OECD publishing

Please cite this paper as:

Temouri, Y. (2012), "The Cluster Scoreboard: Measuring the Performance of Local Business Clusters in the Knowledge Economy", *OECD Local Economic and Employment Development (LEED) Working Papers*, 2012/13, OECD Publishing.
http://dx.doi.org/10.1787/5k94ghq8p5kd-en

OECD Local Economic and Employment Development (LEED) Working Papers 2012/13

The Cluster Scoreboard

MEASURING THE PERFORMANCE OF LOCAL BUSINESS CLUSTERS IN THE KNOWLEDGE ECONOMY

Yama Temouri

THE CLUSTER SCOREBOARD

MEASURING THE PERFORMANCE OF LOCAL BUSINESS CLUSTERS IN THE KNOWLEDGE ECONOMY

Yama Temouri

TABLE OF CONTENTS

Tables

EDITORIAL NOTE

This report has been prepared by Yama Temouri of Aston University, United Kingdom, as part of the programme of work of the Local Economic and Employment Development Committee of the Organisation of Economic Co-operation and Development on boosting entrepreneurship, under the supervision of Jonathan Potter and Marco Marchese of the OECD LEED Secretariat. Advice and support was provided by Chris Jones (Aston University) and Stefano Menghinello (ISTAT).

SUMMARY

The OECD cluster scoreboard presents results on the entrepreneurship performance of 80 selected local enterprise clusters in two key innovative sectors with important roles in local economic growth; high-technology manufacturing (HTM) and knowledge-intensive service activities (KISA). It is based on data from ORBIS, a commercial database collecting demographic, economic, and financial information at the company-level. This has the advantages of enabling presentation of data for functional cluster areas built up from municipality level rather than larger regions, enabling more timely economic analysis and providing information on financial performance not available from standard sources. At the same time care has been taken to assess the quality of the data and address issues of representativeness and bias.

The performance of clusters is gauged across two observation periods – pre-recession (2005-2007) and recession (2007-2009) – through six indicators: i) share of firms aged below 5 years (entrepreneurialism); ii) employment growth; iii) turnover growth; iv) profitability growth; v) liquidity ratio growth; vi) solvency ratio growth. A set of 80 well-researched and internationally leading clusters were selected for the analysis. Coverage is not comprehensive of all clusters and other clusters not included in the scoreboard may have had equal or better performance. What this analysis permits, however, is an assessment of the performance of several leading international clusters and comparisons among them.

Key findings are that the top performing clusters in the pre-recession period were the Madison research district and Silicon Valley in the United States, while during the recession the two leading clusters in HTM and KISA were the Coimbra biotech cluster in Portugal and Daedoek science town in Korea. More generally, in the pre-recession period leading clusters were found in traditional advanced economies such as the United States, Germany and Sweden, while during the recession well-performing clusters came from a more mixed background that includes countries severely struck by the crisis such as Portugal and Ireland. With the exception of entrepreneurialism and partly turnover, fluctuation across the two time periods is significant for most clusters, which suggests that clusters doing well in a phase of economic expansion have different characteristics from those that are able to grow also at a time of economic slowdown. Finally, clusters in knowledge-intensive services experienced rates of growth that were stronger than those of high-tech manufacturing clusters with regard to both employment and turnover, the two most important indicators assessed in the scoreboard. However, the recession has made a deeper dent on KISA clusters, whose growth rates in employment and turnover, compared to the expansion phase, receded more than they did in high-tech manufacturing clusters.

INTRODUCTION

Local business clusters – i.e. geographic concentrations of interconnected companies, specialised suppliers, service providers, and associated institutions – have received increasing attention from academics and policy makers because, rather than wiping out the influence of space, firms in the globalised knowledge economy are relying more and more on their local environment for aspects of their competitiveness, while innovation and entrepreneurship activity is significantly concentrated across space (Potter and Miranda, 2009).

The advantages of business agglomerations have been known for a while. Alfred Marshall identified a market for intermediate inputs, a skilled labour force, and technology spillovers as the three key externalities that benefit firms working close to each other in related industries. The concept was subsequently adapted to Italy's industrial districts, whose success in the 1970s was ascribed to a model of production resting on "flexible specialisation" where each small firm would specialise in a specific input and cooperate with others in the same locality to deliver a final product of quality to international markets (Piore and Sabel, 1984). A further development was by Michael Porter (1990), who referred to factor conditions, demand conditions, related industries and inter-firm rivalry as the drivers of growth in clusters, which favour innovation, competitiveness, and productivity gains at the local level.

Around this seminal work has developed an extensive literature, primarily based on case studies, which has discussed at length the internal dynamics and external relationships behind successful clusters around the world (Schmitz and Nadvi, 1999; Giuliani et al., 2005). Much of the evidence is, however, of anecdotal nature, generally explaining success by some key factor, whether this is vertical or horizontal co-operation amongst firms, government support, industry-university relationships, etc. Quantitative evidence about the performance of business clusters is more limited in the literature. How do clusters compare in terms of employment and turnover? What clusters are on the rise and what others are on the decline? Does being part of a cluster help firms to keep a steadier performance?

This publication tries to fill this gap by providing a set of indicators measuring the performance of 80 selected clusters in high-tech manufacturing and knowledge-intensive services in two distinct periods, 2005-2007 (pre-recession) and 2007-2009 (recession). Cluster performance is estimated through six indicators and a composite index that crystallises different information in one single ranking. The six indicators measure: i) entrepreneurialism (share of young firms out of the total); ii) employment growth; iii) turnover growth; iv) profitability; v) liquidity ratio; vi) solvency ratio. This allows the paper to look at the performance of clusters from different angles, for example, discerning which clusters are able to transform turnover growth into new jobs, which ones are more entrepreneurial, and whether entrepreneurial clusters are also those that grow the most. By looking at two different time periods, it is also possible to see the impact of the global economic crisis on the performance of clusters, including whether average growth has declined, which indicators have declined the most and which clusters have suffered most from the crisis and which have weathered the storm. Some unexpected findings make the analysis particularly interesting and revealing.

First, in the pre-recession period leading clusters were found in traditional advanced economies such as the United States, Germany and Sweden, while during the recession well-performing clusters came from a more mixed background that included countries severely struck by the crisis such as Portugal and Ireland. This could be explained by structural adjustments induced by the crisis which have enabled these clusters

to outgrow the others or by the fact that the advantages of being in a cluster have shielded these firms from the worst effects of the recession.

Second, fluctuation in performance across the two observation periods is strong for most clusters in most of the six observed indicators. This has two major potential explanations: i) clusters performing well in a time of economic expansion do not have the same features as those doing better in a phase of economic contraction; ii) business clusters have an inherent short-term variability in performance.

Third, clusters in knowledge-intensive services experience rates of growth that are stronger than those of high-tech manufacturing clusters with regard to both employment and turnover, the two most important indicators assessed by the scoreboard. However, the recession has made a deeper dent on the performance of KISA clusters, whose growth rates in employment and turnover, compared to the expansion phase, receded more than they did in high-tech manufacturing clusters.

The analysis draws on the commercial database ORBIS by Bureau van Djik, which collects a wide range of economic and financial information at the firm-level worldwide. The choice to use this database stems from a double consideration. Firstly, geographically disaggregated information from national statistical offices (NSOs) is difficult to source or obtain, and is provided with a time lag that makes it hard a timely analysis that feeds decision making in the policy arena. Secondly, business clusters transcend administrative borders, so that data simply presented at NUTS 2 or 3 levels would not capture real business clusters and would not, therefore, be appropriate for an assessment of the performance of business clusters.

THE SELECTED CLUSTERS

Eighty clusters are compared in the scoreboard, equally divided between high-tech manufacturing (HTM) and knowledge-intensive services (KISA) as expressed by the OECD-EUROSTAT definition.[1] The large majority of these clusters are located in OECD member countries, and United States (9), Japan (6), Germany (6), Austria (6), France (5) and Sweden (5) are the most represented. Three OECD enhanced-engagement countries are also included (Brazil, China, and India).

The clusters in the scoreboard have been chosen according to three main criteria: i) economic relevance; ii) information availability; and iii) functional delimitation.

The first criterion refers to the selection of clusters that have been referred to in the literature, which are known to academics, or for which there is reliable information on the web.[2] The rationale has been to focus on real business clusters intended as concentrations of companies working together, and to avoid the inclusion of regional production systems and large metropolitan areas that would have stood out because of greater numbers if only a quantitative approach to cluster identification had been used.

1. High-tech manufacturing includes the following NACE sectors: aircraft and spacecraft; pharmaceuticals; office machinery and computers; radio, television and communication equipment; medical, precision, and optical instruments. Knowledge-intensive services encompass: post and telecommunications; computer and related activities; research and development.

2. For instance, academics specialised in clusters have been contacted and asked to provide information about internationally or nationally relevant business agglomerations in their own countries.

Identified clusters were, then, passed to the ORBIS test to verify whether they were sufficiently covered by the database (e.g. number of firms, breadth of the information for each company, etc.). This implied a minimum number of 20 companies for clusters with a very narrow industry specialisation (e.g. micro nanotechnology), but for cross-industry and related-industry clusters the number of firms sought was much higher.

Finally, a functional delimitation of clusters was chosen where the boundaries of the cluster cross administrative classifications and mirror, as much as possible, the effective spatial distribution of economic activity.[3] As a result, most clusters in the scoreboard include more than one single municipality.

Other factors taken into account in the selection of clusters have been a large presence of SMEs and international comparability. Preference has been given to clusters consisting of many small firms and not driven by a few large companies, considering the existing links between clusters and entrepreneurship. As broad a number of countries as possible have then been represented to ensure the international comparability of the cluster scoreboard.

These steps have resulted in the selection of the following 80 clusters[4]:

3. Further information on the methodology used to identify firms in the cluster and assess their performance is given in Annex I.

4. Further information on these clusters, including number of firms and where the information for each of them has been sourced, is provided in Annex II.

Table 1. List of high-tech manufacturing clusters in the scoreboard

Cluster	Industry specialisation	Reference city
Human technology Styria	bio- and pharmaceutical technologies	Styria, Austria
Life Science Cluster LISA-Vienna	pharmaceutical technologies	Vienna, Austria
Life Sciences Innsbruck	Biotechnology	Innsbruck, Austria
Leuven	Life sciences, medical technology, mechatronics	Leuven, Belgium
Sao Paulo cluster	Aeronautics	São Paulo, Brazil.
Life sciences Montreal	Biotechnology, Life Sciences	Montreal, Canada
Saskatoon (Ag Biotech)	Biotechnology	Saskatoon, Canada
Beijing cluster	Computer hardware	Zhongguancun and Shangdi, China
Mechatronics Cluster	High-tech engineering	Sonderborg, Denmark
Tartu	Electronics, information- and biotechnology	Tartu, Estonia
Lyon biotech cluster	Biotechnology	Lyon, Rhone-Alps, France
Grenoble	Micro-Nanotechnology	Grenoble, Rhone-Alps, France
Sophia-Antipolis	Microelectronics and software development	Sophia-Antipolis, France
Toulouse aerospace cluster	Aeronautics, space and embedded systems	Toulouse, France
Gottingen cluster	Biotechnology	Gottingen, Germany
Heidelberg cluster	Biotechnology	Heidelberg, Germany
Optical Tech Cluster	Optical	Jena, Germany
Microelectronics Cluster	Microelectronics, Semiconductor	Dresden, Germany
Medical Valley Nuremberg	Healthcare	Nuremberg, Germany
Bio-pharma Ireland	Pharmaceuticals	Dublin, Ireland
Med-Tech cluster Ireland	Pharmaceuticals, biotechnology and medical devices	Cork, Ireland
Mirandola	Biomedical	Mirandola, Emilia-Romagna, Italy
Tsukuba	High level research	Tsukuba City, Ibaraki Prefecture, Japan
Toyama Medical-Bio Cluster	Medical systems based on biotech & microelectronics	Toyama, Japan
Ishikawa High-tech Sensing Cluster	High-tech measurement for human intelligent activity	Ishikawa, Japan
Oslo Cancer Cluster	Oncology research	Oslo, Norway
Instrumentation Trondheim	Instrumentation	Trondheim, Norway
Micro-Nanotechnology Horten	Micro-Nanotechnology	Horten, Norway
Bio-Tech Cluster	Biotechnology	Coimbra, Portugal
Lisbon bio-pharma cluster	Bio-pharma	Lisbon and Oeiras, Portugal
Medicon Valley	Biotechnology	Malmo, Sweden
Gothenburg BIO	Life sciences	Gothenburg, Sweden
Uppsala Bio	Life sciences	Uppsala, Sweden
Fiberoptic Valley	Fiberoptics	Sundsvall, Sweden
Cambridge	Health Care & Life Sciences,	Cambridge, UK
Boston (Route 128)	Computers, Software	Boston, Massachusetts, USA
Tucson cluster	Aerospace, Advanced Manufacturing and IT	Tucson , Arizona, USA
Madison research district	Biotechnology and IT	Madison, Wisconsin, USA
Minnesota Medical Devices	Medical devices	Minneapolis, Minnesota, USA
Oxfordshire bioscience	Biotechnology	Oxfordshire county, UK

Table 2. List of knowledge-intensive services clusters in the scoreboard

Cluster	Industry specialisation	Reference city
Macquarie Park, Sydney	Research centre	Ryde, Australia
Linz	ICT, electronics	Linz , Austria
Cluster Informationstechnologien Tirol	ICT	Innsbruck and Hopfgarten, Austria
GIS Cluster Salzburg	Geographic Information Science	Salzburg, Austria
Louvain Technology Corridor	ICT, Centre for Micro Electronics	Louvain, Belgium
Brazilian Silicon Valley	Electronics and Software	Campinas, Florianopolis, Brazil
Sao Paulo	Computers, software, telecommunications	Sao Paulo and Sao Carlos, Brazil
Ottawa ICT cluster	ICT	Ottawa, Canada
Waterloo ICT cluster	ICT	Waterloo, Canada
Beijing	Research and development	Zhongguancun, China
Telecommunications North Jutland	Telecommunications	Aalborg, Denmark
Pervasive Computing Cluster	Digital Media and ICT	Aarhus, Denmark
Espoo	Research and Technology Cluster	Espoo and Otaniemi, Finland
Oulu	ICT	Oulu, Finland
Cap Digital Cluster	ICT	Paris, France
Silicon Valley of Germany	ICT	Dresden, Germany
Bangalore (Silicon Valley of India)	ICT	Bangalore, India
Atlantic Technology Corridor	ICT	Galway to Shannon, Ireland
ICT Cluster Dublin	ICT	Dublin, Ireland
Silicon Wadi	ICT, software, data communications.	Tel Aviv, Israel
Bari ICT Cluster	ICT	Bari, Italy
Kansai Science City	ICT	Kyotanabe, Seika, Kizugawa, Japan
Tsukuba Science City	Research and education centre	Tsukuba city, Japan
Yokosuka Research Park	Research centre	Yokosuka, Japan
Daedoek Science Town	ICT	Daejeon, Korea
Silicon Valley of Mexico	Electronics	Jalisco, Guadalajara, Mexico
Dommel Valley Eindhoven	ICT and R&D centre	Eindhoven, the Netherlands
Amsterdam Alley	ICT	Amsterdam, the Netherlands
Twente ICT Cluster	ICT	Enschede, the Netherlands
Oslo	data processing and software development	Oslo, Norway
Lisbon ICT Cluster	Media and Telecommunications	Lisbon, Portugal
Information processing cluster	ICT	Madrid and Barcelona, Spain
Kista Science Park	ICT	Kista city in Northern Stockholm, Sweden
Oxfordshire R&D Cluster	Research and Development	Oxford, UK
Silicon Glen	ICT	Dundee, Inverclyde, Edinburgh, UK
Austin ITC cluster	Computer and related activities	Austin area in Travis county, USA
Cornell research district	Research	Ithaca (New York), USA
Silicon Valley	Electronics & ICT	Santa Clara county , USA
Modelling and Simulation Cluster	Modelling and Simulation	Virginia beach, Norfolk, Newport, USA
Health care-Medical research Cluster	Health care and Medical Research	Pittsburgh, USA

THE SCOREBOARD

This section presents the rankings of the HTM and KISA clusters by entrepreneurialism, employment growth, economic growth (turnover and profitability), and financial viability (liquidity and solvency). Two observation periods have been chosen, 2005-2007 and 2007-2009, which broadly corresponds to the period preceding the economic crisis and the key years in which the crisis has taken its course. For each of these periods two growth rates have been worked out: 2005-2006 and 2006-2007 for the pre-recession period and 2007-2008 and 2008-2009 for the recession time.

More specifically, the following indicators have been used:

- Entrepreneurialism: share of firms in the cluster aged less than 5 years
- Employment growth: average growth rate of employment in cluster firms
- Economic growth
  - Turnover growth: average growth rate of turnover in cluster firms
  - Profitability: average growth rate of returns on total assets (ROTA) in cluster firms
- Financial viability
  - Liquidity ratio: (current fixed assets – stocks)/current liabilities
  - Solvency ratio: shareholder funds / total assets

Entrepreneurialism

Indicator

This indicator is a proxy of the level of entrepreneurialism in the cluster. It takes the year of incorporation of each firm as indicating its birth year. It represents the number of young firms that are less than five years old at the start of each of the two time periods, pre-recession and recession, over the total number of firms in the cluster.

Rankings

Table 3. Ranking of HTM clusters by proportion of young firms (aged below 5 years)

		Pre-recession (2005-2007)		Recession (2007-2009)	
Name of cluster	**Country**	**Ranking**	**% young firms**	**Ranking**	**% young firms**
Tartu	Estonia	1	27.3	2	34.1
Mechatronics Cluster	Denmark	2	27.3	4	27.3
Instrumentation Trondheim	Norway	3	26.7	8	21.6
Heidelberg	Germany	4	26.4	19	18.6
Oxfordshire bioscience cluster	UK	5	26.4	3	30
Optical Tech Cluster	Germany	6	24.7	11	20.8
Cambridge	UK	7	23.3	5	26.1
Life Science cluster (LISA)	Austria	8	22.3	14	19.8
Madison research district	USA	9	20.6	7	24.6
Toulouse aerospace cluster	France	10	19.1	30	13.1
Göttingen	Germany	11	18.4	22	16
Medical Valley Nuremberg	Germany	12	18.4	21	16.6
Lisbon-Oeiras Bio-pharma cluster	Portugal	13	18.4	6	24.7
Microlectronics cluster	Germany	14	17.3	9	21.3
Human technology Styria	Austria	15	17.3	18	18.8
Cluster Life Sciences Innsbruck	Austria	16	17.1	29	14
Medicon Valley	Sweden	17	16.8	12	20.2
Biotech cluster	Portugal	18	16.7	1	36.1
Tucson cluster	USA	19	16.4	15	19.5
Sophia-Antipolis	France	20	16.3	28	14.1
Bio-pharma cluster	Ireland	21	16.1	16	19.2
Med-Tech cluster	Ireland	22	16	17	19
Minnesota Medical Devices	USA	23	15.4	20	17.8
Uppsala BIO	Sweden	24	15.4	13	19.9
Boston (Route 128)	USA	25	15.2	10	20.8
Grenoble	France	26	14.8	25	15.2
Oslo Cancer Cluster	Norway	27	14.8	26	14.4
Lyon biotech cluster	France	28	14.5	32	10.9
Mirandola	Italy	29	13.7	27	14.3
Tsukuba	Japan	30	13.5	31	11.5
Gothenburg Bio cluster	Sweden	31	12.9	24	15.8
Montreal Biotech cluster	Canada	32	11.7	34	7.9
Micro- and Nanotechnology Horten	Norway	33	9.1	36	4.5
Toyama Medical-Bio Cluster	Japan	34	7.7	37	3.8
Fiberoptic Valley	Sweden	35	7.3	33	8.9
Leuven	Belgium	36	6.8	23	15.9
Ishikawa High-tech Sensing Cluster	Japan	37	6.3	35	5.5
Saskatoon (Ag Biotech)	Canada	38	5.5	39	2.2
Beijing	China	39	5.1	38	2.4
Sao Paulo	Brazil	40	1.6	40	1.6

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Table 4. Ranking of KISA clusters by proportion of young firms (aged below 5 years)

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	% of young firms	Ranking	% of young firms
Pervasive Computing Cluster	Denmark	1	31.3	1	41.1
Atlantic Technology Corridor	Ireland	2	30	2	40.3
Information processing cluster	Spain	3	30	12	24.1
Bari ICT Cluster	Italy	4	29.1	8	28.2
Beijing	China	5	27.6	24	19.2
Oxfordshire R&D Cluster	UK	6	27.2	4	31.3
ICT Cluster Dublin	Ireland	7	26.9	3	34.9
Twente ICT cluster	Netherlands	8	23.6	10	26.7
Telecommunications in North Jutland	Denmark	9	23	5	30.4
Daedoek Science Town	Korea	10	22.2	19	20.4
Silicon Valley	USA	11	21.7	15	22.5
Linz	Austria	12	21.7	7	28.6
Kista	Sweden	13	21.3	17	21.4
Cluster ITC Tirol	Austria	14	21.1	20	20.1
Cap Digital Cluster	France	15	20.6	27	17.2
Silicon Glen	UK	16	19.7	29	12.9
Oslo	Norway	17	19.1	18	20.8
Lisbon ICT cluster	Portugal	18	19.1	6	28.8
Modelling and Simulation cluster	USA	19	18.8	13	23.5
GIS Cluster	Austria	20	18.8	21	19.8
Dommell Valley Eindhoven	Netherlands	21	18.6	14	23.5
Tsukuba Science City	Japan	22	18.3	28	13.8
Amsterdam Alley	Netherlands	23	18.3	11	25.3
Oulu	Finland	24	18.1	9	27.2
Waterloo ICT cluster	Canada	25	17.6	16	22
Austin ITC cluster	USA	26	17.2	23	19.5
Silicon Valley of Germany	Germany	27	16.3	26	18.6
Espoo	Finland	28	13.6	22	19.6
Louvain Technology Corridor	Belgium	29	12.3	25	18.9
Kansai Science City	Japan	30	11.5	30	12.3
Ottawa ICT cluster	Canada	31	9.9	34	7.7
Cornell research district	USA	32	9.2	31	11.5
Yokosuka Research Park	Japan	33	7.7	32	9.6
Macquarie Park, Sydney	Australia	34	6.4	35	6.4
Health care/Medical research	USA	35	5.3	33	8.8
Sao Paulo	Brazil	36	3.6	37	2.8
Silicon Valley of Mexico	Mexico	37	2.5	38	2.5
Bangalore	India	38	2.1	36	3.6
Brazilian Silicon Valley	Brazil	39	0.4	39	0.3
Silicon Wadi	Israel	40	0	40	0

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Key findings

- The best-performing clusters in both high-tech manufacturing and knowledge-intensive services remained approximately the same over the two time periods, thereby showing solid entrepreneurial bases. Tartu in Estonia moved from first to second, the Denmark mechatronics cluster from second to fourth and the Oxfordshire bioscience cluster from fifth to third, while the pervasive computing cluster and the Atlantic technology corridor remained at the top in the knowledge intensive services group.

- This is confirmed by very strong correlation between the two observation periods with regard to entrepreneurialism, both in the case of HTM clusters (0.85) and of KISA clusters (0.88). This suggests that the degree of entrepreneurialism is something inherent to the cluster, with most clusters keeping similar rates both in a phase of economic expansion and of economic contraction. Of course, there are some exceptions, the most notable being Heidelberg that dropped from the fourth to the nineteenth position, while the Coimbra cluster in Portugal climbed from eighteenth to first in the recession period.

- Economic recessions are confirmed to be periods of creative destruction, putting incumbent firms under the competitive threat of new entrants. The share of young firms in the three best performing clusters in each category of clusters was, indeed, higher in the recession period than in the pre-recession one. In HTM, Tartu's share of young firms was 27.3% in the precession period, while Coimbra, the first in the recession period, had a share of young firms of 36.1%. In KISA the two leading clusters remained the same, but the percentage of firms aged below five years increased by 10% in each case.

- In line with expectations, entrepreneurialism was higher in services than in manufacturing, where entry costs tended to be higher. However, the difference was only 1% and less than one might expect. Across HTM clusters an average 16% of firms were aged less than 5 years, while in KISA the same value rose to 17%, in both cases the time of reference being the pre-recession.

Employment

Indicator

The indicator measures the annual growth rate of employment for every firm over a two-year period, for each time span: pre-recession and recession. An overall figure is derived for each cluster by taking the mean of all firms' employment growth.

Rankings

Table 5. Ranking of HTM clusters by employment growth rate

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Oslo Cancer Cluster	Norway	1	71.3	3	35.6
Madison research district	USA	2	62.5	15	10.5
Leuven	Belgium	3	46.9	22	8.6
Boston (Route 128)	USA	4	46.1	9	14
Life Science cluster (LISA)	Austria	5	40	1	48.2
Saskatoon (Ag Biotech)	Canada	6	31.7	2	38.3
Grenoble	France	7	26.4	35	2.3
Human technology Styria	Austria	8	25.6	5	20.1
Mechatronics Cluster	Denmark	9	22.9	11	12.8
Minnesota Medical Devices	USA	10	22.1	14	11.4
Optical Tech Cluster	Germany	11	21	30	5.7
Lisbon-Oeiras bio-pharma cluster	Portugal	12	19.8	28	6.9
Toulouse aerospace cluster	France	13	19.7	27	6.9
Uppsala BIO	Sweden	14	15.7	17	10.4
Montreal Biotech cluster	Canada	15	14.3	10	13
Oxfordshire bioscience cluster	UK	16	14.2	31	4.5
Mirandola	Italy	17	13.6	20	10
Lyon biotech cluster	France	18	12.8	32	3.2
Microlectronics cluster	Germany	19	11.3	23	8.5
Cluster Life Sciences Innsbruck	Austria	20	10.4	13	11.9
Cambridge	UK	21	10.2	24	7.9
Medicon Valley	Sweden	22	9.6	19	10.2
Sophia-Antipolis	France	23	8.6	25	7.8
Sao Paulo	Brazil	24	8.6	38	-1.4
Gothenburg Bio cluster	Sweden	25	8.4	33	3.1
Tartu	Estonia	26	6.8	36	1.5
Ishikawa High-tech Sensing Cluster	Japan	27	5.3	18	10.3
Bio-pharma cluster	Ireland	28	4.6	8	14.7
Toyama Medical-Bio Cluster	Japan	29	2.5	16	10.4
Instrumentation Trondheim	Norway	30	1.9	21	9.3
Gottingen	Germany	31	1.87	34	2.85
Medical Valley Nuremberg	Germany	32	1.5	29	6.3
Heidelberg	Germany	33	1.1	39	-3.9
Beijing	China	34	0.02	37	0.28
Tsukuba	Japan	35	0	4	23.6
Med-Tech cluster	Ireland	36	-1.7	6	16.1
Fiberoptic Valley	Sweden	37	-1.8	7	15.9
Tucson cluster	USA	38	-20.8	26	7.4
Micro- and Nanotechnology Horten	Norway		--		--
Coimbra-Cantanhede's Biotech cluster	Portugal		--	12	12.7

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Table 6. Ranking of KISA clusters by employment growth

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Cornell research district	USA	1	83.3	19	15.6
Health care/Medical research	USA	2	70.1	21	14.1
Silicon Valley	USA	3	59.3	18	15.8
Louvain Technology Corridor	Belgium	4	56.6	7	29.3
Oslo	Norway	5	55.6	11	21.6
Pervasive Computing Cluster	Denmark	6	51.8	5	31.4
Linz	Austria	7	45.9	2	41.4
Oulu	Finland	8	36.9	17	16.1
Silicon Wadi (Jerusalem, Haifa, Tel Aviv)	Israel	9	35.9	39	-19.2
Modelling and Simulation cluster	USA	10	34.7	15	16.9
Austin ITC cluster	USA	11	31.1	4	32
Kista	Sweden	12	28.7	13	18.8
Sao Paulo	Brazil	13	28.1	31	3.6
Information processing cluster	Spain	14	24.9	20	15.4
Daedoek Science Town	Korea	15	24.8	6	30.3
Oxfordshire R&D Cluster	UK	16	23.4	22	13.5
Cap Digital Cluster	France	17	21.9	9	24.1
Silicon Valley of Germany	Germany	18	21.5	14	18.5
Silicon Glen	UK	19	19.9	27	6.3
Waterloo ICT cluster	Canada	20	19.5	24	9.1
Espoo	Finland	21	17.8	12	19.8
Twente ICT cluster	Netherlands	22	16.5	29	5.6
Amsterdam Alley	Netherlands	23	16.2	23	11.6
Silicon Valley of Mexico	Mexico	24	16.1	28	6.1
Ottawa ICT cluster	Canada	25	12.6	30	4.5
Macquarie Park, Sydney	Australia	26	11.5	34	0.83
Lisbon ICT cluster	Portugal	27	10.6	8	26.4
Beijing	China	28	10.3	3	32.4
Bari ICT Cluster	Italy	29	9.6	10	23.7
Kansai Science City	Japan	30	8.2	33	1.1
ICT Cluster Dublin	Ireland	31	7.1	25	7
Cluster Informationstechnologien Tirol	Austria	32	4.2	26	6.4
GIS Cluster	Austria	33	4.1	32	1.6
Yokosuka Research Park	Japan	34	3.5	38	-2.3
Brazilian Silicon Valley	Brazil	35	2.7	1	44.6
Tsukuba Science City	Japan	36	1.8	35	-0.1
Dommell Valley Eindhoven	Netherlands	37	1.2	37	-1.5
Atlantic Technology Corridor	Ireland	38	0	36	-1.2
Telecommunications in North Jutland	Denmark		--	16	16.9
Bangalore	India		--		--

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Key findings

- The average employment growth rate across HTM clusters was 15.7% during the pre-recession period and 11.2% during the recession. The average employment growth across KISA clusters was 24.4% during the prerecession and 14.3% during the recession. As could be expected, the recession caused a slowdown of employment growth, especially for KISA clusters whose average employment growth receded by 10 percentage points, while HTM clusters proved more resilient to the crisis.

- In both two periods KISA clusters outperformed HTM clusters, pointing to the ability of services to create more employment than manufacturing. At the same time, the greater propensity of services to generate jobs was offset by a greater proclivity to lose them during an economic slump.

- Only nine clusters had negative employment growth rates in any of the two periods, and only two shed significant shares of jobs: Silicon Wadi among KISA clusters (-19.2%) during the recession and Tucson among HTM clusters (-20.8%) in the pre-recession period. This might signal that firms in clusters are more resilient to the economic crisis than firms outside of clusters, but it might also be the result of employment being a lagged variable of growth, that is, jobs are destroyed only some time after the outbreak of the crisis. Thus, the process of job destruction may have not been completely over in 2009, when the second observation period stops.

- The performance of some clusters across the two periods was very uneven. Among HTM clusters, Madison and Leuven, second and third in the pre-recession period, were 15th and 22nd in the recession period. Among KISA clusters, the three best-performing clusters during the first observation period were respectively 19th, 21st and 18th in the second one. The impact on employment of the crisis was, therefore, felt more rapidly by those clusters which had experienced stronger employment growth in the previous period. This might be due to newly created jobs being less protected by legislation or less integrated in the production process than old ones.

- The clusters that weathered the crisis better were found in Austria (LISA), Canada (Saskatoon), and Norway (Oslo) in the case of high-tech manufacturing and, interestingly, Brazil (Brazilian Silicon Valley), China (Beijing), and also Austria (Linz) in the case of knowledge-intensive services. Clusters in emerging economies have been among the most resistant to the negative impact of the global recession on employment.

Economic growth (turnover)

Indicator

This indicator measures the economic growth of clusters through turnover. It measures the growth rate of turnover for each firm over a two-year period. An overall figure is derived for each cluster by taking the mean of all firms' turnover growth within each cluster.

Rankings

Table 7. Ranking of HTM clusters by turnover growth

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Boston (Route 128)	USA	1	108.2	5	26.7
Madison research district	USA	2	93.2	17	15.7
Tartu	Estonia	3	73.5	7	25.6
Oslo Cancer Cluster	Norway	4	71.5	16	16.7
Oxfordshire bioscience cluster	UK	5	70.3	18	13.6
Uppsala BIO	Sweden	6	69.6	26	9.4
Heidelberg	Germany	7	67	28	6.2
Mechatronics Cluster	Denmark	8	62	1	67
Life Science cluster (LISA)	Austria	9	61.4	33	-4
Optical Tech Cluster	Germany	10	56.1	34	-5.1
Microlectronics cluster	Germany	11	55.2	20	13.2
Instrumentation Trondheim	Norway	12	54.9	11	22.7
Medicon Valley	Sweden	13	54.7	9	23.3
Gottingen	Germany	14	53.8	35	-7.9
Mirandola	Italy	15	53.7	32	-1.1
Human technology Styria	Austria	16	53	39	-12.3
Gothenburg Bio cluster	Sweden	17	47.6	31	2.4
Cambridge	UK	18	46	6	26.5
Biotech cluster	Portugal	19	46	13	18
Beijing	China	20	45.9	4	27.2
Micro- and Nanotechnology Horten	Norway	21	44.6	38	-11.9
Sophia-Antipolis	France	22	42	21	13
Lyon biotech cluster	France	23	41.1	24	11.7
Sao Paulo	Brazil	24	40.6	12	20
Toulouse aerospace cluster	France	25	39	23	12.1
Grenoble	France	26	37.6	30	3.42
Med-Tech cluster	Ireland	27	36.8	19	13.4
Lisbon-Oeiras Bio-pharma cluster	Portugal	28	35.9	14	17.7
Tsukuba	Japan	29	35.4	29	5.5
Leuven	Belgium	30	34.5	2	61.5
Medical Valley Nuremberg	Germany	31	33.9	37	-10.2
Bio-pharma cluster	Ireland	32	33.6	10	23.3
Saskatoon (Ag Biotech)	Canada	33	30.9	36	-9.1
Cluster Life Sciences Innsbruck	Austria	34	28.1	22	12.6
Tucson cluster	USA	35	27.3	8	24.3
Minnesota Medical Devices	USA	36	25.2	3	29.4
Montreal Biotech cluster	Canada	37	19.6	27	8.7
Ishikawa High-tech Sensing Cluster	Japan	38	18.7	25	10
Toyama Medical-Bio Cluster	Japan	39	11.2	15	17.6
Fiberoptic Valley	Sweden	40	11.2	40	-23

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Table 8. Ranking of KISA clusters by turnover growth

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Cornell research district	USA	1	94.3	18	15.5
Beijing	China	2	89.9	3	42.4
Pervasive Computing Cluster	Denmark	3	87.8	21	13
Oulu	Finland	4	84.2	2	45.4
Silicon Valley	USA	5	82.8	25	9
Amsterdam Alley	Netherlands	6	82.3	24	11.9
Espoo	Finland	7	79.4	15	21.2
Kista	Sweden	8	76.1	16	20.6
Lisbon ICT cluster	Portugal	9	74.7	4	41.3
Dommell Valley Eindhoven	Netherlands	10	74.5	40	-18.3
Silicon Valley of Germany	Germany	11	72.1	12	27.4
Daedoek Science Town	Korea	12	68.9	5	36.8
Sao Paulo	Brazil	13	65	6	35.9
Bangalore	India	14	58.9	28	5.7
Cap Digital Cluster	France	15	58.6	8	31.5
Linz	Austria	16	57.6	35	-2.3
Information processing cluster	Spain	17	55.8	33	0.17
Health care/Medical research	USA	18	54.3	17	20.3
Oxfordshire R&D Cluster	UK	19	53.1	23	12.2
Louvain Technology Corridor	Belgium	20	51.8	14	22.4
Cluster Informationstechnologien Tirol	Austria	21	50.4	11	28
ICT Cluster Dublin	Ireland	22	48.7	20	14.9
Modelling and Simulation cluster	USA	23	47.9	31	3.1
Brazilian Silicon Valley	Brazil	24	44.6	38	-5.3
Twente ICT cluster	Netherlands	25	42.2	26	6.8
GIS Cluster	Austria	26	37.8	36	-3.4
Macquarie Park, Sydney	Australia	27	34.9	27	6.6
Oslo	Norway	28	34.4	29	5
Kansai Science City	Japan	29	32.1	34	-0.4
Bari ICT Cluster	Italy	30	30.9	37	-3.8
Austin ITC cluster	USA	31	26.7	7	32
Tsukuba Science City	Japan	32	25.4	30	4.3
Waterloo ICT cluster	Canada	33	21.7	19	15.5
Atlantic Technology Corridor	Ireland	34	18.6	13	26.1
Silicon Valley of Mexico	Mexico	35	18.3	1	62.8
Ottawa ICT cluster	Canada	36	16.3	32	1.5
Silicon Glen	UK	37	9.9	39	-12.9
Silicon Wadi	Israel	38	-20.2	10	28.4
Yokosuka Research Park	Japan	39	-30.8	22	12.9
Telecommunications in North Jutland	Denmark		--	9	29.2

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Key findings

- The average growth rate of turnover across HTM clusters was 46.7% prior to the recession and 12.8% during the recession, whereas the same rate for KISA clusters was 49% in the pre-recession period and 16% at the time of the recession. As could be expected and in line with employment results, knowledge-intensive services clusters outperformed high-tech manufacturing in both observation periods also in terms of turnover growth.

- Turnover growth was positively correlated with the share of young firms in clusters (entrepreneurialism), especially in high-tech manufacturing clusters where correlations were respectively 0.51 and 0.31 before and during the recession. Correlation between the variables was less strong among KISA clusters.

- The correlation between the average turnover growth and the average employment growth within each sector for each observation period was positive and strong at 0.78. This suggests that for the large majority of clusters growth in turnover has resulted in job creation. Extending the analysis to the rates of growth of the single clusters (rather than the aggregate averages) shows that correlation was especially strong in the first observation period (pre-recession) both in HTM (0.33) and KISA (0.50) clusters.

- The difference of growth rates across the two sectors was smaller in turnover than in employment in the pre-recession period, where the KISA/HTM gap in turnover growth rate was 2.3%, versus the 8.7% in employment. This means that for a 1% increase in turnover, clusters in KISA sectors created a bigger proportion of jobs than clusters in HTM. But this was true only in a time of economic expansion, for in the recession period the growth rate gap between the two sectors was similar, 3.2% for turnover and 3.1% for employment. So, in this case, a 1% increase in turnover generated the same share of additional employment across the two macro sectors.

- As could be expected turnover was subject to bigger fluctuations than employment across the two observation periods, which implies that business turnover feels sooner the negative effects of the crisis. So, for HTM clusters the turnover growth of the first cluster in the pre-recession period (Boston, Route 128) was 108%, whereas the rate of the leading cluster in the recession period (Denmark's mechatronics cluster) was 67%. The same Route 128 dropped by 75% across the two periods, but was still 5th in the recession period with a turnover growth rate of 26.7%. Among KISA clusters the fluctuation was less radical but still significant, with Cornell leading before the recession with a rate of 94.3% and Mexican Silicon Valley during the crisis with 62.8%. Cornell's turnover growth rate during the recession plummeted to 15.5%.

- Nevertheless, only 9 HTM clusters (Fiberoptic Valley in Sweden; Human technology Styria and LISA in Austria; nanotech in Horten, Norway; Medical Valley in Nuremberg, optical tech cluster and Gottingen in Germany; AG Biotech in Saskatoon; and Mirandola in Italy) and 7 KISA clusters (Linz and GIS clusters in Austria; Kansai in Japan; Bari ICT in Italy, Brazilian Silicon Valley in Brazil; Silicon Glen in the UK; and Dommel Valley in the Netherlands) experienced negative turnover growth during the recession, which illustrates the relative resilience of clusters to the economic crisis.

Economic growth (profitability)

Indicator

This indicator shows the performance of clusters according to profitability as measured by the returns on total assets (ROTA) of a firm. It measures the growth rate of returns on total assets for every firm over a two-year period. An overall figure is derived for each cluster by taking the mean of all firms' profitability growth.

For this indicator data are available for only 37 clusters in the pre-recession and 36 clusters in the recession for the high-manufacturing sector, and 34 clusters in the pre-recession and 32 in the recession for knowledge-intensive services.

Rankings

Table 9. Ranking of HTM clusters by profitability growth

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Human Technology Styria	Austria	1	6.81	29	-0.89
Uppsala BIO	Sweden	2	1.93	2	0.85
Fiberoptic Valley	Sweden	3	1.35	21	-0.45
Sao Paulo	Brazil	4	1.12	1	1.56
Minnesota Medical Devices	USA	5	0.87	4	0.7
Microlectronics cluster	Germany	6	0.84	18	-0.34
Boston (Route 128)	USA	7	0.79	3	0.79
Heidelberg	Germany	8	0.75	8	0.06
Leuven	Belgium	9	0.54	34	-1.81
Toyama Medical-Bio Cluster	Japan	10	0.35	7	0.1
Montreal Biotech cluster	Canada	11	0.35	17	-0.23
Instrumentation Trondheim	Norway	12	0.14	36	-8.09
Micro- and Nanotechnology Horten	Norway	13	0.12	26	-0.72
Göttingen	Germany	14	0.12	16	-0.23
Life Science cluster (LISA)	Austria	15	0.11	12	-0.18
Ishikawa High-tech Sensing Cluster	Japan	16	0.07	23	-0.55
Mechatronics Cluster	Denmark	17	0.01	5	0.31
Toulouse aerospace cluster	France	18	-0.01	22	-0.48
Grenoble	France	19	-0.03	32	-1.02
Medical Valley Nuremberg	Germany	20	-0.04	15	-0.22
Tucson cluster	USA	21	-0.07		--
Beijing	China	22	-0.15	13	-0.18
Sophia-Antipolis	France	23	-0.17	9	0.05
Lyon biotech cluster	France	24	-0.28	35	-2.1
Tsukuba	Japan	25	-0.29	24	-0.68
Gothenburg Bio cluster	Sweden	26	-0.31	11	-0.15
Mirandola	Italy	27	-0.5	31	-0.95
Oxfordshire bioscience cluster	UK	28	-0.51	10	-0.13
Bio-pharma cluster	Ireland	29	-0.56	14	-0.2
Medicon Valley	Sweden	30	-0.62	28	-0.86
Med-Tech cluster	Ireland	31	-0.65	30	-0.93
Lisbon-Oeiras Bio-pharma cluster	Portugal	32	-0.87	19	-0.39
Oslo Cancer Cluster	Norway	33	-0.91	20	-0.45
Cambridge	UK	34	-1.04	25	-0.69
Optical Tech Cluster	Germany	35	-1.57	27	-0.79
Coimbra-Cantanhede's Biotech cluster	Portugal	36	-1.91	6	0.25
Tartu	Estonia	37	-4.12	33	-1.13
Cluster Life Sciences Innsbruck	Austria		--		--
Saskatoon (Ag Biotech)	Canada		--		--
Madison research district	USA		--		--

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Table 10. Ranking of KISA clusters by profitability growth

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Cap Digital Cluster	France	1	2.6	24	-0.72
Health care/Medical research	USA	2	2.08		--
Silicon Valley of Germany	Germany	3	1.38	6	0.27
Tsukuba Science City	Japan	4	1.29	9	-0.02
Modelling and Simulation cluster	USA	5	0.84		--
Kista	Sweden	6	0.81	18	-0.61
Silicon Valley of Mexico	Mexico	7	0.39	5	0.6
Dommell Valley Eindhoven	Netherlands	8	0.31	28	-1.27
Beijing	China	9	0.3	13	-0.24
Macquarie Park, Sydney	Australia	10	0.22	7	0.09
Oulu	Finland	11	0.14	14	-0.34
Sao Paulo	Brazil	12	0.12	11	-0.09
Daedoek Science Town	Korea	13	0.01	8	0.05
Information processing cluster	Spain	14	-0.01	31	-1.82
Espoo	Finland	15	-0.03	15	-0.48
Louvain Technology Corridor	Belgium	16	-0.06	25	-0.78
Oslo	Norway	17	-0.07	19	-0.64
Austin ITC cluster	USA	18	-0.14	17	-0.54
Silicon Glen	UK	19	-0.24	2	2.67
Atlantic Technology Corridor	Ireland	20	-0.31	12	-0.19
ICT Cluster Dublin	Ireland	21	-0.37	27	-1.14
Silicon Wadi	Israel	22	-0.38	32	-4.42
Amsterdam Alley	Netherlands	23	-0.4	23	-0.71
Lisbon ICT cluster	Portugal	24	-0.41	10	-0.04
Kansai Science City	Japan	25	-0.47	3	2.12
Yokosuka Research Park	Japan	26	-0.48	22	-0.7
Waterloo ICT cluster	Canada	27	-0.56	21	-0.68
Oxfordshire R&D Cluster	UK	28	-0.7	16	-0.51
Brazilian Silicon Valley	Brazil	29	-1.21	26	-0.97
Pervasive Computing Cluster	Denmark	30	-1.49	4	0.71
Bangalore	India	31	-1.77	29	-1.32
Telecommunications in North Jutland	Denmark	32	-2.21	20	-0.64
Bari ICT Cluster	Italy	33	-4.84	1	4.42
Twente ICT cluster	Netherlands	34	-12.6	30	-1.8
Cornell research district	USA		--		--
Silicon Valley	USA		--		--
Linz	Austria		--		--
Ottawa ICT cluster	Canada		--		--
Cluster Informationstechnologien Tirol	Austria		--		--
GIS Cluster	Austria		--		--

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Key findings

- With regard to profitability, negative growth rates were much more common and involved 20 and 27 cases for HTM clusters across the two observation periods, and 21 and 24 cases for KISA clusters. Returns on total assets (ROTA), therefore, give a very different perspective of cluster performance than turnover. Most clusters found it difficult to make the best use of their assets to generate profits, and this is all the more true during the crisis.

- The average rate of profitability growth across clusters was positive only for HTM clusters in the prerecession period (0.04), while it was negative in all other cases: HTM clusters in the recession period (-0.56%), KISA clusters in the prerecession (-0.54%), and KISA clusters in the recession (-0.30%). The performance in profitability of KISA clusters was therefore steadier than for HTM clusters. Surprisingly, KISA clusters did better before the recession than during it.

- Fluctuation across observation periods is significant, unlike in the case of entrepreneurialism. So, in the HTM macro sector, the clusters ranked 1st and 3rd in the pre-recession, ranked 29th and 21st during the recession. The leading KISA cluster in the recession period was 33rd prior to the recession. Profitability measured as returns on total assets changed significantly across time within clusters, and this could be the result of the fierce competition with which clusters are faced in the globalised economy.

Financial viability (liquidity ratio)

Indicator

This indicator assesses the financial viability of cluster businesses through the growth rate of liquidity.

- Liquidity = (Current Fixed Assets – Stocks) / Current Liabilities

The liquidity ratio is measured for every firm within the cluster over a two-year period. An overall figure is derived for each cluster by taking the mean of all firms' liquidity growth.

Data for this indicator are available only for 38 HTM clusters and 35 KISA clusters (36 during the observation period of the recession)

Ranking

Table 11. Ranking of HTM clusters by liquidity ratio

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Instrumentation Trondheim	Norway	1	3.21	27	0.16
Tartu	Estonia	2	1.06	1	1.59
Human technology Styria	Austria	3	1.05	2	1.05
Life Science cluster (LISA)	Austria	4	0.99	13	0.41
Optical Tech Cluster	Germany	5	0.85	24	0.2
Tucson cluster	USA	6	0.74	16	0.34
Microlectronics cluster	Germany	7	0.74	3	0.94
Med-Tech cluster	Ireland	8	0.7	8	0.52
Bio-pharma cluster	Ireland	9	0.69	9	0.5
Lisbon-Oeiras Bio-pharma cluster	Portugal	10	0.59	6	0.6
Tsukuba	Japan	11	0.58	14	0.36
Oslo Cancer Cluster	Norway	12	0.55	35	0.06
Cambridge	UK	13	0.49	12	0.41
Medical Valley Nuremberg	Germany	14	0.43	25	0.2
Gothenburg Bio cluster	Sweden	15	0.4	17	0.3
Gottingen	Germany	16	0.38	5	0.71
Medicon Valley	Sweden	17	0.37	20	0.25
Cluster Life Sciences Innsbruck	Austria	18	0.36	32	0.08
Oxfordshire bioscience cluster	UK	19	0.31	7	0.57
Heidelberg	Germany	20	0.28	15	0.35
Fiberoptic Valley	Sweden	21	0.27	21	0.25
Boston (Route 128)	USA	22	0.22	38	-0.1
Sao Paulo	Brazil	23	0.19	30	0.14
Leuven	Belgium	24	0.17	37	-0.03
Mirandola	Italy	25	0.17	26	0.2
Sophia-Antipolis	France	26	0.16	22	0.22
Beijing	China	27	0.16	19	0.29
Biotech cluster	Portugal	28	0.15	4	0.93
Minnesota Medical Devices	USA	29	0.14	29	0.15
Uppsala BIO	Sweden	30	0.12	10	0.49
Grenoble	France	31	0.06	34	0.06
Toulouse aerospace cluster	France	32	0.03	23	0.22
Lyon biotech cluster	France	33	-0.02	31	0.1
Toyama Medical-Bio Cluster	Japan	34	-0.02	36	-0.01
Ishikawa High-tech Sensing Cluster	Japan	35	-0.06	33	0.07
Micro- and Nanotechnology Horten	Norway	36	-0.07	28	0.16
Montreal Biotech cluster	Canada	37	-0.27	11	0.45
Mechatronics Cluster	Denmark	38	-0.3	18	0.3
Saskatoon (Ag Biotech)	Canada		--		--
Madison research district	USA		--		--

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Table 12. Ranking of KISA clusters by liquidity ratio

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Twente ICT cluster	Netherlands	1	2.38	1	6.61
Linz	Austria	2	1.8	25	0.22
Atlantic Technology Corridor	Ireland	3	1.37	16	0.39
Austin ITC cluster	USA	4	1.3	23	0.26
GIS Cluster	Austria	5	0.99	20	0.34
Daedoek Science Town	Korea	6	0.78	3	0.92
Macquarie Park, Sydney	Australia	7	0.77	32	0.02
Tsukuba Science City	Japan	8	0.69	22	0.29
Silicon Valley of Germany	Germany	9	0.68	12	0.43
Cluster Informationstechnologien Tirol	Austria	10	0.65	14	0.41
Information processing cluster	Spain	11	0.61	5	0.77
Silicon Glen	UK	12	0.58	4	0.78
ICT Cluster Dublin	Ireland	13	0.55	8	0.56
Amsterdam Alley	Netherlands	14	0.54	7	0.58
Espoo	Finland	15	0.5	10	0.51
Oslo	Norway	16	0.48	24	0.23
Sao Paulo	Brazil	17	0.44	15	0.39
Oxfordshire R&D Cluster	UK	18	0.44	21	0.3
Waterloo ICT cluster	Canada	19	0.43	11	0.48
Yokosuka Research Park	Japan	20	0.38	27	0.13
Lisbon ICT cluster	Portugal	21	0.38	19	0.35
Dommell Valley Eindhoven	Netherlands	22	0.37	17	0.36
Oulu	Finland	23	0.33	6	0.65
Silicon Valley of Mexico	Mexico	24	0.3	18	0.36
Health care/Medical research	USA	25	0.25	34	-0.11
Kista	Sweden	26	0.2	26	0.15
Cap Digital Cluster	France	27	0.19	2	1.36
Louvain Technology Corridor	Belgium	28	0.18	13	0.43
Bari ICT Cluster	Italy	29	0.17	31	0.03
Bangalore	India	30	0.16	29	0.07
Beijing	China	31	0.1	28	0.12
Brazilian Silicon Valley	Brazil	32	0.08	36	-0.28
Kansai Science City	Japan	33	0.02	30	0.03
Silicon Wadi	Israel	34	-0.09	35	-0.21
Pervasive Computing Cluster	Denmark	35	-0.31	9	0.54
Telecommunications in North Jutland	Denmark		--	33	-0.07
Cornell research district	USA		--		--
Silicon Valley	USA		--		--
Modelling and Simulation cluster	USA		--		--
Ottawa ICT cluster	Canada		--		--

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Key findings

- The average growth rate of the liquidity ratio across HTM clusters was 0.42% in the prerecession period and 0.36% during the recession. The rates for KISA clusters were 0.53% and 0.51%. As with profitability and turnover, therefore, HTM clusters suffered the most from the impact of the crisis in terms of liquidity.

- The growth rate of the liquidity ratio was negative in 6 and 3 cases across the two observation periods among HTM clusters, but only 2 and 4 times among KISA clusters. This tends to confirm the view that clusters in knowledge intensive services are more liquid than those in high-tech manufacturing, although the recession has had an impact on liquidity also for KISA clusters. Similar trends can be observed for solvency in the following indicator.

- The correlation between the pre-recession and the recession period with regard to liquidity was 0.24 across all HTM clusters and 0.62 across all KISA clusters. This implies that liquidity performance between the two periods was steadier for KISA clusters than for HTM clusters, suggesting that high-tech manufacturing suffered the most the effects of the recession on business performance.

Financial viability (solvency)

Indicator

This indicator assesses the financial viability of clusters through the growth rate of the solvency ratio:

- Solvency = Shareholder funds / Total assets

The solvency ratio is measured for every firm within the cluster over a two-year period. An overall figure is derived for each cluster by taking the mean of all firms' solvency growth.

Data for this indicator are available for 38 HTM clusters and 34 KISA clusters across the two observation periods.

Rankings

Table 13. Ranking of HTM clusters by solvency ratio

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Cluster Life Sciences Innsbruck	Austria	1	1.37	13	0.1
Med-Tech cluster	Ireland	2	0.31	9	0.13
Bio-pharma cluster	Ireland	3	0.3	6	0.19
Gottingen	Germany	4	0.21	29	-0.02
Medicon Valley	Sweden	5	0.16	16	0.08
Gothenburg Bio cluster	Sweden	7	0.15	12	0.11
Toyama Medical-Bio Cluster	Japan	6	0.15	26	-0.01
Optical Tech Cluster	Germany	8	0.13	35	-0.14
Fiberoptic Valley	Sweden	10	0.12	17	0.06
Ishikawa High-tech Sensing Cluster	Japan	9	0.12	27	-0.01
Heidelberg	Germany	11	0.11	25	-0.01
Tsukuba	Japan	12	0.09	21	0.02
Uppsala BIO	Sweden	13	0.08	3	0.27
Sao Paulo	Brazil	14	0.05	8	0.15
Instrumentation Trondheim	Norway	15	0.04	24	-0.01
Beijing	China	16	0.04	15	0.08
Tucson cluster	USA	17	0.03	14	0.08
Microlectronics cluster	Germany	18	0.03	22	0.02
Mirandola	Italy	19	0.03	32	-0.08
Leuven	Belgium	22	0.01	23	0
Minnesota Medical Devices	USA	21	0.01	20	0.02
Grenoble	France	20	0.01	33	-0.13
Sophia-Antipolis	France	23	-0.01	31	-0.07
Oslo Cancer Cluster	Norway	24	-0.03	18	0.05
Tartu	Estonia	25	-0.04	34	-0.14
Human technology Styria	Austria	27	-0.06	5	0.24
Cambridge	UK	26	-0.06	4	0.25
Toulouse aerospace cluster	France	28	-0.08	1	0.38
Life Science cluster (LISA)	Austria	30	-0.11	30	-0.02
Lyon biotech cluster	France	29	-0.11	7	0.18
Medical Valley Nuremberg	Germany	31	-0.12	2	0.29
Micro- and Nanotechnology Horten	Norway	32	-0.13	10	0.11
Oxfordshire bioscience cluster	UK	33	-0.16	36	-0.26
Mechatronics Cluster	Denmark	34	-0.16	37	-0.52
Montreal Biotech cluster	Canada	35	-0.26	11	0.11
Boston (Route 128)	USA	36	-0.49	38	-0.61
Biotech cluster	Portugal	37	-0.62	19	0.05
Lisbon-Oeiras Bio-pharma cluster	Portugal	38	-1.05	28	-0.01
Saskatoon (Ag Biotech)	Canada		--		--
Madison research district	USA		--		--

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Table 14. Ranking of KISA clusters by solvency ratio

Name of cluster	Country	Pre-recession (2005-2007)		Recession (2007-2009)	
		Ranking	Growth rate	Ranking	Growth rate
Macquarie Park, Sydney	Australia	1	3.25	14	0.1
GIS Cluster	Austria	2	1.26	15	0.1
Tsukuba Science City	Japan	3	1.03	3	0.54
Information processing cluster	Spain	4	0.49	10	0.31
ICT Cluster Dublin	Ireland	5	0.42	9	0.33
Cluster Informationstechnologien Tirol	Austria	6	0.4	20	0.02
Atlantic Technology Corridor	Ireland	7	0.37	35	-0.2
Twente ICT cluster	Netherlands	8	0.34	23	0.01
Kista	Sweden	9	0.27	7	0.37
Yokosuka Research Park	Japan	10	0.2	25	0
Linz	Austria	11	0.17	26	-0.01
Bari ICT Cluster	Italy	12	0.17	12	0.15
Oxfordshire R&D Cluster	UK	13	0.16	13	0.13
Sao Paulo	Brazil	14	0.13	16	0.06
Amsterdam Alley	Netherlands	15	0.12	30	-0.02
Louvain Technology Corridor	Belgium	16	0.12	31	-0.03
Silicon Glen	UK	17	0.1	1	1.52
Oslo	Norway	18	0.09	11	0.15
Bangalore	India	19	0.06	32	-0.07
Telecommunications in North Jutland	Denmark	20	0.06	19	0.02
Espoo	Finland	21	0.04	17	0.06
Lisbon ICT cluster	Portugal	22	0.04	33	-0.12
Health care/Medical research	USA	20	0.04	22	0.01
Kansai Science City	Japan	22	0.04	24	0
Daedoek Science Town	Korea	23	0.03	5	0.47
Dommell Valley Eindhoven	Netherlands	24	0.03	27	-0.01
Austin ITC cluster	USA	25	0.02	28	-0.02
Waterloo ICT cluster	Canada	26	0.02	6	0.41
Cap Digital Cluster	France	27	0.01	4	0.52
Brazilian Silicon Valley	Brazil	28	0	21	0.02
Silicon Wadi	Israel	29	-0.02	36	-1.57
Silicon Valley of Mexico	Mexico	30	-0.06	2	0.72
Beijing	China	31	-0.06	29	-0.02
Silicon Valley of Germany	Germany	32	-0.07	18	0.03
Oulu	Finland	33	-0.11	34	-0.13
Pervasive Computing Cluster	Denmark	34	-1.92	8	0.34
Cornell research district	USA		--		--
Silicon Valley	USA		--		--
Modelling and Simulation cluster	USA		--		--
Ottawa ICT cluster	Canada		--		--

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Key findings

- The average growth rate of the solvency ratio across HTM clusters was 0.001% in the pre-recession compared with 0.02% during the recession. The same rate for KISA clusters was 0.20% and 0.12% across the two observation periods. KISA clusters appear, therefore, more solvent than HTM clusters, although the former suffered more than the latter the impact of the crisis on their performance.

- The correlation between pre-recession and recession was nil for KISA clusters and 0.22 for HTM clusters. This implies that performance in solvency across the two observation periods varies significantly, but was relatively steadier among HTM clusters.

- This is further confirmed by significant fluctuations in specific cases. The best performing HTM cluster in the pre-recession period (Life science Innsbruck) ranked only 13th during the recession, while the first (Toulouse aerospace) in the recession was 28th in the pre-recession period. Similarly, among KISA clusters, Macquarie Park in Sydney moved from first to 14th position during the two periods and Silicon Glen in the UK did the opposite, passing from the 17th to the first place in the recession period.

- The correlation between the two financial viability indicators, i.e. liquidity and solvency ratios was not high in any of the four following cases: 0.33 and 0.11 in the case of KISA clusters across the pre-recession and recession periods; 0.06 and 0.09 for HTM clusters across the two same time periods.

- The growth rate of the solvency ratio was negative in 16 and 15 cases across the two observation periods among HTM clusters, but only 6 and 10 times among KISA clusters. This corroborates the view that clusters in knowledge intensive services were more solvent than those in high-tech manufacturing, although the recession did have an impact on solvency also for KISA clusters.

The composite indicator

Indicator

The composite indicator shows a simple ranking of the clusters based on the arithmetic mean of the six local indicators grouped together: an indicator of entrepreneurialism (share of firms less than 5 years old); an employment growth indicator (average rate of employment growth); two economic growth indicators (average rate of turnover growth and average return on total assets); two financial viability indicators (average liquidity ratio and average solvency ratio). For a small number of clusters, the composite indicator is limited to the first three indicators, given constraints in data availability in their specific case.

Rankings

Table 15. Ranking of HTM clusters by the composite indicator

Name of cluster	Country	Composite Indicator	
		Pre-recession (2005-2007)	Recession (2007-2009)
Madison research district	USA	1	6
Human technology Styria	Austria	2	11
Life Science cluster (LISA)	Austria	3	14
Instrumentation Trondheim	Norway	4	23
Optical Tech Cluster	Germany	5	37
Microlectronics cluster	Germany	6	10
Heidelberg	Germany	7	28
Uppsala BIO	Sweden	8	3
Gottingen	Germany	9	33
Tartu	Estonia	10	18
Boston (Route 128)	USA	11	13
Oslo Cancer Cluster	Norway	12	19
Medicon Valley	Sweden	13	15
Oxfordshire bioscience cluster	UK	14	16
Cluster Life Sciences Innsbruck	Austria	15	27
Mechatronics Cluster	Denmark	16	4
Cambridge	UK	17	5
Gothenburg Bio cluster	Sweden	18	24
Bio-pharma cluster	Ireland	19	2
Leuven	Belgium	20	32
Minnesota Medical Devices	USA	21	8
Med-Tech cluster	Ireland	22	7
Toulouse aerospace cluster	France	23	21
Grenoble	France	24	40
Sao Paulo	Brazil	25	25
Mirandola	Italy	26	39
Lisbon-Oeiras Bio-pharma cluster	Portugal	27	12
Tucson cluster	USA	28	9
Sophia-Antipolis	France	29	29
Medical Valley Nuremberg	Germany	30	26
Tsukuba	Japan	31	20
Fiberoptic Valley	Sweden	32	31
Toyama Medical-Bio Cluster	Japan	33	30
Saskatoon (Ag Biotech)	Canada	34	34
Lyon biotech cluster	France	35	36
Beijing	China	36	22
Ishikawa High-tech Sensing Cluster	Japan	37	35
Micro- and Nanotechnology Horten	Norway	38	38
Biotech cluster	Portugal	39	1
Montreal Biotech cluster	Canada	40	17

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Table 16. Ranking of KISA clusters by composite indicator

Name of cluster	Country	Composite Indicator	
		Pre-recession (2005-2007)	Recession (2007-2009)
Silicon Valley	USA	1	25
Linz	Austria	2	21
Information processing cluster	Spain	3	19
Cornell research district	USA	4	30
Kista	Sweden	5	10
Daedoek Science Town	Korea	6	1
Modelling and Simulation cluster	USA	7	27
Twente ICT cluster	Netherlands	8	28
ICT Cluster Dublin	Ireland	9	8
Cluster Informationstechnologien Tirol	Austria	10	18
Oxfordshire R&D Cluster	UK	11	12
Oslo	Norway	12	20
Silicon Valley of Germany	Germany	13	6
Health care/Medical research	USA	14	33
Amsterdam Alley	Netherlands	15	26
Atlantic Technology Corridor	Ireland	16	22
Cap Digital Cluster	France	17	3
Oulu	Finland	18	5
Sao Paulo	Brazil	19	24
Tsukuba Science City	Japan	20	29
Macquarie Park, Sydney	Australia	21	32
Beijing	China	22	14
Espoo	Finland	23	7
Pervasive Computing Cluster	Denmark	24	2
Louvain Technology Corridor	Belgium	25	23
Austin ITC cluster	USA	26	17
Telecommunications in North Jutland	Denmark	27	15
Silicon Glen	UK	28	16
Lisbon ICT cluster	Portugal	29	4
Dommell Valley Eindhoven	Netherlands	30	36
GIS Cluster	Austria	31	31
Bari ICT Cluster	Italy	32	13
Waterloo ICT cluster	Canada	33	11
Bangalore	India	34	38
Silicon Valley of Mexico	Mexico	35	9
Yokosuka Research Park	Japan	36	37
Kansai Science City	Japan	37	34
Silicon Wadi	Israel	38	39
Ottawa ICT cluster	Canada	39	40
Brazilian Silicon Valley	Brazil	40	35

Source: OECD elaboration based on ORBIS database available from Bureau van Dijk

Key findings

- The Madison research district and the renowned Silicon Valley were the top performers respectively in high-tech manufacturing and knowledge-intensive services prior to the 2008 recession. The biotech cluster of Coimbra in Portugal and the Daedoek science town in Korea were, on the other hand, the clusters that do best during the recession.

- In the first observation period, when the economy was in a phase of expansion, the best performing clusters came from countries with a traditionally solid economy. So, for HTM clusters, the first five clusters came from the United States, Austria, Norway and Germany, while for KISA clusters they were found again in the United States and Austria together with Sweden and Spain.

- The picture is quite different during the recession, when the best performing clusters came from a more unusual mix of countries. So, the top five HTM clusters in the recession period were found in Portugal, Ireland, Sweden, Denmark, and UK, while the top five KISA clusters were found in Korea, Denmark, France, Portugal, and Finland. It is particularly surprising to see that for HTM clusters during the recession the two leading clusters in terms of growth rates across the six observed indicators were from countries quite struck by the crisis, Portugal and Ireland. This suggests that to an important degree cluster performance can be decoupled from the performance of their national economies.

- Fluctuations across the two periods are significant. Silicon Valley, which ranked first in the pre-recession, was only 25th during the recession. The pervasive computing cluster in Denmark, 24th before the recession, climbed up to the second post during the recession. One possible reason could be that clusters that do well in a time of expansion do not have the same features of those able to weather better economic slowdowns. A second alternative explanation could be that clusters are highly dynamic entities, so that comparing them against each other would inevitably result in volatile rankings where maintaining similar positions is difficult.

CONCLUSIONS

The OECD cluster scoreboard is a pilot attempt at measuring the performance of business clusters from a quantitative viewpoint focused on the growth rates and vitality of the firms within them. To do this, the scoreboard draws on ORBIS, a commercial database that collects company and financial information at the firm level. The use of ORBIS has at least three distinct advantages for the purposes of a cluster scoreboard. First of all, it permits a functional definition of clusters that cuts across administrative geographical boundaries. This allows a better identification of clusters that include the municipalities that are actually part of it and does not simply overlap NUTS 2 or NUTS 3 level agglomerations. Secondly, ORBIS makes it possible an economic analysis with a better time lag and a geographical disaggregation than is often possible through data from the national statistical offices (NSOs). Thirdly, this is all the more true for financial information such as solvency and liquidity, which is generally unavailable from NSOs. A commercial database such as ORBIS nonetheless also presents a number of methodological drawbacks that are discussed in more detail in the methodological annex of this publication. Here, suffice it to say that

there is certainly uneven coverage and standard of quality across countries, as proven by the fact that it was not possible to collect financial information on the whole set of 80 clusters included in the scoreboard.

The various rankings that are included in the scoreboard provide detailed information about the entrepreneurialism, the employment performance, economic growth, and financial viability of the 80 clusters across the two observation periods of pre-recession and recession. It is worth recalling here some highlights of the analysis:

- The best-performing clusters come from a restricted club of solid economies in the pre-recession period (e.g. United States, Germany and Sweden), but from a broader and more heterogeneous group during the recession, including some countries struck severely by the crisis (e.g. Portugal and Ireland).

- With the significant exception of entrepreneurialism and partly liquidity, which show strong correlation between the pre-recession and recession periods, the fluctuation of clusters in performance across the two time periods is significant.

- Clusters in knowledge-intensive services outperformed those in high-tech manufacturing with regard to both employment and turnover growth rates, the two most important indicators measured by the scoreboard. Knowledge-intensive services clusters, though, appear to have suffered more from the impact of the crisis.

- The strongest correlations among variables are found between entrepreneurialism and turnover growth and between turnover growth and employment growth. This suggests that having a large number of young firms boosts turnover growth in clusters and that, especially during a positive economic cycle, turnover growth also results in employment growth in clusters.

ANNEX I – THE SCOREBOARD METHODOLOGY

The ORBIS database

The data used in this paper is collected from *ORBIS*, a firm-level database developed and maintained by Bureau van Dijk, a Dutch-based electronic publishing company. A growing number of researchers have used this rich data set in recent years to analyse various economic issues, including Helpman *et al.* (2004), Budd *et al.* (2005), Konings and Murphy (2006) and Temouri *et al.* (2008). The basic characteristics of the ORBIS database can be synthesised by the following stylised facts. It includes over 60 million companies (in effect company records). Its geographical coverage goes up to 200 countries, while all sectors of economic activity are potentially considered. There are no exclusion thresholds in terms of enterprise size, unless national based limitations reduce the coverage of administrative data sources. Compared with national data sources, ORBIS provides more detailed financial, economic and other operational and ownership information on private and public companies operating worldwide.

The ORBIS database is essentially an international collection of national based administrative data sources focusing on business accounting variables and ownership information. Although the target

population of enterprises included in national based administrative data sources is generally restricted to firms with a corporation legal status, these types of firm represent in most countries the largest majority of large, medium and even small firms, with the sole exception of micro-businesses. Micro-businesses are defined as firms with less than 10 people employed where a non corporation legal status is generally dominant. The census nature of administrative data sources consents to rearrange business data by country, industry, or company location with limited loss of information. Thus, the scope of the ORBIS database for territorial analysis relies on the possibility to re-arrange firm level business data according to the company location. The information on company location is provided by its complete postal address, which includes street, city and postal code.

The identification of clusters

The sample of clusters drawn from this database has the following two main characteristics. First, it includes firms specialised in high technology manufacturing (HTM) industries and knowledge intensive services activities (KISA). The main activity of firms in the cluster should be consistent with the local business cluster dominant specialisation or group of industries that identifies the local business cluster's main economic activity. The analysis also adopts the municipality level as the reference unit for territorial analysis. This is in line with the definition of business clusters as a non standard agglomeration of municipalities not necessarily in line with higher level administrative breakdown (the county/province or the region). The "core" municipalities are selected as sufficiently reliable both from a statistical point of view (sufficient number of local companies for a reasonably good sample size) as well as economic perspective (the municipality is the "core" of a business clusters identified by the literature). However, certain business cluster boundaries were extended to neighbouring municipalities, based on information given in the literature or local government websites. Finally, the dataset includes all firms that have the key variables used in the scoreboard analysis for at least one year in the period 2005-2009. The dataset represents an unbalanced panel of firms in this time period.

The indicators

The scoreboard is based on six demographic, economic and financial performance indicators that are calculated at the local level from the *ORBIS* database. The first is a firm demography indicator and measures the share of firms that are less than five years of age during two periods, 2005-07 and 2007-09. Then follow employment growth, turnover growth and profitability. The remaining two are financial performance indicators, namely the liquidity ratio (cash flow over turnover) and the solvency ratio (profit and loss for the period over total liabilities). These local indicators for a given municipality are calculated as the average value of the same indicator for all local firms that are resident in the business cluster. This is done to partially mitigate outlier problems and other sources of bias, which may be amplified in the case of aggregation of local firm data. To account for inflation turnover, liquidity and solvency values were deflated with each country's price indices before measuring the local indicators.

Methodological caveats

With regards to data quality, the ORBIS database presents an uneven coverage and standard of quality across countries. Thus, the establishment of a scoreboard at the local level raises a set of additional methodological issues that need to be addressed in order to accurately assess cluster performance at the local level. These include: a) availability of a limited number of indicators at the local level, potentially plagued by high correlation; b) spatial correlation of indicators across localities; c) problems of international comparability.

Correlation between indicators for the same locality should be tested to reduce potential bias and to concentrate on relevant information only. However, this is a priority for local indicators in level, but it is

less true for dynamic local indicators (growth rates) such as those adopted in this publication. Nevertheless, the consistency of these indicators can be affected by a dynamic version of the same spatial correlation bias, which can occur in some specific cases because commercial databases are sometimes upgraded in terms of coverage and data quality of a given national source. This database upgrading is in effect a structural break in the time series, indeed in the panel of micro-data, that can dynamically alter the spatial distribution of companies, increasing or decreasing the static territorial bias. Spatial correlation across localities is a relevant issue, but it is not feasible to be tested in the framework of a scoreboard. International comparability of local indicators for the selected sample of business clusters is a critical issue, but the stratification of the sample of business clusters by technology intensity of the main local industry permits to make international comparison across relatively similar business clusters.

Although coverage and measurement errors can reasonably be considered not spatially correlated within a given country, the presence of a sufficient sample size and the lack of major biases at the local level were empirically assessed before considering each local business cluster as eligible for the scoreboard. From an operation point of view, only business records with at least one year of available accounts with the date of incorporation are considered. More strict selection criteria, such as for instance the presence of a complete set of variables for the entire time period 2005-09, generates a drastic loss of coverage for most of the localities, and therefore was not adopted. Therefore, the more flexible selection approach adopted makes the sample an unbalanced panel.

Lastly, biases arising from outlier values at the firm-level were excluded. We used two methods for this. One method is to identify and remove the first and last percentile of the distribution of each indicator to reduce outlier bias. In addition, the second is to check for volatile growth rates. For example, employment growth rates over a two-year period that are greater than a few hundred percent were seen as not credible (although clusters which have high shares of SMEs may achieve high growth rates).

ANNEX II –THE SCOREBOARD CLUSTERS IN DETAIL

Name of business cluster	Industry specialisation	Region/City	Further information sources	No of Firms
HTM Clusters				
Boston (Route 128)	Computers, Medical devices Software	Boston, Lowell, Cambridge, Brockton, Quincy, Lynn, Nashua, Newton, Somerville, Lawrence	Wonglimpiyarat (2005)	1 129
Tartu	Electronics, information- and biotechnology	Tartu	Mets (2005)	85
Tucson cluster	Aerospace, Advanced Manufacturing and IT, Bio-Industry, Nanotechnology, Optics	Tucson	Tucson Economic Blueprint Strategic Analysis Paper (2006)	584
Lyon biotech cluster	Biotechnology	Lyon in the Rhone-Alps region	Mytelka (2004); Corolleur et al. (2003)	179
Grenoble	Micro-Nanotechnology	Grenoble	http://www.minalogic.org/88-grenoble-cluster-innovation.htm OECD(2009)	198
Sophia-Antipolis	Microelectronics, telecommunications, software development and content production and broadcasting solutions	Sophia-Antipolis in the commune of Valbonne	http://investincotedazur.com/en/sophia-antipolis/ Ter Wal (2010) www.s-m-i.net/pdf/Sophia%20Conlusions.pdf)	854
Madison research district	Biotechnology and IT	Madison	Patton and Kenney (2009) OECD (2009)	349
Minnesota Medical Devices	Medical Devics	Minneapolis	Porter and Ramirez-Vallejo (2011)	2 451
Toulouse aerospace cluster	Aeronautics, space and embedded systems	Toulouse	http://www.aerospace-valley.com/en/skills.html Niosi and Zhegu (2005)	163
Leuven	Life sciences, medical technology, mechatronics, Micro-electronics & Nanotechnology	Leuven	http://www.cross-works.eu/Brainport_C01/default.asp?custid=354&comid=29&nodid=1918&itemid=0&time=7023	44
Tsukuba	High level research	Tsukuba City, Ibaraki Prefecture	Lambert (2000)	52
Oslo Cancer Cluster	Oncology research		http://www.oslocancercluster.no/	199
Instrumentation Trondheim	Instrumentation	Trondheim	http://ekstranett.innovasjonnorge.no/templates/Page_Meta____56540.aspx Spilling and Steinsli (2003)	78
Micro- and Nanotechnology Horten	Micro-nanotechnology	Horten	Onsager et al. (2007)	21
Cambridge Fen	Health Care & Life Sciences, biotechnology.	Cambridge, East Cambridgeshire, South Cambridgeshire	Harper et al. (2007) Athreye (2000) http://www.sqw.co.uk/file_download/284	462
Göttingen	Biotechnology	Göttingen	Häussler & Zademach (2006)	125
Heidelberg	Biotechnology	Im Neuenheimer Feld, Czernyring, Wieblinger Weg in the city of Heidelberg	Häussler & Zademach, (2006)	140
Optical Tech Cluster	Optical	Jena	http://www.gtai.com/homepage/info-service/publications/our-publications/cutting-edge-fields-in-eastern-germany/optical-technologies/ http://korea.ahk.de/fileadmin/ahk_korea/images/thueringen/fac	178

			tsheet_optik_en_03.pdf Fraunhofer innovation clusters report (2008)	
Microelectronics Cluster	Microelectronics, Semiconductor	Mainly Dresden but also Chemnitz and Leizig	http://www.smwa.sachsen.de/en/MICRO_-_IT__Microelectronics/142254.html	629
Medical Valley Nuremberg	Healthcare	Nuremberg	Norgall (2010)	223
Toyama Medical-Bio Cluster	Medical systems based on biotechnology and microelectronics	Toyama	Toshihiro Kodama (2004)	78
Ishikawa High-tech Sensing Cluster	High-tech measurement and support technology for human intelligent activity	Ishikawa	Toshihiro Kodama (2004)	238
Mirandola	Biomedical	Mirandola in the commune of Emilia-Romagna; Camposanto,Cavezzo,Concordia sulla Secchia,Finale Emilia,Medolla,Mirandola,San Felice sul Panaro,San Possidonio,San Prospero,Bondeno	Belussi et al. (2008)	161
Human technology Styria	bio- and pharmaceutical technologies	Styria	Schabereiter et al. http://www.humantechnology.at/	259
Life Science Cluster LISA	pharmaceutical technologies	Vienna	http://www.lifescienceaustria.at/; http://www.lisavr.at/siteLayout.php?language=english	434
Cluster Life Sciences Innsbruck	Biotechnology	Innsbruck	www.investinaustria.at	193
Montreal (Biotech, life sciences)	Biotechnology, Life Sciences	Montreal	http://www.ic.gc.ca/eic/site/cbc-gccb.nsf/eng/bq00013.html	788
Saskatoon (Ag Biotech)	Biotechnology	Saskatoon	Procyshyn (2004)	91
Sao Paulo	Aeronautics	Arujá, Barueri, Biritiba- Mirim, Cajamar, Caieiras, Carapicuíba, Cotia, Diadema, Embu, Embu-Guaçu, erraz de Vasconcelos, Francisco Morato, Franco da Rocha,Guararema,Guarulhos,Itapevi, Itaquaquecetuba, Itapecerica da Serra, Jandira, Juquitiba, Mairiporã,Mauá, Mogi das Cruzes,Osasco, Pirapora do Bom Jesus, Poá, Ribeirão Pires,Rio Grande da Serra,Salesópolis, Santa Isabel, Santana de arnaíba,Santo André,São Bernardo do Campo, São Caetano do Sul São Lourenço da Serra, São Paulo,Suzano, Taboão da Serra,Vargem Grande Paulista	Diniz and Razavi (1995); Goldstein (2002)	4 160
Beijing	Computer hardware	Zhongguancun, Shangdi	Yun-Chung Chen (2008)	1 304
Medicon Valley Sweden	Biotechnology	Copenhagen, Malmo, Scania	Asheim and Moodysson (2008)	878
Gothenborg BIO Sweden	Life sciences	Gothenborg	The Cluster Initiative Green Book (http://www.ictcluster.bg/_Code/UserFiles/Library/1.Cluster_Green_Book_2.pdf) http://www.goteborgbio.se/	560
Uppsala Bio Sweden	Life sciences	Uppsala	http://www.uppsalabio.com Teigland et al. (2005) Teigland et al. (2004)	202
Fiberoptic Valley Sweden	Fiberoptics	Sundsvall in the north to Gävle in the south with Hudiksvall in the center.	http://en.fiberopticvalley.com/	40
Bio-pharma Ireland	Pharmaceuticals	Dublin, Cork, Wexford, Galway, County Wicklow, Waterford	Enterprise Ireland Irish Biopharma Clusters (2009) http://www.biotechnologyireland.com/SITE/UPLOAD/DOCUMENT/BioclusterBooklet.pdf	651
Med-Tech cluster Ireland	Pharmaceuticals,biotechnology and medical devices	Cork, Dublin, Wyeth, Galway, Sligo and the midlands region	Knowledge and enterprise clusters in Ireland (2008) http://www.djei.ie/trade/euaffairs/Knowledgeandenterpriseclusters.pdf	637
Bio-Tech Cluster	Biotech	Coimbra-Cantanhede	OECD questionnaire	66
Bio-pharma cluster	Biopharma	Lisbon-Oeiras	OECD questionnaire	237

Oxfordshire bioscience cluster	Biotechnology	Oxfordshire county in the South East England region	Oxfordshire bioscience cluster paper (2005)	483
Mechatronics Cluster	High-tech engineering	Sonderborg	www.mechatronic. www.clusnet.eu/	137
KISA Clusters				
Austin ITC cluster	Computer and related activities	Austin area in Travis county	Munn-Venn and Voyer (2004)	2,775
Cornell research district	Research	Ithaca (New York)	Patton and Kenney (2009)	750
Silicon Valley	Electronics & ICT	Santa Clara county in the Northern California; South Bay cities include Campbell,Cupertino,Gilroy,Los Altos and Los Altos Hills, Los Gatos,Milpitas,Monte Sereno,Morgan Hill,Mountain View,Palo Alto, San Jose, Santa Clara,Saratoga,Sunnyvale	Jorge Vieto y Lawrence Pratt (1999)	4 249
Modelling and Simulation Cluster	Modelling and Simulation	Virginia beach, Norfolk, Newport News	OECD questionnaire (2011)	709
Health care/Medical research	Health care and Medical Research	Pittsburgh	OECD questionnaire (2011)	256
Sao Paulo	Computers, software, telecommunications	Sao Paulo, Sao Carlos	http://egateg.usaidallnet.gov/sites/default/files/Nurturing%20Entrepreneurs%20Creating%20Enterprises.pdf	6,514
Oslo	data processing and software development	Oslo	Spilling and Steinsli (2003)	1 789
Oxfordshire R&D Cluster	Research and Development	Oxford	Cooke (2001)	295
Linz	ICT, electronics	Linz	Gassler and Frohlich (1998)	332
Espoo	Research and Technology Cluster	Espoo and Otaniemi	http://www.24-7pressrelease.com/press-release/otaniemi-technology-cluster-opens-us-office-in-silicon-valley-4902.php	1 051
Oulu	ICT	Oulu in Northern Ostrobothnia region	Honkamakila (2009); Teräs (2008)	320
Silicon Valley of Germany	ICT	Dresden	Elbert et al. (2009)	560
Daedoek Science Town	ICT	Daejeon	Lee (2003)	468
Kista Science Park	ICT	Kista city in Northern Stockholm	Barinaga and Ramfelt (2004)	255
Beijing	Research and development	Zhongguancun	Chen (2008)	247
Ottawa ICT cluster	ICT	Ottawa	Wolfe (2002); Bramwell et al. (2008); Shavinina, (2004)	1 156
Waterloo ICT cluster	ICT	Waterloo	Wolfe (2002); Bramwell et al. (2008)	824
Telecommunications North Jutland	Telecommunications	Aalborg	Lorenzen and Mahnke (2002)	295
Silicon Wadi	ICT, software, data communications, electro-optics, hardware design, and internet technologies	Tel Aviv	De Fontenay and Carmel (2002) Roper and Grimes (2005)	20
Kansai Science City	ICT	Kyotanabe, Seika, Kizugawa, Hirakata, Shijonawate, Katano, Nara and Ikoma.	http://www.kri-p.jp/english/whats.html	130
Tsukuba Science City	Research and education centre	Tsukuba city in southwest Ibaraki Prefecture	www.nec.com/global/cases/**tsukuba**/pdf/catalogue.pdf	109
Yokosuka Research Park	Research centre	Yokosuka	http://www.yrp.co.jp/en/	52
Macquarie Park, Sydney	Research centre	Ryde	http://www.biotechnology.nsw.gov.au/sectors.aspx?sectorid=11&companyid=850	77
Atlantic Technology Corridor	ICT	Galway to Shannon (incorporating; Limerick, Ennis and Gort)	Ryan et al. (2003) Ryan et al. (2002)	320
ICT Cluster Dublin	ICT	Dublin	http://www.oecd.org/dataoecd/8/60/2754426.pdf	2 774
Dommel Valley Eindhoven	ICT and R&D centre	Eindhoven, Son en Breugel, Nuenen, Gerwen en Nederwetten, Geldrop-Mierlo, Heeze-Leende, Waalre, Veldhoven, Oirschot, Eersel e Best.	Hulsink (2003)	694
Amsterdam Alley	ICT	Amsterdam	http://www.economia.unimore.it/convegni_seminari/CG_sept03/Papers/Parallel%20Session%201.5-2.5/Hulsink_Bouwman_Elfring.pdf	2 586
Twente ICT Cluster	ICT	Enschede	Hulsink (2003)	330

Lisbon ICT Cluster	Media and Telecommunications	Lisbon	OECD questionnaire (2011)	1 194
Cluster Informationstechnologien Tirol	ICT	Innsbruck, Wien, Hopfgarten, Kitzbuhel,Polling, Oberperfuss, Landeck, Kematen, Hofen, Rum, Haiming, Navis, Inzing, Mils, Elimau	http://www.standort-tirol.at/page.cfm?vpath=cluster/mitgliederverzeichnis	573
GIS Cluster Salzburg	Geographic Information Science	Salzburg	http://www.giscluster.at/	192
Louvain Technology Corridor	ICT, Centre for Micro Electronics	Louvain	Hulsink (2003)	106
Silicon Valley of Mexico	Electronics	Jalisco, Guadalajara	Jorge Vieto y Lawrence Pratt, 1999	551
Brazilian Silicon Valley	Electronics and Software	Campinas, Florianopolis	Botelho et al. (2005)	2 422
Bangalore (Silicon Valley of India)	ICT	Bangalore	Basant (2006)	28
Information processing cluster	ICT	Madrid and Barcelona	Chaminade (1999)	3 659
Cap Digital Cluster	ICT	Paris	www.capdigital.com/	307
Bari ICT Cluster	ICT	Bari	Van Winden and Woetfs (2003)	106
Silicon Glen	ICT	Dundee, Inverclyde, Edinburgh, Fife, Glasgow, Stirling	Reid and Ujjual (2008)	143
Pervasive Computing Cluster	Digital Media and ICT	Aarhus	www.pervasive.dk/	989

REFERENCES

Asheim B.T. and Moodysson, J. (2008), "The Öresund region: A dynamic region in Europe due to inter-regional collaboration? ", *Working Papers On Line,* Autonomous University of Barcelona.

Athreye, S. (2004), "Agglomeration and Growth: A Study of the Cambridge Hi-Tech Cluster", in Bresnahan, T. and A. Gambardella (eds.), *Building High-Tech Clusters: Silicon Valley and Beyond*, Cambridge University Press, New York.

Audretsch, D. B. and M. Feldman, (1996), "Innovative Clusters and the Industry Life Cycle", *Review of Industrial Organisation*, n. 11, pp. 253-273.

Barinaga, E. and L. Ramfelt (2004), "Kista: The Two Sides of the Network Society" *Networks and Communication Studies*, 18 (3/4), pp. 225-244.

Basant, R. (2006), "Bangalore Cluster: Evolution, Growth and Challenges", *IIMA Working Papers WP2006-05-02*, Indian Institute of Management, Ahmadabad.

Becattini, G. (1990), "The Marshallian Industrial District as a Socio-economic Notion", in F. Pyke, G. Becattini, and W. Sengenberger (eds.), *Industrial Districts and Inter-firm Cooperation in Italy*, International Institute for Labour Studies, Geneva.

Belussi, F., A. Sammarra and R. Sedita (2008), *Industrial Districts Evolutionary Trajectories: Localized Learning Diversity and External Growth*", paper presented at the DRUID conference on "Entrepreneurship and Innovation: Organization, Institutions, Systems and Regions", Copenhagen, June 2008.

Botelho, A.J., G. Stefaunto and F. Veloso (2005), "The Brazilian Software Industry", in A. Arora and A. Gambardella, *From Underdogs to Tigers: The Rise and Growth of the Software Industry in Brazil, China, India, Ireland, and Israel*, Oxford University Press, Oxford.

Braczyk, H. J., P. Cooke and M. Heidenreich (1998), *Regional Innovation Systems*, UCL Press, London.

Bramwell, A., J. Nelles and D. Wolfe (2008), "Knowledge, Innovation and Institutions: Global and Local Dimensions of the ICT Cluster in Waterloo, Canada", *Regional Studies*, n. 42, pp. 1–16.

Budd, J.W., J. Konings and M.J. Slaughter, (2005), "Wages and International Rent Sharing in Multinational Firms", *Review of Economics and Statistics*.

Chaminade, C. (1999), "Innovation Processes and Knowledge Flows in the Information and Communications Technologies (ICT) cluster in Spain", in OECD, *Boosting Innovation: The Cluster Approach*, OECD Publishing, Paris.

Chen, Y. (2008), "Why do Multinational Corporations Locate their Advanced R&D Centres in Beijing", *Journal of Development Studies*, n. 44 (5), pp. 622-644.

Cooke, P. (2001), "Regional Innovation systems, Clusters, and the Knowledge Economy", *Industrial and Corporate Change*, n. 10, pp. 945–974.

Corolleur, F., V. Mangematin and A. Torre (2003), "French Biotech Start Ups and Biotech Clusters in France: The Importance of Geographic Proximity", in G. Fuchs and B. Luib (eds.), *Biotechnology in Comparative Perspective: Growth and Regional Concentration*, Routledge, London.

Dahl, M.S., C. Pedersen and B. Dalum (2003), "Entry by Spinoff in a High-tech Cluster", *DRUID Working Papers 03-11*, Copenhagen Business School.

Diniz, C.C. and M. Razavi (1995), "High Technology and New Industrial Areas in Brazil: the Development of Sao Jose dos Campos and Campinas Cities", CEDEPLAR, *Texto para Discussão no. 94*, UFMG – Regional Planning and Development Centre, Belo Horizonte.

Elbert, A., F. Muller and D.J. Persch, (2009), "ICT cluster", Technical University of Darmstadt, available at: http://www.hessen-it.de/mm/IKT-Studie-Kurzfassung_V4_eng_tcm16-53755.pdf

De Fonteney, B. and N. Carmel (2002), "Israel's Silicon Wadi: The Forces Behind Cluster Formation", *Berkley Business Review*, pp. 1-36.

Gassler, H. and J. Frohlich (1998), *The Regional Variation of New Technology-based Firms in Austria*, European Regional Science Association Conference Paper.

Giblin, M., R. Green, R. and M. Moroney (2002), *Atlantic Technology Corridor: Dynamics of Cluster Development in Ireland*, Irish Academy of Management Conference, Waterford.

Giblin, M. and L. Martinez-Solano (2003), *The Atlantic Technology Corridor: Problems and Prospects of Cluster Formation in Ireland*, paper presented at the Conference on Innovation in Europe , Roskilde, Denmark , May, 2003.

Giuliani E. (2005), "Cluster Absorptive Capacity: Why do Some Clusters Forge Ahead and Others Lag Behind", *European Urban and Regional Studies*, 12 (3), pp. 269-288.

Goldstein, A. (2002), "The Political Economy of High-Tech Industries in Developing Countries: Aerospace in Brazil, Indonesia and South Africa", *Cambridge Journal of Economics*, Oxford University Press, 26(4), pp. 521-538.

Harper, D., R. White, M. van Leeuwen, M. Holi, J. Lawton, Coffman, C., R. Franklin and E. Hugo (2007), *Looking Inwards, Reaching Outwards: The Cambridge Cluster Report*, Library House.

Häussler, C. and H. M. Zademach (2006), "Cluster Performance reconsidered: Structure, Linkages and Paths in the German Biotechnology Industry, 1996-2003", *Discussion Papers 188, SFB/TR 15 Governance and the Efficiency of Economic Systems*, Free University of Berlin.

Honkamakila, H. (2009), "Introducing New Regions: Oulu Region, Finland", in OECD Reviews of Higher Education in Regional and City development, Roundtable for Regions.

Helpman, E., Melitz, M.J, and Yeaple, S.R. (2004), "Export Versus FDI with Heterogeneous Firms," *American Economic Review*, Vol. 94, 300–316.

Hulsink, W., H. Bouwman, and T. Elfring (2007), "Silicon Valley in the Polder? Entrepreneurial Dynamics, Virtuous Clusters and Vicious Firms in the Netherlands and Flanders", *Research Paper ERS-2007-048-ORG,* Erasmus Research Institute of Management (ERIM), Rotterdam.

Jeong, J.H. and J.M Lee (2006), *Identifying Industrial Clusters in Korea*, Korea Institute for Industrial Economics and Trade (KIET), Seoul.

Kodama, T. (2004), *Cluster Promoting Initiatives in Japan*, presented at the OECD-EU Conference on "Innovation and Regional Development," November 2004, Florence.

Konings, J. and A. Murphy (2006), "Do Multinational Enterprises Relocate Employment to Low-Wage Regions? Evidence from European Multinationals", *Review of World Economics*, 142 (1): pp. 1–20.

Krugman, P. (1991), *Geography and Trade*. MIT Press, Cambridge, MA

Lambert, B. H. (2000), "Building Innovative Communities: Lessons from Japan's Science City Projects", *EIJS Working Paper Series107,*The European Institute of Japanese Studies.

Lee, J. (2003), "Development Strategies of Daedeok Valley: To build it as the R&D Hub of Northeast Asia", http://www.wtanet.org/english/referenceroom/dataBDList.mf?tableName=Eforum

Lorenzen, M. and M. Volker (2002), "Global Strategy and the Acquisition of Local Knowledge: How MNCs Enter Regional Knowledge Clusters", *DRUID Working Papers 02-08*, Copenhagen Business School.

Mets, T. (2005), "Innovation Paths of Estonian Biotechnology*", Tallinn School of Economics and Business Administration Working Paper n 131*, Tallinn.

Munn-Venn, T. and R. Voyer (2004), *Clusters of Opportunity, Clusters of Risk*, The Conference Board of Canada, Ottawa.

Mytelka, L.K. (2004), "Clustering, Long-distance Partnerships and the SME: a Study of the French Biotechnology Sector", *International Journal of Technology Management*, 27(8), pp. 791-808.

Nadvi K. and H. Schmitz (eds.) (1999), "Industrial Clusters in Developing Countries", *World Development*, 27 (9), pp. 1503-1734.

Niosi, J. and M. Zhegu, M. (2005), "Aerospace Clusters: Local or Global Knowledge Spillovers?", *Industry and Innovation*.

Norgall, T. (2010), "ICT Solutions for Enhanced Mobility of Elderly People – State of the Art Examples from the Nuremberg Metropolitan Region", Fraunhofer Institute Integrated Circuits, Brussels.

OECD (1999*), Boosting Innovation: The cluster Approach*, OECD Publishing, Paris.

OECD (2001), *Innovative Clusters: Drivers of National Innovation Systems*, OECD Publishing, Paris.

OECD (2004), *OECD Territorial Reviews: Montreal, Canada*, OECD Publishing, Paris.

OECD (2006), *OECD Territorial Reviews: Stockholm*, OECD Publishing, Paris.

OECD (2007), *Competitive Regional Clusters: National Policy Approaches*, OECD Publishing, Paris.

OECD (2007), *Staying Competitive in the Global Economy: Moving up the Value Chain*, OECD Publishing, Paris

OECD (2010), *SMEs, Entrepreneurship and Innovation*, OECD Publishing, Paris.

Onsager, K., A. Isaksen, M. Fraas, and T. Johnstad (2007), "Technology Cities in Norway: Innovation in Glocal Networks", *European Planning Studies*, 15(4), pp. 549-566

Oxfordshire bioscience cluster paper 2005, Oxfordshire bioscience network.

Patton, D. and M. Kenney (2009), "The University Research-Centric District in the USA", forthcoming in *Handbook of Industrial Districts*, Edward Elgar Publishing.

Piore M. and C. Sabel (1984), *The Second Industrial Divide*, Basic Books, New York.

Porter, M. E. (1990), *The Competitive Advantage of Nations*, Free Press, New York.

Porter, M.E. (1996), "What is Strategy", *Harvard Business Review*, Nov/Dec.

Porter, M.E. (1998), "Clusters and the New Economics of Competition", *Harvard Business Review*, 76:6

Porter, M.E. (2000), "Location, Competition, and Economic Development: Local Clusters in a Global Economy", *Economic Development Quarterly*, 14: pp. 15–34.

Porter, M.E. and J. Ramirez-Vallejo (2011), *The Minnesota Medical Devices Cluster*, Harvard Business School Publishing Corporation, Boston.

Potter, J. and Miranda, G. (2009), *Clusters, Innovation and Entrepreneurship*, OECD Publishing, Paris.

Pratt, L. and J. Vieto (1999), "Eco-Efficiency in a High-Tech Cluster: A meta Analysis of the Evolving High-tech Electronics Cluster Headed by Intel in Costa Rica" available at http://www.incae.edu/ES/clacds/publicaciones/pdf/cen703final.pdf

Procyshyn, T.L. (2004), "Saskatoon's Agricultural Biotechnology Cluster and the Canadian Light Source: An Assessment of the Potential for Cluster Extension", available at http://www.usask.ca/politic/phillips/pdfs/Procyshyn%20-%20Thesis.pdf.

Reid, G.C. and V. Ujjual (2008), "Firms in Scottish High Technology Clusters: Software, Life Sciences, Microelectronics, Optoelectronics and Digital Media – Preliminary Evidence and Analysis on Firm Size, Growth and Optimality", *CRIEFF Discussion Paper 0804*, Centre for Research into Industry, Enterprise, Finance and the Firm.

Teigland, R.., G. Lindqvist, A. Malmberg and A. Waxwell (2004), "Investigating the Uppsala Biotech Cluster", *CIND Research Paper 2004:1*, Centre for Research on Innovation and Industrial Dynamics, Uppsala University.

Teigland, R., D. Hallencreutz and P. Lundequist (2005), "Uppsala BIO – the Life Science Initiative Experiences of and Reflections on Starting a Regional Competitiveness Initiative", *CIND Research Paper 2005:3*, Centre for Research on Innovation and Industrial Dynamics, Uppsala University.

Roper, S. and S. Grimes (2003 or 2005), "Wireless Valley, Silicon Wadi and Digital Island: Helsinki, Tel Aviv and Dublin in the ICT Boom", *ERSA conference papers ersa03p62*, European Regional Science Association.

Rosenfeld, S. A. (1997), "Bringing Business Clusters into the Mainstream of Economic Development", *European Planning Studies*, n.5, pp. 3-21.

Saxenian, A. (1994), *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Harvard University Press, Boston.

Schabereiter, W., S. Prossnegg and T. Mrak,, (), "Report on Cluster in Styria: Especially Cross Border Activities of the Clusters" available at http://www.ebn-cbc.net/assets/clusters%20in%20styria%20sfg.pdf

Scott, A. (1996), "Regional Motors of the Global Economy", *Futures*, 28(5), pp. 391-411.

Teräs, J. (2008), *Regional Science-based Clusters: A Case Study of three European Concentrations*, Thesis from the Faculty of Technology of the University of Oulu, Finland.

Spilling, O.R. and J. Steinsli (2003), "Evolution of High-technology Clusters: Oslo and Trondheim in International Comparison", *Research Paper 1/2003*, BI Norwegian School of Management.

Stoerring, D. and J.L. Christensen (2008), "Clusterpreneurs – Promoting High-Tech Clusters in Low-Tech Regions", *Working Paper Series No. 12, 2008*, Aalborg University, Department of Business Studies.

Temouri, Y., N. Driffield and D. Higón (2008), "Analysis of Productivity Differences among Foreign and Domestic Firms: Evidence from Germany", *Review of World Economics*, pp.

Shavinina, L.V. (2004), "Silicon Valley North: a high-tech cluster of innovation and entrepreneurship", Elsevier.

Ter Wal, A. (2010), "Cluster Emergence and Network Evolution: A Longitudinal Analysis of the Inventor Network in Sophia-Antipolis", *Regional Studies*, 45, pp.

Tucson Economic Blueprint Strategic Analysis paper Section 6: Industry Cluster Analysis available at: http://www.treoaz.org/TREO/media/docs/Blueprint%20Analysis%20Section%206%20Industry%20Cluster%20Analysis.pdf

Wonglimpiyarat, J. (2006), "The Boston Route 128 Model of High-Tech Industry Development", *International Journal of Innovation Management*, 10(1), pp. 47-63.

Winden van, W. and P. Woets (2003), *Local Strategic Networks and Policies in European ICT Clusters: The cases of Amsterdam, Bari, Dublin and Oulu*, paper prepared for the 15th Annual Conference of the European Association for Evolutionary Political Economy, Maastricht, the Netherlands, 7-10 November 2003.

Wolfe, D. (2002), *Knowledge, Learning and Social Capital in Ontario's ICT Clusters*, Paper prepared for the Annual Meeting of the Canadian Political Science Association, 29-31 May 2002, Toronto.