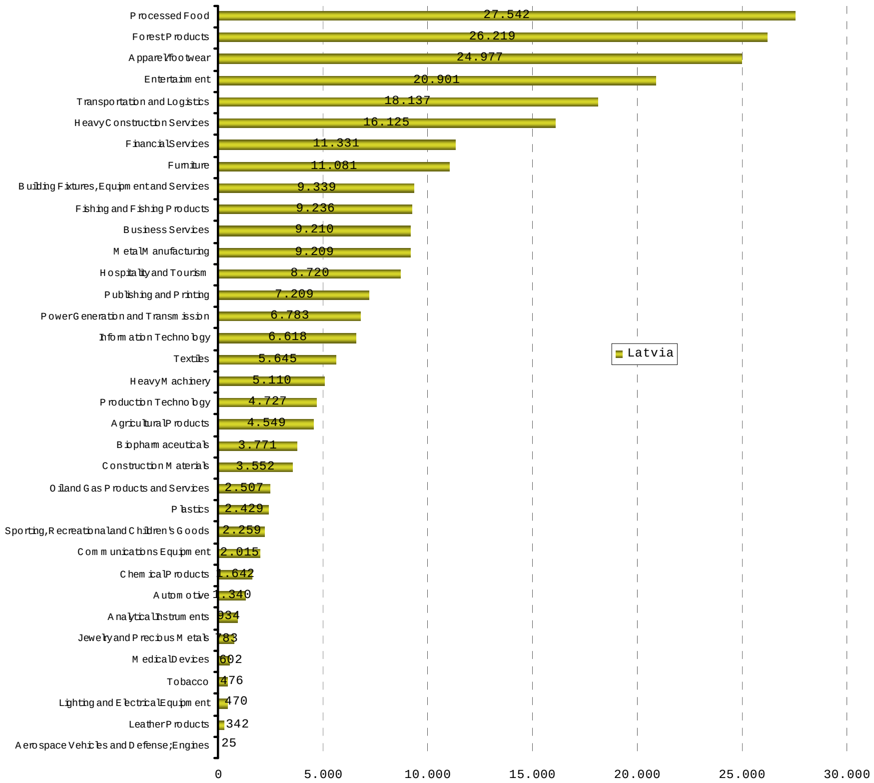

Employment by cluster 2004
Heavy Construction Services 80.007
Transportation and Logistics 79.023
Information Technology 49.672
Processed Food 47.949
Hospitality and Tourism 46.743
Business Services 44.719
Financial Services 42.443
Fishing and Fishing Products 28.793
Metal Manufacturing 23.879
Oil and Gas Products and Services 20.375
Forest Products 20.305
Power Generation and Transmission 16.409
Agricultural Products 15.509
Publishing and Printing 15.122
Building Fixtures, Equipment and Services 14.241
Production Technology 11.093
Construction Materials 9.784
Chemical Products 9.660
Biopharmaceuticals 9.448
Apparel/footwear 8.781
Furniture 8.055
Automotive 6.140
Plastics 5.235
Communications Equipment 5.024
Analytical Instruments 4.482
Heavy Machinery 3.498
Entertainment 3.008
Medical Devices 2.582
Sporting, Recreational and Children's Goods 2.531
Textiles 2.257
Aerospace Vehicles and Defense; Engines 1.540
Lighting and Electrical Equipment 1.105
Jewelry and Precious Metals 965
Tobacco 407
Leather Products 206
0
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
90.000
Norway


Employment by cluster 2004
Heavy Construction Services 109.522
Forest Products 60.780
Information Technology 55.603
Business Services 54.337
Transportation and Logistics 45.628
Metal Manufacturing 43.588
Processed Food 43.523
Financial Services 42.702
Hospitality and Tourism 35.041
Communications Equipment 34.548
Production Technology 33.344
Building Fixtures, Equipment and Services 22.031
Power Generation and Transmission 20.236
Publishing and Printing 19.888
Furniture 14.301
Apparel/footwear 13.666
Plastics 12.196
Entertainment 11.293
Heavy Machinery 11.246
Construction Materials 11.151
Biopharmaceuticals 10.706
Automotive 10.643
Chemical Products 9.317
Agricultural Products 6.911
Analytical Instruments 6.751
Medical Devices 4.993
Textiles 4.464
Sporting, Recreational and Children's Goods 4.360
Oil and Gas Products and Services 4.290
Aerospace Vehicles and Defense; Engines 2.633
Fishing and Fishing Products 2.461
Jewelry and Precious Metals 1.445
Lighting and Electrical Equipment 1.183
Leather Products 968
Tobacco 22
0
20.000
40.000
60.000
80.000
100.000
120.000
Finland

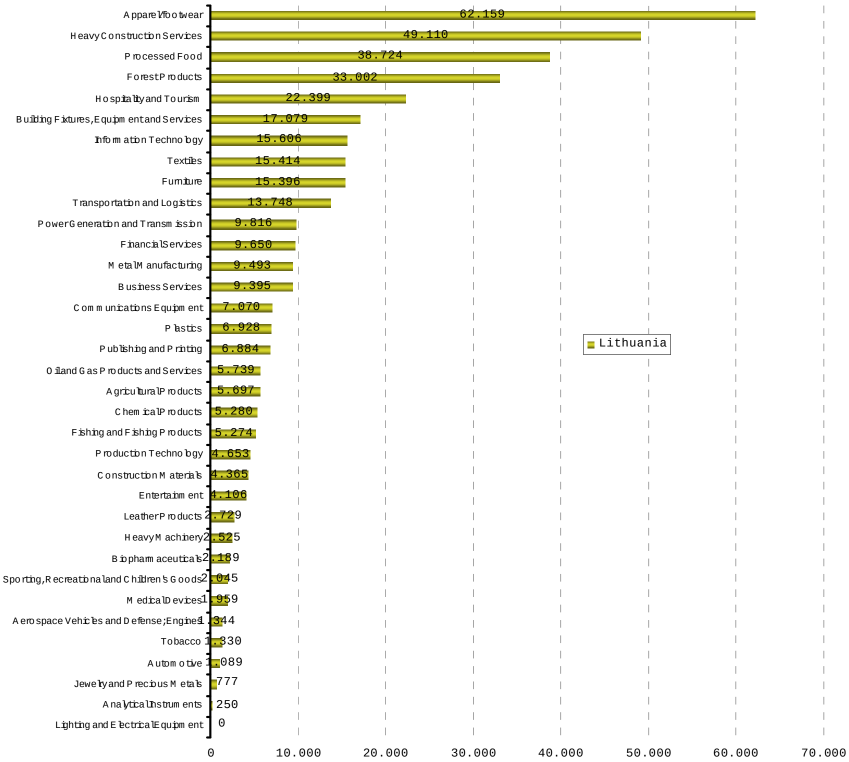
Employment by cluster 2004



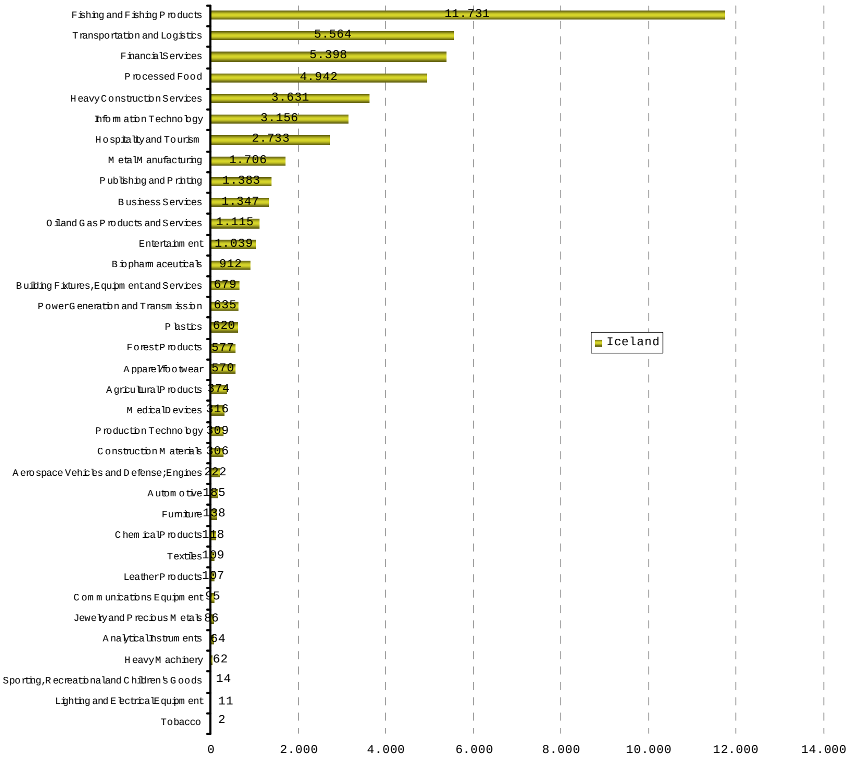
Employment by cluster 2004



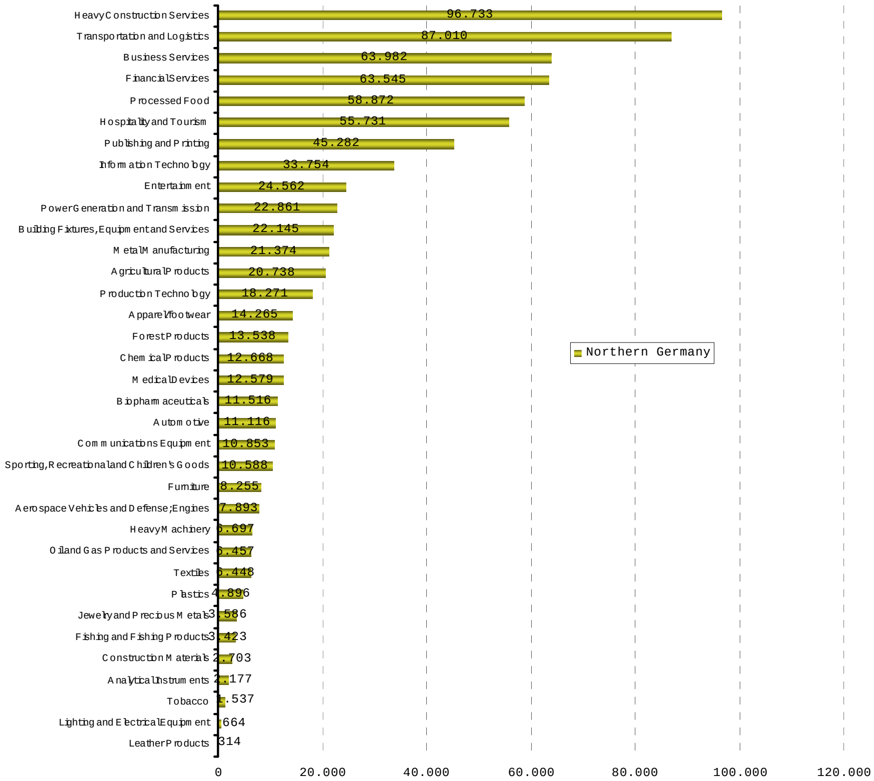
Employment by cluster 2004



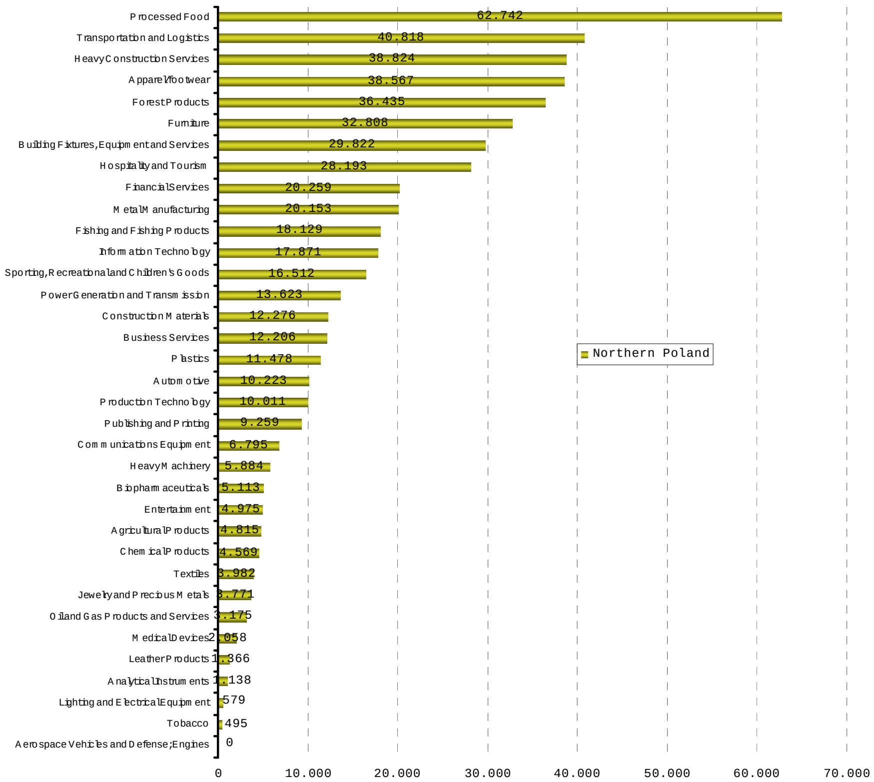
Employment by cluster 2004



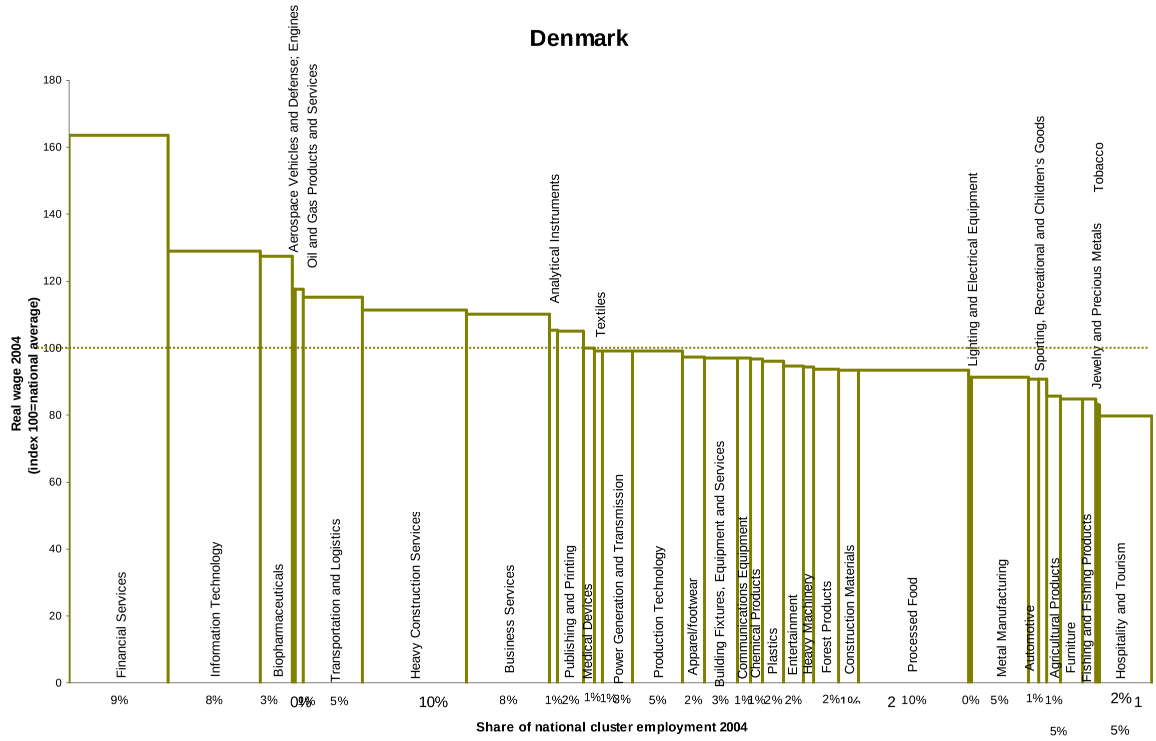
Employment by cluster 2004

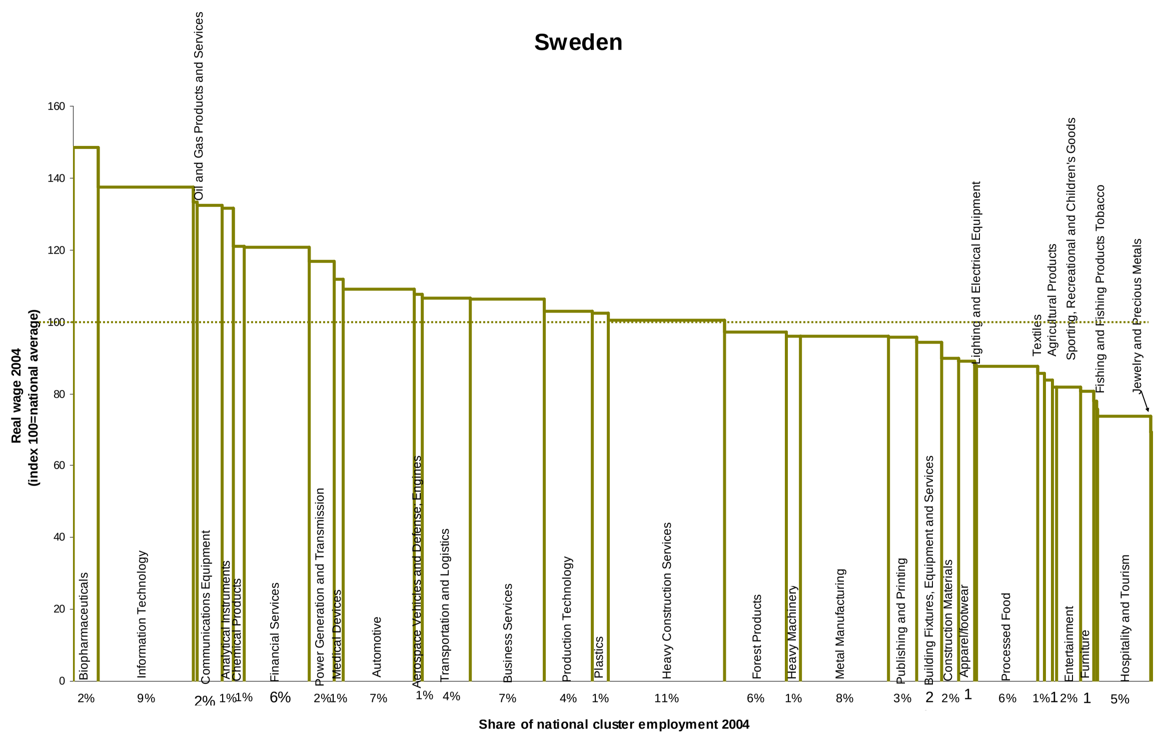


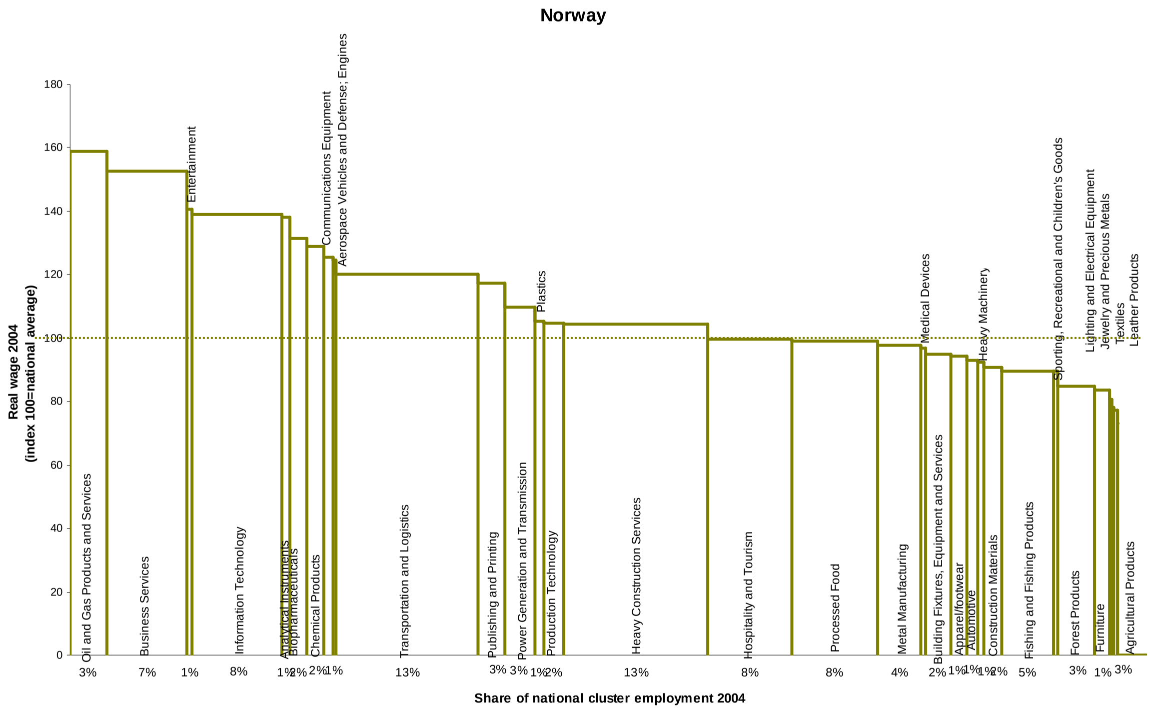
Employment by cluster 2004

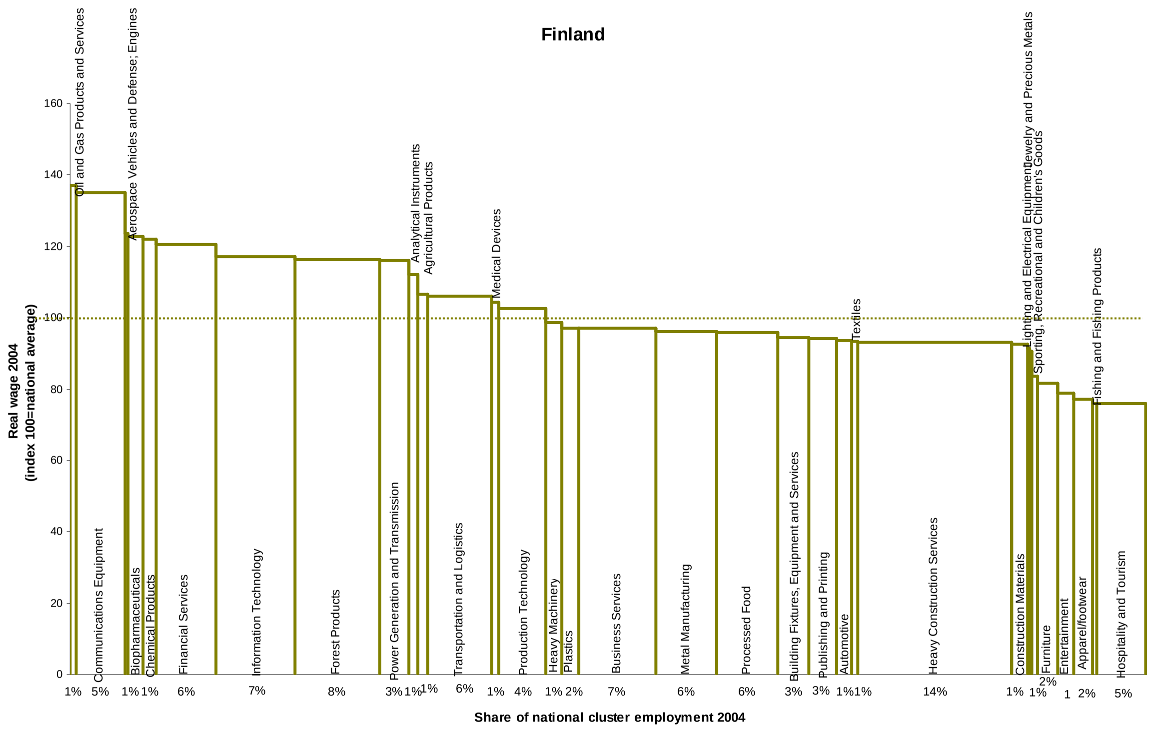


Appendix 4 – Cluster Stairs, illustrating productivity (national level)

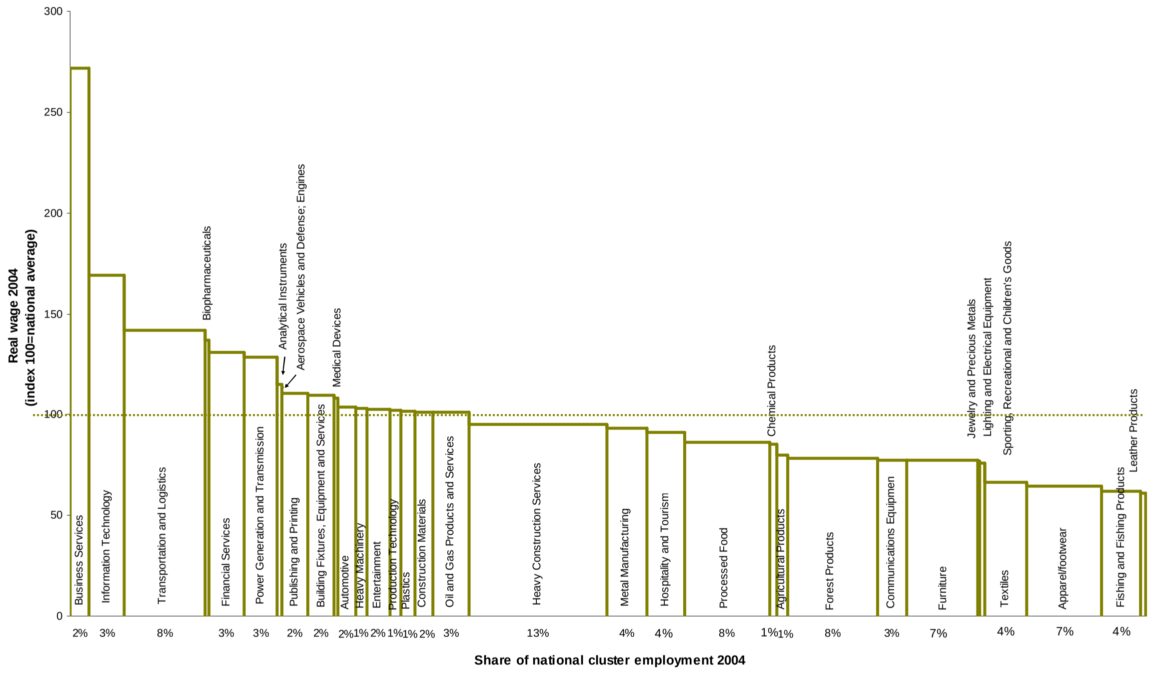




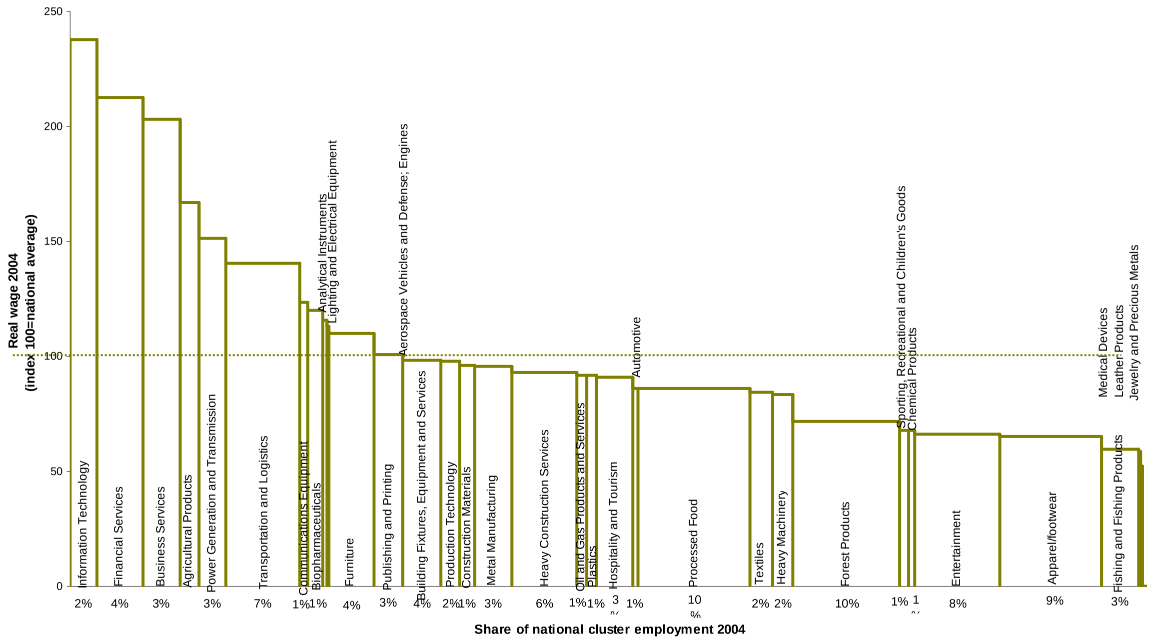

Norway
Real wage 2004
(index 100=national average)
Share of national cluster employment 2004
0
20
40
60
80
100
120
140
160
180
Oil and Gas Products and Services
Business Services
Entertainment
Information Technology
Analytical Instruments
Biopharmaceuticals
Chemical Products
Communications Equipment
Aerospace Vehicles and Defense; Engines
Transportation and Logistics
Publishing and Printing
Power Generation and Transmission
Plastics
Production Technology
Heavy Construction Services
Hospitality and Tourism
Processed Food
Metal Manufacturing
Medical Devices
Building Fixtures, Equipment and Services
Apparel/footwear
Automotive
Heavy Machinery
Construction Materials
Fishing and Fishing Products
Sporting, Recreational and Children's Goods
Forest Products
Furniture
Lighting and Electrical Equipment
Jewelry and Precious Metals
Textiles
Leather Products
Agricultural Products
3%
7%
1%
8%
1%
2%
2%
1%
13%
3%
3%
1%
2%
13%
8%
8%
4%
2%
1%
1%
1%
2%
5%
3%
1%
3%


Finland
Real wage 2004
(index 100=national average)
Share of national cluster employment 2004
0
20
40
60
80
100
120
140
160
Oil and Gas Products and Services
Communications Equipment
Aerospace Vehicles and Defense; Engines
Biopharmaceuticals
Chemical Products
Financial Services
Information Technology
Forest Products
Power Generation and Transmission
Analytical Instruments
Agricultural Products
Transportation and Logistics
Medical Devices
Production Technology
Heavy Machinery
Plastics
Business Services
Metal Manufacturing
Processed Food
Building Fixtures, Equipment and Services
Publishing and Printing
Automotive
Textiles
Heavy Construction Services
Construction Materials
Lighting and Electrical Equipment
Jewelry and Precious Metals
Sporting, Recreational and Children's Goods
Furniture
Entertainment
Apparel/footwear
Fishing and Fishing Products
Hospitality and Tourism
1%
5%
1%
1%
6%
7%
8%
3%
1%
1%
6%
1%
4%
1%
2%
7%
6%
6%
3%
3%
1%
1%
14%
1%
1%
2%
1
2%
5%

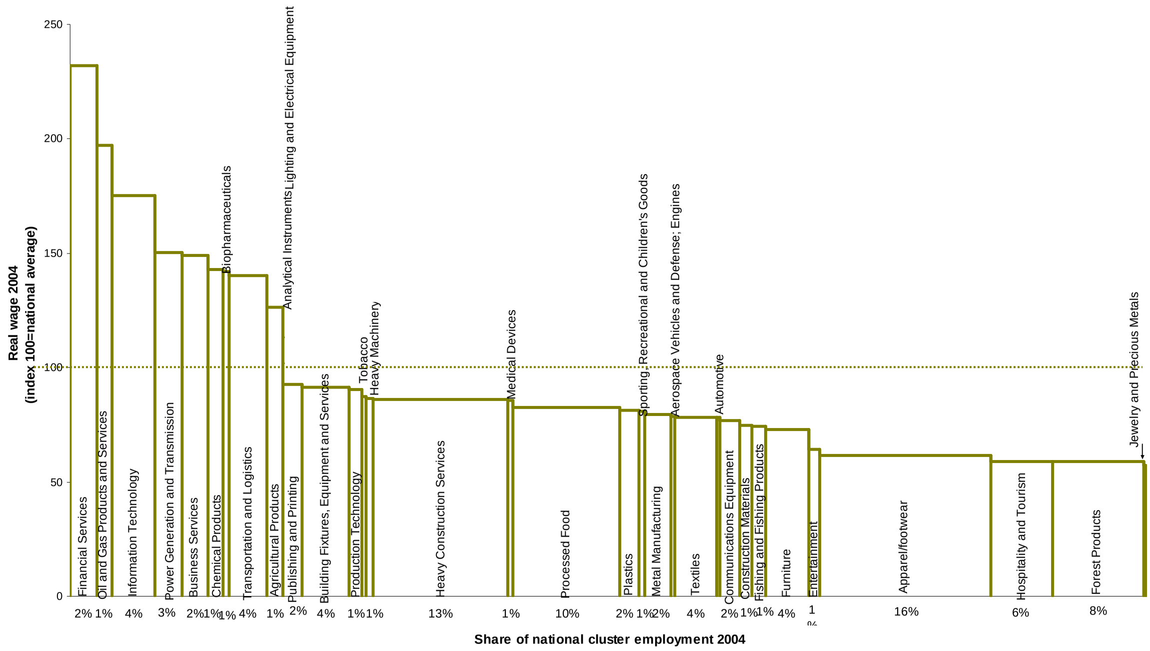
Estonia



Latvia



Lithuania


Real wage 2004
(index 100=national average)
250
200
150
100
50
0
Financial Services
Oil and Gas Products and Services
Information Technology
Power Generation and Transmission
Business Services
Chemical Products
Biopharmaceuticals
Transportation and Logistics
Agricultural Products
Analytical Instruments
Lighting and Electrical Equipment
Publishing and Printing
Building Fixtures, Equipment and Services
Production Technology
Tobacco
Heavy Machinery
Heavy Construction Services
Medical Devices
Processed Food
Plastics
Sporting, Recreational and Children's Goods
Metal Manufacturing
Aerospace Vehicles and Defense; Engines
Textiles
Automotive
Communications Equipment
Construction Materials
Fishing and Fishing Products
Furniture
Entertainment
Apparel/footwear
Hospitality and Tourism
Forest Products
Jewelry and Precious Metals
2% 1% 4% 3% 2% 1% 1% 4% 1% 2% 4% 1% 1% 13% 1% 10% 2% 1% 2% 4% 2% 1% 1% 4% 1 16% 6% 8%
Share of national cluster employment 2004