Innovation system and knowledge-intensive entrepreneurship

Denmark

Timmermans, Bram

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Abstract	The goal of this deliverable is to investigate the properties and the nature of knowledge-intensive entrepreneurship as a largely distributed phenomenon at firm, sector and national levels in Denmark. Following the guidelines previously developed in the Deliverable 2.2.1 "Innovation systems and knowledge-intensive entrepreneurship: Analytical framework and guidelines for case study research" I will investigate the interplay between national innovation systems and knowledge-intensive entrepreneurship by focusing on two main sectors: machine tools, and computer and related activities.

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1 Introduction

Entrepreneurship is said to be an important driver of innovation and economic growth. Consequently, there is an interest in identifying those factors that support entrepreneurial activities and enhance the entrepreneurial propensities in the different national innovation systems.

In this deliverable, I investigate the degree of entrepreneurial activities and the overall entrepreneurial propensity in two industries in Denmark, i.e. Computer and Related Activities and Machine Tool Manufacturing. These sectors represent activities in two very different industry types as Computer and Related Activities and Machine Tool Manufacturing are active in respectively (knowledge intensive) services and (medium high-tech) manufacturing, the type of activities also indirectly influence the degree of entrepreneurial activities since services in general has a lower barrier of entry for starting up compared to manufacturing. In the former there is no need for large initial investments in machinery, i.e. for Computer and Related Activities the presence of a computer with the necessary software and an Internet connection is often enough to get started, while the latter requires investments in buildings and machinery. In the particular case of Denmark there are other distinctive features of these industries. First the importance of the industry is very different; Computer and Related Activities is a relative large industry and includes several thousands of firms and employing tens-of-thousands of workers. Furthermore, this industry has been identified as a cluster of competence and can rely on a national, regional, and local support infrastructure. The activities are clustered around the larger urban areas in Denmark, i.e. Copenhagen, Århus, Odense and Aalborg, which are each specialized in the type of IT activities they develop. Machine tool manufacturing on the other hand is very small, based on an official company register from 2011, 144 firms are reported to be active in this industry (a relative high share of these firms do not have employees), employing just a couple of thousand workers and cannot rely on a supportive frame compared to firms that lie within the realm of IT services.

To investigate the entrepreneurial propensity in the Danish Computer and Related Activities and Machine Tool Manufacturing, I apply a quantitative approach relying on a range of data sources, e.g. OECD STAN database, EUROSTAT, StatBank from Statistics Denmark, a company register maintained by NN Markedsdata that is based on information from the Danish central company register, and the Danish Integrated Database for Labour Market Research (IDA). Furthermore, I conducted an open semi-structured interview with different industry and firm representatives who could provide me with additional information on entrepreneurship in the National Innovation System of Denmark.

The overall structure of this document is as follows: Section 2 will provide some contextual information by presenting the characteristics of the Danish Innovation System and the innovative performance of this system. Afterwards, I will present additional information on the overall entrepreneurship policy and support system. In the section that follows, Section 3, I will present the entrepreneurial propensities in the two different industries.

2 KIE and NIS in Denmark

2.1 The Danish Innovation System

In the last couple of decades thorough investigations on the Danish National System of Innovation have been conducted (e.g., Edquist and Lundvall, 1993; Lundvall, 2002; Christensen et al, 2008). In this section, I will take my point of departure in these studies to describe the characteristics of the Danish Innovation System. Denmark is a small country with relatively high wages and, together with the other Scandinavian and some smaller northwest European countries, has one with the highest tax levels in the world. In comparison, the public sector is relatively large and the industry structure of Denmark can be characterized by the presence of a many SME's and just a few large firms (in Danish terms a large firm is characterized of having more than 250 employees). Traditionally, a relative high share of Danish value added in manufacturing an employment is found in low-tech industries. Furthermore, Denmark has a clear export specialization in low-tech products (Christensen et al. 2008).

But low-tech, which in this case is equivalent to low R&D intensity, is not equal to a low-knowledge intensity; on the contrary, as Smith (2005) indicates, low-tech often involves the acquisition of technology making it more knowledge intensive as initially believed. The same is true for low- and medium-tech industries in Denmark where *"production is based upon extensive resources, including rapid diffusion of new technologies and frequent incremental product innovation that combines a high level of competence in industrial design with advanced organizational techniques and marketing methods. The innovations often reflect interaction between skilled labour, engineers, and marketing people"* (Lundvall, 2009).

Table 1: Cluster of Competence

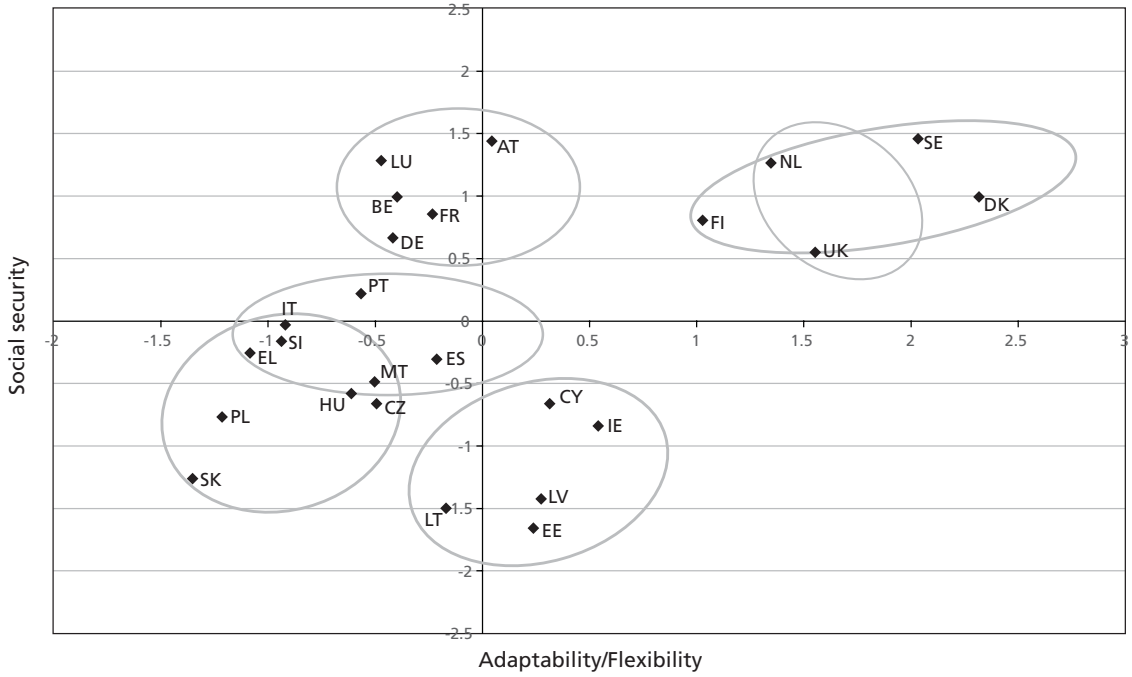
National	Regional
Existing Cluster of Competence	
Thermal technology	Mobile/satellite communication in Northern
Technical appliances for disabled	Jutland
Pork meat	Business Tourism in the metropolitan area
Dairy products	Stainless steel in Eastern Jutland
Water environment	Horticulture at Funen
Fur	Healthcare in the Øresund region
Seed-growing	Textiles/clothing in Herning-Ikast
Power electronics	Offshore industry in Esbjerg
Hearing aids	Furniture in Salling
Wind technology	Transport in Eastern-Southern Jutland
Maritime industry	
Emerging Cluster of Competence	
Organic food	Movies/TV-production in Copenhagen
Children's play & learning	Øresund Food Network
Waste management	PR/Communication in Copenhagen
Sensor technology	Pervasive Computing in Copenhagen and Aarhus
Bio-informatics	

Note: These are the clusters of competence identified in 2001.
Source: Christensen et al. (2008)

Changes are, however, underway as the importance of the low-tech sector has slightly decreased in the last couple of years. The relative decrease in the share of value added, employment and exports could be explained by the better positioning of high-tech areas, in particular pharmaceutical and medical equipment, which have come forward as two important Danish clusters of competence (see Table 1). In addition, the 'creative industries', which also include software, make up for a substantial and increasing share of the Danish economy and are targeted as upcoming clusters of competence (Christensen et al., 2008).

Overall, Denmark has for several decades been able to adjust to changing international markets and remained competitive, often hailed as an example small and high-income economies. Which has been primarily attributed to two interdependent factors (Lundvall, 2002; Christensen et al 2008). First, the Danish welfare state model, which over time, due to interaction between state, trade unions, and employers has created flexibility for employers to hire and fire workers combined with a relatively high degree of income security, better known as *flexicurity*. The level of flexicurity is one of the highest, together with Sweden, within Europe (see Figure 1). Second, the mode of innovation, where the dominant SME's make incremental innovation is based on learning by doing, using, and interacting, mainly with customers and suppliers. However, due to recent developments these pillars experienced increase pressure. First, neoliberal tendencies that are seen throughout entire Europe put pressure on the social cohesion model. Second there is a change in the international division of labour due to globalization, which leads to changes in the mode of innovation (Christensen et al. 2008; Lundvall 2009).

Figure 1: Adaptability/flexibility versus social security in EU Member States



Source: Philips and Eamets (2007)

The Danish economic uprising in the last years has come to a halt. Nowadays, studies claim the presence of a Danish productivity paradox (Ministry of Economics and Business Affairs, 2009). This paradox lies in the overall improvement of framework conditions that should promote productivity while economic growth in Denmark for the period 1995-2008 has been much lower compared to other OECD countries, i.e. hourly productivity has, on average, increased with 1.1 percent while economic growth has only increased by 0.5 percent on an

average annual basis. Out of all OECD countries, only Italy had a productivity development that was worse (Ministry of Economics and Business Affairs, 2009). Part of this explanation is the business cycle and the financial crisis in which Denmark found itself in 2008; however, the productivity growth was already low before the start of the crisis and the long period of low productivity growth indicates a structural problem. One potential issue raised in the report by the Danish Ministry of Economics and Business Affairs (2009) is that the increase in capital could not keep up with the increase in labour, which also resulted in the low level of unemployment. Furthermore, which this report also mentions, is that the low level of unemployment has also resulted that people entered the labour market who where not well equipped to function accordingly, which lead to lower levels of productivity growth.

Not only productivity development has stagnated, also Denmark's innovation performance the Danish position has worsened as well. The share of turnover from new-to-the-firm and new-to-the-market innovation has according to the latest Community innovation survey (CIS4) been relatively low, only 10 percent compared to, e.g., Finland and Sweden with more than 15 percent. A new survey is on its way and here the level of innovation has decreased even more.[1] In addition, for these countries the share of turnover on new-to-the-market innovations exceeds the ten percent. Furthermore, even though business R&D expenditures have increased in the last couple of years, firms are lagging behind when measuring expenditures on innovation as share of turnover, especially the large ones (OECD, 2010).

Nevertheless In the recent Innovation Union Scoreboard (Pro Inno Europe, 2011), Denmark is still considered to be one of the innovation leaders, occupying the 2nd position in EU27[2] just behind Sweden, overall in Europe Denmark occupies the 3rd place since Switzerland is on the first place. Innovation performance is well above EU27 average on most of the dimensions listed in Figure 10, which says more about the European innovation challenge in general than it does over the individual performance of Denmark. What remains disturbing are the low and negative growth rates on almost all of these dimensions (see Figure 11), which will most likely lead to a worsening in innovation performance in the nearby future. However, these lower growth trends have been visible in the Trendchart reports of 2007-2009 (Pro Inno Europe, 2008, 2009, 2010) while Denmark has not fallen lower on the IUS ranking.

Figure 2 illustrates the innovation performance on the different innovation indictors for 2010. Compared to the EU 27 average, Denmark is an above average performer with relative strengths in providing open, excellent and attractive research systems, on linkages and entrepreneurship, and intellectual asset. Denmark underperforms on topics as Finance and Support, particular venture capital and innovators and output compared to the EU 27 average.

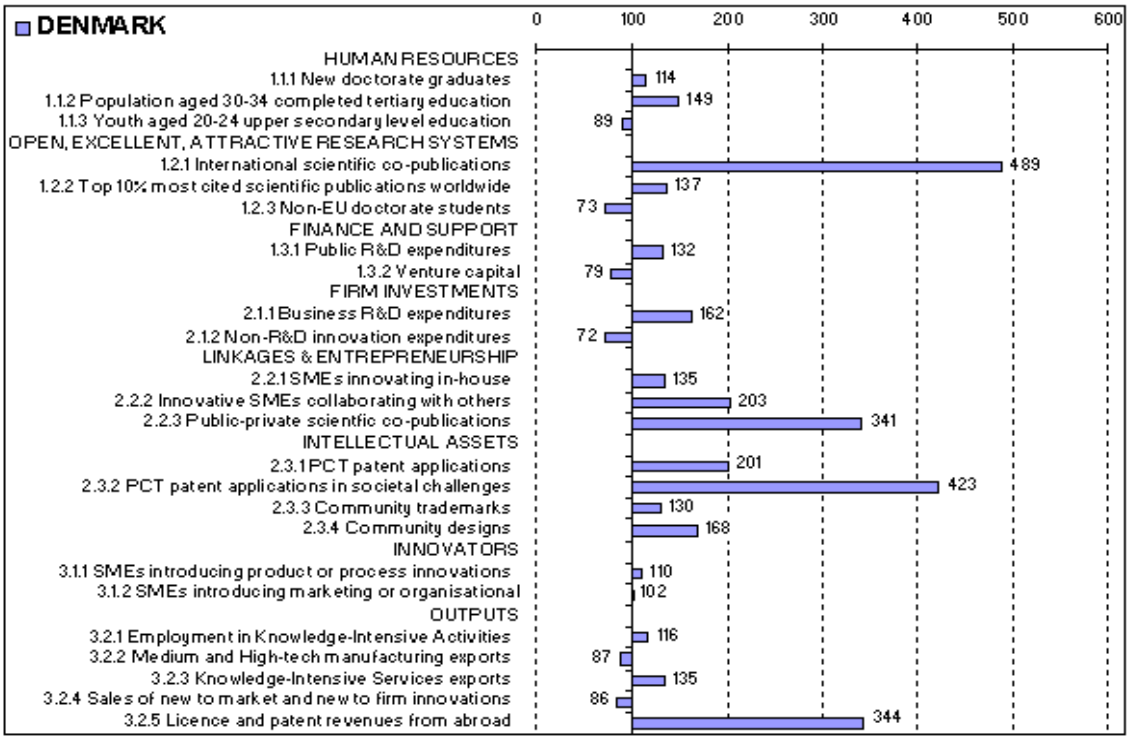
Figure 3 Figure 3 presents the growth in the various indicators. In general, Denmark is considered to be a slow grower (Pro Inno Europe (2011), which it has been for the last couple of years. The factors that experience the strongest decline are economic effects, which are predominantly caused by a decrease in sale of new-to-the-market and new-to-the-firm

[1] One has to note that in the new survey firms were obliged to answer. In the previous survey there is a response bias towards innovative firms. Experiences with the Norwegian CIS, where answering was obligatory in earlier version, show that non-innovative firms are less diligent. Non-innovative firms are inclined not to return the questionnaire but now they have to in order to avoid receiving a fine. From a Norwegian perspective, this might partly explain the systematically lower ranking compared to other Scandinavian countries.

[2] Other innovation leaders who are mentioned in the European Innovation Scoreboard 2009 are: Germany, the United Kingdom, Sweden, and Finland

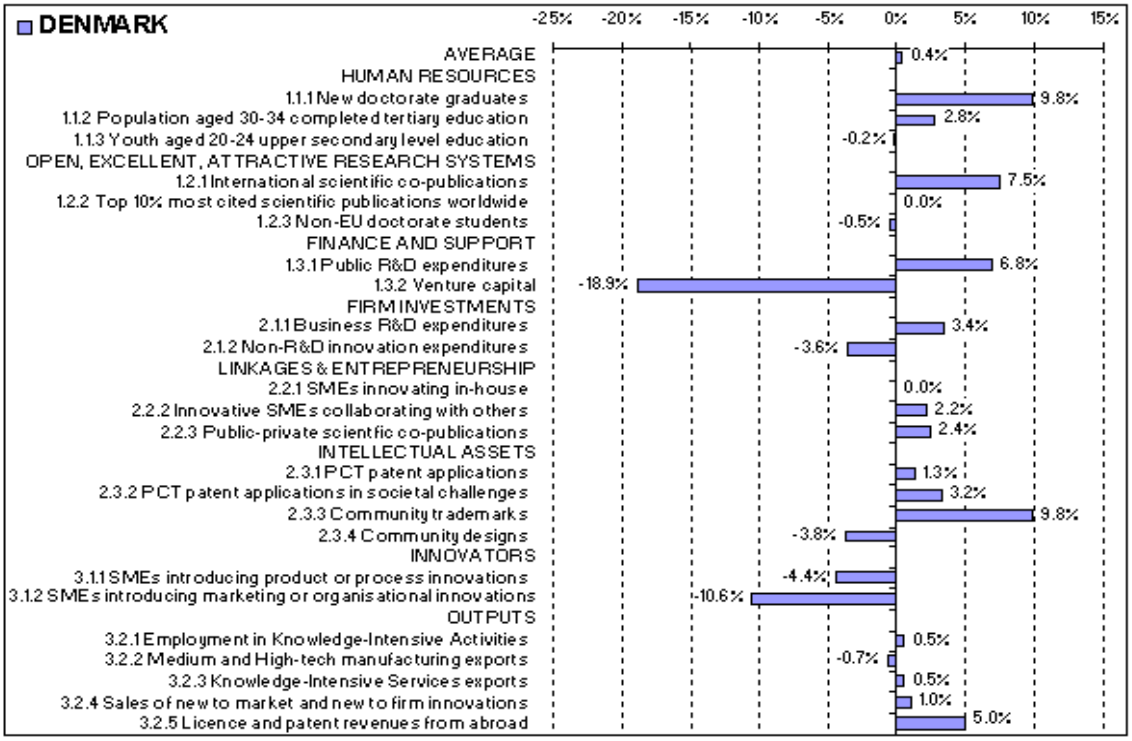
products, and innovators, which is a decrease in product and process innovators. There are important challenges ahead for Denmark to remain one of the world's innovation leaders. These challenges do not lie only in improving technological innovation. According to data from the Community Innovation Survey, Denmark is also falling behind in creating non-technological innovation compared to the leading innovators (Christensen et al. 2008).

Figure 2: Relative innovation performance per indicator in 2010 (index 100=EU27 average)



Source: Pro Inno Europe (2011)

Figure 3: Annual average growth per indicator in 2010



Source: Pro Inno Europe (2011)

2.1.2 Actors in the Danish Innovation System

There are a broad number of actors active in the Danish national innovation system. The private sector is responsible for the lion's share of R&D and innovation. The firms in this private sector can, as mentioned in the previous section, are mainly SMEs and are characterized for being active in sectors that are low tech and export oriented; however, there can be observed a shift towards more high-tech types of activities (also in traditional low tech industries). In addition to the large share of SME there are several large multinational firms that have their roots in Denmark. These firms are active in a broad range of activities offering products varying from shipping to textile and from the manufacturing of toys to pharmaceuticals. Nevertheless, the manufacturing industry as a whole is losing ground and services are on the increase, partly because of the closing down of manufacturing activities but also partly due to the relocation of manufacturing activities abroad. As a result of this relocation firms might not be regarded any longer as manufacturing firm but as, e.g., wholesaler or industrial designers.

In addition to the private sector, the Danish economy is characterized by a large public sector. This public sector have initiated a range of activities that are focused on creating an environment that supports innovation in general but also entrepreneurship in particular. Nevertheless, investments in R&D have been lagging behind compared to what was formulated in the Barcelona agreement but in 2009 there can be observed a significant increase. For that reason, Denmark managed in 2009 to have investments in R&D that were three percent of GDP.

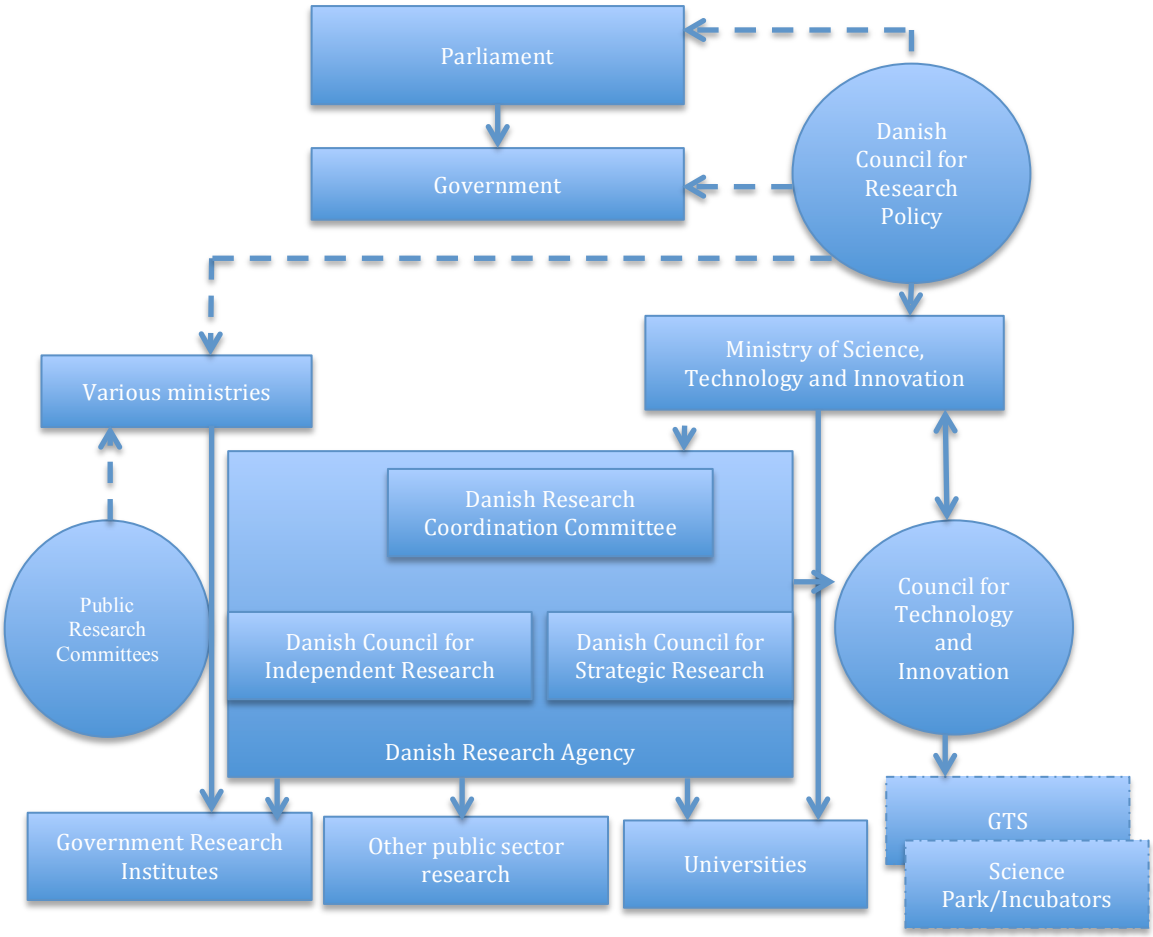
To coordinate the various science, technology and innovation initiative, which have been very fragmented in the Danish economy, the Danish government has founded the Ministry of Science, Technology and Innovation in the year 2001. This ministry took over the responsibilities for universities from the Ministry of Education and the responsibility for innovation and high-tech business development from the Ministry of Economics and Business Affairs. Furthermore, this Ministry takes has a coordinating role in innovation policy (Pro Inno Europe, 2007). The Ministry of Science, Technology and Innovation has founded the

Danish Agency for Science, Technology and Innovation in 2006. This agency is responsible for interaction between the various actors, i.e. knowledge institutes and industry but also with international research and innovation partnerships. In this role they are responsible of several important initiatives (some initiatives work better than others) to promote these linkages (Ministry of Economics and Business Affairs 2010; Christensen 2011), e.g.:

- Industrial PhD program;
- Innovation consortia program (large business-research collaboration programs);
- Strategic high Technology Projects;
- Strategic High Technology Platforms;
- Innovation Voucher Scheme;
- Proof of Concept program for Universities; and
- Innovation assistant scheme (support for hiring the first employee with an academic degree) in SMEs.

In Figure 4, the organizational chart of the national innovation government system from 2007, this ministry has a central role acting as the intermediate between parliament, government, and the council for research policy, who defines the policy objectives, and the various executive bodies.

Figure 4: Organization Chart of the National Innovation Governance System



Source: adapted from Pro Inno Europe (2007)

Even thought the Ministry of Science, Technology and Innovation has the main task of coordinating innovation policy and has the responsibility of high-tech, innovation and universities, other ministries remain responsible for smaller innovation policy initiatives. The ministries that are to a high extent responsible for these initiatives are (Ministry of Economics and Business Affairs, 2010; Christensen 2011),

- Ministry of Economic and Business Affairs;
- Ministry of Foreign Affairs;
- Minister of Food, Agriculture and Fisheries;
- Ministry of Environment
- Ministry of Climate and Energy; and
- Ministry of Finance.

In addition to the various ministries a list of other actors can be identified that play an important role within the Danish innovation system. First, there are various universities and research institutes in the Danish system, which are responsible for research and teaching. The Danish University and Property Agency, which is another agency under the Ministry of Science, Technology, and Innovation, is engaged in creating an exciting and attractive education and research environment and deal with analysis, legislation, administration, and policy development for the universities, the various study programs and PhD education.[3] The most relevant universities within the Danish innovation system are:

- Copenhagen University;
- Aarhus University;
- University of Southern Denmark;
- Roskilde University;
- Aalborg University;
- Technical University of Denmark;
- Copenhagen Business School; and
- IT University of Copenhagen.

In addition to these universities, there are a couple of dozen national and sector research institutes that are responsible for research in the field of, e.g., nanotech, cleantech, IT, food, health, space, construction, and others. These research institutes are all state-owned independent research institutes that operate under the various Danish ministries. It is again the Ministry of Science, Technology and Innovation, often in consulting the Strategic Research Council to establish or abolish these research centers.

Second, there are the different GTS institutes, which stand for “Approved Technological Institutes”. These institutes are currently a total of nine independent not-for-profit organizations that have the purpose of transferring and disseminating technical know-how and knowledge to industry and society. The goal is to create and increase development. The Ministry of Science, Technology, and Innovation provides this sign of approval for a period

[3] www.ubst.dk

of three years based on an assessment of their technological, professional, and financial performance including organizational solidity. These institutes are independent from political or economic interests and that any profit is reinvested in research and development. Some of these GTS also administer various incubator environments and science parks. The different GTS institutes are:[4]

- Agrotech;
- Alexandra Institute;
- Bioneer;
- DBI (Danish Institute of Fire and Security Technology);
- DELTA (Danish Electronics, Light and Acoustics);
- DFM (Danish Institute of Fundamental Metrology);
- DHI;
- FORCE Technology; and
- Danish Technological Institute.

Funding for innovation and support for R&D activities is an important issue within. Mainly the lack of these activities in the Danish context is an area of concern. Nevertheless, within the public domain there are a number of relevant funding bodies from where the various actors, i.e. firms, universities, and research centers, can apply for funding. These funding bodies are:

- Danish Council for Technology and Innovation;
- National High Technology Foundation;
- The Strategic Research Council;
- Program for Energy Development and Demonstration;
- Program for Green Development and Demonstration;
- Fond for Renewal of Small Business; and
- six Regional Growth Fora.

In addition to these national actors there is a system of regional and local growth houses. These houses are meant as a portal for entrepreneurs and growth business where they can receive support and advice from experts. These growth houses are spread out over the entire country with the head offices based on the level of regions. Finally, there are a number of national cluster and network organizations that are established in those areas where Denmark has a strong level of competence, e.g., in those sectors descripted in Table 1.

2.1.3 Main Activities that Influence Innovation

The focus on actors is one approach to investigate innovation systems. The other approach is an activity-based approach towards Innovation System, i.e. that what happens within the system. Edquist (2005) identified ten activities, which are divided in four thematic areas, i.e. provision of knowledge inputs to the innovation process, demand side activities, provision of

[4] www.teknologiportalen.dk

constituents of SI, and support services for innovative firms. This list of activities, which are presented in Box 1, have been used in many occasions, including the various chapters in Edquist and Hommen (2008), which investigates the Innovation System of small countries, also Denmark (Christensen et al. 2008). Radosevic et al. (2011) argue that these activities can provide an indicator for the entrepreneurial propensities in a system. These activities are used later on in this document to identify the entrepreneurial propensities in the two industries under investigation in this document. A short overview of how Denmark performs on a range of innovation indicators has been presented in Section 2.1 when describing the Danish innovation system. In this section, and as done by Christensen et al. (2008), I provide a more detailed description on all the activities that influence innovation in the Danish innovation system; nevertheless, these activities will be used to characterize the Danish Innovation System.

Box 1:Key Activities in Systems of Innovation

I. Provision of knowledge inputs to the innovation process
1. Provision of R&D and, thus, creation of new knowledge, primarily in engineering, medicine and natural sciences.
2. Competence building, e.g. through individual learning (educating and training the labor force for innovation and R&D activities) and organizational learning.

II. Demand-side activities
3. Formation of new product markets.
4. Articulation of quality requirements emanating from the demand side with regard to new products.

III. Provision of constituents for Sis
5. Creating and changing organizations needed for developing new fields of innovation. Examples include enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms; and creating new research organizations, policy agencies, etc.
6. Networking through markets and other mechanisms, including interactive learning among different organizations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.
7. Creating and changing institutions e.g., patent laws, tax laws, environment and safety regulations, R&D investment routines, cultural norms, etc. that influence innovating organizations and innovation processes by providing incentives for and removing obstacles to innovation.

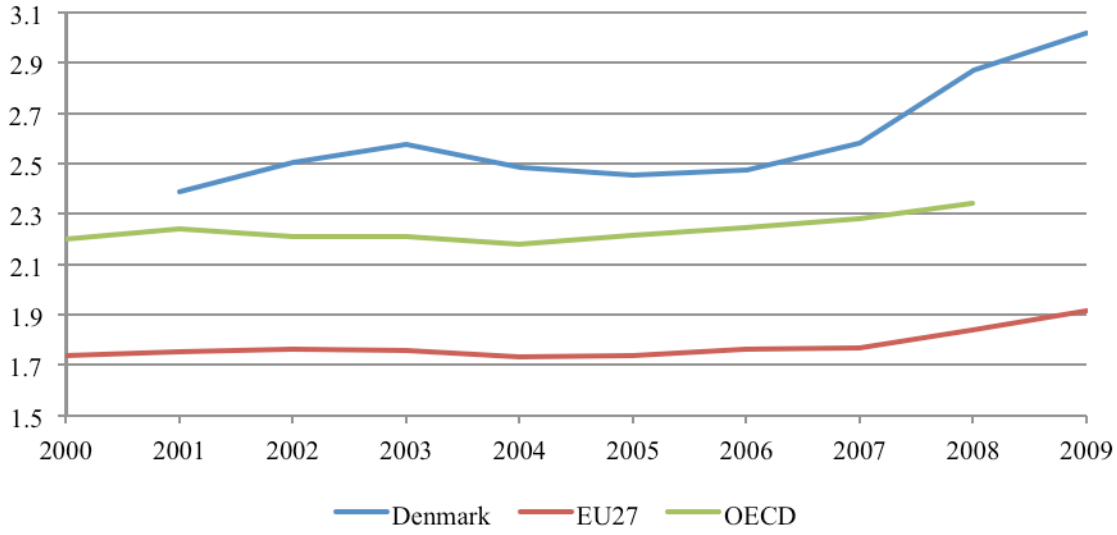
IV. Support services for innovating firms
8. Incubation activities such as providing access to facilities and administrative support for innovating efforts.
9. Financing of innovation processes and other activities that may facilitate commercialisation of knowledge and its adoption.
10. Provision of consultancy services relevant for innovation processes, e.g., technology transfer, commercial information, and legal advice.

Source: Edquist (2005)

In terms of provision of knowledge inputs to the innovation process, i.e. R&D and competence building, there can be observed a steady increase in R&D expenditures (OECD, 2010). This increase has, as can been seen in Figure 5 resulted in a slight increase in the R&D expenditures as a proportion of GDP. With this increase, Denmark has surpassed the 3

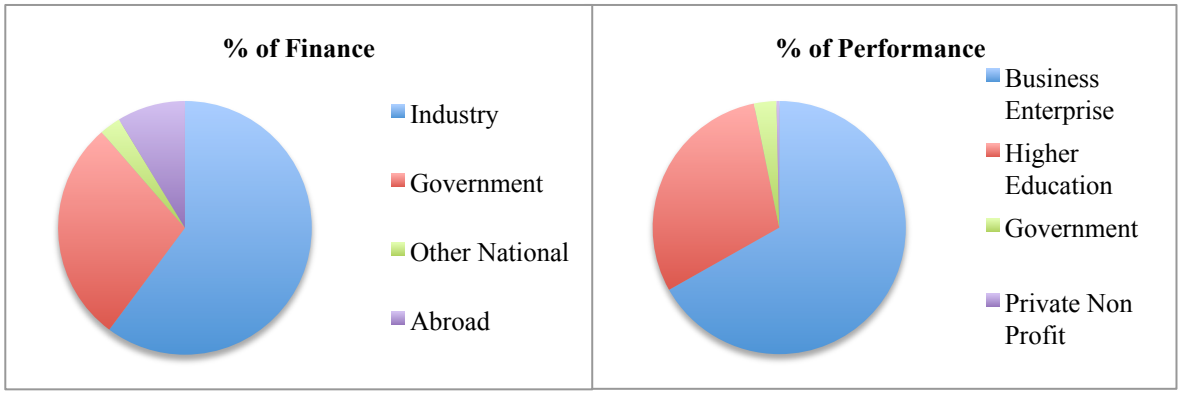
percent of GDP as required in the Barcelona agreement in 2009. The position of Denmark remains strong and exceeds EU27 and OECD average. Internationally, only Sweden, Finland and Switzerland exceed Denmark in the overall investments in R&D. The expenditure levels are well above the OECD and EU27 average but still below Sweden and Finland who are in the European and global forefront. Furthermore, this increase is partly caused by (i) the decrease in GDP as a results of the recent financial crisis and (ii) a slight alteration in the way by which R&D expenditures are measured.

Figure 5: R&D Expenditures as a Percentage of GDP



Source: OECD (2011)

Figure 6: Percentage of finance and performance of R&D

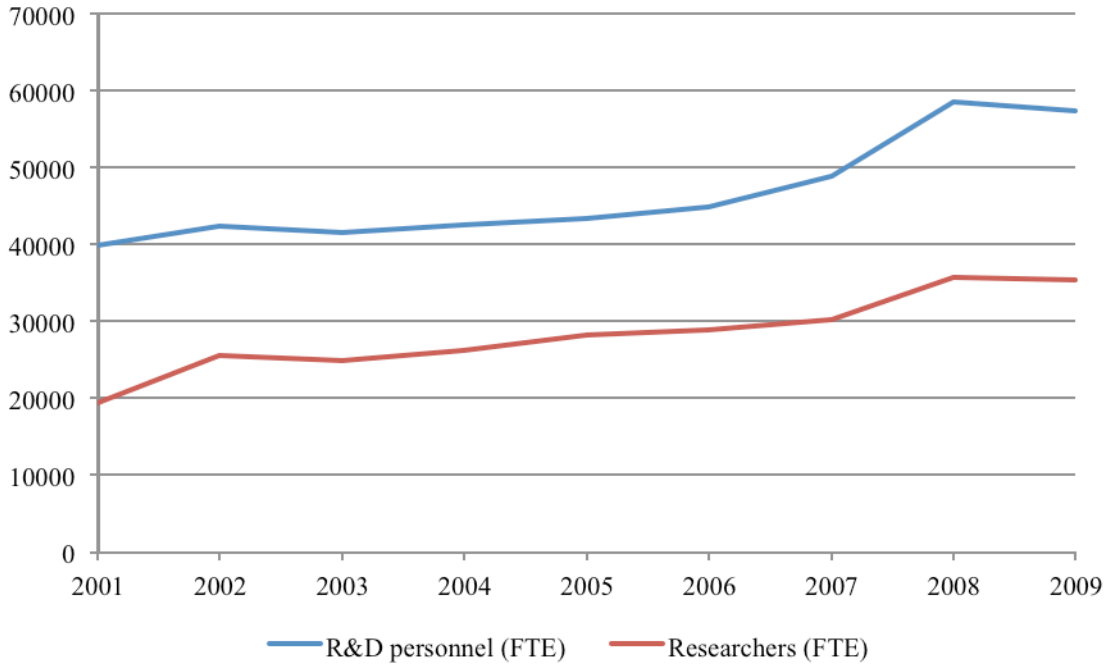


Source: OECD (2011)

As shown in Figure 6, the private sector contributes the lion's share of R&D finance and performance. In 2009 this level of performance was 2 percent of GDP, which is on the level set in the Barcelona agreement (OECD, 2010). Public expenditures, which include government and expenditures and expenditures by higher education, have after a number of years of stagnation significantly increased to the required one percent where the vast majority are higher education expenditures in R&D (HERD). Denmark had in 2009 one of the highest level of investments (in percentage of GDP), even higher compared to Sweden, Finland and Switzerland.

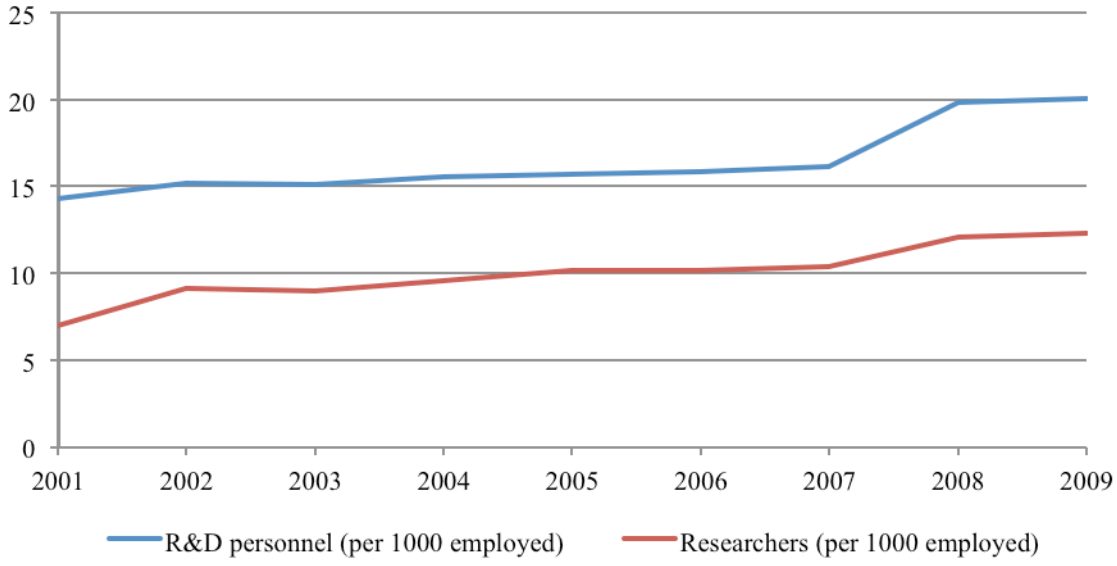
Since in practice 50 percent of the investments in R&D are spend in wages for R&D personell and researchers (Hall and Lerner 2010) I will present in more detail the change in this particular work force. Over the period 2004-2008 Denmark experienced an absolute (see Figure 7) and relative (se Figure 8) increase in the number of R&D and research personnel. Part of this increase might be explained by the increase in the share of population with a tertiary education, which will be described in the next section. Despite the increase in the number of researchers and R&D personnel Denmark is lagging behind compared to the leading European economies, i.e. Finland and Sweden.

Figure 7: R&D Personnel and Researchers (FTE)



Source: OECD (2010)

Figure 8: Total R&D personnel and researchers in thousands of total employment



Source: OECD (2010)

Only focusing on investments in R&D and the number of researchers and R&D personnel has a very strong science, technology, and innovation modes of learning (STI) rather than doing using and interacting modes of learning (DUI). The former approach is much easier to measure and manipulate and is more formalized, explicit and codified. The experience mode of learning, which is a crucial to successful innovation, is more embedded and embodied knowledge and for that reason much more difficult to measure and manipulate (Jensen et al. 2007). Jensen et al. (2007) created an indicator for these two types of learning within organization and based on these findings characterize Danish firms as more DUI or STI learning but that many firms that have an STI learning strategy have elements related to DUI learning. In Table 2 the probability that a Danish firm given a set of characteristics is characterized by a particular practise or policy is presented. The DUI/STI cluster provides an indication that a firm is characterized of having a DUI/STI practise and/ or policy. As observed in the table, the presence of these learning strategies is very depending on size and industry class. Co-existing of these two types of learning is crucial as firms that incorporate both learning strategies appear to have a higher likelihood to innovate.

Table 2: DUI and STI modes of learning in Danish Firms

Variables	Low learning cluster	STI cluster	DUI cluster	DUI/STI cluster	*N*
Less than 50 employee	0.5605	0.0855	0.2566	0.0973	339
50-99 employees	0.3314	0.1775	0.3018	0.1893	169
100 or more employees	0.2457	0.1257	0.2686	0.3600	175
Manufacturing, high tech	0.2231	0.2645	0.2314	0.2810	121
Manufacturing, low tech	0.3522	0.1321	0.2893	0.2264	159
Construction	0.6139	0.0495	0.2574	0.0792	101
Trade	0.5780	0.0462	0.3064	0.0694	173
Business service	0.2727	0.0909	0.2576	0.3788	66
Ohter services	0.6512	0.0465	0.2791	0.233	43
Danish group	0.4073	0.1371	0.2460	0.2097	248
Foreign group	0.2903	0.1694	0.2903	0.2500	124
Single firm	0.4890	0.0789	0.2776	0.1546	317
Standard product	0.3574	0.1687	0.2851	0.1888	249
Customized product	0.4518	0.0871	0.2673	0.1976	425
All firms	0.4249	0.1171	0.2673	0.1908	692

The conditional probabilities for belonging to each cluster given that a firm has implemented a particular set of practices/policies can be calculated from the latent class model. Based on this, we assign each firm to the cluster having the highest conditional probability.

Source: Jensen et al (2007).

Furthermore, the modes of learning are closely linked to the way work is organized. Studies have investigated the link between the proportion of creative workers in a set of European firms and how this impacts the likelihood of these firms to engage in innovation (Lorenz and Lundvall, 2011). Holm et al (2010) already linked this difference to different ways of labour market organization. As discussed in the deliverable discussing the Swedish innovation system (Zabala, 2011), Denmark and the other Nordic countries are those countries that appear to have a higher proportion of firms with creative workers (see Table 3). This is

relevant since the proportion of creative workers seem to be positively correlated with the innovation performance of firms.

Table 3: Organization of Work in EU27

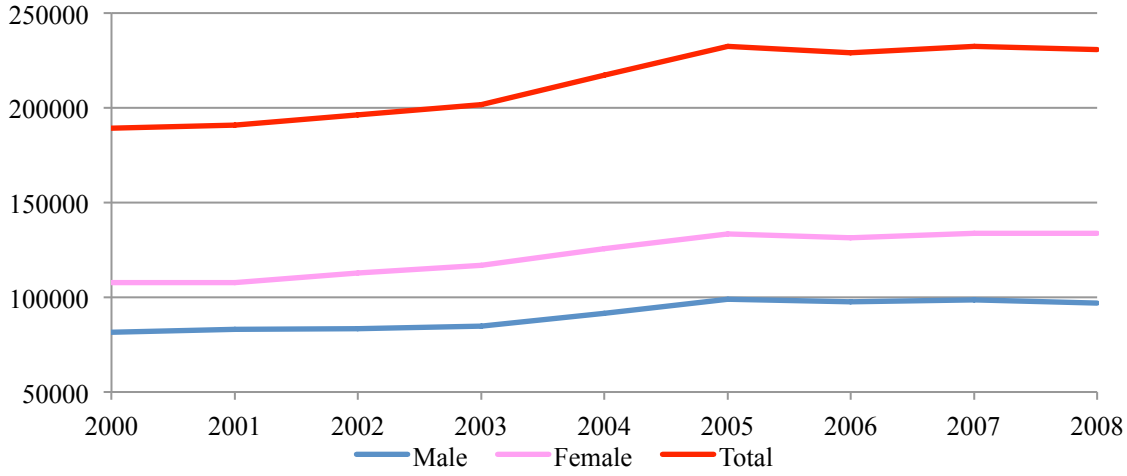
	Creative workers	Constrained problem solvers	Taylorized work	Total
Belgium	60	21	19	100
Czech Republic	40	30	30	100
Denmark	70	15	14	100
Germany	52	23	26	100
Estonia	58	22	20	100
Greece	39	33	28	100
Spain	35	30	36	100
France	63	18	19	100
Ireland	58	18	24	100
Italy	37	29	34	100
Cyprus	42	26	32	100
Latvia	53	19	27	100
Lithuania	35	27	38	100
Luxembourg	60	20	20	100
Hungary	44	31	25	100
Malta	70	14	16	100
Netherlands	67	16	16	100
Austria	50	28	23	100
Poland	43	34	23	100
Portugal	46	24	29	100
Slovenia	50	25	25	100
Slovakia	33	32	35	100
Finland	66	21	13	100
Sweden	82	10	8	100
United Kingdom	51	22	27	100
Bulgaria	39	30	31	100
Romania	35	38	27	100
EU27	51	24	25	100

Source: Lorenz and Lundvall (2011).

In terms of competence building through education and training, Denmark is one of the countries with the highest level of investments in education. When measured in relation to GDP, reports of 2006 show that they are ranked second behind Iceland with approximately 8 percent of GDP (OECD, 2009a). These investments seem to have their positive impact on the

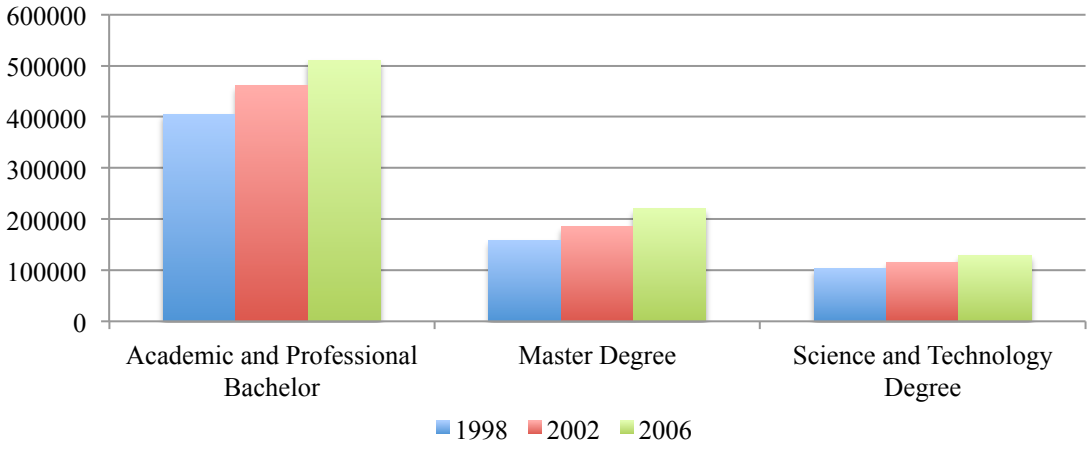
overall level of education. Our primary interest is, however, tertiary level of education and here I observe an increase in the number of students that participate on this level, where more women are enrolled compared to men (see Figure 9). The number of people in the population with an academic degree, both academic and professional bachelor and master has steadily increased, an increase that is also visible in the number of people with a science and technology degree (see Figure 10). Both increasing trends appear to have continued for the following years. The same positive trends are visible in the number of PhD graduates. The number has increased on all scientific disciplines; medical sciences have even doubled the number of PhD graduated in the last 15 year (see Figure 11).

Figure 9: Students enrolled in tertiary education



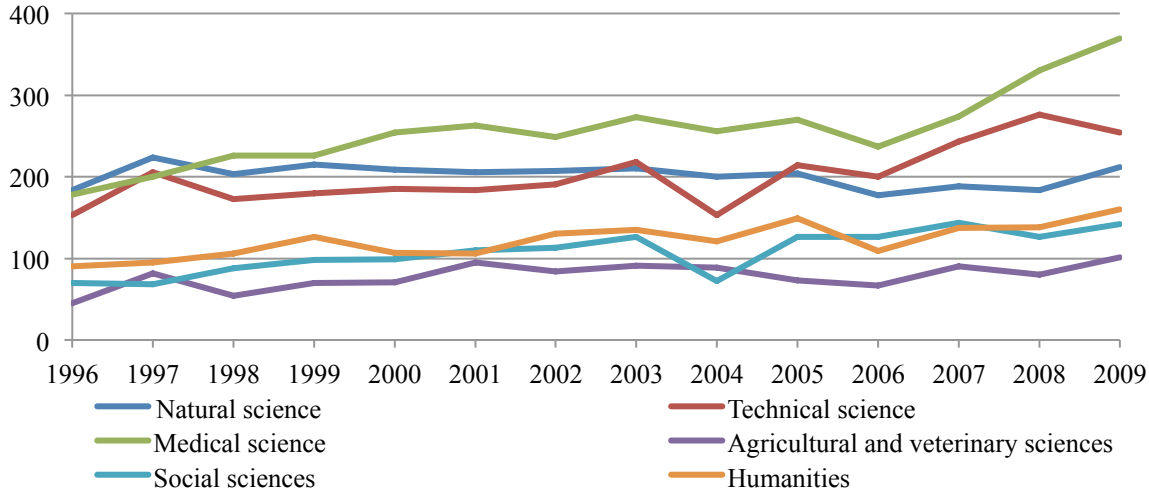
Source: OECD

Figure 10: Educational attainment of the population



Source: Statistics Denmark

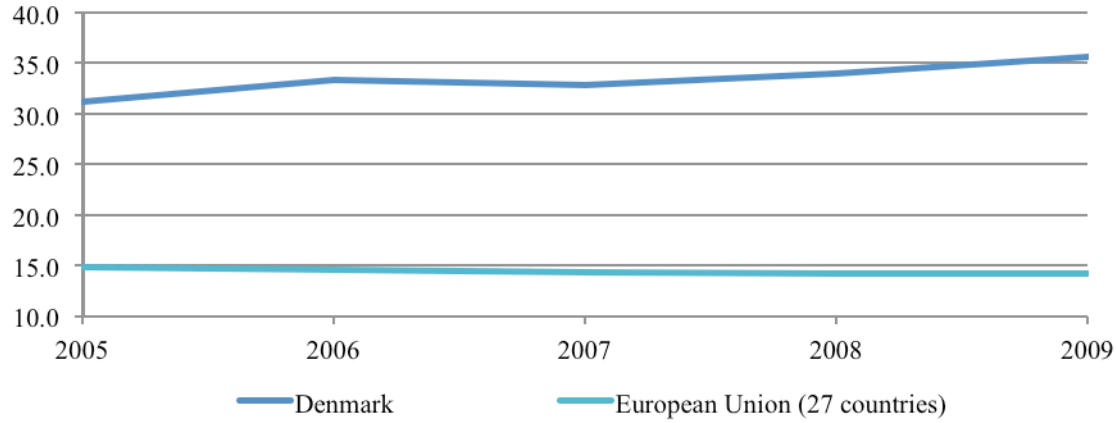
Figure 11: PhD Graduates by Scientific Discipline



Source: StatBank Statisics Denmark

Furthermore, Denmark has a long-standing tradition in adult education and training with a very high percentage of the Danish population involved in lifelong learning (Christensen et al. 2008). Compared to the EU27, but also the other Nordic countries, Denmark scores considerable higher in the share of the adult population that participates in some form of life-long learning (see Figure 12). This lifelong learning comes also forward in the education activities that are being offered by firms (see Table 2). A remarkable large share of these enterprises offers courses to their employees, courses they offer both internally but also to courses offered by external partners. Investments happen in firms of all sizes although, not surprisingly, larger firms offer more.

Figure 12: share of the population in the age 18-69 that participate in life long learning



Source: Eurostat

Table 4: Continuing Education in Enterprise in 2005 (in percent)

	Enterprises total	10-49	50-249	250+
Enterprises with courses	81	78	91	98
No continuing education	15	17	4	1
Enterprises with external courses	78	76	82	97
Enterprises with internal courses	52	46	72	90

Enterprises with other continuing education	61	57	76	97
On the job training	30	23	51	89
Job rotation	14	10	23	52
Learning circles	25	20	40	72
E-leaning	19	15	30	66
Conferences	53	48	66	90

Source: Statistics Denmark

With regards to demand-side factors, both the CIS but also the DISKO4[5] have shown that clients and customers are important partners in the innovation process of firms, i.e. close to 90 percent of firms that participated in DISKO4 have stated that they in some extent cooperated with customers. The domestic market functions as a testing ground for new products. Furthermore, the role of public procurement, regulation and advanced public demand has been an important driver in the creation of novelty and contributed to the establishment of several clusters of competence in Denmark, in particular the windmill and hearing aid industry (Christensen et al., 2008).

A main component of provision of constituents of SI is entrepreneurship. Denmark is often said to be not very entrepreneurial but recent figures show otherwise, more on entrepreneurship in the Danish Innovation System will be discussed in the next section. The majority of Danish innovative firms collaborate with external partners, much more with customers and supplier than with university and other knowledge providers, although the collaboration with these external partners is increasing. This development, in combination with the increase in private R&D investments and science and engineering graduates might point to a change in the mode of innovation, where there is more focus on science and technology.

Support services for innovating firms have changed over the years. Incubating activities, which are important to stimulate entrepreneurship in predominantly high-tech and knowledge-intensive business areas have been on the rise. The availability of venture capital has improved over the years. These funds are, however, mainly government supported venture capital funds and work in close collaboration with the above-mentioned incubator environments. For that reason, experts state contradicting claims on the level and accessibility of venture capital finance in Denmark. The provision of consultancy services has the main function of acting as a bridge between the various research organization and firms. Just as in many other countries, the knowledge intensive service sector went through a rapid growth and plays an increasing role in private R&D investments. This sector is also more connected to universities and knowledge institutes than those firms in manufacturing industries.

2.1.4 Opportunities

Out from the different activities discussed above, I will move into a discussion of opportunities, in particular entrepreneurial opportunities that arise from the system. The

[5] DISKO4 is a questionnaire based innovation survey collected in 2006 focusing on organizational and technical change in more than 1,600 Danish manufacturing and service firms in the period 2003-05 conducted by research groups at Aalborg University.

question that follows is, however, what constitutes these entrepreneurial opportunities? Based on the analytical framework described in Deliverable 2.2.1, Radosovic et al. (2010) have, by referring to both innovation and entrepreneurship literature, decomposed entrepreneurial opportunities into three components, i.e. market opportunities (OM), technological opportunities (TO) and institutional opportunities (IO). Based on the complementarities that arise from the interaction between these three types of opportunities it is possible to create a composite index of knowledge intensive entrepreneurial opportunities (IKIEO), which is created by summing the sub-index of the different opportunities into one overall IKIEO measure, i.e.:[6]

$$\mathrm{IKIEO} = \mathrm{MO} + \mathrm{TO} + \mathrm{IO}$$

Based on the set of observed variables for the year 2007,[7] the level of IKEO for Denmark is:

$$\mathrm{IKIEO}_{\mathrm{DK}} = 47.70_{\mathrm{MO}} + 57.49_{\mathrm{TO}} + 80.68_{\mathrm{IO}} = 202.98$$

Table 5: Market, Technological, and Institutional Opportunities

Country	MO	*(rank)*	TO	*(rank)*	IO	*(rank)*	IKIEO	*Overall Rank*
Finland	50.26	*(6)*	83.09	*(1)*	91.33	*(1)*	224.68	*(1)*
Sweden	59.09	*(3)*	80.72	*(2)*	82.36	*(2)*	222.18	*(2)*
Denmark	47.70	*(7)*	74.60	*(3)*	80.68	*(3)*	202.98	*(3)*
Luxembourg	72.74	*(1)*	41.37	*(10)*	75.46	*(4)*	189.57	*(4)*
UK	62.71	*(2)*	52.22	*(9)*	65.06	*(6)*	179.99	*(5)*
Netherlands	57.81	*(4)*	52.52	*(8)*	67.14	*(5)*	177.48	*(6)*
Belgium	39.62	*(9)*	56.33	*(7)*	62.06	*(7)*	158.00	*(7)*
Germany	38.58	*(10)*	61.12	*(4)*	55.66	*(12)*	155.36	*(8)*
Ireland	52.19	*(5)*	38.78	*(12)*	60.94	*(9)*	151.91	*(9)*
France	37.19	*(11)*	56.89	*(6)*	56.00	*(11)*	150.08	(10)

Source: based on Radosevic and Yoruk (2011)

Based on the overall ranking on these activities, Denmark is situated, just as often in innovation-based rankings, in the top performers (see Table 5). Based on a comparison Denmark is ranked number three just after the usual suspects Sweden and Finland and just before countries like Luxembourg and the United Kingdom. When observing the performance in the three sub indices of opportunity, Denmark ranks third on in technological and institutional opportunities (again after Finland (1) and Sweden (2)) and seventh in market opportunities (after Luxembourg, the UK, Sweden, The Netherlands, Ireland and Finland).

A closer look at the different subcategories of the three opportunity classes shows that Denmark scores high on some but has room for improvement in other on dimensions, in particular those dimensions that create the market opportunity indicator. In Table 6, I present the values for the various indicators and the possibility to compare these values to four other

[6] These three opportunities sub indices are: (i) MO, which is a combination of demand side activities (DEMAND), Finance of innovation (FINANCE), and other activities, and market for knowledge intensive services (MKIS); (ii) TO, which is a combination R&D activities (RND), competence building (SKILL) and knowledge and value chain networks(KNWK); and (iii) IO, which is a combination of regulatory (REGULATION) and policy support (SUPPORT).

[7] Due to the comparative nature of this study, 2007 has been chosen since for this year the majority of variables were available for all countries

countries, i.e. The Netherlands and Austria and the Nordic partners Sweden and Finland. I will address the overall score on the different subcategories and indicators separately.

In demand types of activities (DEMAND), Denmark has an index score of 11.80 and occupying a shared 10th place together with Cyprus just after the UK and just ahead of Austria. It is a relative long way up to the Luxembourg, which is ranked number one in this sub category. Looking at the values of the indicators, there is lots of room for improvement, i.e. (i) GDP growth is amongst the lowest in the EU27, (ii) share of trade is higher compared to the other Nordic countries but Denmark is placed in the middle or the EU27, (iii) buyers sophistication is in the top 10 but remains behind that of the other Nordic countries, The Netherlands, UK, Germany and Luxembourg.

Improvement is also demanded for the finance indicator (FINANCE). In 2007, despite the ambiguous opinion on the access to financial capital, Denmark was ranked 7th with a score of 17.22. This is way ahead of most countries but also far away from the leading countries like the UK (23.61) and the Netherlands (23,30). Even the other Nordic countries outperform Denmark on this level with a score above 20 points. That indicator where Denmark is performing strong within this sub category is domestic credit to the private sector. Here where it is only outperformed by Cyprus. It lags behind regarding the trading of stock and is ranked outside the top 5 regarding venture capital; however, this position is rather ambiguous when looking at various data sources and industry experts.

The final dimension of market opportunities is the market for knowledge intensive services (MKIS). In this dimension Denmark is ranked 6th with a score of 18.67 and is surrounded by the Netherlands (19.51) and Hungary (18.57). There is a relative large step to countries in the top, i.e. the UK (27.25) and Luxembourg (25.61). From a Nordic context, Denmark is ahead of Finland (17.02) but lags behind Sweden (23.50). As can be observed, there is lots of room for improvement in market opportunities in the Danish context. In this sub category, there is lots of attention towards the high tech and knowledge intensive sector. An issue regarding this measure is that, as described earlier, Denmark has a dominant low-tech industry and this has an impact on the ranking in terms of the number of firms active in high tech and knowledge intensive industries. Consequently, the share of high tech exports is limited and hence the low ranking on this indicator. Nevertheless, employment in high tech and knowledge intensive industries are relatively high.

On technological opportunities Denmark performed, as mentioned earlier, better with ranked third after Finland and Sweden. On all the sub categories and indicators, Denmark is lying in the top. In terms of R&D activities (RD) Denmark is on the third places. However, this is data on 2007. Recent data indicates that Denmark, as mentioned earlier in this document, improved their position; however, still behind Finland and Sweden. The Danish score (22.47) is just ahead of Austria and Germany and way ahead of the country that is ranked 5th, i.e. France. This high rank is both type of R&D expenditures as mentioned in Table 6.

In terms of competence building, Denmark is ranked 4th with a score of 21.83 after Finland (30.89), Sweden (29.87) and France (23.23) and just ahead of the UK (21.66) and Belgium (20.76). The position is relative strong but there is some distance to the top while there is pressure from the direct followers to exceed the Danish level. This improvement can in particularly be reached in the percentage of people with a tertiary education. In this indicator, Denmark is together with the Netherlands placed on a shared 8th place. Furthermore, on the quality of research Denmark is ranked high, i.e. 6th, one place behind the Netherlands and one ahead of Finland, but even here there is room for improvement to the top, i.e. the UK, Sweden and Germany.

Where Denmark excels compared to the other countries in the EU27 is knowledge and value chain networks (KNNTWK). Here Denmark is ranked first with a score of 30.30, which is well ahead of the Netherlands who is ranked second with a score of 20.89. The reason why

Denmark is ranked this high is mainly due to the high level of innovation collaboration and job-to-job mobility. The latter is often ascribed to the earlier-mentioned flexicurity system.

Finally, there are the institutional opportunities. On the regulatory indicator (REGULATION), Denmark occupies the 3rd place with a score of 42.94, which is just behind Finland (46.36) and Sweden (45.70). Other countries are lacking behind, in particular the Southern and Eastern European countries. Denmark scores high on all indicators related to the ease of starting up a business. It requires even less days compared to countries like Sweden, Finland, The Netherlands and Austria. IPR protection is on the same level as Germany, The Netherlands and Austria while it is less strict compared to the other Nordic countries. Given that the public sector is relatively high, the burden associated with government regulation is also higher. However, there are higher levels of efficiency of the legal framework.

In policy support (SUPPORT) Denmark scores better compared to the overall ranking within this category, i.e. second with a score of 37.74. This score is closely followed by Sweden (36.66) and Luxembourg (35.49) while the leader, Finland, is way ahead with a score of 44.97. Denmark scores particular high in the indicator regarding the opportunity to sell innovations in a public tender. The interest in public procurement is also high, although it is outperformed by a small number of mainly eastern European countries. In the Danish context, there is definitely room for improvement in cluster development and cluster membership since it is lagging behind the majority of top performers.

Table 6: Indicator value for the IKIEO categories

Category	Subcategory	Indicators	DK	NL	AUT	FI	SE
Market Opportunities	DEMAND	GDP per capita (current US$) (2007)	56770.08	47377.41	44656.52	46493.79	49553.08
		GDP growth (annual %) (2007)	1.65	3.46	3.07	4.20	2.56
		share of trade(X+M) in GDP (2007)	102.20	140.20	112.90	86.50	96.30
		buyer sophistication (Q.6.15, 2009–10 weighted average)	4.30	4.60	4.10	4.40	5.00
	FINANCE	domestic credit to private sector (%GDP) (2007)	203.39	189.63	114.97	81.60	123.94
		stocks traded (% in GDP) (2007)	78.11	232.37	32.76	220.97	213.72
		venture capital (early and expansion and replacement % of GDP) (2007)	0.10	0.10	0.02	0.12	0.22
		venture capital availability (Q.8.05, 2009–10 weighted average)	3.30	3.70	2.90	4.20	4.00
	MKIS	high-tech sector enterprises (Manuf+KIS)% in total enterprises (2007)	5.31	5.56	5.39	3.67	7.26
		high tech exports % in total exports) (2006)	12.75	18.27	11.17	18.12	13.40
		employment in KIS+hitech manuf (% in total employment) (2007)	49.54	45.86	36.66	47.76	54.03
Technological Opportunities	RD	GERD %GDP (2007)	2.55	1.70	2.52	3.47	3.53
		BERD %GDP (2007)	1.77	0.96	1.78	2.51	2.61
	SKILL	%R&D personnel in total employment (2007)	1.67	1.05	1.32	2.26	1.69
		% population with tertiary education (Graduates per 1000 of the population aged 25-34) (2008)	1.60	1.60	2.00	3.00	3.20
		quality of scientific research institutes (Q.12.02, 2009–10 weighted average)	5.50	5.60	5.10	5.40	5.90
		availability of scientists and engineers (Q. 12.06, 2009–10 weighted average)	5.10	5.00	4.70	6.00	5.80
	KNNTWK	firms involved in innovation cooperation (%in total) (2006-2008)	0.57	0.40	0.39	0.37	0.40
		job-to-job mobility of HRST (%) (2007)	14.10	8.20	6.40	9.00	2.80
		value chain breadth (Q.11.05, 2009–10 weighted average	5,40	5.60	5.70	5.30	6.20
Institutional Opportunities	REGULATION	number of procedures required to start a business (Q.6.05) (2009)	4	6	8	3	3
		time required to start a business (days) (Q. 6.07) (2009)	6	10	28	14	15
		IPR protection (Q.1.02) (2009–10 weighted average)	5.7	5.7	5.7	6.2	6.2
		burden of government regulation (Q.1.09) (2009–10 weighted average)	3.8	3.1	3.6	4.3	4
		efficiency of legal framework Q.1.11) (2009–10 weighted average)	5.2	5.1	5.2	5.5	5.8
	SUPPORT	state of cluster development (Q.11.03) (2009–10 weighted average)	4.6	4.7	4.6	5.1	5.1
		declared cluster membership among enterprises in cluster-like environment (%) (2006)	73	77	50	90	81
		interest in public procurement (%firms in total) (2009)	49	32	38	55	38
		firms with opportunities for innovations in public tenders (% of firms with experience in PP)	46	39	27	40	42

2.2 KIE in the Danish Innovation System

2.2.1 Entrepreneurship policies and support in Denmark

In the above, I described some of the main features of the Danish Innovation System. However, the main concern of this document is in relation to one specific activity that is undertaken in the innovation system, i.e. knowledge intensive entrepreneurship, and how Denmark positions itself to this important driver for creativity and innovation.

Denmark has set two ambitious goals with respect to entrepreneurship, defined as new business start-ups. First, it wants to be one of the countries with the highest number of start-ups. Furthermore, it aspires to be amongst those countries with the highest rate of high-growth entrepreneurs by the year 2015 (Danish Enterprise and Construction Authority, 2009). This ambition requires a supportive framework especially in a country where entrepreneurship does not fill a prominent position in the national culture. The various entrepreneurship policies, entrepreneurship support program, and other entrepreneurship initiatives, which can be found on different level of government, i.e. national, regional and local level, reflect this ambition. These actions are predominantly aimed to create favorable framework conditions for entrepreneurship by, e.g., lowering barriers to start and liquidate a business and create positive market conditions, easing the access to finance, providing entrepreneurship education to develop entrepreneurial skills, and technology transfer.

Overall, Danish barriers to start-up a business have decreased considerably compared to a decade ago and are seem to be low compared to other countries, both in the OECD but also worldwide (OECD, 2009b). Where providing access to counselling, e.g. setting up incubators and connected mentorship programs is an important component of this strategy. The World Bank (2010) ranks Denmark the number eighth country in starting a business. Based on the same report of the World Bank the average number of days to start a business in Denmark is 6 days, partly due to its central administration, which is well below the OECD average of 13 days. Furthermore, regulatory barriers are relatively low and Denmark is ranked number 6 in the OECD. Out of these regulatory barriers, administrative burdens are lower compared to most other OECD member countries while barriers to competition are the biggest regulatory barriers for entrepreneurship in Denmark (OECD, 2010). Furthermore, other market conditions, i.e. import and export burdens, are among the lowest in the OECD (OECD 2009b). One of the regulatory barriers for starting up a business that is considered to be high in Denmark is the high level of taxation (OECD, 2009b).

Closely related to barriers to start-up a business are the conditions connected to bankruptcy. Lenient bankruptcy arrangement reduce the cost of failure and the risk that potential entrepreneurs face, although this should be weighted against the negative impact it has for receiving capital. Overall, the laws regarding bankruptcy have improved but Denmark is still behind the leading countries (Danish Enterprise and Construction Authority, 2009). Based on "Doing Business 2010 (World Bank, 2010) the ease of closing a business, based on the recovery rate[8], Denmark is ranked number 6. In addition, Danish bankruptcy laws made debt restructuring easier and close of bankruptcy business faster but also facilitate restarting and reorganization as an alternative to liquidation. This has led to a decrease in the number of

[8] Recovery rate is measured by how cents on the dollar claimants (creditors, authorities and employees) recover from the insolvent firm.

bankruptcies up to the recent economic crisis (Danish Enterprise and Construction Authority, 2009).

A continuing pressing issue in supporting entrepreneurship, not only in Denmark but also worldwide, is providing access to adequate sources of finance to start up and invest in new founded businesses; surveys show that lack of finance is one of the most important factors that impediments entrepreneurship (OECD, 2008; Bosma & Levie, 2009). Financial capital can be obtained by means of personal saving; loan from fools, friends and family; bank loans; business angels and venture capital funds. Based on the World Competiveness Report 2008/2009 (World Economic Forum, 2008) Denmark ranks high regarding access to a number of these financial sources. With respect to obtaining bank loans for business plans, Denmark scores a 5.4 on a 7-point scale, thereby taking up the first position worldwide. This result is supported by the Danish Enterprise and Construction Authority (2009), who state that Denmark ranks number one for receiving loan capital, both for starting up a business but also for investing in these new firms. Concerning availability of venture capital, Denmark, despite lacking a strong venture capital market, takes the ninth position with a score of 4.7 on a 7-point scale (World Economic Forum, 2010), similar findings are reported by the Danish Enterprise and Construction Authority (2009). This availability has increased significantly from the level of venture capital that was available in the late 1990s, which can for a large part be explained by government intervention including the start of innovation incubator environments, which are nowadays seen as an addition the early-stage venture capital market (Christensen et al, 2008); the start of the various growth for a, a state investment fund that provides early stage venture capital funding; and Seed Capital Denmark Fund, a public-private fund that invests in the early start-up phase. All these activities focus predominantly on high-tech and high-growth start-ups (OECD, 2008). A type of risk capital funding on which Denmark is lagging behind is with regards to Business Angels. This form of funding, which is often accompanied by entrepreneurial and managerial expertise, is very weak, the OECD (2009b) reports the presence of only three business angel networks, as only seven percent of high growth start-ups in Denmark receive capital from Business Angels funding compared to, e.g., the United States where this funding is estimated to account for approximately 90 percent (Danish Enterprise and Construction Authority, 2009). Interestingly, despite the overall good availability of capital, surveys, e.g. Global Entrepreneurship Monitor (GEM), show a critical attitude of entrepreneurs towards this issue.

Denmark has put lots of emphasis has put the development of entrepreneurial skills and improvement of the entrepreneurial culture. Surveys have shown that the individuals perceive the lack of skills as the biggest barrier for starting a business, a barrier higher compared to, e.g., lack of finance and the lack of ideas. There is a desire to improve entrepreneurial culture in Denmark as this culture, in terms of entrepreneurial mindset and social attitude, is lagging behind other countries (Danish Enterprise and Construction Authority, 2009). Also the perception of entrepreneurial failure could be improved as starting up fresh after initial failure is considered to be low (OECD, 2008). Nevertheless, entrepreneurial intentions have increased and Danes rank high in perceiving opportunities for entrepreneurship (OECD, 2008). Furthermore, the perception of entrepreneurs is, compared to other countries, very positive and many see those involved in entrepreneurship as job and wealth creator (OECD, 2008). Although, stating the outcome of GEM, the number of people who perceive entrepreneurship as a good career choice and the attention for entrepreneurs in the media is considerably low (Bosma et al, 2010).

To further affect the entrepreneurial culture and skills several initiatives have started that involve entrepreneurship education, initiatives often administered by overarching entrepreneurship supporting organization, e.g. International Danish Entrepreneurship Academy (IDEA) and the Foundation of Entrepreneurship. This type of education can be found from the lower levels of secondary education all the way up to university, and even

outside the formal education system, in establishing the perspective that entrepreneurship is a possible career trajectory. According to the GEM, just over 20 percent of the respondents participated in such activities. However, despite the increase in entrepreneurial education activities entrepreneurship receives less attention in the Danish education system compared to the top performing countries, upholding only an average position (OECD, 2008). Closely related to this coursework is the growing focus on university incubators to support both students and university staff in starting a business. These activities are undertaken in all Danish universities and according to a survey conducted by the Ministry of Science and Education in 2005 around 11 percent of the students were engaged in entrepreneurial activities (Christensen et al. 2008).

2.2.2 Entrepreneurial Activities in the Danish Innovation System

Overall, the conditions for stimulating entrepreneurship in the Danish Innovation System can be regarded as relatively beneficial; however, the question is whether such an environment has a positive influence on the entrepreneurial activities being undertaken in Denmark. The answer to this question is not straightforward and several investigations show different and rather contradicting results; the only point on which they agree is the negative impact of the recent economic crisis on the degree of entrepreneurial activities.

An often-used reference to indicate the level of entrepreneurial activity in a country is the GEM. This study has been conducted annually since 1999 on a large sample of individuals in a various number of countries. Based on this study, Denmark belongs to the countries with the lowest level of Total early-stage Entrepreneurial Activity (TEA)[9] score of all western economies (see Table 7), in 2009 this score was even 3.6 percent. However, when disaggregating this number it shows that Denmark has also the lowest share of entrepreneurial activities that are founded based on necessity-based motives (see Table 8). In addition, the majority of the entrepreneurial activities have an improvement-based motive with levels equal to the US; however, other Nordic countries outperform Denmark on that indicator (see Table 8).

Table 7: Total Entrepreneurial Activity based on GEM

	2005	2006	2007	2008	2009	2010
Denmark	4.8%	5.3%	5.4%	4.4%	3.6%	3.8%
Norway	9.2%	9.1%	6.5%	8.7%	8.5%	7.7%
Finland	5.0%	5.0%	6.9%	7.3%	5.2%	5.7%
Sweden	4.0%	3.5%	4.2%	n/a	n/a	4.9%
United Kingdom	6.2%	5.8%	5.5%	5.9%	5.7%	6.4%
United States	12.4%	10.0%	9.6%	10.8%	8.0%	7.6%
World Average	8.4%	9.5%	9.1%	9.7%	10.7%	11.9%

Source: Global Entrepreneurship Monitor 2005-2009

9 TEA is calculated by the share of respondents (n=2000) that either are considered to be nascent entrepreneurs, i.e. those that have the intention to start a business but have not so yet, or are the owner-manager of a new firm, i.e. those that own or a top manager of a firms less than 3.5 years old. Consequently, GEM attempts to include entrepreneurial activities that do not lead to the formal establishment of a new firm.

Table 8: Necessity and improvement based TEA as percentage of total TEA (2009 and 2010)

	Necessity-driven		Improvement-driven	
	2009	2010	2009	2010
Denmark	7 %	8%	56%	54%
Norway	9%	15%	74%	74%
Finland	19%	18%	62%	54%
Sweden	n/a	13%	n/a	72%
United Kingdom	16%	11%	43%	43%
United States	17%	28%	56%	51%

Source: Global Entrepreneurship Monitor 2009-2010

In contradiction to GEM, other studies, which use different measurements of entrepreneurial activity, paint a considerable better picture. Based on the share of self-employed individual in the entire active labour force, Denmark actually outperformance economies that are traditionally regarded as entrepreneurial, e.g. the United States (Dahl et al. 2009). The Danish Enterprise and Construction Authority (2009) indicate that Denmark, in 2006, had the second highest start-up rate in Europe and was one of the countries with the highest growth in start-up rates in the period 2002-2006. In the latter study, start-up ratio has been defined the share of new firms out of a total number of active firms in a given year. Part of the difference might be explained by the difference in measurement and the distinction between firm level and individual level approach. GEM has an individual level approach while the other studies us a firm level approach. Consequently, these studies do no include entrepreneurial activities that do not lead to the formal establishment of business, i.e. the nascent entrepreneurship dimension of TEA. Nevertheless, Denmark scores also low on the new business ownership rate in GEM, which is more closely related to the measurement of entrepreneurial activity reported in the other studies. To add more to the existing ambiguity, we can observe Denmark scores average on the new enterprise indicator that is presented in Table 9. However, firm level data is not strongly harmonized and for that reason more difficult to compare across countries.

It is rather problematic that this ambiguity regarding the level of entrepreneurial activities in Denmark and how Denmark ranks on this indicator exist, not in the last place for political reasons. Having said this, it is not clear on what causes these structural differences since these differences are visible over a longer period of time. Nevertheless, I am for methodological reasons more inclined to believe that GEM underestimates the entrepreneurial activities in Denmark[10] although I also believe that firm level data gathered by statistical offices slightly

[10] In GEM 2010, Denmark has a nascent entrepreneurship rate of 1.8 percent and new business ownership rate of 2.2 percent. Given a sample of 2000 individuals this would mean that there are 36 nascent entrepreneurs and 44 new business owners in the Danish sample. A question that arises is whether the non-response of nascent entrepreneurs and new business owners is higher compared to other countries. In a survey conducted by Dahl et al. (2009) between a large sample of entrepreneurs and wage-earners it showed that entrepreneurs had a lower response rate. Studies that can provide an indication whether the potential non-response bias of entrepreneurs varies in the various countries would shed some light on this issue. Furthermore, because the rates are relatively

overestimates real start-up rates, e.g. due to difficulties in identifying truly new start-ups within register databases. So the true entrepreneurial activities must lie somewhere in the middle. Furthermore, despite the fact that these studies show that Denmark has high start-up rates, figures also show that the Danish death rate of firms, in both manufacturing and services, is also among the highest (OECD, 2010). Finally, what should not be underestimated, is the fact that in Denmark a large percentage of the new business activities are started within the framework of an existing firm, so-called intrapreneurship (Christensen et al, 2008). There might be a slight trade-off between intrapreneurship and entrepreneurship, i.e. if existing firms offer the same challenges, freedom, and creativity to their employees their might be a lower incentive for these employees to leave the firm and start up a business for reasons of risk, e.g. the ability to attract finance.

Table 6 showed that the institutional opportunities in Denmark are relatively high, in particular regarding the procedure and the number of days to start a business. Due to the ambiguity in entrepreneurial activities there is no clear answer on how these strong institutional opportunities have affected entrepreneurship in general. Comparing this to GEM, and in particular to the business ownership rate, there seems to be no impact. However, when looking at the relative high self-employment and start-up rated reported in other studies there seems to be some positive affect. In addition, how does the strong flexicurity system in Denmark affect entrepreneurship? There might be as much ambiguity on the link between flexicurity and entrepreneurship as there exist ambiguity on the entrepreneurial activities. Studies that have explicitly investigate the link between flexicurity and entrepreneurship do are not to be found. Nevertheless, flexicurity could influence the overall entrepreneurial activities in several ways. First, due to the strong level of social security in the Danish system, there is less need to start a business out of necessity, which would lower the rate of entrepreneurship. This can also be observed in the low rate of necessity-driven entrepreneurship in Denmark (and the other welfare state countries). However, the high level of flexibility in the system makes it easier for firms, and also entrepreneurs, to hire and fire employees. An easier hiring and firing could help nascent entrepreneurs in finding the necessary human resources and thereby assist new business creation. Finally, a well established labour market security, one leg of the flexicurity concept, can only be supported by a strong welfare state, which is associated with high level of taxes. A study by Henrekson (2005) shows that productive entrepreneurship is likely to be reduced in mature welfare states with the type of taxes they collect and the welfare arrangements they have introduced.

From the perspective of Innovation Systems, there is a particularly interest in those forms of entrepreneurship that are innovative, knowledge intensive, and/or have high growth potential, which contribute to economic growth and learning. A study by the OECD, reveals that 35 percent of all firms that patent are start-ups or young firms, i.e. younger than five years, taken responsibility for approximately 18 percent of all filed patents. Denmark has been able to improve the level of high-growth start-ups, which Statistics Denmark defines as one to two-year-old business with five or more employees at the time the enterprise is founded and over a three-year period the number of employees must grow by an average of 20 percent a year and corresponds with the OECD term gazelle, compared to the situation in 2004 and the decline in high-growth start-ups was not as large as in the overall start-ups population. Nevertheless, the start-up rate of high growth start-ups in Denmark, is not as well as the overall start-up compared to other countries (Danish Enterprise and Construction Authority, 2009). Thus, the

low a relative and the total sample of 2000 individuals creates difficulties in creating a representative sub-sample regarding entrepreneurial activities, in general there lacks some sensitivity analysis on the findings.

framework conditions set up in the Danish Innovation System contribute to a high percentage of start-ups but is still underperforming in the start-up of high-growth firms compared to the best-performing countries.

The purpose of this study is to make national and sectoral analyses of entrepreneurial propensities of IS as comparable and coherent as possible. To do so, Radosovic et al. (2010), which defines national knowledge-intensive entrepreneurship as the "country's capacity to generate new enterprises in knowledge-intensive sectors, to generate sales based on innovation and to increase its knowledge intensity, have introduced a methodology that decomposed knowledge intensive entrepreneurship into three components, i.e. new enterprises (NE), new technology and innovation (NTI) and knowledge intensity (KI). Based on the complementarities that arise from the interaction between these three types of opportunities it is possible to create a composite index of knowledge intensive entrepreneurship (IKIE), which is created by summing the sub-index of the different components into one overall IKIE measure, i.e.:

$$\mathrm{IKIE} = \mathrm{NE} + \mathrm{NTI} + \mathrm{KI}$$

Based on the set of observed variables for the year 2007, the level of IKEO for Denmark is:

$$IKIE_{\mathrm{DK}} = 18.32_{\mathrm{NE}} + 19.89_{\mathrm{NTI}} + 19.28_{\mathrm{KI}} = 57.49$$

In Table 9, I present the ranking of the top 10 countries in the EU27 and present also the ranking in each of the sub-categories. Overall, Denmark occupies the fourth place with an average score of NE, which is a number in between the rankings presented in the studies mentioned earlier, and a high score on NTI and KI. Sweden, Finland, Germany, and Luxembourg complete the top five with a score of respectively 71.75, 66.82, 58.79 and 55.67. Sweden and Finland are way ahead while the other countries are relatively close to each other.

Table 9: Index of knowledge intensive entrepreneurship

Country	NE	*(rank)*	NTI	*(rank)*	KI	*(rank)*	IKIE	*Overall Rank*
Sweden	16.84	*(17)*	25.48	*(1)*	29.43	*(1)*	71.75	*(1)*
Finland	21.28	*(7)*	20.30	*(3)*	25.25	*(2)*	66.82	*(2)*
Germany	16.41	*(20)*	24.16	*(2)*	19.22	*(4)*	59.79	*(3)*
Denmark	18.32	*(14)*	19.89	*(5)*	19.28	*(5)*	57.49	*(4)*
Luxembourg	21.56	*(6)*	12.11	*(16)*	22.00	*(3)*	55.67	*(5)*
Netherlands	22.06	*(5)*	13.95	*(12)*	17.33	*(8)*	53.34	*(6)*
France	23.52	*(2)*	16.03	*(9)*	13.61	*(11)*	53.17	*(7)*
Belgium	17.65	*(15)*	18.79	*(6)*	15.10	*(9)*	51.54	*(8)*
Estonia	22.97	*(3)*	20.03	*(4)*	4.70	*(19)*	47.70	*(9)*
Cyprus	21.01	*(10)*	17.15	*(7)*	7.95	*(13)*	46.11	(10)

Source: based on Radosevic and Yoruk (2011)

Now, I will discuss the values as they can be observed in each of the three sub-categories and discuss them more in depth by looking at the various indicators that create this measure. Within this section I will also compare Index of Knowledge-Intensive Entrepreneurial Opportunities (IKIEO) of Denmark with the performance of The Netherlands, Austria, Sweden and Finland. This results in Table 10, which presents the value of the different indicators and it is possible to compare these values with the same countries as I did in Table 6.

Denmark ranks in the component that indicates new enterprises (NE) relatively low compared to its comparable counterparts with a 14th place. However, many countries in the overall top 10 perform fall outside the top 10 in this category, which might be an indicator for the higher level of necessity based entrepreneurship in many of the other countries. Nevertheless comparable countries, e.g. The Netherlands but also Finland, outperform Denmark. In any case, in this category there is lots of room for improvement possible on all indicators. First, the net entry is low with a 16th place in the ranking, behind the Netherlands, Finland but ahead of Sweden and Austria. However, as already indicated earlier, there is lots of ambiguity since in other rankings Denmark scores very high. Second, the number and share of firms that are less than 5 years old Denmark has a position in the middle[11], although this is a direct results of the low number of new established businesses. The survival rate is below 50 percent, where it is again placed in one of the middle positions. Sweden and Greece are the leading countries in terms of survival rate, which draws an interesting picture given the large difference between these countries in terms of innovative performance. The position of Denmark is comparable with, e.g., The Netherlands and Finland. However, this survival rate provides no indication for the type of businesses and whether these businesses are knowledge intensive.

Table 10: Indicator value for the IKIE categories

Category	sub-category	Indicator	DK	NL	AUT	FI	SE
Knowledge Intensive Entrepreneurship	NE	Net entry rate (net business population growth-2007)	2,83	7,66	1,00	3,91	2,60
		Five year old enterprises employment growth rate (2007)	107,88	140,09	29,03	199,33	52,17
		Survival rate 5 (2007)	48,00	48,62	n/a	47,17	64,28
		5 year old enterprises' share of the business population (2007)	4,29	3,87	4,31	3,14	3,40
	NTI	% innovative enterprises (2006-2008)	52	45	56	52	54
		% innovation expenditures in turnover (2006-2008)	3,30	2,42	2,05	3,37	4,45
	KI	Patent applications to EPO (Per million of inhabitants) (2007)	194,05	223,49	216,97	250,76	298,36
		Royalty and license fees receipts (%GDP) (2007)	0,63	0,56	0,20	0,52	1,05
		High tech sector (high tech industries and knowledge intensive services) value added (%GDP) (2007)	5,77	n/a	4,41	8,71	6,85

The second component is new technology and innovation (NTI), which is measured by combining two indicators, i.e. share of innovative firms and share of innovation expenditures.

[11] There are many missing observations in this category

Overall, Denmark has a fifth position and the leading economies are Sweden and Germany.[12] Based on the indicators, there is room for improvement in the number of innovative firms. In terms of innovation expenditures, Denmark is located in the top only outperformed by Finland and Sweden and well ahead of countries like the Netherlands and Austria but also Germany and the UK, who can be found even lower on this list.

The final component in the index knowledge intensive entrepreneurship is knowledge intensity (KI), which is created by the three indicators, i.e. patent applications to EPO, royalty and license fees, and high tech sector value added. Overall, Denmark occupies the 5th position in this subcategory outperformed Sweden, Germany, Finland, Luxembourg, the Netherlands and Austria. There is room for improvement although the ranking in this category is very dependent on the number of firms in high tech industries, a category in which Denmark scores overall relatively low but in general, as mentioned earlier, is improving. Despite the lower performance on patents, where it lags behind all countries listed in Table 10, it outperforms most countries in royalty and license fees, the only exception being Sweden. Finally, the position of high tech sector value added can be improved but this indicator is again closely related to the relative low level of activity in the Danish economy, in particular compared to Finland and Sweden but most likely also The Netherlands, despite the fact that data is missing.

To summarize, the first element that was observed is the contrast between the different TEA on the one hand and the other entrepreneurial activity indicators, including the KIE and IKEO, on the other hand. Thus, from the innovation system perspective, knowledge intensive entrepreneurship and firm level perspective, Denmark seems to have a much stronger level of entrepreneurship. However, Denmark fall slightly behind on the KI indicator compared with other top-ranked countries, mainly focussing on Sweden; however, this relative lower performance can be explained by the fact that Denmark is not as active in high tech areas which are a big driver of the indicator reported. Technological opportunities are, however, reported to be relatively strong. This can be explained that Denmark scores high on collaboration for innovation and the high level of labour mobility. Finally, the availability of R&D and innovation-based human resources are also relatively strong in Denmark compared to other countries in the overall analysis.

An element in which Denmark scores relatively high are institutional opportunities, there are hardly any institutional barriers for entrepreneurship and there is a public support structure in place with a focus on supporting entrepreneurship and innovation. The only structural challenges are associated with the overall welfare state, which lead to a relative large public sector, e.g. more government regulations and higher taxes, which counters other more beneficial arrangement of the system, e.g. ease of registration and hiring and firing. These institutional arrangements are alike in all the Nordic countries.

[12] This measures are taken from CIS5, an important issue that needs to be addressed is the non-response bias toward non-innovative firms, which has a significant impact on the ranking.

3 Danish Sectoral Case Studies of EPIS

To investigate the entrepreneurial propensity in the Danish Innovation System, I will, just as in the other sector studies, focus on two very different industries. The first industry is the Danish Computer and Related Industries (NACE 72), which include: hardware consultancy (72.1), software consultancy and supply (72.2), data processing (72.3), database activities (72.4), maintenance and repair of office, accounting and computing machinery (72.5), and other computer related activities (72.6). With software consultancy and supply being by far the largest sub category in this industry class. The second industry class that will be discussed in this document is machine tool manufacturing (NACE 29.4).

Entrepreneurial activity has been put forward as one of the main activities that should take place within a System of Innovation. In this case entrepreneurial activity refers mainly to the establishment of new organization but other activities that can lead to entrepreneurial acts, e.g. investment in R&D and human capital, which take place within the two industries are taken into consideration.

The presence of entrepreneurial opportunities, either opportunities that existed but were not discovered yet or opportunities that were created, is an imperative requisite for any form of entrepreneurship, including knowledge intensive entrepreneurship, to arise. In the overall framework of investigating this issue there is made a distinction between: (i) market opportunities, (ii) technological opportunities, and (iii) institutional opportunities.

To investigate the level of entrepreneurial activities and various opportunities in the two sectors, I rely on quantitative data extracted from various national and international data sources, this data is supplemented with semi-structured interviews conducted with industry representatives. The quantitative information included is collected from three online data sources, i.e. Eurostat, OECD-STAN, and StatBank Denmark. Data that could not be retrieved from any of these sources where supplemented with data from the Danish Integrated Database for Labour Market Research (IDA).

Qualitative data in the sector analysis has been gathered through a series of interviews with experts in these industries. These interviews have taken place in the second half of 2010 and the first half of 2011. For this interview I followed a guideline that has been distributed among the work-package members in May 2010.

The people I interviewed were:

- Tom Togsverd (head of DI-ITEK)
- Jesper Jespersen (Director of NOVI)
- Karsten Fogh Ho-Lanng (Director of NNIT and Columnist for Computerworld)
- Finn Støy (Director IT-Forum)
- Grimur Lund (Director of Logitech and Chairman of Brainsbusiness)
- Christian R. Østergaard (Associate Professor Aalborg University)
- Two anonymous company representatives of firms (start-up and established firm) in the (high tech/knowledge intensive segment) machine tool industry.

3.1 Danish Computer and Related Activities

The overall IT industry, including both manufacturing and service activities, is an important driver of innovation. The industry under investigation, i.e. Computer and Related Activities, being part of IT (service) industries, is thus an important industry for Denmark as a whole.

Within services, it is one of the largest industry classes where the majority of the firms in this industry class are active in software consultancy. In terms of entrepreneurial activity, the industry seems to perform well given the relative high start-up rate. However, one also has to consider the relative low barriers of entry to start a business in this industry since in general there is a low requirement to by large and vey expensive machinery. This, in combination with hardly any cost of production and the fact that their core business is software, the industry is truly knowledge intensive.

As IT is one of the key areas, the supportive framework for entrepreneurial activities is fairly extensive. There are study programs that focus on IT on all different levels of education. In addition, almost every science-center and incubator reserves space to accommodate IT firms and entrepreneurs. Nevertheless, as these science-centers and incubators operate regionally there is hardly any competition between the regions but a strong cooperation. In some cases incubator environment redirect people with a business plan to each other when they feel that their plan would fit better in another incubator environment. This better fit can be explained by the regional specialization, e.g. the large international players are located in Copenhagen, Aalborg is specialized in mobile communication, Aarhus in health software, Odense is specialized robotics. The statement that IT loves cities visible when considering that around 80 percent of all employees are located in the larger urban areas in Denmark. The majority of this labour and firms are located in Copenhagen and the second largest city of Denmark Århus.

Another characteristic of the start-ups are that the majority have a national, or even regional, focus, despite the fact that this industry is highly global. Nevertheless, globalization pressures will remain and will get stronger, especially with countries like India lifting up, and even surpass, the skill level to the standards of Western companies for a lower price. For Danish firms to remain competitive is an important challenge for the future.

In investigating the entrepreneurial propensity in this sector another challenge arises. IT and computer related activities are not limited to the identified industry classes. Lots of entrepreneurial and innovative activities within this discipline occur in other industry classes.

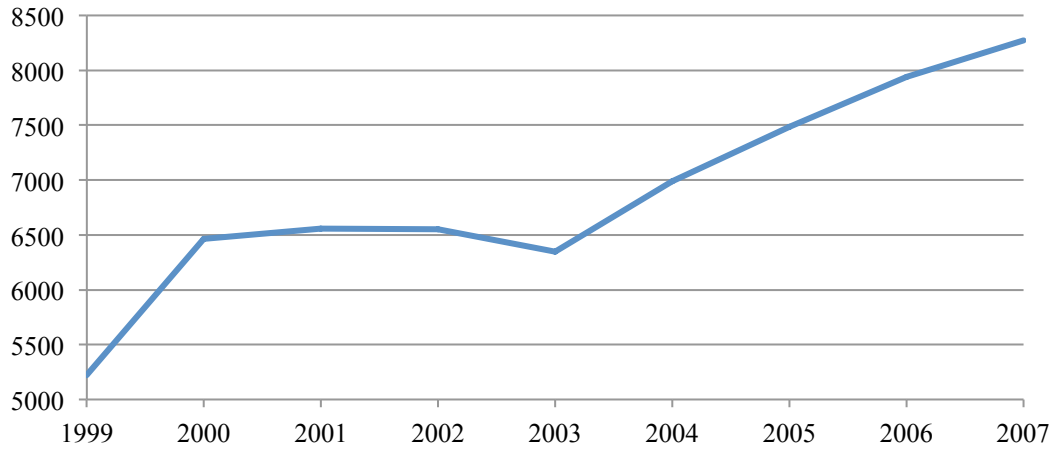
3.1.1 Entrepreneurial activities

Starting a business in Computer and Related Activities can be associated with low barriers of entry. First, as mentioned in earlier, Denmark is ranked high on the ease to register a firm and have all administrative requirements sorted out. Second, to get going with the business often one only requires, in addition to a viable idea and the right skills and competences, (i) a computer, (ii) the proper software, and (iii) Internet access. Any larger investments would depend on the need to acquire additional hardware. This relative ease, in combination with a strong IT infrastructure, can explain the significant Danish increase of IT service firms in general and Computer and Related Activities in particular; a rise which basically started in the beginning of the 1990s. This increase was, understandably, very high at the end of the 1990's during the IT bubble. In addition to the overall increase in the number of firms the industry is characterized by an increase in turnover, value added and employment (including the number of researchers); however, this growth stagnated or even decreased during the crisis. Recent data that is obtained during the last financial crisis is not yet available. However, the expectation is that this has stagnated new firm creation.

In the last decade, as can be seen in Figure 13, the number of firms in Computer and Related Activities have continued to increase with stagnation around the start of the new millennium which can be explained by (i) the burst of the IT bubble, and (ii) the overall economic recession that hit Denmark in the start of the 21st century. From 1997 to 2000 there was a strong increase, this increase can be explained by the overall advancements of technology within the field including the more important role of Internet. Taking a closer look at firm

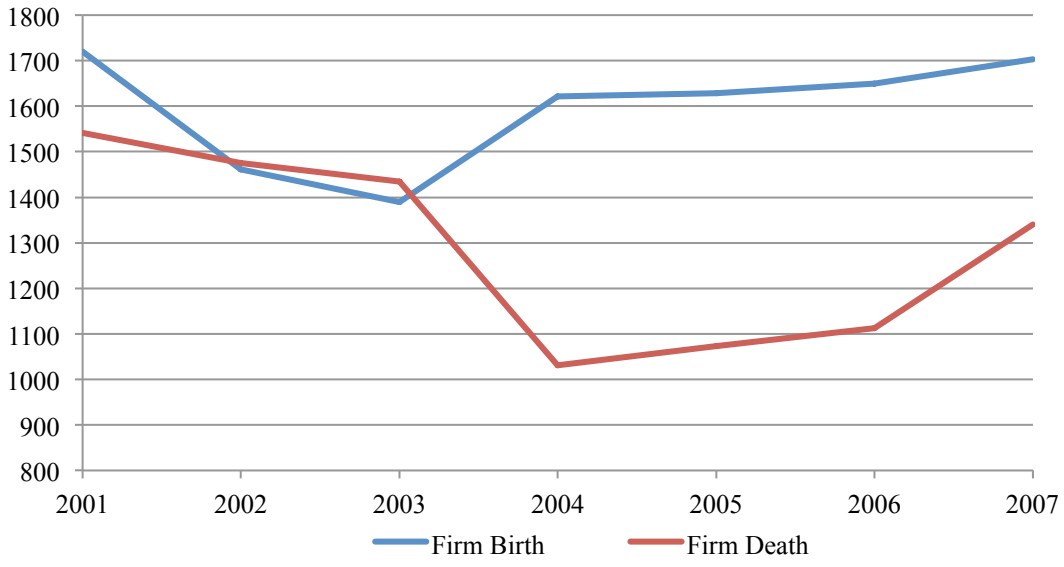
birth and firm death in this industry class (see Figure 14) a similar pattern is visible. Just after the IT crash, the level of birth was approximately similar to the number of death, which is connected to the overall economic situation in Denmark, who suffered of a recession that reached the lowest point in 2003. However, from 2004 the number of death declined while there was an increase in the number of new firms. The overall level of increase in IT firm does not only involved start-ups in the traditional sense. Many large firms, e.g. several Danish banks, have separated there IT department in an independent unit. Furthermore, many people started a business as IT consultant next to their existing job.

Figure 13: Number of Firms in Computer and Related Activities



Source: Eurostat

Figure 14: Firm Birth and Firm Death in Computer and Related Activities



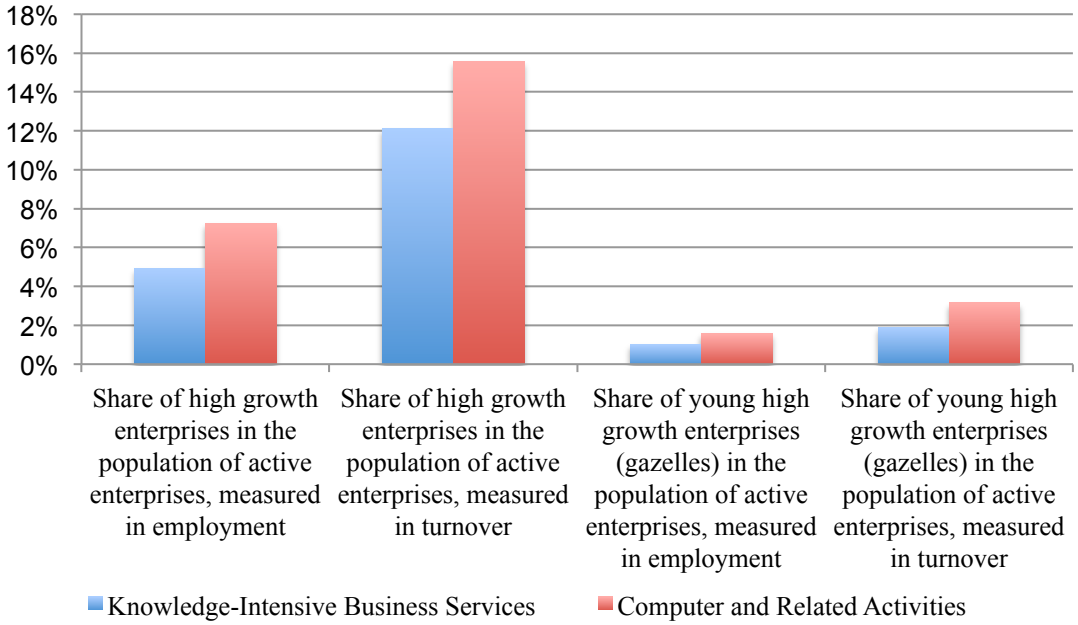
Source: Eurostat

However, due to the low barriers of entry it would not be enough to only focus our attention to the start-up and death rate. The ease of establishing a business might result in a relative high share of firms with close to zero activity with no growth or innovative aspirations. So, to evaluate the potential of these start-ups and create a more complete picture on the entrepreneurial and innovative propensities of this industry you need to identify the degree of start-ups that start a business and fail almost immediately, the number of firms that start-up

and reach a modest number of employees (not more than 20) with which they are satisfied,[13] and the companies with high growth potential.

Figure 15 illustrates the share of high growth firms in NACE 72 in comparison to the overall growth share of high growth firms in Knowledge Intensive Business Services (KIBS), which is the industry that in addition to Computer and Related Industries includes other consultancy-based firms. The numbers, which are not reported in this figure, show that KIBS scores high in the percentage of high growth firms and the share of gazelles, both measured in employees and turnover. External partners and collaboration is a requirement to reach such levels of growth especially considering the high level of change that happens in the industry. This can be collaboration with large and small firms and in different areas like competitors, the parent company but also with suppliers, customers and users and universities all depending on the needs of the entrepreneur and the type of products and services they are offering. Lots of this collaboration occurs within their local network, e.g. within the regional IT based networks.

Figure 15: Share of High Growth Firms and Gazelles in KIBS and Computer and Related Activities (2006)



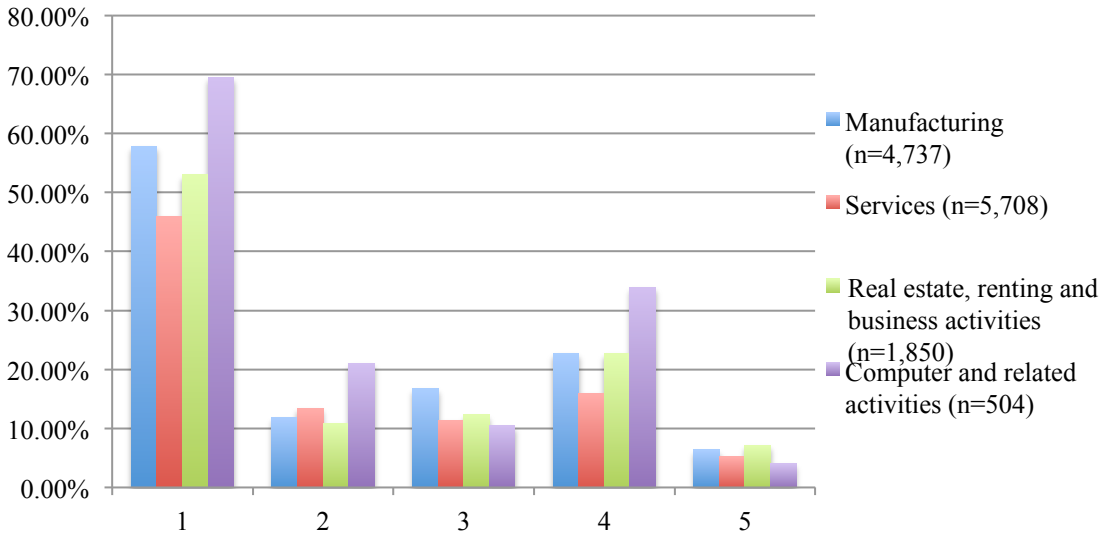
Source: Eurostat (2010)

To identify the innovative performance of this industry I take my point of departure in the fourth Community Innovation Survey. In Figure 16 I illustrate the share of firms that where innovative and which type of innovation they were involved in during the period 2002-2004. From the first column, which presents the share of innovative firms, it shows that manufacturing is more innovative than services. However, when disaggregating toward the level of Computer and Related Activities, it shows that those firms that 350 of the 504 firms that are identified to be active in this industry said that they introduced and innovation. These

[13] One of the expert said that it is not necessarily that they do not have the potential or resources to become very big but that some entrepreneurs in this category suffers of what he called the "BMW-syndrome". In this stage the entrepreneur can afford to buy a nice car and is not very interested to think bigger and more global.

firms produce both product and process innovations although mostly a combination of the two. They score relatively low on only process innovation.

Figure 16: Share of Enterprises with Innovation Activities in Computer and Related Activities (2004)



1 *Enterprises with innovation activities*

2 *Novel innovators, product only*

3 *Novel innovators, process only*

4 *Novel innovators, product and process innovators*

5 *Establish innovators, on-going and/or abandoned only*

Source: Eurostat (2010)

In addition, the death of a start-up is not necessarily a bad sign and especially not in this type of industry. A high share of entrepreneurs in this industry does not have the goal to create a large firm that could grow out to employ hundreds or maybe thousands of employees. These firms have an exit strategy to sell their business within 5 to 10 years after starting up to a larger company or to individuals that are better able to sell the product or service.

Nowadays, IT is a crucial component for the competitive position of firms in all industries. Consequently, entrepreneurial activities and innovation that is related to the core activities in NACE class 72 can be found many different types of firms that are active in a wide range of industry classes. The interviews with industry experts illustrate very well the interdisciplinary nature of entrepreneurial activities as they make a distinction between IT start-ups and second there are IT-based start-ups, where latter type is not placed within an IT industry class but where the business model of these start-ups is on IT. To identify the entrepreneurial propensity of a system within this activity it is necessary to look across industries. As pointed out by Danish Industries-ITEK (the largest Danish IT trade association), approximately 50 percent of start-ups that make use of their entrepreneurship support services are active in non-IT industry class, both in services and manufacturing, industries. Furthermore, firms in other industries employ IT specialist.

Focusing on the profile of the individuals that start a business within this field, it can clearly be stated that most start-ups are entrepreneurial start-ups, i.e. the founder has work experience in the same or a related industry or, due to the horizontal nature of the activities in this industry class, worked with activities that are closely related to this industry class. These

entrepreneurs appear to be more goal-oriented compared to other types of entrepreneurs and are better in making the business into a success. Furthermore, many of these spinoffs maintain a good relationship with their parent company, which is helpful for the overall performance of the new venture. When looking at the profile of the younger entrepreneurs, most of them start a business from an idea they developed during their studies. This is especially true for the start-ups that are connected to the different university incubators. This does not mean that these young entrepreneurs followed an IT education. Many entrepreneurs, but also employees in the industry, have a professional bachelor or higher but not only within IT engineering. This provides an indication that many people worked, e.g., as web developer of junior IT consultant next to their humanities of social science study. The number of start-ups that arrive from university is relatively low compared to those countries like, e.g., the United States. The experts provide several explanations. First, there is no culture of researchers exiting and entering academia due to the career-building process in academia in which you receive credit by research and not by starting an own business. Second, university research is too far away from that which plays within the Danish IT industry. Finally, when researchers decide to start their own business, they are often too theoretical and have a problem in letting go their role as researcher.

The character and set of competences of the entrepreneur is, however, evident in the success of the venture. The idea itself is only a part of the success of the entrepreneurial venture. Many of the ideas fall true because of the incompetence of the idea generator and the unwillingness of the idea generator to give to sell the idea to those who can. One expert who is very involved in IT incubator environment assesses that this happens in 75 percent of all cases with a big potential. Furthermore, the person needs to have to motivation to put the idea through and financial capital

Due to the importance of the character of the entrepreneur and the high degree of diversity in what type of product or service the start-ups are offering it is very difficult to identify some general growth patterns of firms. However, there are of course conditions that are important elements for a firm to grow. A first requirement is the access to sources of finance; especially second stage financing. Many new started firms struggle with this second round of financing, which can make a difference between success and failure and between high or low growth. This is even more so an issue for firms in western part of Denmark since most venture capital funds is active in the east, i.e. in and around Copenhagen. Furthermore, since the industry is active in services, the relationship with customers is important; however, the presence of a strong network is an overall important requirement to obtain the resources need. Closely related to this issue is being able to “read” the market and identify the needs of the customers. Since this is a highly volatile market the difference between growth and non-growth can be determined by correct timing of the introduction of a specific product or service. Finally, if a firm manages to expand and requires recruiting employees, the availability and identification of skilled workers is an important requirement.

3.1.2 Market opportunities

From the perspective of the demand-side activities, the growth of the market can already be identified by the increase in the number of firms (see Figure 13). In addition to the growth of the number of firms, there is also a clear sign that the overall turnover, value added, gross operating cost, purchases and exports in the industry and the turnover, gross operating cost and value added per employee have improved (See Table 11). This pattern can be explained by the increasing demand of IT solutions for firms not only in Denmark but internationally. This increase global demand can also be seen in the increase of exports. However, from the perspective of new start-ups, the international market is, according to the industry experts, not considered to be very important. The majority of firms provide solutions for a national or

even regional market and the number of young firms that focus on international markets is rather limited.

In terms of the price of input factors and taxes there are of course two factors. First the wage level in Denmark high compared to other countries. As the products are knowledge, and thus labour intensive, this high wage level will press down the competitive advantage in terms of pricing. This pressure is more evident due to the quick rise of competences in foreign markets, e.g. India, combined with cheap labour. In addition, the level of taxes is high adds an additional problem, also for the establishment of international firms.

Table 11: Indicators for market opportunities

	2000	2001	2002	2003	2004	2005	2006	2007
Number of firms	6466	6556	6552	6350	6989	7488	7943	8276
Turnover	5545.3	5899.4	6126.1	6001.6	6614.8	7358.3	8705.3	9684.0
Value Added	2384.3	2696.5	2742.5	2889.4	3197.4	3516.2	4175.3	4627.7
Gross operating surplus	321.4	345.1	542.9	638.3	787.0	883.3	982.7	1095.7
Turnover per employee	126.2	128.3	152.1	152.6	153.2	160.9	166.9	174.2
Gross value added per employee	59.8	64.8	72.1	77.9	80.3	83.8	86.6	89.3
Gross operating surplus/turnover (gross operating rate) %	5.8	5.9	8.9	10.6	11.9	12.0	11.3	11.3
share of gross operating surplus in value added	13.5	12.8	19.8	22.1	24.6	25.1	23.5	23.7
total purchases of goods and services	3209.5	3310.6	3547.6	3214.1	3521.5	4022.4	4755.8	5260.5
*Total Exports in Goods (million euro)**	727.3	926.7	1041.6	1029.4	1167.0	1268.0	1499.5	1660.1

*Source Eurostat and *Statistics Denmark*

Another market opportunity that has not been fully utilized is the related large size of the Danish public sector. Many of the large firms that existed in Denmark entered the market as a spin-off from the public sector and other large organization, e.g., the Danish banking system. One reason for creating spin-offs and engaging in outsourcing is that the IT tasks necessary became too complicated to keep it in-house and required specialists attention. Nevertheless, this large sector could according to industry experts contribute more in supporting entrepreneurial activities through, e.g., public procurement to support and help the industry to develop in particular tenders that also target start-up and SMEs. Such activities are not new to the Danish economy and have helped other industries to become world-class, e.g. hearing aids, and windmills. [14]

[14] For a description on the implementation of public procurement policies with a strong focus to support innovative activities and knowledge intensive entrepreneurship, the reading of the Deliverable 1.5.1. (A conceptual framework for analyzing the relations between demand and public innovative procurement and between knowledge intensive entrepreneurship and innovation) is recommended.

Another issue is the availability for sources of finance as previously discussed. Some data provides an indication that the overall scores for Denmark are relatively high considering the availability of risk capital for starting a business. Nevertheless, the interview reveals that the difficulty in obtaining funds is an important barrier in the growth of firms, especially in the western parts of Denmark because most venture capital firms are located in the Copenhagen area. Due to a lack of a network in this venture capital market these firms face the problem that they not only need to sell their idea but also sell themselves as the venture capitalist are not familiar to the entrepreneur that comes from outside the Copenhagen Area. Start-ups in this industry use different kind of financial sources but depending on the level of ambition the funding lies more to venture capital funds. Existing firms predominantly rely on their own capital to finance innovation projects.

What experts seems to agree upon is that the problem is not necessarily the availability of seed capital but the funding that is available in the second stage financing. In the first round they can build on funding from regional and local venture capital funds although this money is limited compared to the seed capital provided by private venture capital funds. The problem of these public venture capital funds is that their focus is solely on getting business started but not to provide them second stage finance, which requires a substantial higher level of investments. Consequently, many start-ups will remain small or even go bankrupt despite their high growth potential. Another problem in terms of financing is that start-ups with a high business potential cannot rely on any financial support of larger and established firms in the region. The sole motivation for established firm to invest in start-ups is to take over the activities in a later stage.

The lack of venture capital funds has been recognized for many years and for that reason Danish Industries started an initiative to attract venture capital funding from the United States. This initiative was a success since it was able to create awareness in the US venture capital market and venture capital firms were interested to invest in Danish start-ups. However, a problem that arose was that many venture capital funds required that these Danish start-ups had to relocate to the US. Consequently, the initiative stopped because Danish Industries did not want to run the risk that high potential firms would already leave Denmark in an early stage.

Despite the problem on availability of venture capital, firms have the opportunity to obtain finances from other sources. Due to the relative low level of investments that are required they can often rely on bank financing, their own savings, or borrow money from family and friends. Furthermore, the overall total investment in the industry has increased over the years (see Table 12). However, when looking at the investments per employee there is some volatility with relative low values in 2002 and 2003. This can partly be explained by the crisis that hit Denmark, which also caused the stagnation of growth in companies as observed earlier.

Table 12: Indicators of financing of the innovation process

	2000	2001	2002	2003	2004	2005	2006	2007
Gross investment in tangible goods	259,3	324,7	199,9	190,3	260,9	273,0	297,3	323,5
Investment per person employed	5,9	7,1	5,0	4,8	6,0	6,0	5,7	5,8
Investment rate (investment/value added at factor cost)	10,9	12,0	7,3	6,6	8,2	7,8	7,1	7,0

Source: Eurostat

Regarding the obtainment of knowledge intensive or consultancy services the firms, as mentioned earlier, hardly contact universities and they rely most on their internal capabilities. When they search for external knowledge they are more inclined to get these services from other consultancy firms. Whether they get this support from inside the country or form abroad really depends on the problem at hand. Those that operate only national will in the majority of cases rely on local sources while those that want to or are in international markets will search for these services in those foreign markets.

Lots of support and knowledge sharing occurs with the various regional networks, e.g. Brainsbusiness in North Jutland. These platforms are created for companies to share their expertise and knowledge among the members. These platforms not only include firms but also other stakeholders in the region, e.g. knowledge institutes, universities and representatives of the region.

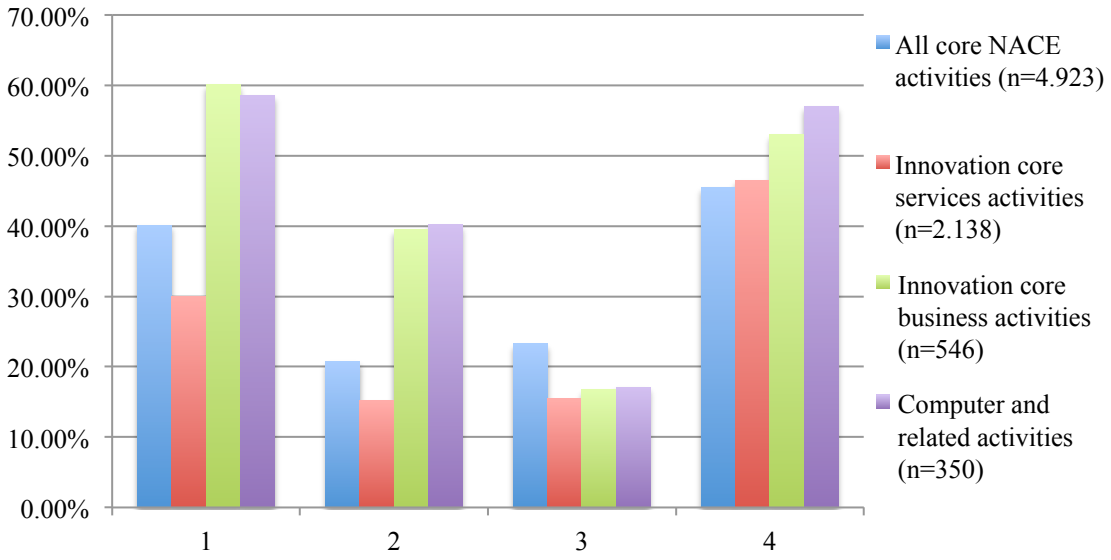
Finally, the hiring and firing of employees is relatively easy, which also explains the high level of job mobility in Denmark. This ease lowers the risk of firms, especially new firms, of recruitment. The problem for this industry, however, is not the availability of personnel but the availability of personnel with the right skills, as mentioned in the competence building section. Especially since less students are starting an education in IT. In the case of Northern Jutland, the IT industry works close together with Aalborg University so they can educate students after the needs in the industry. Larger firms can rely on international labour markets to recruit people from abroad although this international recruitment is often difficult when recruiting from growth markets like India due to the strict immigration policies.

3.1.3 Technological opportunities

A point of departure in investigating the technological opportunities is to focus on investments in R&D. Since this industry is part of knowledge intensive services, the focus in industry studies is mainly focused on the skill level of the employees in this industry. Nevertheless, the level of R&D investments as a percentage of GDP was according to Eurostat on 0.31 percent in 2007, which is relatively high given the overall size of the industry and provides good insight in the R&D intensity in service industries. Here we have to be aware that, similar to the entrepreneurial activities in relation to IT, a large share of IT related R&D is not conducted in this specific industry class. In overall the IT industry the percentage of business expenditures on R&D is around 90 percent of all R&D investments being made in the industry.

To further investigate the R&D intensity in this industry I rely on the results from the fourth Community Innovation Survey (CIS4). Figure 17 presents some descriptive statistics on the R&D expenditure of this industry in comparison to the overall expenditures and the more innovative (business) services. Computer and Related Activities scores high on the level of intramural R&D expenditures while the share of firms engaged in extramural R&D expenditures is lower (although still higher compared to other firms in innovative services). It is also clear from Figure 14 but also from the interview with industry experts that these firms are for a high degree involved in continuously intramural R&D activities, something that is required due to the presence in a highly volatile industry. A high share of firms where engaged in innovative activities, as seen in Figure 17, but a relative high share are also involved in the market introduction of an innovation.

Figure 17: Enterprises engaged in different types of technological opportunity created (2004)



1 *Enterprises, engaged in intramural R&D*

2 *Enterprises, engaged continuously in intramural R&D*

3 *Enterprises, engaged in extramural R&D*

4 *Enterprises, engaged in market introduction of innovation*

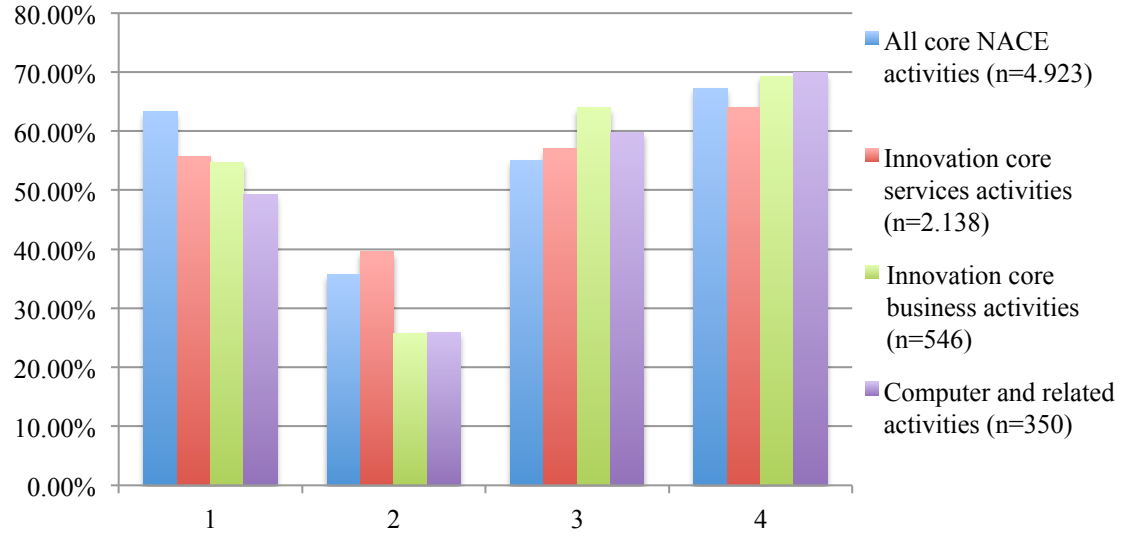
Note: percentages are based on the number of firms with innovative activities from the respondents of CIS4.

Source: Eurostat (2010)

One outcome of these activities is patent applications. Information on the patenting activities in this industry is limited. Nevertheless, based on CIS4 it can be observed that patenting activities are relatively low. Just over 10 percent of the firms in this industry class that have innovation activities in 2002-2004 have indicated they applied for a patent (compared to 20 percent of all innovative firms), more firms indicate that they filed an industrial design of a copyright, respectively 15 and 25 percent. These activities are more common in this industry compared to other types of industries, as patenting in software is difficult in Europe. In addition, the degree of change is so fast that by the time a patent for a specific IT solution is accepted another already surpassed the patented solution.

R&D is not the only method for the generation of knowledge. Other sources are also important and many are engaged in other types of innovation activities. These activities are, however, not as prominent in this industry compared to other industries, also not in other innovative (business) services as can bee seen in Figure 15.

Figure 18: Enterprises engaged in different types of knowledge acquisition (2004)



1 *Enterprises, engaged in acquisition of machinery, equipment and software*

2 *Enterprises, engaged in other external knowledge*

3 *Enterprises, engagement in training*

4 *Enterprises, engaged in other preparations*

Note: percentages are based on the number of firms with innovative activities from the respondents of CIS4.

Source: Eurostat (2010)

One of the activities presented in Figure 18 is training. This activity falls under the overall competence building in the sector. It appears from the figure that a relative high share of firms is engaged in this activity. However, the majority of this training takes place in the larger firms. Competence building is overall an important issue, which is not surprising given that this industry is knowledge intensive. A problem that is faced by these firms is the availability, despite lay-offs in the industry, of employees with the right and very specific skills; industry experts consider this issue one of the major growth barriers in this industry. This is partly attributed to the low interest in following an IT education. In the particular case of Northern Jutland, there is a close collaboration between university and BrainsBusiness, which is a regional network that includes many firms that are active, to develop education programs and courses that are closely related to the needs of the regional industry. When these skills cannot be provided locally, firms are engaged in international recruitment for obtaining these skills and attract these skills not only within Europe but also from large IT nations like India, although this international recruitment faces some institutional barriers. Overall, as presented in Table 13, there can be observed a strong increase on the number of employees in the industry, including an increase in employees with a high level of education. There is only a slight decrease in the number of employees in the industry as a result of the crisis.

Table 13: Competence building indicators

	2000	2001	2002	2003	2004	2005	2006	2007
number of employees	39847	41635	38060	37096	39807	41947	48213	51815
number of employees in full time equivalent units	33994	37146	34243	33932	36173	37740	43227	46428
growth rate of employment (%)	26.6	4.6	-12.4	-2.3	9.8	5.9	14.1	6.5
Number of persons employed per enterprise	6.8	7.0	6.1	6.2	6.2	6.1	6.6	6.7
Percentage of employees with a master or PhD degree*	5.1	5.1	5.0	5.2	5.2	5.3	5.6	n/a
personnel costs	2062.9	2351.4	2199.7	2251.1	2410.4	2632.9	3192.5	3532.0
share of personnel costs in production (%)	45.2	45.2	40.7	38.3	42.7	42.7	43.2	40.5
average personnel costs (costs per employee) (thousand euro)	51.8	56.5	57.8	60.7	60.6	62.8	66.2	68.2
share of personnel costs in total purchases of goods and services	64.3	71.0	62.0	70.0	68.4	65.5	67.1	67.1
wage adjusted labour productivity (apparent labour productivity by average personnel costs %)	104.8	103.8	117.9	121.1	122.3	122.5	120.9	12.2

*Source: Eurostat and *Statistics Denmark*

Regarding the education within this industry there is a strong regional difference. Overall, the level of high-level education is high in this industry. Much higher compared to other industries. In addition, the profile of these high-skilled individuals differs significantly between the different geographical areas. The universities that educate many of the IT specialists in the region heavily drive this profile. For example, in Aalborg skilled labour in the IT industry are IT engineers. In Århus there are many people with a computer science background, these engineers come from the institute of mathematics. In Odense, there are people with an engineering background but this is often combined with a background in natural sciences. While in Copenhagen the most highly educated IT specialist are active. Thus, also here the regional dimension is very visible.

In addition to the recruitment of labour, including high skilled, there is also a focus on the competence building of these employees within the firm both by offering courses internally as externally. The opinion of firms is that after the recruitment of person they need to provide this person with, often certified education, to obtain the right skills in relation to the product of service they are offering. Another way how much learning takes place in this industry is by Learning by Doing, Using and Interacting. Denmark offers a well-developed prolonged education system where individuals can follow courses paid for by the state, contrary to other countries where the firm or individual is responsible for training.

Despite the fact that external sources are not regarded as important as in other industries; look here at the extramural R&D activities and searching for other knowledge. The role of knowledge networks is still an important factor especially to get to know other companies and as a way to transfer and share knowledge. How firms in the Community Innovation Survey think on the importance of external knowledge sources is presented in Table 14. A high level of importance is contributed internally in the organization, which is also reflected in the high level of intermural R&D expenditures, which was presented earlier. Other important sources

are suppliers and customers. Interestingly, the role of universities is here not considered to be highly important. The problem is that the knowledge that is developed at universities often is not considered to fit very well with the private firms. Furthermore, knowledge sharing between these two groups hardly occurs because they operate in different environment, e.g. private firms hardly participate in university conferences while university researchers hardly participate in conference organized by private firms. The incubator environments in Denmark provide many start-ups with the introduction to potential important players. Especially since these incubators are embedded into the regional IT networks. This assists them in creating a knowledge network that can help them to survive and grow.

Table 14: Highly Important Sources for Innovation

	All core NACE activities (n=4.923)	Innovation core services activities (n=2.138)	Innovation core business activities (n=546)	Computer and related activities (n=350)
Within the enterprise or enterprise group	56.16%	60.09%	70.29%	73.35%
Suppliers of equipment, materials, components or software	27.55%	30.08%	30.72%	29.48%
Clients or customers	32.43%	30.34%	37.99%	36.06%
Competitors or other enterprises of the same sector	8.09%	7.48%	9.58%	7.78%
Consultants, commercial labs or private R&D institutes	7.66%	5.46%	6.50%	3.70%
Universities or other higher education institutes	3.27%	2.59%	3.10%	0.00%
Conferences, trade fairs, exhibitions	5.70%	6.01%	3.72%	4.19%

Source: Eurostat

Important external sources of innovation are clients and customers. This is closely related to the importance of user driver innovation and user-producer interaction. Users in general, not only sophisticated users, are by the experts considered to be very important especially since this industry operates in a technological field that develops itself very quickly and because many products are customized to the needs of the individual user. By not following the users, it is very difficult to keep up and identify the overall needs in the market. Furthermore, the users in Denmark are in general very sophisticated. Denmark always scores high on computer use and broadband penetration. In addition the knowledge of the English languages, which within the world of IT seems to be of relative importance is strong. Furthermore, many people are used to interact in digital forms, not only to communicate but also in other forms of transactions. The issue is, however, that the supply of that what Danish companies offer is not very sophisticated.

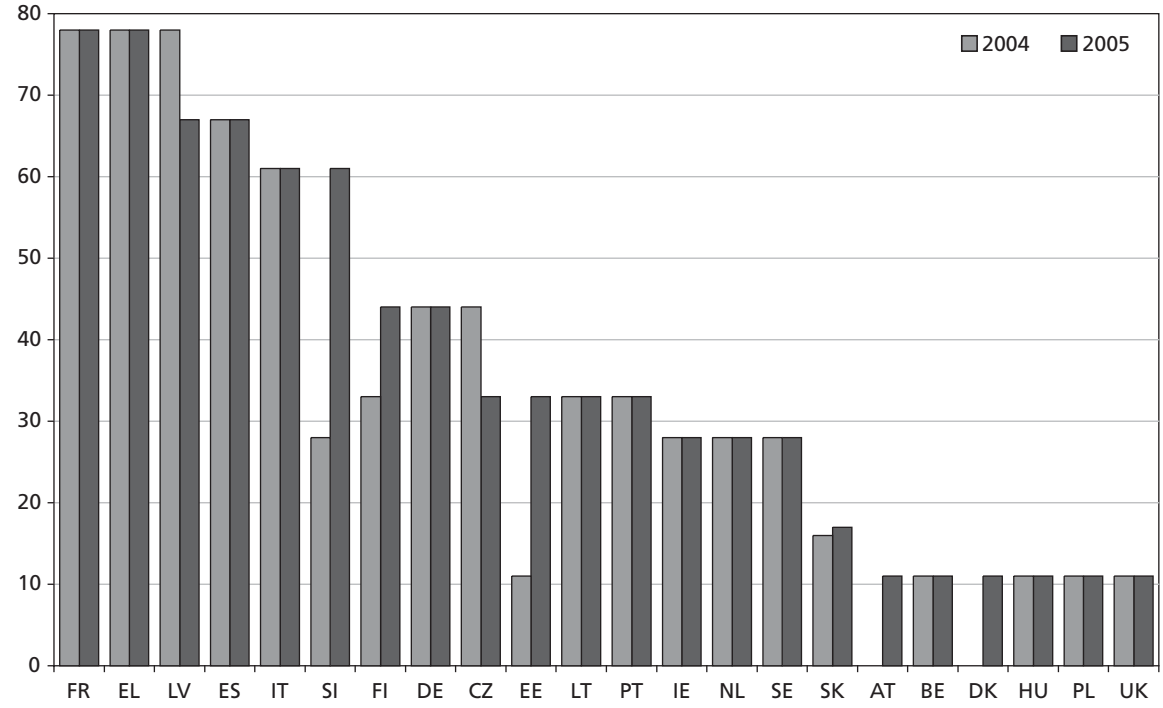
3.1.4 Institutional opportunities

Barriers for starting up a business in the sector are, just as in the entire economy, rather limited. Overall, there are not considered to be barriers that specifically apply for this industry. On the contrary, starting up in this industry is considered to be easier. The time it requires to start up a business is a matter of a couple of days compared to countries where it takes weeks and sometimes months and involves much bureaucracy.

The main barrier for starting up a business is the high level of taxes, not only for starting the business itself but also to attract qualified labour. Talented workers will not move to Demark and those who are in Denmark will move abroad to, e.g. the United States, an pay considerable less income taxes.

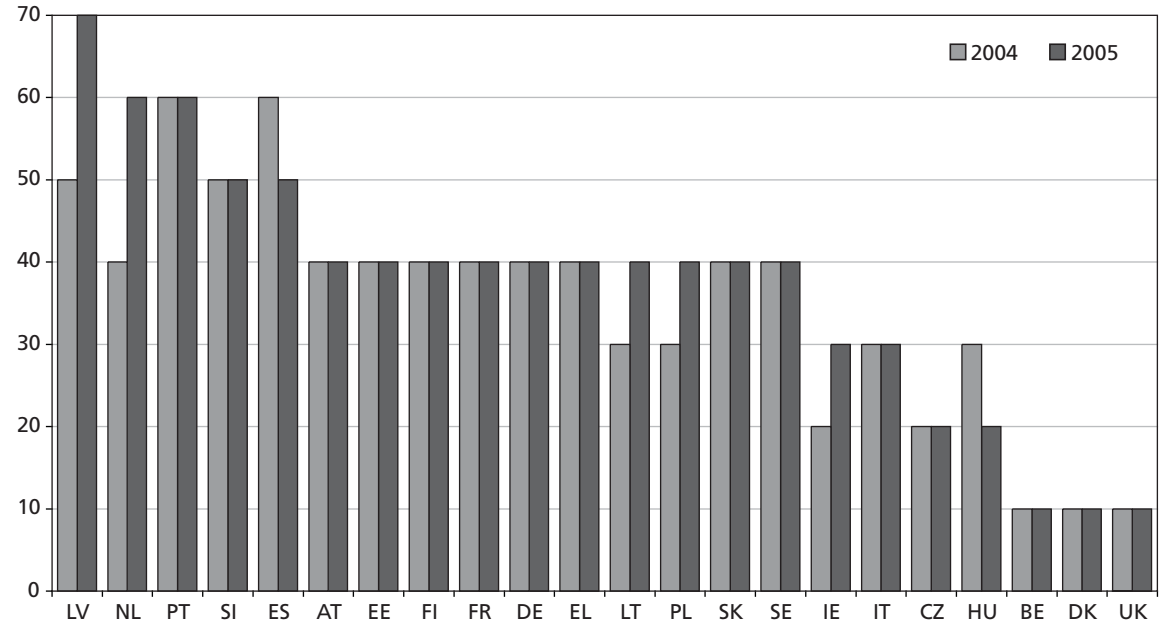
With regards to the labour market in general Denmark, as mentioned earlier, Denmark has a very flexible labour market where it is relatively easy to hire (Figure 19) and fire (Figure 20) individuals (Philips and Eamets 2007). This is also beneficial for start-ups as the risk of recruitment is low, i.e. the entrepreneur will recruit a person quicker because they will not be stuck with this person in times of economic hardship or when the employees' competences are not required anymore. However, the employment from talented foreigners, especially from countries outside the EU, is a problem due to time consuming process of receiving a residence and work permit. A general problem for small firms is to recruit high skilled labour because they are not familiar to this group while they would contribute positive to the growth of these firms. There are some public initiatives to provide support to small firms in recruiting high skilled labour.

Figure 19: Difficulty of hiring, by country, 2004 and 2005



Source: Philips and Eamets (2007)

Figure 20: Difficulty of firing, by country, 2004 and 2005



Source: Philips and Eamets (2007)

In terms of bankruptcies, there are not necessarily any problems. The only problem of bankruptcy is the barrier it creates to start a new business. Funding agencies, but also the social network of the entrepreneur, are not very tolerant towards failure. This means that an entrepreneur will experience difficulty in starting again. This increases the risk perceived by entrepreneurs to start a business as well.

Another overall barrier for entrepreneurship is the potential loss of income, especially for those persons that start from being wage earner in an established firm. Many of these persons have a job with a steady income, some owned a house, where married and had children. Due to the change into entrepreneurship they most likely will start with a considerable lower income and have to put their house and other assets on the line.

There are of course issues with IPR protection, however, this is not valid for this industry since the speed in which this industry develops there is not time to use much time on property protection. By the time a patent is granted the solution will already by yesterday's news.

There are many public support initiatives that have a regional character that support incubation and other entrepreneurship activities. However, a big potential for this public sector could be on the demand side. The public sector takes up 50 percent of the entire Danish economy and in this process they are a big user of services. However, as a small firm it is difficult to become a solution provider for the public sector. Public sector should therefore focus more on these small firms, especially those with growth potential.

There remain some overall socio-economic factors that create barriers for entrepreneurship. It is still considered a difficult step to move from an existing form of employment to starting up a business. Nevertheless, the image of entrepreneurship has changed over the years and people are more positive toward entrepreneurship than before. The challenge is now to create more high growth entrepreneurs, an area where Denmark is lagging behind. This also requires warming people up to start a more technology-based education. Nevertheless, the growth in the number of IT-based incubators and the IT oriented educations have definitely had an impact on the start-up rate in the industry.

3.1.5 Summing Up

Thus, overall, the industry Computer and Related Industries seems to be characterized as an industry with lots of opportunity of knowledge intensive entrepreneurial activities. It also shows that this industry is very active in terms of new venture creation, which also can be explained by the low entry barriers. It also shows that this industry is responsible for a relative high share of high growth start-ups in Denmark and (entrepreneurial) spin-off dynamics in the industry is an interesting characteristic of this industry, particular those spin-offs that come from the public sector and banking, which gives these new ventures a strong competitive edge. In addition to new venture creation, this industry is also above-average active with innovative activities. Based on the level of venture creation and innovation activities, it can be derived that this industry can be characterized by relative strong market opportunities. The indicators that are presented in Table 11 also confirm this. Possible inhibitors in relation to these market opportunities are the availability of venture capital, despite the fact that this availability has increased in the last couple of years. Furthermore, the public sector, as an important customer, could focus more on smaller firms in this industry.

Technological opportunities are also strong. There is a strong IT infrastructure not only in terms of technology but also regarding the availability of labour. The role of universities are important in delivering this labour and it also shows that the universities define the characteristics of the local labour market and for the same reason the regional activities that take place within this industry. Firms are very active in collaboration, mainly along the value chain. Finally the industry is relatively R&D intensive.

Institutional opportunities are not specific to the industry and have a rather general character. Overall these institutional opportunities are strong due to low administrative hurdles. Flexible labour market policies make it easier for new ventures to hire and fire, which might be have a positive impact on entrepreneurial activities, but the level of social security and the related high level of taxes might act as an inhibitor, i.e. lower level of necessity based entrepreneurship but also a low incentive to start a business due to high level of taxiation.

3.2 Danish Machine Tools

The second industry class that will be discussed in this document is machine tool manufacturing (NACE 29.4). This industry can be subdivided in three type of industrial activities, i.e.: 29.41 manufacturing of portable hand held power tools; 29.42 manufacturing of other metalworking machine tools; and 29.43 manufacturing of other machine tools. Compared to Computer and Related Activities, this industry is a remarkable small industry within the Danish context. The two databases that form the basis for the analysis of this sector, i.e. the Danish labour market database and the Danish company register, indicate there are, depending on the data source and year of observation, between 100 and 150 firms registered to be active in this industry class. Here I need to note that many of these firms have no or only a very few employees. However, other industries that are closely related to machine tool manufacturing are more represented in the Danish economy. In particular the position of machine tool wholesale is relatively strong, which might be an indication on the importance of foreign produced machine tools on the Danish market. The dominance of machine tool wholesale is illustrated by a remark made by the Danish Machine and Machine Tool federation (VOV) who stated that the majority of their members are wholesalers and only a small percentage of their members are machine tool manufactures. In addition, I identified 992 firms from the Danish company register that in their firm description mention that they are closely engaged with machine tools. The industries in which these firms are active are very broad and 460 of these firms are engaged in wholesale activities, both specialized on machine tools but also other wholesalers. Furthermore, during the latest edition

of the Danish machine tool fair, only four out of the approximately 100 stands at the were occupied by Danish machine tool manufactures.[15]

Other firms represented on this fair, in addition to the large number of wholesalers (in machine and machine tools), were other manufacturing firms and firms in IT and engineering consultancy firms. Based on the information on the website of these companies it was clear that they operate in close connection to machine tools, i.e. providing advice and software solutions.

The fact that there are hardly any machine tools manufacturing activities in Denmark does not mean that machine tools industry is not innovative or entrepreneurial. Just as in the case of Computer and Related activities, many of the entrepreneurial activities and innovation related to the activities in this industry are done in other (related) industry classes. By looking at the activities of some wholesalers, which is based on the description presented on company website and company reports, it is obvious that they are engaged in competence building and innovation to keep up-to-date with the new international developments in the market. They also provide knowledge intensive services to customers regarding installation and maintenance of the single machine tool and the design of the machine tool park. IT and engineering consultancy provide other types of knowledge intensive services in close relation to the machine tools. However, I will from now on focus on machine tools manufacturing.[16]

Due to the relative small size of the industry, it is a daunting task to find disaggregated statistical information on Danish machine tool manufacturing. Statistics Denmark has aggregated this industry class with the much larger machine manufacturing industry. Consequently, relying on these figures would immensely overestimate the role of machine tools manufacturing in the Danish innovation system. To provide some information on the machine tool industry I will rely on different data sources. The first data source is IDA, which is unusually rich and comprehensive data on the dynamics of the Danish economy. IDA combines information on individuals and plants from a variety of registers maintained by the Danish government. There are several important elements that characterize the data from IDA. First, IDA contains rich information on individual characteristics, including information on education (length and type) and work experience. Second, individuals in the labour force are matched to establishments and employers, which can be characterized in various ways, including industry affiliation. Third, the data are longitudinal, being updated annually since 1980. In addition, it is possible to obtain limited financial information.

Second, I obtained information on the plants that are active in machine tool manufacturing in January 2011 from the Danish company register (Navn og Numre Ehrverv). From this database it is possible to select firms based on their industry code. In total I identified 144 different firms that are reported to be active in machine tool manufacturing (a list of these firms is included in the appendix). For some firms machine tool manufacturing is not their main activity. An advantage of this register is the possibility to identify who these firms are and what kind of activities they undertake. It shows, which is also confirmed by the company interviews, that machine tool manufacturing is a very diverse kind of industries where many firms operate on a niche market. So, despite being active in the same industry class, many firms do not operate in the same product class and are for that reason not competitors.

[15] www.vtm2011.dk

[16] Other industry that are closely related are reparation of machines, machine manufacturing, tools manufacturing, IT and engineering consultancy; however, it is not possible to isolate the machine tool manufacturing component and can for this reason not be identified inthe overall industry statistics.

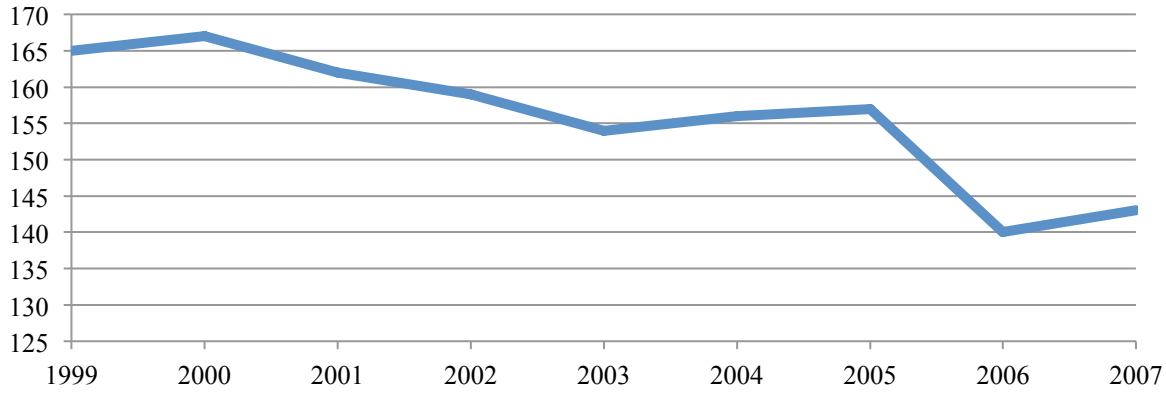
Furthermore, firms seem to deliver to a various sets of customers who are active in a diverse set of industries located both in Denmark and abroad.

For the interviews, I contacted a range of organizations (e.g. Danish Metal, Danish Industry, and even the representative for the Danish Machine Tool Federation) to inform if they have employees in their organization that could be considered to be experts within this industry or if they could provide me with names of people that otherwise could be regarded as experts. However, due to the relative small size of the industry and the dominance of machine tool wholesale, there is not an individual that considers themselves expert on the Danish machine tool manufacturing. Consequently, I selected, based on the Danish company register, a set of firms active in this industry to provide us with the necessary information. To have a spread of companies I decided to select medium large and large firms (>50),[17] and a newly founded firm.

3.2.1 Entrepreneurial activities

In order to identify the entrepreneurial activities in this industry class, I will start with identifying the number of firms that are active in this industry (see Figure 19). There is a strong decline in the number of firms in Denmark that are active in this industry class. This decline is a general pattern in the Danish economy where manufacturing, mainly due to the high cost of labour, lose a competitive edge. In addition, more firms engage in moving business activities abroad. This has an impact on how firms are classified since this depends on the level of value added the activity has within Denmark, e.g., a firm that offshored all production will not be classified as a manufacturing company but as a wholesaler or an industrial design company.

Figure 21: Number of Firms in Machine Tool Manufacturing



Source: Eurostat

To better estimate the activities within machine tool manufacturing, I did not only select those firms that are active in the manufacturing of machine tools but also plants that are reported to be active in this industry class. A plant is an organizational unit with its own type of activities and/or geographical location. Consequently, one firm can consist out of multiple plants. A problem with that arises is that firms are classified in only one industry class, i.e. that industry that generates the highest value added. Consequently, some firms might have some activities in the manufacturing of machine tools but are not classified as being active in this industry

[17] There is only one firm active in machine tools manufacturing in Denmark in 2011 that has more than 100 employees.

class because the most value added is obtained by wholesaling activities. In this case firms will be classified as being active in NACE 51.61. To illustrate the latter, from the Danish company register I could find 144 firms that are reported to be active in the manufacturing of machine tools at the start of 2011. However, 40 of those firms are active in multiple industries, industries that vary from software and R&D to wholesale and other manufacturing activities. In some of these cases the manufacturing of machine tools is not their major activity. Table 15 shows how many plants are registered in IDA to be active in machine tool manufacturing. In addition, it indicates how many firms own at least one plant that is active in this industry class (it might be that the firm as a whole is classified in a different industry class). These numbers are significantly lower compared to the number of firms found to be active in the manufacturing of machine tools in Figure 19. An explanation for this difference is that IDA only reports those firms that have at least one employee and have a minimal level of economic activity. A relative large number of firms in the Danish company register do not have information on the number of employees. Second, there is a triviality limit, which means that firms have to have some kind of economic activity before they are visible in IDA. Nevertheless, one might question the relevance of firms that have a low number of employees in particular in an industry as machine tool manufacturing.

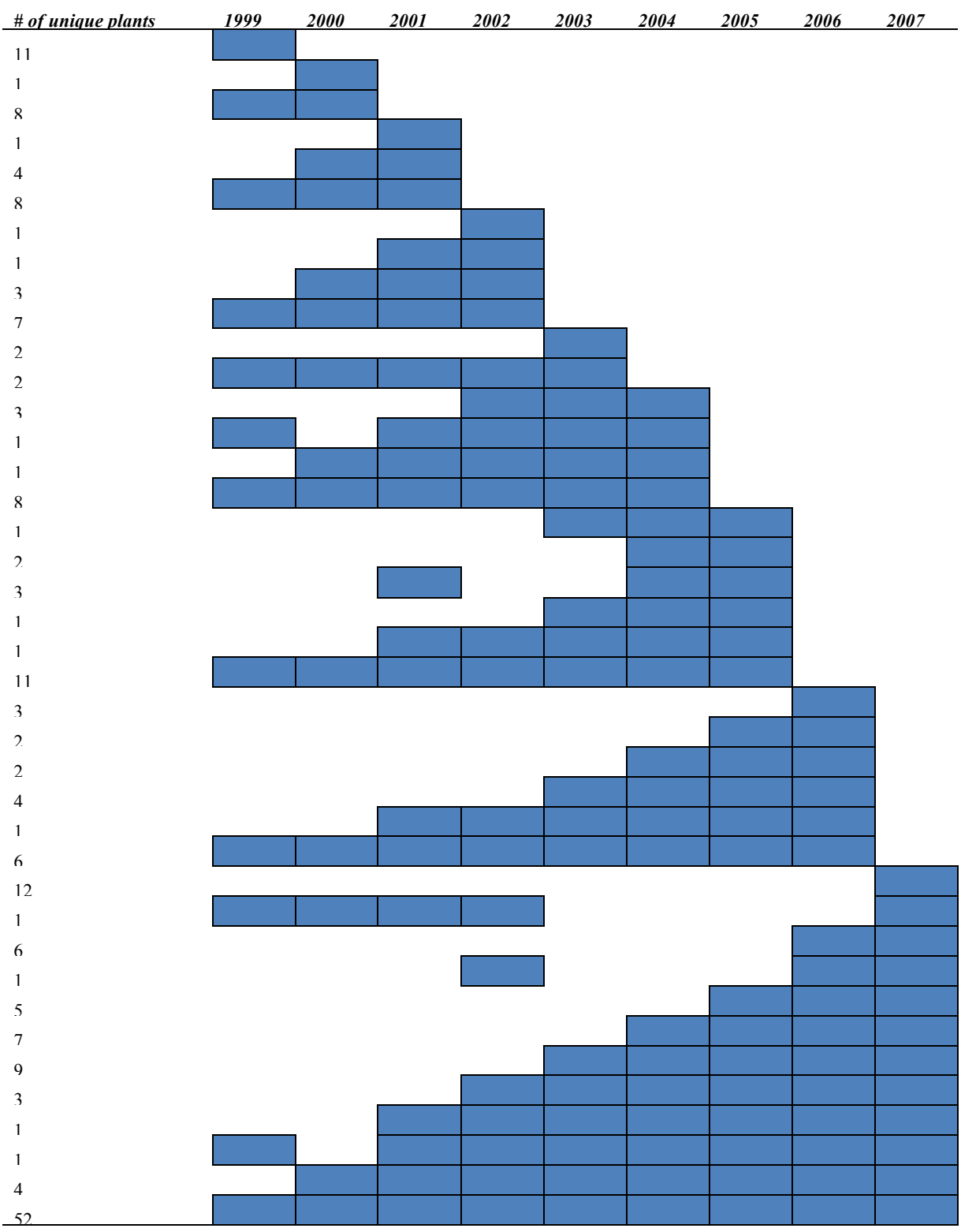
Table 15: Plants and firms with activities in machine tool manufacturing 2000-2007

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Plants	116	116	117	109	112	121	116	107	102
Firms	113	113	112	107	110	117	111	104	99

Source: Statistics Denmark

In Table 16, I present a more dynamic picture of the number of plants that were active in the industry in any given year between 1999 and 2007. In this table it shows when the plants where active and how many firms appeared and disappeared from the industry. First, from this table it shows that over the period 1999-2007 I can identify 201 unique plants, i.e. unique plant identification numbers that can be found in this period. In 1999, a total of 116 plants were active, a number I also presented in Table 15; however, this table also shows that 11 plants that were active in 1999 are only present in 1999 and disappeared the year after. Roughly a quarter of these firms have present over all the years and as also show in the table above, 102 plants can be identified in 2007. Within this period of time a total of 83 plants have appeared but 99 have disappeared again. Consequently, the number of plants and firms has slightly decreased over the years.

Table 16: dynamics of plants in machine tool manufacturing 2000-2007



# of unique plants	1999	2000	2001	2002	2003	2004	2005	2006	2007
# of plants	116	116	117	109	112	121	116	107	102
plants entering the industry		13	10	8	17	14	7	10	13
new established plants		5	2	5	9	5	3	5	4
ownership change		5	1	3	3	1	3	3	1
disappeared plants		13	9	16	14	4	13	19	18

Source: Statistics Denmark

Concerning the number of new firms and plants, I have to make a distinction between two different types of newness. First, there are plants that are newly founded and are active in the industry. This is easily identifiable since the first four digits of the plant identification number indicate the year in which it appears for the first time. However, a new identification number does, due to the complexity of what constitutes a new plant, not necessarily mean a 100 percent new plant. It can also mean that the characteristics of the plant have significantly altered compared to the previous year, e.g. a combination of change in ownership, significant change in the number of employees, active in a new industry, reallocated to a new geographical location, and a split up from an existing plant. A change of only one of these factors does not change the plant identification number. [18] The number of new plants, i.e. plants that are indicated as newly founded, is very low, i.e. on average just over four plants each year, which would be a start-up rate of approximately four percent (remember that these are plants, which can also mean that existing firms found a new plant although in this case the new plants do not have affiliated plants and can therefore be regarded as new firms).

Second, there are the firms that have been active in other industries and who did not experience a large enough change to receive a new plant identification number.[19] Nevertheless, these plants entered the machine tool manufacturing industry. Combined with the new established firms, an average of 11.5 plants appear in the industry in any given year in the period 1999-2007. The majority of plants are, however, not new but move into the industry after having been active in another industry class. In addition, it can be observed that in total 20 firms over this have remained the same but had a change in ownership, which means that they have been sold or issued stocks and changed ownership structure during that period.

The death of plants, just as their birth, is also a fuzzy concept. Overall, there is a decline in the industry in terms of number of firms. On average, 13,25 plants disappear each year between

[18] Timmermans (2010) discusses in more detail when firms and plants change identify. In short, IDA follows a person oriented approach towards change. Consequently, an establishments identification number stays the same from one year to the other whenever one of the following criteria is fulfilled:

1. a plant has the same owner and is active in the same industry;

2. a plant has the same owner and the same labor force; or

3. a plnt has the same labor force and is located on the same address or is active in the same industry.

Denmark Statistics follows a strict definition on what is meant with the same owner, same industry, same address, and same labor force. The owner of the plant is the same whenever the firm identification number is the same from one year to the other. A firm is active in the same industry when the four-digit NACE industry code remains the same between the two consecutive years and the same plant address is rather straightforward. The definition of the same labor force varies between bullet points two and three. In point two, at least 30 percent of the labor force should be present in one of the two years. This means that either 30 percent of the employees that worked in year 1 should be present in year 2 or 30 percent of the employees in year 2 should have been present in year 1. In bullet point three, when there is a change in ownership, at least 30 percent of the employees should be present in both years. This means that 30 percent of the employees that worked in year 1 should also be present in year 2 and 30 percent of the employees in year 2 should have been employed in the establishment in year 1. The definition of the same labor force is more restrictive in bullet point three.

[19] It is important to note that each plant is indicated to be active in only one industry class. In reality a firm can be active in multiple industry classes. However, IDA only reports that industry in which the firm has reported the highest value added.

1999 and 2007. These plants might not disappear permanently as some plants return after one or more years of absence. Furthermore, plants might still exist but have exited the industry.

As mentioned earlier, the Danish official company register identifies 144 firms that are active within machine tool manufacturing. From this cross sectional register I can obtain the founding years of the firm. Based on these numbers it appears that a large share of firms has been founded in the period 1999-2010, i.e. a total of 73 firms. However, there are two reservations I have regarding these number. First, many of these firms are very small or do not have any employees; it is questionable on how many of these firms are actively engaged in the manufacturing of machine tools. Second, for 51 firms I have the possibility to check the reported founding year with the founding year mentioned in their historical records that are presented on the company website. From the 20 firms that based on the database are founded in the period 1999-2010, only four indicate this on their website. The remaining 16 firms present founding dates that go back further in time. Furthermore, for almost all firms the dates reported in the database are different compared to the information on the history of the firm reported online. The majority of these firms state to be founded in the 1970s and 1980s. Making it a very mature industry.

One explanation for the difference is that with a change in ownership, e.g. change from sole proprietorship to public offering, the firm receives a new founding date. Furthermore, some firms might have completely altered their focus over time. Some firms were not active within machine tool manufacturing at founding. The low number of start-ups in the industry is, however, not surprising. Starting up a business in this particular industry requires capital and the availability of relatively large buildings for manufacturing, which leads to high barriers of entry. This also explains that some new entrants in the industry are required to take over an already existing firm. Furthermore, due to the need of factory space, incubator will be relatively limited, or maybe even non-existing, within the manufacturing component. Those incubator activities that are related to machine tool manufacturing are most likely activities related to the design of machine tools.

However, there are more, in similar fashion as the IT industry, many entrepreneurial activities related to machine tool manufacturing that does not take place within the machine tool manufacturing industry classification. There are, according to representative of the start-up in machine tool manufacturing, many people that like to enter into machine tool manufacturing. A large share of these entrepreneurs will start a business in designing and providing consultancy services regarding machine tools. The latter requires considerable fewer investments since it requires computer equipment and the necessary software and the necessary competences to adequately design such type of machine and provide; in addition, you do not need a factory, employees that can make the machine tools. Thus, there might be many (knowledge intensive) start-up activities connect to machine tool manufacturing but because these start-ups are not engage in manufacturing they will not appear in industry class 29.4.

These start-ups are, however, face challenges due to the close link that exist between design and manufacturing of these, often specialized and custom-made, machine tools. This requires their close contact to customers and experience in the industry. Industry experience is therefor an important characteristic of the entrepreneur within this industry. Mainly because according to their judgment starting without an existing network of suppliers and customers, it is nearly impossible to successfully start your own business.

Another observation when looking at the various websites of machine tool manufacturing, and which the representatives of the company confirmed, is the diversity in type of machine tools these firms produce. Some firms deliver to large firms (it remains a industry that delivers products to other manufacturing firms), other to small firms; in addition, some machine tool manufacturing firms produce sophisticated high tech machine tools while other

firms produce less sophisticated machine tools. Furthermore, these firms deliver to a broad range of industries varying from high tech like medical and optical instruments to metal and plastic industries and saw mills where some firms focus on the Danish market while others operate internationally al depending whether the industry they supply to is active on the Danish market. Consequently, it is difficult to picture a general growth pattern of firms because it is very dependent to all of the above-mentioned patterns.

3.2.2 Market Opportunities

As observed in the previous section, the number of manufacturing firms in machine tools has been decreasing, which might be regarded as a strong signal on the relative weak demand side activities from the perspective of Danish manufacturing firms. This is even more so when looking at the other indicators presented in Table 17. On the majority of indicators there is a declining performance. Up to the break, which can be observed in 2004, there is a persistent negative trend in practically all indictors.

According to the representative of the new entry, the demand for products is rather conservative, which caused a big hurdle for them in becoming successful. Customers were reluctant to change their supplier, which was the parent company of the new venture, despite the fact that they offer a, technological superior, which better fitted the demands of the customers. The company representative of the larger confirms this close link to customers and firms in the industry.

Due to the earlier mentioned diversity in type of machine tools and the high degree of custom-made solutions, it is difficult to characterize the typical customer in the industry. The majority of customers are manufacturing firms. These firms can be large or small, be active in high-tech and low-tech industries and be active within Denmark or abroad. Nevertheless, as mentioned by the representative of the new venture, many relations that exist between customer and machine tool manufacturer are based on long term contract, which include an advisory role on the use of the machine and the after sales services. For new entrants in the market it is for that reason difficult to enter the market because interaction often occurs based on strong existing relation.

Furthermore, the level of buyer sophistication also varies. Some customers, mainly the heavy users, know exactly which functions the machine should have. These users are also more familiar with the functionality of the machine than then the machine tool manufacturer itself. In the manufacturing of this machine tool and innovation processes related to these machines, these customers are narrowly involved. Other firms, those that are new in the market or not heavy users, are less sophisticated and rely on the machine tool manufacturer to act as a consultant to provide the solution necessary.

As indicated in the start of Section 3, there are many firms active in industries that are closely related to machine tool manufacturing. The largest industry is machine tool wholesalers, i.e. firms that import machines from abroad and sell it on the Danish market. This might give rise to foreign competition on the market for machine tool manufacturers.

In terms of the price of input factors and taxes the overall issues remain in particular to remain competitive with foreign manufactures. First, the high level of wages that puts pressure on the competitive advantage in relation to pricing. Second, the taxes are relatively high in Denmark. This is a problem that is felt broadly within manufacturing industries, not only in Denmark but also in other North-West European countries. Offshoring is a common day practice, which adds to foreign-based pressures on the Danish market. Nevertheless, the company representatives do not see this as a large threat as their main competitive edge is not price but rather quality, know-how and technological advancement. The solutions many machine tool manufacturers offer focus on a niche market and might be able to justify a higher price compared to foreign product. The company representatives argue that those firms

that are not active within a niche market, or a niche market where the product is easy to copy and does not possess a high level of know-how will not remain active for long in Denmark. Many of these firms are due to, e.g., labour cost to close down or move their production to low cost countries.

Table 17: Indicators for market opportunities in machine tool manufacturing

	2000	2001	2002	2003	2004	2005[b]	2006	2007
number of enterprises	167	162	159	154	156	157	140	143
turnover	251.7	314.6	253.4	245.9	n/a	338.4	356.3	349.9
production value	246.0	305.6	236.7	229.8	n/a	319.2	337.9	330.8
value added at factor cost	107.9	128.9	104.5	101.0	n/a	133.0	122.2	138.5
value added at factor cost in production value	43.9	42.2	44.2	43.9	n/a	41.7	36.2	41.9
gross value added per employee	49.5	50.4	53.2	52.1	n/a	63.5	65.4	74.0
gross value added per employee FTE	55.0	53.6	55.8	54.5	n/a	69.4	75.9	82.7
gross operating surplus	29.6	31.3	24.2	19.0	n/a	37.3	41.6	49.4
change in stocks of finished products and work in progress manufactured by the unit	0.1	2.6	-1,0	0.4	n/a	-4.2	0.0	2.1
turnover from principal activity at the NACE Rev.1 4-digit level	241.6	287.9	230.0	221.9	n/a	309.6	320.3	299.9
turnover from trading activities of purchase and resale and intermediary activities (agents)	10.2	26.8	23.4	24.0	n/a	22.8	35.9	49.9
turnover per person employed	111.9	119.9	125.3	123.7	n/a	157.9	186.0	182.5
share of value added in manufacturing total	0.4	0.5	0.4	0.4	n/a	40.5	0.4	0.5
share of production value in manufacturing total	0,3	0.4	0.3	0.3	n/a	0.4	0.4	0.4
share of turnover in manufacturing total	0.3	0.4	0.3	0.3	n/a	0.4	0.4	0.4
gross operating surplus/turnover (gross operating rate) %	11.7	9.9	9.6	7.7	n/a	11.0	11.7	14.1
share of gross operating surplus in value added	27.4	24.3	23.2	18.8	n/a	28.1	34.0	35.7
total purchases of goods and services	147.6	n/a	149.0	147.1	n/a	203.1	243.0	219.9
purchases of energy products	1.9	2.8	1.9	2.2	n/a	3.1	4.0	2.0

[b]: *Break in the data.*

Source Eurostat

Regarding financing, there seems to be no indication that venture capital funds are actively targeting these types of activities. Public venture funds are often connected to incubator environments, which hardly harbour these manufacturing activities. Furthermore, the decline in the sector would make the sector as very risky. There is potential finance in the form of EU projects or other public investment initiatives like the different growth foras but such types of funding are by both company representatives regarded as very cumbersome to administer and difficult to obtain.

Table 18 presents the indicator on financing of the innovation process. Again there is a break in the data but overall the indicators show a downward trend over the years. However, the representative from the new start-up stated that they received relatively easy access to a bank loan. This loan was supplemented with a small investment from a person who could be regarded as a business angel, a person who has competences within business. This competence was lacking according to the entrepreneur. Finally, they were required to invest their own money into the new venture. Larger firms use internal finance.

Table 18: Indicators of financing of the innovation process

	2000	2001	2002	2003	2004	2005	2006	2007
Gross investment in tangible goods	10,4	12,6	10,9	9,9	n/a	19,6	17,4	7,9
net investment in tangible goods	8,5	11,1	9,5	7,3	n/a	18,1	15,5	6,2
Gross investment in machinery and equipment	7,3	12,0	7,8	8,6	n/a	17,7	11,8	6,4
payments for long term rental and operational and financial leasing of goods	0,5	0,6	0,2	1,5	n/a	0,3	2,6	0,8
investment per person employed	4,6	4,8	5,4	5,0	n/a	9,2	9,1	4,1
investment rate (investment/value added at factor cost)	9,7	9,7	10,5	9,9	n/a	14,8	14,2	5,7

Source: Eurostat

According to the company representatives, it is relative difficult to hire skilled labour. Not necessarily that they have the wrong type of education, firms recruit machine engineers with the right educational qualification and industry related experience, but rather that the products these firms produce are highly specific and that is why they need to be trained within the firm. Mainly because there is not enough critical mass in terms of firms and potential workplaces for education institutes to focus on these specific type of skills. Furthermore, they foresee a problem in the nearby future to attract young engineers since this skilled labour is more interested to work for other "more sexy" industries. They assess this to be a general problem in the industry.

In terms of support programs, the company representatives indicate that general support programs (e.g. help in export, knowledge sharing, etc.) are in place. Nevertheless, they also see that such programs are accompanies with an administrative burden, which affects their and other firm's participation in such programs.

Other provision of knowledge is very company specific. Some firms actively engage in collaboration with universities and research institutes while other machine tool manufacturing

firms do not. This is very dependent on the experiences, size but also the specific characteristic of the product and the level of product development.

3.2.3 Technological Opportunities

As mentioned on several occasions in this document, the industry structure is very diverse. Most firms in the industry are small and medium sized enterprises; there are hardly any firms that have more than 100 employees. Some of these small and medium sized enterprises are regarded international market leader within their niche while other firms have a strong regional focus. Innovation strategy is important to remain competitive particular on technology but also innovation to lower price since but remain quality because it is difficult to compete solely on price to the high cost of input.

How the absorption of new technology in the industry is closely related to the decline of firms that are active within the industry. The numbers presented in **Table 19**, which are not available for all years, shows a decline in all variables. Expenditures in R&D have been less in 2007 compared to 2006. And this declines is also visible when looking at the number of R&D personnel where not only the absolute number has decreased (halved within a year) but also the percentage. Patents at the European Patent Office have been declining from 8 patents per million habitants in 2000 to 5 patents per million habitants in 2006 while USPTO patents is lower in 2003 compared to 2000.

Table 19: Indicators of knowledge development and diffusion

	2000	2001	2002	2003	2004	2005	2006	2007
Share of R&D expenditure in value added	n/a	n/a	n/a	n/a	n/a	n/a	8.2	5.3
Total intra-mural R&D expenditure	n/a	n/a	n/a	n/a	n/a	n/a	10.0	7.3
Total number of R&D personnel	n/a	n/a	n/a	n/a	n/a	n/a	173	87
Share of R&D employment in the number of persons employed (%)	n/a	n/a	n/a	n/a	n/a	n/a	9.0	4.5
Total number of researchers FTE	n/a	n/a	n/a	156	n/a	167	128	n/a
Patent applications to the EPO (per million habitant)	8.231	6.643	6.783	7.597	7.648	7.613	5.223	n/a
Patents granted by USPTO (per million habitant)	2.865	3.079	2.633	2.522	n/a	n/a	n/a	n/a
Sales of tangible investment goods	1.9	1.5	1.4	2.7	n/a	1.6	1.9	1.7

Source: Eurostat

In terms of competence building the company representatives painted each a different picture. The representative of the established firm had the opinion that training and development is an important strategy for the firms in the industry to bring the know-how, which was regarded as an important asset that gives this firm the competitive edge, on a satisfactory level. The new start-up indicated that it is an important task but the financial means for a start-up are limited to engage in any formal type of training. Most employee development is done by on the job learning. Again, just as many factors, there appears to be a different strategy in different type of firms. Based on the company description of some firms in the wholesale, they are engaged in training by the manufacturers so they are able to provide the necessary advice regarding the product to their customers.

According to the representative established firm in the industry is it also important to have a professional board. Many small and medium sized enterprises have a board that consist of people that are closely connected to the management but do not have an understanding of the product or the market in which the company operates. To have a professional board has proven to be a valuable asset in the development of the company, both in terms of entering into new markets but also in terms of developing the innovation process.

Indicators on competence building are presented in Table 20. When ignoring the break in the data in 2004, there is a declining pattern visible on almost all indicators. This declining trend is to be expected given the overall state of the industry. The variables that indicate labour costs have increased, which provides a better picture on that what the company representatives have indicated and which puts competitive pressures on firms that are active within the industry.

Table 20: Indicators of competence building

	2000	2001	2002	2003	2004	2005	2006	2007
Number of employees	2179	2556	1966	1939	n/a	2094	1869	1872
Number of part-time employees	231	252	188	158	n/a	202	206	208
Number of employees in full time equivalent units	1960	2404	1872	1852	n/a	1917	1611	1676
Growth rate of employment (%)	0.10	16.7	-23.0	-1.70	n/a	n/a	-10.6	0.10
Number of persons employed per enterprise	13.5	16.2	12.7	12.9	n/a	13.6	13.7	13.4
Share of employment in manufacturing total	0.5	0.5	0.4	0.5	n/a	0.5	0.5	0.5
Personnel costs	78.3	97.6	80.3	82.0	n/a	95.7	80.7	89.1
Share of personnel costs in production (%)	31.8	31.9	33.9	35.7	n/a	30.0	23.9	26.9
Average personnel costs (costs per employee) (thousand euro)	35.9	38.2	40.8	42.3	n/a	45.7	43.2	47.6
Labour cost per employee FTE	40.0	40.6	42.9	44.3	n/a	49.9	50.1	53.2
Share of personnel costs in total purchases of goods and services	53.0	n/a	53.9	55.7	n/a	47.1	33.2	40.5
Employer's social charges as percentage of personnel costs	5.5	5.4	5.8	5.9	n/a	6.2	7.2	7.1
Apparent labour productivity (gross value added per person employed)	47.9	49.1	51.7	50.8	n/a	62.0	63.8	72.3
Wage adjusted labour productivity (apparent labour productivity by average personnel costs %)	133.4	128.5	126.6	120.2	n/a	135.8	147.9	151.8
Share of principal activity in turnover (degree of	96.0	91.5	90.8	90.2	n/a	91.5	89.9	85.7

specialisation)

Source: Eurostat

Based on the information obtained from the website many firms are engaged in manufacturing of their own machines. However, since some firms are a combination of wholesale and manufacturing they also sell machines of other international manufacturers.

The collaboration of firms in this industry varies depending on the type of product they produce. Based on the interview with the company representatives, they assess the collaboration with both suppliers and customers to be very important in the process as a whole but in particular regarding innovation. Users of the machine tools have, as mentioned earlier, due to their daily contact with the machine at one point a better understanding of the potential of the technology than the manufacturers. Interaction with users is into the innovation process is therefore, at least by the company representatives, regarded as crucial and detrimental for success. As many firms buy readily made parts from their supplier it is important to be in close collaboration with them as well. Particularly to engage in quality improvement being one of the main factors on which they compete.

All depending on the activities and the size of the firm, there are firms that engage with collaboration with universities and other knowledge institutes. However, one company representative mentioned the relative high cost of collaborating with these knowledge institutes. Collaboration can take several firms, some collaborate on specific projects related to the product others use the collaboration to identify new opportunities.

The degree of international collaboration varies per firm all depending on the international character of the organization. The representative of the established firm indicated that over 90 percent or their products are sold internationally and that they collaborate intensively with international customers but also international suppliers. The interaction with knowledge providers was, however, locally organized with the nearby university. The new established firm was not very active internationally and only collaborates with local suppliers, customers and knowledge centers.

3.2.4 Institutional opportunities

The institutional opportunities within this industry are not very different compared to the overall institutional opportunities. As mentioned earlier, barriers for starting up a business in the sector are, just as in the entire economy, rather limited. Overall, there are not considered to be barriers that specifically apply for this industry. Although starting up in this particular industry requires considerable level of investment, which might, due to the lack of a strong venture capital market, be rather limited. Alternatively, start-ups occur in related industry, e.g. consultancy and design related to machine tools.

Also here, the flexible labour market, as shown in Figure 19 and Figure 20, creates a relatively ease for employers to hire and fire individuals. This is also beneficial for start-ups as the risk of recruitment is low, i.e. the entrepreneur will recruit a person quicker because they will not be stuck with this person in times of economic hardship or when the employees' competences are not required anymore. Nevertheless, the supply of skilled labour in this industry and engineers in particular might be an issue and so is the relative expensive labour cost is an issue in this industry and affects the international competitive position, which presses firms to engage in global sourcing or even offshoring strategies. Despite the high labour costs, firms are aware that their main competitive edge is know-how, technology, and quality.

The issues regarding bankruptcies are also valid here. There are not necessarily any problems relation to filing bankruptcy; however, the impact might be stronger since the level of investments is relatively high. Furthermore, the chance for bankruptcy remains a barrier to

start a new business. This might explain why some people will not start up within manufacturing but more within a related industry, e.g. design of machine tools. Overall, funding agencies, but also the social network of the entrepreneur, are not very tolerant towards failure. This means that an entrepreneur will experience difficulty in starting again. This increases the risk perceived by entrepreneurs to start a business as well.

Compared to the IT industry, there are more activities in relation to IPR protection. There are no real barriers to obtain a patent in the Danish context. A challenge is, however, how to enforce a patent in foreign market, mainly in Asia. The public support initiatives that exist are of a general character. A problem that has been identified is the cumbersome administration that follows these public support initiatives.

3.2.5 Summing Up

As observed, the industry in the Danish context is relatively small and declining. In addition, there is a high level of diversity in the type of machine tools these manufacturers produce. New venture creation is a rare phenomenon in the industry, which can be explained by the relative high barriers of entry, i.e. building, equipment. Those people that would like to be active in machine tools will buy an already existing companies or will choose those activities that are closely related to machine tools but with relative lower entry barrier, e.g. design of machine tools. This also explains why related industries, e.g. wholesale and design, are larger compared to manufacturing. There is, as the firm representative pointed out, a symbiotic relation between design and manufacturing.

The relative weak market opportunities are sketched in the different indicators, which are almost all declining and have low values. The industry suffers several challenges relating to market opportunities. First, A challenge new firms encounter rather conservative customers, i.e. customers have a degree of solidarity towards supplier of machine tools. Firms are aware that it is difficult to compete internationally but they are also of the opinion that Danish firms in the industry can outcompete lower wage countries with know-how, technology and quality of products.

The firms in the industry consider collaboration along the value chain as very important although the level of sophistication from customers varies considerably. In many cases, the firms offer package solution, i.e. not only the machine tool but also consultancy services around it. Despite that the representatives of the industry consider innovation important, the firms in the industry invest in R&D but the share is lower compared to the leading countries in machine tool manufacturing. Overall, the levels of technological opportunities are decreasing according to the indicators. There is less competence building, it is difficult to find skilled labour in Denmark and the high level of taxes combined with the strict immigration laws create difficulties in getting international labour. There are no technological institutes focusing on this industry although the high-technology end of the industry collaborates with industry in the form of projects.

ON the level of institutional opportunities there is not much to mention that is specifically valid for this industry. This industry has not specific position in the Danish economy. However, the normal challenges relating to high taxes and flexible labour markets are mentioned and also the support framework. A problem what these industry mentioned is, however, the costs associated with obtaining exports grants and the participation in larger projects.

4 Synthesis: Entrepreneurial Propensity of the Danish Innovation System

In this deliverable, I have discussed the Knowledge-Intensive Entrepreneurship and entrepreneurial opportunities, divided in technological, market and institutional opportunities, at the overall level of the country and on the sectoral level where I focused, as agreed with the other participants of the work package, on two very different industries classes, i.e. Computer and Related Activities (NACE 72) and Machine Tool Manufacturing (NACE 29.4); where Computer and Related Activities remains, as it has been for several years, growing industry, also in terms of entrepreneurial activities, and machine tool manufacturing can be regarded as an industry in decline where activities seem to rapidly disappear and where entrepreneurial activities might be found in other parts of the value chain. In this synthesis section, I will discuss the entrepreneurial propensities within the Danish innovation system and whether this system is supportive in creating knowledge intensive entrepreneurship by connecting the results found on the national and the sectoral level.

Overall, Denmark scores high on innovation ranking as it has done for many years. Due to the fact that there is a strong overlap between how the innovative performance and entrepreneurial propensity is measures it is therefore not surprising that Denmark ranks high on this ranking as well. Also in this case, its fellow Nordic countries, i.e. Finland and Sweden, outperform Denmark in both overall innovation performance but also on the index knowledge intensive entrepreneurship (IKIE). The components that made up this where New Enterprises (NE), New Technology and Innovations (NTI) and Knowledge Intensity (KI). These components provide us an insight in how Denmark is performing, where its strengths are and what can be improved.

Compared to the rest of the EU27, Denmark scores relatively low on the ranking considering New Enterprises. These ranking are rather ambiguous since some scores shows that Denmark scores on top while other show that Denmark occupies the lower positions. However, many western countries have a low ranking which could provide an indication to the motives for starting up a business. The entry of firms should not only be assessed by looking at the number of start-ups but also whether these start-ups are necessity or opportunity based and to which extend these opportunity based start-ups are knowledge intensive. Studies in GEM show the relative low number of necessity based forms of entrepreneurship. This can be attributed to the Danish institutional framework where necessity based entrepreneurship is kept relatively low and might explain the low score on this indicator compared to many eastern European countries. Furthermore, entrepreneurial activities and opportunities ascribed to a specific industry present itself only partially within this industry classification. Both the industry studies present evidence of this fact.

Many entrepreneurial and innovative activities within IT occur in other industries while many entrepreneurial acts and knowledge intensive tasks related to machine tool manufacturing occur in other parts of the value; therefore, these activities also take place in other industry classes, e.g. wholesale and industrial design. Thus the growth of knowledge intensive entrepreneurship in this industry might be higher than what the industry data presents.

In addition, it has to be noted that the start of a business is regarded as an alternative to other career choices and might be closely relate to the organization of work, i.e. when wage-earners have the possibility to be creative in their work and in that way act entrepreneurial there might be a lower incentive for these individuals to engage in starting up a business. Entrepreneurial acts of wage-earners often fall under the corporate entrepreneurship category, a type of entrepreneurship that is high within the Danish context but is included in the start-up indicator. Nevertheless, in Denmark, there has been an increase in entrepreneurial activities

and the attitude towards starting a business has improved. Also here, the institutional framework, i.e. the ease to start a business, can be considered an important factor.

The start-up is not the only factor that is of importance. It is important to see the survival rate as well. In the Danish context the survival rate is just below 50 percent and which is comparable to countries like the Netherlands and Finland. In terms of young firms, i.e. firms less than five years of age, Denmark scores relatively high compared to comparable economies. Nevertheless, there are industry differences in stating how important survival is. Firms might deliberate choose to close down the firm. As explained, some firms have an active exit strategy to sell the firm to a larger player. Consequently, the technology behind the start-up survives and might even have a better chance of survival.

The level of innovative firms and the innovation expenditures, i.e. the indicators in the NTI component, are high in the Danish setting. Not as high as in some other countries but Denmark can still be regarded as one of the innovation leaders. However, not all industries seem to contribute to this high ranking as can be illustrated with the machine tool manufacturing. On all the indicators, the performance weakens both absolute but also relative as percentage of total activities within the industry. True, manufacturing activities in general and machine tool manufacturing firms face challenges, many of which are related to the relative high cost of input factors. However, the company representatives indicated that they undertake innovation efforts and focus on know-how and quality since they see this as the main approach to remain internationally competitive. Other firms might change tasks and outsource or offshore production functions; due to this process these firms are no longer classified as manufacturing firms but might still exist and engage in activities that are more value added oriented, e.g. R&D, design, or sales. The IT industry sees a remarkable growth, then again, this activity is in essence more knowledge intensive and might provide support on the change of focus that occurs within the Danish economy. Important is to establish where the innovation and technological change happens and what the linkage, both national and international, are between the different industry classes; despite the fact that machine tool manufacturing is declining, related activities might experience a boom that could not take place without some of these activities being active within the Danish setting.

The component Knowledge Intensity (KI) provides the last part of the Index for Knowledge Intensive Entrepreneurship. Also here Denmark scores relatively high although it is way behind the leaders, i.e. Sweden and Finland. On patent activities and high tech sector value added, Denmark scores relatively low compare but high on royalty and licence fees. However, one has to be aware these indictors have a strong focus on activities that take place within high tech industries. As indicated earlier, despite the increase in firms active in this industry class, Denmark has a specialization within more traditional low-tech industry classes. However, low-tech industries include many high-tech and knowledge intensive processes, mainly because if this is not included it is very hard also for firms in these industry classes to remain competitive. This issue is taking up in more detail AEGIS work package 1.3. A challenge is how we can include these knowledge intensive activities within the IKIE, and the KI component in particular, in the future. Given these considerations it might be that Denmark's level of knowledge intensity is much higher, although not necessarily exceeding the leading countries within this ranking, compared to the picture that is drawn based on these indicators.

Overall, institutional opportunities and technical opportunities seem to be rather similar across the two industries; which could be an indication on the level of the country in relation to efforts of supporting innovation and competence building within the economy as a whole. Market opportunities are, however, different since this is more difficult to steer.

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Pro Inno Europe (2011): Innovation Union Scoreboard 2010. Brussels: European Commission

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Appendix 1: Companies in the Danish Machine Tool Industry (January 2011)

Name	Industry description 1	Industry description 2	Website	Number of employees (category)	Year of Establishment	Year of Establishment (website)
AP Teknik ApS	Man. of other machine tools		www.apteknik.dk	2-4	2008	n/a
PDC-Tooling A/S	Man. of metalpreparing machine tools		www.pdc-tooling.dk/	0-1	2006	n/a
Bylderup Bov Maskinfabrik v/ Povl Vestergaard	Man. of other machine tools		www.bbm.dk/	2-4	1991	n/a
Brio Komponenter A/S	Man. of other machine tools		www.brio-comp.dk/	5-9	2002	n/a
HF Ejendomme A/S	Man. of metalpreparing machine tools		www.hydraulico.dk/	-	1987	n/a
J.T Teknik V/ Troels Toft Pedersen	Man. of other machine tools		www.JTTeknik.dk	2-4	1996	1990
Povl Møllers Maskinfabrik A/S	Man. of metalpreparing machine tools	wholesale with machine tools	www.pmborup.dk/	20 - 49	1956	1921
Hammer Graphic Supply ApS	Man. of other machine tools		www.svend-carstensen.dk	2-4	2005	1970
Akea Automation ApS	Man. of metalpreparing machine tools		www.akeaautomation.dk	10-19	2005	1985
Alsform Toolssfabrik ApS	Man. of metalpreparing machine tools		www.alsform.dk	50 - 99	1993	1970
AMC-Schou A/S	Man. of metalpreparing machine tools		www.amc-schou.dk	20 - 49	1951	1951
Amida V/ Anton Michael Davidsen	Man. of metalpreparing machine tools		www.amida.dk	-	2009	n/a
Brødbæk & Co. A/S	Man. of other machine tools	Manu. of lifting and handling equipment	www.brodbaek.dk	50 - 99	1996	1984
Søndergaards Maskinfabrik A/S	Man. of metalpreparing machine tools		www.bsv.dk	5-9	2000	1960
C. A. Maskinteknik A/S	Man. of metalpreparing machine tools		www.ca-maskinteknik.dk	0-1	2007	1995
Caltec V/ Carsten Albrechtsen	Man. of metalpreparing machine tools		www.caltec.dk	-	2004	1980
Ceetec A/S	Man. of metalpreparing machine tools	Manu. of pipes	www.ceetec.dk	10-19	1988	1970

C.F. Nielsen A/S	Man. of other machine tools		www.cfnielsen.com	20 - 49	1998	1889
Dan-List A/S	Man. of other machine tools	wholesale with machine tools	www.danlist.dk	20 - 49	1982	1911
Dapeca ApS	Man. of metalpreparing machine tools		www.dapaca.dk	2-4	2002	1986
Ducarbo Drills ApS	Man. of metalpreparing machine tools		www.ducarbo.com	2-4	1985	1986
Dyreborg Maskinteknik v/ Ove Dyreborg Hansen	Man. of metalpreparing machine tools		www.dyreborg-maskinteknik.dk	0-1	1989	1996
Ematec A/S	Man. of other machine tools		www.Ematec.dk	0-1	2003	n/a
Enkotec A/S	Man. of metalpreparing machine tools		www.Enkotec.dk	20 - 49	1991	1981
K. K. Maskinservice v/ Klaus Kirk	Man. of metalpreparing machine tools		www.fagorservice.dk	-	1993	n/a
FC Plast A/S	Man. of plastic packaging	Manu. of metalpreparing machine tools	www.FCPlast.dk	10-19	1998	1998
Felder Kg	Man. of other machine tools		www.felder.dk	2-4	2006	1955
FK Svejseudstyr ApS	Man. of other machine tools		www.fksvejs.dk	0-1	2005	1999
G.K. Trådgnist ApS	Man. of metalpreparing machine tools	Manu. of tools	www.gk-traadgnist.dk	5-9	1999	1986
Gråsten Maskinservice A/S	Man. of other machine tools	Wholesale with other machinery and equipment	www.graasten-maskinservice.dk	10-19	1999	n/a
Grit A/S	Man. of metalpreparing machine tools		www.grit.dk	10-19	1992	1981
Jka Machines v/ Jørn Kruse Andreasen	Man. of other machine tools		www.gulvMachines.dk	0-1	1997	1967
Hellco Tools ApS	Man. of metalpreparing machine tools	non-specialized wholesale	www.hellco.dk	5-9	2003	1977
IndustriMachines ApS	Man. of metalpreparing machine tools		www.im-aps.dk	2-4	2006	1971
Inelco A/S	Man. of metalpreparing machine tools	Manu. of electric motors, generators and transformers	www.Inelco.dk	5-9	1989	1981
Værktøjsfabriken Jeni A/S	Man. of metalpreparing machine tools		www.jeni.dk	5-9	1975	1959

K2 System v/ Karsten Kristiansen	Man. of other machine tools	Renting of business property	www.k2system.dk	-	1988	1984
Kurt Sørensen Maskinfabrik A/S	Fremstilling af lejer, tandhjul, tandhjulsudvekslinger og drivelementer	Manu. of other machine tools	www.ksm.dk	20 - 49	2008	1980
Maskinfabrikken Kuni A/S	Man. of other machine tools		www.kuni.dk	20 - 49	1985	1981
Dansk Maskinproduktion ApS	Man. of other machine tools		www.maskinproduktion.com	5-9	1999	1979
Mipex v/ Michael Pedersen	Man. of metalpreparing machine tools		www.mipex.com	2-4	1991	n/a
Modan ApS	Man. of metalpreparing machine tools		www.modan.com	0-1	2003	1980
F.A. M¸ggler Service A/S	Repair of Machines	Manu. of other machine tools	www.muggler.com	50 - 99	1986	1975
Nodi A/S	Man. of metalpreparing machine tools		www.Nodi.dk	10-19	2001	n/a
NU Service ApS	Man. of other machine tools		www.nu-service.dk	0-1	1987	n/a
Pedersen Machines A/S	Man. of metalpreparing machine tools		www.pedersen-Machines.dk	2-4	2003	1910
Pehama Production A/S	Man. of metalpreparing machine tools	Manu. of tools	www.pehama.dk	20 - 49	1997	1965
Phasion Group A/S	Man. of handheld power tools	Manu. of other machine tools	www.phasion.com	50 - 99	1977	n/a
Podek ApS	Man. of other machine tools	Fremstilling af andre beton-, gips- og cementprodukter	www.podek.dk	5-9	2000	1987
Maskinfabrikken Polund ApS	Man. of metalpreparing machine tools		www.polund.dk	10-19	1998	n/a
Prima-Vent A/S	Man. of other machine tools		www.prima-vent.dk	20 - 49	1975	n/a
Rilesa Maskinværksted Ribe ApS	Man. of other machine tools	Reparation af Machines	www.Rilesa.dk	20 - 49	1988	1985
Roed Machine tools V/ Thomas Roed	Man. of metalpreparing machine tools		www.roedMachines.dk	-	1981	n/a
Rˆttgers Værktøj A/S	Man. of metalpreparing machine tools		www.roettger.dk	10-19	1997	1968
RK Service ApS	Man. of other machine tools		www.rudkramper.dk	-	1984	n/a

Sik Teknik ApS	Man. of metalpreparing machine tools		www.sikteknik.dk	5-9	2008	2002
Spitzer Engineering ApS	Man. of metalpreparing machine tools		www.spitzer.dk	-	2004	1990
Stema Engineering A/S	Man. of metalpreparing machine tools	wholesale with machine tools	www.stema.dk	50 - 99	1978	1926
Stenhøj Hydraulik A/S	Man. of metalpreparing machine tools	wholesale with machine tools	www.stenhoj.dk	20 - 49	1993	1917
Struers A/S	Man. of metalpreparing machine tools	Manu. of other and industrial textiles	www.struers.com	100 - 199	1991	1875
Tama ApS	Man. of metalpreparing machine tools	Manu. of tools	www.tamatools.com	10-19	1974	1970
Teccluster A/S	Man. of metalpreparing machine tools	Manu. of tools	www.teccluster.com	2-4	2003	2004
Thorsted's Maskinværksted V/ Niels Peter Thorsted	Man. of other machine tools		www.thorsted-maskinvaerksted.dk	5-9	1997	1998
Twin Seam Company A/S	Man. of metalpreparing machine tools	wholesale with machine tools	www.twinseam.com	10-19	1987	1973
Unimec A/S	Man. of other machine tools		www.unimec.dk	5-9	2007	2007
Vorning Maskinfabrik ApS	Man. of other machine tools	Manufacutring of other metal products	www.vorning.dk	20 - 49	1999	n/a
Innovania ApS	Fremstilling af løfte- og håndteringsudstyr	Manu. of other machine tools	www.weissteknik.com	-	1987	1986
3V Værktøj ApS	Man. of metalpreparing machine tools		www.wollenberg.dk	5-9	2002	n/a
WTT A/S	Man. of other machine tools		www.wtt.dk	20 - 49	2003	1977
2 Produktion ApS	Man. of metalpreparing machine tools			-	2010	n/a
A.K.S. Etipol A/S	Man. of other machine tools			0-1	2009	n/a
A/S Løsning Værktøjsfabrik	Man. of other machine tools	Renting of business property		-	1980	n/a
Agin ApS	Man. of other machine tools			0-1	1997	n/a
Ajla Consult V/ Jytte Larsen	Man. of metalpreparing machine tools			-	2007	n/a
Allan Andersen	Man. of other machine tools			-	1996	n/a

Allan Olesen	Man. of other machine tools		-	2001	n/a
Alu-Part A/S	Man. of other machine tools		5-9	1988	n/a
Amco Ingeniørfirma v/ Jonna Steffensen	Man. of other machine tools		0-1	1989	n/a
Amida A/S	Man. of other machine tools		-	2010	n/a
Arne Nygård Sørensen	Man. of other machine tools		-	1967	n/a
Ba Service V/ Bent Ankersen	Man. of other machine tools		-	2007	n/a
Bakkegården v/ Ole Nymark Jensen	Man. of other machine tools		-	1988	n/a
Bats A/S	Non-Financial holding	Manu. of other machine tools	-	1997	n/a
Bauer Drill I/S	Man. of other machine tools		-	2010	n/a
Bh Maskinservice v/ Boye Høj	Man. of other machine tools		-	1994	n/a
Brink Construction ApS	Man. of other machine tools		-	2006	n/a
Bˆhler Welding Group Nordic Ab	Man. of metalpreparing machine tools	Wholesale with other machinery and equipment	-	2008	n/a
Carsten Jørgensen Værktøjsfabrik	Man. of other machine tools		-	1999	n/a
CT International ApS	Man. of other machine tools		-	2001	n/a
Danish Water & Energy Optimisation V/ Henrik Juul	Man. of other machine tools	Other research and experimental development	-	2009	n/a
Danværktøj ApS	Man. of metalpreparing machine tools		2-4	2003	n/a
Dee Mota ApS	Man. of other machine tools		-	2009	n/a
Fenger System ApS Aars	Man. of other machine tools		0-1	2007	n/a
Flexidata V/ Henning Guldborg	Man. of other machine tools	Computer-programmering	-	1992	n/a

Fraefel Værktøjsfabrik A/S	Man. of other machine tools		10-19	1994	n/a
Germans Boada Danmark, Filial af Germansboada S.A., Spanien	Man. of other machine tools		0-1	2008	n/a
Gl Tools Efterfølger v/ Peter Andreasen	Man. of other machine tools		-	1994	n/a
Gmv Export ApS	Man. of metalpreparing machine tools	Manu. of machines for the food, beverage and tobacco industry	-	2010	n/a
Grimsac Claus Bremer Hansen	Man. of metalpreparing machine tools		-	2008	n/a
H M T Machines Hans Møller Thomsen	Man. of metalpreparing machine tools		-	1978	n/a
H V K v/ Henrik V. Knudsen	Man. of other machine tools		-	2004	n/a
Hall Andersen Værktøjsfabrik	Man. of other machine tools	Byggemarkeder og værktøjsmagasiner	-	1967	n/a
Hj Tools ApS	Man. of other machine tools		-	2010	n/a
Hjorths Maskinservice v/ Karl-Emil Hjorth	Man. of metalpreparing machine tools		-	1993	n/a
Hornslet Værktøjsfabrik ApS	Man. of metalpreparing machine tools		2-4	1985	n/a
HPC Værktøjs- og Maskinfabrik A/S	Man. of other machine tools		5-9	1985	n/a
Hymaco v/ Mogens Lauritsen	Machine preperation	Manu. of other machine tools	10-19	1987	n/a
J.B.S. Spændteknik/J B Sørensen	Man. of other machine tools		0-1	1991	n/a
Ja Tool Design V/ John Andersen	Man. of metalpreparing machine tools		-	2000	n/a
Jegstrupvej 30, Hasselager ApS	Man. of medical equipment	Manu. of other machine tools	-	1977	n/a
Ji Thy Invest ApS	Man. of other machine tools		-	2010	n/a
John Skov's Spånsugeanlæg ApS	Man. of other machine tools		5-9	1977	n/a
Jørgen Pedersen Maskin Service	Man. of other machine tools		-	1996	n/a

Kallesoe Machinery A/S	Man. of other machine tools	Manu. of hydrollic equipment	5-9	2010	n/a
Kamø Industri v/ Birthe Møller	Man. of other machine tools		-	1995	n/a
KD Værktøj ApS	Man. of other machine tools		2-4	2007	n/a
Kema Denmark ApS	Man. of other machine tools		-	2009	n/a
Km Røjle v/ Hanne Elisabeth Ebbesen	Man. of metalpreparing machine tools		-	1982	n/a
Leading Edge Technology ApS	Non-Financial holding	Manu. of other machine tools	-	1998	n/a
Leif & Lorentz A/S	Man. of other machine tools		2-4	2007	n/a
Magbend V/ Torben Kirk Hansen	Man. of other machine tools		-	2007	n/a
Michael M/Michael Elkjær Madsen	Avl af pelsdyr mv.	Manu. of other machine tools	-	1991	n/a
Multi-Hejs ApS	Man. of metalpreparing machine tools	Buying and Seling of land	-	2007	n/a
N.P.Hansens Maskinfabrik, Kolding A/S	Man. of pumps and compressors	Manu. of other machine tools	0-1	1956	n/a
Norican Group ApS	Man. of metalpreparing machine tools		-	2008	n/a
Pedersen Machine tools ApS	Man. of metalpreparing machine tools		2-4	1992	n/a
Pedersen Machine tools ApS	Man. of metalpreparing machine tools		2-4	1992	n/a
Sam Teknik ApS	Man. of other machine tools		0-1	2007	n/a
Sancon ApS	Man. of other machine tools		2-4	2005	n/a
Scanhugger 2010 ApS	Man. of other machine tools		0-1	2009	n/a
Schmidt Tools V/ Henrik Schmidt-Sørensen	Man. of other machine tools		-	2007	n/a
Slipcon Machinery ApS	Man. of other machine tools		5-9	2005	n/a
Ssc ApS	Man. of metalpreparing machine tools		2-4	2009	n/a

Stack-O-Matic ApS	Man. of other machine tools		-	2008	n/a
Steen Stenholm	Man. of other machine tools		-	1993	n/a
Søstrøm Maskinteknik V/ Allan Søstrøm Hansen	Man. of other machine tools		-	1995	n/a
Thecankey ApS	Man. of other machine tools		-	2006	n/a
Tranum Maskinværksted	Man. of other machine tools		-	1992	n/a
Trebbien Teknik ApS	Man. of other machine tools	Repair of Machines	-	2010	n/a
Ulmadan-R.D. ApS	Wholesale of other machineriy and equipment	Other research and experimental development	-	2009	n/a
V. Bech Tool Manufactoring A/S	Man. of metalpreparing machine tools		0-1	2004	n/a
Vamdrup Smede- & Hydraulik ApS	Man. of metalpreparing machine tools		-	2008	n/a
Vbm A/S	Man. of metalpreparing machine tools		2-4	2010	n/a
Weld-Tech International v/ Hanne Dalsgaard Grønmark	Man. of other machine tools		-	2006	n/a

Source: navn og numre erhverv