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Sectoral Innovation Watch

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Textiles and Clothing Sector

Final sector report

December 2011

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Europe INNOVA Sectoral Innovation Watch

Detailed insights into sectoral innovation performance are essential for the development of effective innovation policy at regional, national and European levels. A fundamental question is to what extent and why innovation performance differs across sectors. The second SIW project phase (2008-2010) aims to provide policy-makers and innovation professionals with a better understanding of current sectoral innovation dynamics across Europe

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Central to the work of the Sectoral Innovation Watch is **analysing trends in, and reporting on, innovation performance in nine sectors** (Task 1). For each of the nine sectors, the focus will be on identifying the innovative agents, innovation performance, necessary skills for innovation, and the relationship between innovation, labour productivity and skills availability.

Sector Innovation Performance: Carlos Montalvo (TNO)	
Automotive: Michael Ploder (Joanneum Research)	Knowledge Intensive Business Services: Christiane Hipp (BTU-Cottbus)
Biotechnology: Christien Enzing (Technopolis)	Space and Aeronautics: Annelieke van der Giessen (TNO)
Construction: Hannes Toivanen (VTT)	Textiles: Bernhard Dachs (AIT)
Electrical and Optical Equipment: Tijs van den Broek (TNO)	Wholesale and Retail Trade: Luis Rubalcaba (Alcala) / Hans Schaffers (Dialogic)
Food and Drinks: Govert Gijsbers (TNO)	

The **foresight of sectoral innovation challenges and opportunities** (Task 2) aims at identifying markets and technologies that may have a disruptive effect in the nine sectors in the future, as well as extracting challenges and implications for European companies and public policy.

Sector Innovation Foresight: Matthias Weber (Austrian Institute of Technology)	
Automotive: Karl Heinz Leitner (AIT)	Knowledge Intensive Business Services: Bernhard Dachs (AIT)
Biotechnology: Govert Gijsbers (TNO)	Space and Aeronautics: Felix Brandes (TNO)
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Electrical and Optical Equipment: Tijs van den Broek (TNO)	Wholesale and Retail Trade: Susanne Giesecke (AIT)
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Task 3 will **identify and analyse current and potential bottlenecks that influence sectoral innovation performance, paying special attention to the role of markets and regulations**. Specifically, the analysis will cover the importance of the different factors in the propensity of firms to innovate.

Role of markets and policy/regulation on sectoral patterns of innovation: Carlos Montalvo (TNO)	
Katrin Pihor (PRAXIS)	Klemen Koman (IER)

Task 4 concerns **five horizontal, cross-cutting, themes related to innovation**. The analyses of these horizontal themes will be fed by the insights from the sectoral innovation studies performed in the previous tasks. The **horizontal reports will also be used for organising five thematic panels** (Task 5). The purpose of these panels is to provide the Commission services with feedback on current and proposed policy initiatives.

Horizontal reports	
National specialisation and innovation performance	Fabio Montobbio (KITes) and Kay Mitusch (KIT-IWW)
Organisational innovation in services	Luis Rubalcaba (Alcala) and Christiane Hipp (BTU-Cottbus)
Emerging lead markets	Bernhard Dachs (AIT) and Hannes Toivanen (VTT)
Potential of eco-innovation	Carlos Montalvo and Fernando Diaz Lopez (TNO)
High-growth companies	Kay Mitusch (KIT-IWW)

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Acknowledgements

The final sector report for the textiles and clothing sector builds on the results of various tasks in the Europe INNOVA Sectoral Innovation Watch:

Dachs, B. and G. Zahradnik (2010) *Sectoral Innovation Performance in the Textiles and Clothing Sector*, Final Report Task 1, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, May 2010

Zahradnik, G., B. Dachs and M. Weber (2010) *Sectoral Innovation Foresight - Textiles and Clothing Sector*, Final Report Task 2, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, December 2010

Montalvo, C., K. Pihor and B. Dachs (2011) *Analysis of market and regulatory factors influencing sector innovation patterns – Textiles and Clothing Sector*, Final Report Task 3, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, December 2011

H. Grupp[†], D. Fornahl, C.A. Tran, J. Stohr, T. Schubert, F. Malerba, Montobbio F., L. Cusmano, E. Bacchiocchi, F. Puzone, (2010) *National Specialisation and Innovation Performance*, Final Report Task 4 Horizontal Report 1, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, March 2010

Rubalcaba, L, J. Gallego, C. Hipp, and M. Gotsch (2010) *Organisational innovation in Services*, Final Report Task 4, Horizontal Report 2, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, February 2010

Dachs, B., I. Wanzenböck, M. Weber, J. Hyvönen and H. Toivanen (2011) *Lead Markets*, Final Report Task 4, Horizontal Report 3, for DG Enterprise and Industry, European Commission, March 2011

Montalvo, C., Diaz Lopez F.J., and F. Brandes, (2011) *Potential for eco-innovation in nine sectors of the European economy*, Final Report Task 4, Horizontal Report 4, Europe INNOVA Sectoral Innovation Watch, DG Enterprise and Industry, European Commission, December 2011

Mitusch K. and A. Schimke (2011) *Gazelles – High-Growth Companies*, Final Report Task 4, Horizontal Report 5, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, January 2011

Executive Summary

The textiles and clothing (T/C) industry is often regarded as a 'low tech' sector. Various studies point to its underperformance in terms of R&D intensity, output of new products, or skill levels of their employees and draw a pessimistic picture of the future of the sector.

Our results draw a more differentiated picture of innovation in the T/C industry. Innovation performance at the aggregate level is indeed below manufacturing average. Innovation activity relies to a higher degree on the acquisition of external technologies and is - to a lesser degree - based on in-house R&D. Innovation co-operation is less frequent, and patents or other means to protect intellectual property are rarely used. Explanations for this weak innovation performance include the low average firm size, poor access to financial resources, a lack of qualified personnel, and shortcomings in the ability to transfer research into products.

The statement that T/C generally lacks behind in innovation, however, is misleading for some reasons. First, various indicators indicate a considerable variety in innovation intensity and strategies at a more disaggregates level. Empirical analysis reveals that a number of enterprises - both in the textiles and in the clothing industry - that are R&D-oriented, link to external sources of knowledge and invest a considerable share of their turnover in innovation projects. In many aspects of their innovative behaviour, these firms are similar to firms in 'high-technology' sectors. These firms, however, are still only a minority in the T/C industry.

Second, it is also worth noting that the competitiveness of enterprises in textiles and clothing is based on non-technological activity to a considerable degree. Innovation statistics, however, often fail to capture these activities, and may therefore underestimate innovative efforts in particular in the clothing industry.

Third, despite a lower innovation intensity, there is a considerably degree of entrepreneurship in T/C firms, as can be seen in the large number of fast-growing "Gazelles" firms. Fourth, it seems that globalisation poses incentives to invest in R&D, advanced production technologies, and new organisational concepts.

In a dynamic perspective, we expect that new technological opportunities will emerge for the T/C sector. Intelligent clothing and smart materials will find widespread applications. Materials made of advanced fibres offer a variety of new properties and applications for textile products. New production methods are another main technological driver, enabling the T/C sector to reduce the still-high share of rather low-skilled manual labour, reduce the amount of energy and raw materials used, and increase the flexibility and quality of production processes. New products and production methods are complemented by the more frequent use of E-Commerce and other interactive technologies, offering a wide range of new business models. On the demand side, changes in consumer behaviour are driven by demographic changes or an increasing consumer awareness of factors affecting health and sustainability.

Policy can support this transformation by fostering an innovation culture in textiles and clothing and removing barriers to innovation: first, the sector suffers from a lack of skilled employees. A second main challenge is the sufficient access to funds. Branding and design are important innovation activities for clothing enterprises in particular, but only rarely supported by many funding schemes which still focus on R&D. Third, with respect to globalisation, levelling the playing field and creating equal conditions for EU and non-EU competitions is the way forward. Moreover, our results illustrate a variety of innovation strategies in the textiles and clothing sector. Policy should account for this variety by horizontal policies to create favourable framework conditions rather than concrete policy intervention.

1 Introduction

1.1 Patterns and performance of sectoral innovation

There are different public perceptions of innovation in the textiles and clothing (T/C) industry. On the one side, the T/C industry is today often described as 'low tech' in terms of R&D intensity, output of new products, or skill levels of their employees (von Tunzelmann and Acha 2005; Harris and Halkett 2007; Hirsch-Kreinsen 2008). The industry faced substantial structural change in the past, partly due to pressure from competitors in Asian and African countries; according to the 2008 EU Competitiveness Report, the sector lost about one third of its total employment since 1995 (EC 2009).

But there is also a different side of innovation in the T/C industry. T/C firms in different parts of Europe invest considerable resources in developing new materials – such as technical textiles - or new combinations of existing materials and improving their production technologies to raise labour productivity. Companies are exploring new ways of commercializing their products, integrating with clients and suppliers or identifying new markets for their products. A considerable degree of creativity can also be found in small, entrepreneurial the design firms.

This first section of the report wants to examine these two sides of innovation activities in the T/C industry. The report builds on previous work done by the Europe INNOVA programme (Böheim 2006; Peneder 2007; Peters et al. 2007; Böheim 2008) as well as literature from outside Europe INNOVA (von Tunzelmann and Acha 2005; Bender 2006; NetFinTex 2006; Harris and Halkett 2007; Hirsch-Kreinsen 2008). It is not the goal of this contribution to replicate results already reported in previous Europe INNOVA reports. Instead, we try to add additional aspects to the picture of how innovation takes place in the textiles and clothing industry.

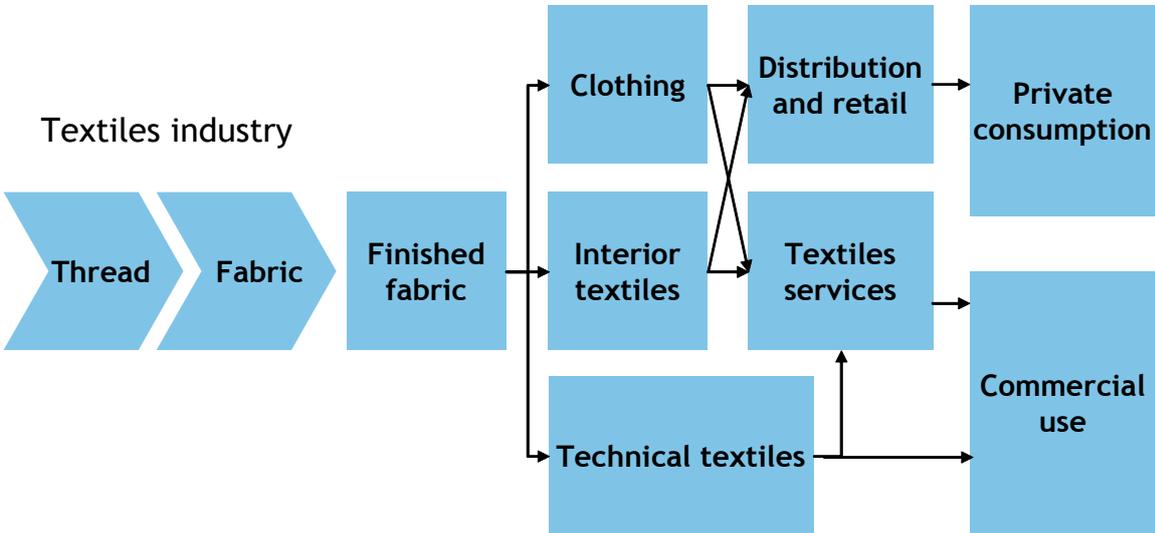
After a short discussion of the statistical definition of textiles and clothing industry (chapter 2), chapter 3 investigates the innovation performance of the textiles clothing industry. Special attention is given to differences between the textiles and the clothing industry. Chapter 4 describes main actors of innovation in the T/C industry – people, organisations, and clusters and networks. Chapter 5 focuses on four important aspects of innovation in T/C industry; variations of innovation behaviour between sub-sectors of the T/C industry; non-technological innovation; eco-innovation; and the link between globalisation and innovation in T/C.

1.2 Statistical definition of the sector

There are several ways to define the textiles and clothing industry. The most comprehensive approach is to think of the industry as a 'value chain' of activities that span from the treatment of raw materials (cotton, wool, artificial fibres) to final consumption of textiles and clothing goods (Figure 1.1). This value chain includes also retail and distribution of textiles and clothing and firms that provide services such as textiles rentals to hotels, restaurants or hospitals. Moreover, one could also add the suppliers of machinery to produce textiles and clothing, the suppliers of information and communication

equipment, or the chemicals industry. We could even add some types of knowledge-intensive services such as the creative industries to this textiles and clothing value chain.

Figure 1.1 The textiles and clothing industry value chain



Source: own illustration after EMCC (2008c), p. 2

INNOVA follows a more narrow definition of T/C provided by EUROSTAT’S NACE classification. This definition focuses on the production of textiles and clothing (Table 1.1). EUROSTAT defines the industry by NACE (Rev 1.1) codes 17 ‘manufacture of textiles’ and 18 ‘manufacture of wearing apparel; dressing and dyeing of fur’. This structure is also retained in a new version of NACE (Rev 2) which came into effect in 2007. Many data sources referring to years before 2008, however, are only available in the NACE Rev. 1.1 classification.

Unfortunately, there are some differences between sub-sectors of the T/C industry which are neither by the old nor the new classification adequately reflected. One important issue is the manufacture of technical textiles, which cannot be separated from the manufacture of textiles for non-technical applications on grounds of the NACE classification. Producers of textiles for non-clothing applications (for example in health services or in the automotive industry) often regard themselves as part of their client industries rather than as part of the T/C sector. These linkages are not adequately reproduced by the NACE classification.

According to EUROSTAT (2008, p. 73), about two Third of all enterprises in the European T/C sector belong to NACE 18 (clothing) which also employs 57% of all personnel in T/C. NACE 17 (textiles) accounts for 57% of turnover and 58% of value added. It follows that textiles enterprises, on average, are larger than enterprises in clothing and have a higher personnel productivity which points to a higher capital intensity.

Clothing, in contrast, is based on human labour to a considerably higher degree than textiles. According to EUROSTAT, the clothing sector is, at the level of NACE divisions, the industry with the lowest level of labour productivity within the European business sector. Average labour productivity in

clothing reaches only 36.7 % of average productivity level in the European non-financial business sector (EUROSTAT 2008, p. 81).

Table 1.1 Classification of activities: the textiles and clothing industry, NACE Rev. 1.1 and Rev. 2, 2-digit level

NACE Rev. 1.1		NACE Rev. 2	
17	Manufacture of textiles	13	Manufacture of textiles
17.1	Preparation and spinning of textile fibres	13.1	Preparation and spinning of textile fibres
17.2	Textile weaving	13.2	Weaving of textiles
17.3	Finishing of textiles	13.3	Finishing of textiles
17.4	Manufacture of made-up textile articles, except apparel	13.9	Manufacture of other textiles
17.5	Manufacture of other textiles		
17.6	Manufacture of knitted and crocheted fabrics		
17.7	Manufacture of knitted and crocheted articles		
18	Manufacture of wearing apparel; dressing and dyeing of fur	14	Manufacture of wearing apparel
18.1	Manufacture of leather clothes	14.1	Manufacture of wearing apparel, except fur apparel
18.2	Manufacture of other wearing apparel and accessories	14.2	Manufacture of articles of fur
18.3	Dressing and dyeing of fur; manufacture of articles of fur	14.3	Manufacture of knitted and crocheted apparel

Source: EUROSTAT RAMON

Italy has the largest textile sector in the EU27 with a share of about 30% on total value added generated in the EU27. Other important countries are Germany, France and the United Kingdom which together account for a third of total value added in the EU27 (EUROSTAT 2008, p. 77). A similar concentration can be found in clothing, where Italy accounts for 31.8% of total EU27 value added, followed by France and Germany. Clothing has also a high importance for the EU12 in terms of employment. Every fifth employee in employee of the European clothing industry works in Romania, followed by Italy with a employment share of 16.6%, Poland (10.6%) and Bulgaria (9.6%).

It is difficult to assess the industrial structure of the European T/C sector with the NACE classification because, as already mentioned, NACE does not distinguish between various textiles according to their usage. Based on the fibre consumption in the EU, we can say that about a fourth of total EU fibre usage goes into industrial and technical textiles, and another third into home and interior textiles. Clothing is the largest user sector within T/C with a share of about 40% (NetFinTex 2006, p. 7).

Before we start our analysis of innovation performance in the T/C sector, it is important to highlight some characteristics of T/C products. We have already introduced the distinction between fabrics, textiles for technical use, interior textiles and clothing. We suggest that keeping in mind this distinction is essential for the analysis of innovation in the sector; the utility (and their price) derived from fabrics, technical textiles and interiors is mostly based on their physical propensities. Clothing, in contrast, very much carries a symbolic value, and includes a non-tangible, emotional component that creates utility for the user (Ravasi and Lojacono 2005; Di Maria and Finotto 2008). Clothing allows to express personality and identity, to distinguish oneself from others or to demonstrate membership in a certain group. Due to their reputation and their strong brands, some clothing enterprises can therefore yield a price premium for their products. The ability of enterprises to build and sustain brand identity and

brand recognition over time is therefore an important source of competitive advantage in the clothing market (Davies 1992; Bridson and Evans 2004). A lot of firms in the T/C would regard these activities as highly innovative; they are, however, to a considerable degree outside of the definition of innovation brought forward by the OECD (a discussion of this issue can be found in chapter 5.2).

1.3 Common set of indicators of innovation performance

We will now give an overview on the innovation performance of the sector with data from the fourth round of the Community Innovation Survey (CIS). In contrast to the sectoral report of the previous INNOVA project, we have separated the textile from the clothing industry. Columns ‘% GAP’ reports the value of the sector as a percentage of the value of the total business sector average¹. We calculated most indicators twice, for innovative firms only (Table 1.2) and for all firms (Table 1.3).

From the comparison in Table 1.2 it is obvious that in terms of innovative behaviour, the textiles (column 2) and clothing industry (column 4) differ significantly in almost all indicators. A first main difference is that 36.1% of all enterprises in textiles report innovative activity, compared to only 17.4% in clothing. The value for clothing is considerably below business sector average (columns 1 and 3).

All following information in Table 1.2 include only enterprises that reported innovative activity, and do not refer to the whole firm population of the sector. In textiles, new products and processes are based on own in-house innovative activity to a high degree. 56.3% of all innovative active textiles enterprises perform in-house innovation, compared to 40.4% of the clothing enterprises. Differences in innovative efforts measured by innovation expenditure intensity are even larger. Textiles enterprises spend 3.4% of their turnover on innovation, compared to 2.1% in clothing. Compared with total business sector average, textiles enterprises spend more than the average firm on innovation, while clothing enterprises spend less.

Major differences can also be found in innovative output. The share of total sales from new to market products is significantly higher for the textiles (5.3%) than for the clothing industry (2.8%). Clothing, in contrast, has a slightly higher share from innovations which are only new to the enterprise (6.5% vs. 6.2%). Moreover, the ratio of total turnover to the number of employees which may be used as a crude proxy for productivity is twice the value of clothing in textiles. In all these indicators, the textiles industry performs above or around total business sector average, while the clothing industry lies far below that average.

There is also a difference how policy promotes innovation in the two sectors. While more than one third (36.2%) of all innovative active enterprises in the textiles sector receive public subsidies to innovate, this is only the case for 16.7% of the enterprises in the clothing industry. This may simply be caused by less innovative activity in clothing; it may be, however, also sign that innovation in clothing

¹ Total business sector averages vary between columns 2 and 4 because not all countries included textiles and clothing industry in their surveys. Only countries which covered the sector are included in the average. A list of these countries for each variable is given in the Annex.

often does not match with the criteria for funding laid out by innovation support schemes, which often focus und R&D and technological innovation and leave design out.

Table 1.2 Textiles (NACE 17) and clothing (NACE 18) industries over CIS innovation dimensions; only innovative enterprises

	Average Textiles (2)	Average Core NACE (1)	% GAP (2/1)	Average Clothing (4)	Average Core NACE (3)	% GAP (4/3)
Share of innovative active enterprises	36.1%	39.4%	91.6%	17.4%	38.4%	45.3%
Share of enterprises innovating in-house	56.3%	51.1%	110.1%	40.4%	51.4%	78.6%
Innovation expenditures as a percentage of total turnover	3.4%	3.0%	114.0%	2.1%	3.0%	69.0%
Share of total sales from new-to-market	5.3%	6.1%	85.7%	2.8%	5.9%	47.9%
Share of total sales from new-to-firm but not new-to-market products	6.2%	6.1%	101.9%	6.5%	6.2%	104.5%
Share of enterprises that use patents	10.1%	14.9%	67.7%	5.4%	14.9%	36.1%
Share of enterprises that use trademarks	13.5%	17.5%	77.1%	18.4%	17.5%	105.1%
Share of enterprises that use design registrations	15.9%	14.7%	107.8%	15.9%	15.1%	105.3%
Ratio between total turnover and number of employees (in 1000)	108	260	41.4%	75	257	29.0%
Share of enterprises that receive public subsidies to innovate	36.2%	22.9%	157.8%	16.7%	21.8%	76.6%
Enterprise introduced marketing innovation	31.4%	34.1%	92.0%	33.1%	33.4%	99.1%

Source: CIS 4, own calculations, countries included see annex

Finally, both sectors are also distinct in their strategies to protect innovation. Patents are more frequently used in textiles. Compared to the whole business sector, however, enterprises that apply for a patent are underrepresented in both, textiles and the clothing. Much more important than patents are trademarks. This is the only variable where clothing performs considerably *better* - compared to textiles as well as to the total business sector. 13.5% of the innovating enterprises in the textiles industry, but 18.4% of the enterprises in the clothing industry used trademarks to protect their intellectual property.

Similarities between the two sectors are only found in three indicators: both show quite similar shares of new-to-the-firm products on turnover, a similar propensity to use design registration and a fairly similar share enterprises that introduced marketing innovations. Another major similarity of textiles and clothing is their position compared to the whole business sector as indicated by the columns ‘% GAP’ in table 1.2. These columns report the value of the sector as a percentage of the value of the total business sector average. We see that both sectors perform below average in the majority of the indicators.

The numbers in Table 1.2 are percentage values of all *innovative* enterprises, and do not refer to the *whole enterprise population* of the sector. While the share of innovative active enterprises in textiles is on average, it is less than half of the average in the clothing sector (table 1.2, row 1). Therefore, the clothing sector performs even worse if we consider all enterprises and not only the innovative active, as can be seen in Table 1.3. Only 6.8% of all enterprises in clothing industry have in-house innovation

activities, compared to 20% in the whole enterprise sector. Similar performance differences can also be found in other indicators.

Table 1.3 Textiles (NACE 17) and clothing (NACE 18) industries over CIS innovation dimensions; all enterprises

	Average Textiles (2)	Average Core NACE (1)	% GAP (2/1)	Average Clothing (4)	Average Core NACE (3)	% GAP (4/3)
Share of innovative active enterprises	36.1%	39.4%	91.6%	17.4%	38.4%	45.3%
Share of enterprises innovating in-house	20.0%	19.7%	101.2%	6.8%	19.9%	34.3%
Innovation expenditures as a percentage of total turnover	2.0%	2.2%	91.6%	0.7%	2.3%	33.0%
Share of enterprises that use patents	3.7%	5.9%	62.0%	1.0%	5.9%	16.3%
Share of enterprises that use trademarks	4.8%	6.8%	70.8%	3.2%	6.8%	46.2%
Share of enterprises that use design registrations	5.8%	5.8%	98.6%	2.7%	5.9%	46.1%
Ratio between total turnover and number of employees (in 1000)	94	229	41.1%	56	224	24.8%
Share of enterprises that receive public subsidies to innovate	13.3%	9.2%	144.7%	2.8%	8.5%	33.2%
Enterprise introduced marketing innovation	11.4%	13.5%	84.3%	5.6%	12.9%	43.4%

Source: CIS 4, own calculations, countries included see annex

We have argued that textiles and clothing industries differ considerable in their innovation strategies.

Table 1.4 brings additional evidence for this claim, by showing the share of enterprises in each sector engaged in a number of particular innovation activities.

The textiles industry again does not differ in most categories from the manufacturing average, with only two exceptions: the share of enterprises that invest in the acquisition of external knowledge and training is lower than average in the textiles sector. The clothing sector, in contrast, shows lower levels of innovative activity in almost all dimensions, compared to the industry average as well as to textiles. The acquisition of equipment and software is in both industries of about average importance and is in both cases by far the most frequent innovative activity employed by about $\frac{3}{4}$ of all enterprises, followed by intramural R&D, which is performed by 57.1% of all enterprises in the clothing sector and 40.4% of all enterprises in the textiles sector. Surprisingly, clothing enterprises also are less frequently investing in training activities – given the problems with a lack of qualified personnel; one may assume that these activities can be found more frequently in the sector.

Table 1.4 Textiles (NACE 17) and clothing (NACE 18) industries over CIS innovation dimensions; kind of innovative activity

	<i>Average Textiles (2)</i>	<i>Average Core NACE (1)</i>	<i>% GAP (2/1)</i>	<i>Average Clothing (4)</i>	<i>Average Core NACE (3)</i>	<i>% GAP (4/3)</i>
Enterprises, engaged in intramural R&D	57.1%	52.1%	109.6%	40.4%	51.4%	78.6%
Enterprises, engaged in extramural R&D	20.4%	22.1%	92.3%	16.8%	22.0%	76.3%
Enterprises, engaged in acquisition of machinery, equipment and software	81.5%	75.4%	108.1%	77.3%	75.9%	101.9%
Enterprises, engaged in acquisition of other external knowledge	16.5%	21.2%	77.9%	19.2%	21.0%	91.4%
Enterprises, engagement in training	40.7%	51.3%	79.3%	41.9%	51.5%	81.3%
Enterprises, engaged in market introduction of innovation	27.4%	33.1%	82.9%	23.4%	33.0%	71.0%
Enterprises, engaged in other preparations	35.1%	37.4%	93.9%	21.3%	37.3%	57.2%
Enterprises, engaged in innovation activities	94.9%	92.3%	102.7%	93.0%	92.8%	100.2%
Enterprises, engaged continuously in intramural R&D	32.1%	28.9%	111.2%	22.6%	28.1%	80.5%
Enterprises, engaged occasionally in intramural R&D	25.4%	23.3%	109.1%	19.7%	23.8%	82.8%

Source: CIS 4, own calculations, countries included see annex

To sum up, a comparison of innovative behaviour in the textiles and clothing sector has found that:

- Innovation performance of the T/C sector, at least at the aggregate level, is poor compared to the industry average.
- Innovation in the T/C sector relies to a higher degree on the acquisition of external technologies from suppliers, and is to a lesser extent based on in-house R&D
- Non-technological innovation like marketing innovation or design protected by trademarks plays a more important role compared to other sectors.

Moreover, the indicators show significant differences between the textiles and clothing industry in terms of innovative behaviour. Textiles enterprises have more in-house innovation activities and invest a higher share on turnover in innovation activity compared to clothing enterprises. Innovation co-operations are also more frequent in the textiles sector than in the clothing sector. While the clothing sector performs comparably poor in most dimensions this holds not true for the use of information for innovation, here clothing lies above textiles and the business sector average.

Explanations for this innovation pattern brought forward in the literature include the low average firm size and poor access to financial resources, innovation strategies that are based on external technology, a lack of qualified personnel, shortcomings in the ability to transfer research into products or problems in enforcing intellectual property rights (EURATEX 2004; Ożegalska-Trybalska and Winkler 2006; Böheim 2008; EMCC 2008c; Hirsch-Kreinsen 2008). Policy that wants to improve the innovative performance of the T/C sector should tackle these factors.

1.4 Characterisation of innovation in the T/C sector

In order to understand better the innovative performance of the T/C sector, will now take a closer look at three issues important aspects of innovation in the sector: Variations in the innovation process between sub-sectors of the T/C industry, non-technological innovation, and the relationship of innovation globalisation. Variation of innovation strategies, on the one hand, indicates that the *sources* of innovation as well as innovative behaviour and performance differ in various sub-sectors of the T/C sector. Non-technical innovation addresses the nature of innovation and knowledge in clothing enterprises. Eco-innovation points to the importance of regulation and demand for innovation in T/C. Globalisation, finally, addresses the geography of knowledge creation in T/C sector.

1.4.1 Variations of innovative behaviour

The previous section has shown a considerable degree of heterogeneity in the innovation strategies of T/C enterprises. *Textiles* enterprises tend to engage in (technological) innovation more frequently, pursue in-house innovation activities, and invest a higher share of their turnover in innovation activity than the average enterprise in the business sector. Patents as a means to protect the results of innovative activity are more important than in clothing. More than a third of all innovating enterprises receive public support for innovation. *Clothing* enterprises, in contrast, pursue less frequently in-house innovative activities and invest far less in these activities than textiles enterprises and enterprises in the whole business sector. Trademarks are a more important means to protect innovation than for textiles enterprises. The probability to receive public funding for innovation is only half of that in textiles.

The frequent notion of T/C as a 'low-tech' sector is therefore certainly not true for all enterprises in T/C; it is even wrong for large parts of the sector. The textiles industry does not match biotechnologies or the aerospace industry with respect to R&D intensity or science linkages; nevertheless, there are areas within the sector which are highly innovative, engage in formal R&D and exhibit little differences to these high-technology industries. Leaving aside this intra-sectoral heterogeneity would lead to an oversimplification and to wrong conclusions. Further support for this claim is delivered by some very recent studies based on CIS microdata (Clausen 2007; Leiponen and Drejer 2008; Srholec and Verspagen 2008). These studies suggest that industries are in no way homogenous in terms of how enterprises innovate. Previous work within the Europe INNOVA framework has only partly considered variations of innovation strategies in the T/C sector. The sectoral analysis on T/C (Böheim 2008) does not put too much emphasis on the issue and treats textiles (NACE 17) and clothing (NACE 18) as one uniform industry. Michael Peneder, in contrast, brings forward a more differentiated picture of the T/C sector in his contribution on sectoral taxonomies. Peneder (2007, p. 54) sees the textiles industry as a 'Medium-High-Technology' sector, the second-highest rank in his classification, with innovation activity characterized by intramural R&D. The clothing industry, in contrast, is a 'Low-Technology' industry in his taxonomy. Hugo Hollanders (Arundel and Hollanders 2005; Hollanders 2007) identified four types of innovation modes and found that most innovators in the T/C sector innovate through diffusion-based innovation strategies. Strategic innovators with continuous R&D and in-house development of

innovations, in contrast, are found rarely. Hollander's analysis has the advantage that it reveals intra-sectoral heterogeneity, the differences in innovation strategies between enterprises of the same sector. The main drawback from Hollander's analysis, however, is the fact that he does not distinguish between textiles and clothing.

We will follow and continue Peneder's and Hollander's approach and study differences in innovation strategies between enterprises of the T/C sector. The purpose of our analysis is to find sub-groups within the T/C sector consisting of firms that share a similar innovative strategy. A tool that helps to find such sub-groups is statistical cluster analysis (not to be confused with the analysis of industrial clusters or agglomerations), a method to identify entities that have much in common with other members of the same sub-group, but only little with members of other groups (Kaufman and Rousseeuw 2005).

Since we are mostly interested in differences between enterprises within the T/C sector, we have to base our analysis on observations in individual enterprises. A new dataset offered by EUROSTAT allows to study enterprise behaviour with data from the Community Innovation Survey at the enterprise level with microdata. The sample from the CIS database includes 1,528 innovative active enterprises, 828 textile enterprises (NACE 17) and 700 clothing enterprises (NACE 18). 676 of these enterprises are located in Central and Eastern European countries (CEE) including the Czech Republic, Slovakia, Slovenia, Hungary, Latvia, Estonia and Lithuania. 484 of the enterprises are based in Southern Europe (SE), in Spain, Portugal, Greece and Italy. The remaining 368 enterprises are located in the North and Western European countries (NWE) of Sweden, Denmark, Luxembourg, France and Norway.

The sub-group analysis is based on six input variables to describe innovative strategies of enterprises:

- Engagement in intramural R&D
- Intensity of the innovative activities (share of innovative expenditure on turnover)
- Co-operation arrangements on innovation activities
- Engagement in training
- Engagement in design and activities that prepare the market introduction of innovation
- Engagement in acquisition of machinery

We choose these variables because it is completely in the discretion of each enterprise to invest or not to invest in one of these categories. Output variables, like the share of new products on turnover, in contrast, depend very much on market acceptance of innovations and can therefore only partly be influenced by the enterprise. Information on the amount spent on various expenditure categories is not available for many enterprises, so we decided not to include metric variables with the exception of innovation intensity.

Using the Ward algorithm we identified four sub-groups, each representing a different innovation strategy. Enterprises within one sub-group are as homogenous as possible regarding these variables. The input variables, the four resulting sub-groups and means for each input variable for the four sub-groups are summarized in Table 1.5. The last column of the table reports values for the total sample.

Table 1.5 Sub-groups relating to different innovation strategies in the T/C sector

	<i>R&D</i>	<i>Internal Capabilities</i>	<i>Open Innovation</i>	<i>Technology Adoption</i>	<i>Total sample</i>
Number of firms	448	450	231	399	1,528
Engagement in intramural R&D	88%	61%	41%	0%	50%
Innovation intensity	7%	3%	13%	7%	7%
Co-operation arrangements on innovation activities	32%	9%	97%	0%	50%
Engagement in training	86%	32%	31%	27%	44%
Engagement in market introduction of innovation	55%	43%	32%	0%	40%
Engagement in acquisition of machinery	100%	15%	64%	100%	63%

Source: Eurostat CIS microdata, own calculations

The first sub-group is named “*R&D*”; enterprises following this strategy are characterized by a high level of intramural *R&D* (88% of the enterprises in this sub-group perform intramural R&D). Moreover, a large share (86%) of the enterprises in this sub-group is also engaged in training activities and all of the enterprises in this sub-group have acquired machinery during the reporting period. More than half of the enterprises engaged in design and the market introduction of innovation, and about one third has co-operation arrangements on innovation activities. The Innovation intensity, the ratio of total innovation expenditures to turnover, is 7%, which matches the average of the whole sample.

Firms in the second sub-group have a considerably lower level of innovation intensity compared to the first one. They rather focus on the development of internal capabilities through R&D and training than on external knowledge acquired by the purchase of machinery or co-operative arrangements. We have named this strategy “*Internal Capabilities*”.

Almost all enterprises (97%) following the “*Open Innovation*” strategy have co-operated for innovation activities. The second specific fact about this strategy is the high innovation intensity, which is almost two times higher than for any other strategy. While about two thirds of the enterprises in this sub-group have acquired machinery in the reporting period, about one third was engaged in training and the market introduction of innovation. With 231 enterprises, this strategy is the least common innovation mode.

Firms in the fourth sub-group, “*Technology Adoption*”, follow an innovation strategy which is closest to the conventional image of innovation in T/C. This strategy is characterized by the acquisition of external technology. Not a single enterprise in this sub-group is engaged in intramural R&D, co-operation for innovation or the market introduction of innovation, but all of the enterprises were engaged in the acquisition of machinery. About a fourth of the enterprises also perform training, which seems to accompany the acquisition of external technology. The innovation intensity is about 7% of turnover which is the average.

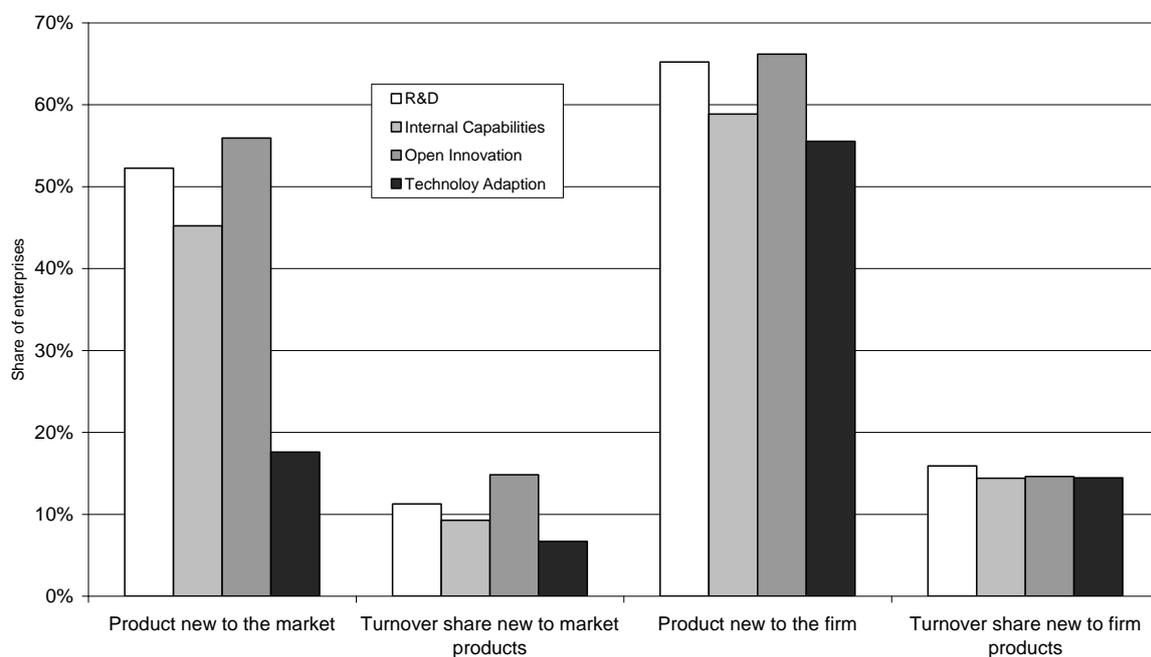
How do these different innovation strategies translate into differences in the innovative output and growth? We have calculated means for various output variables which are shown in the figures below.

In terms of innovative success measured by innovative output, the results show that the two most ambitious strategies in terms of novelty and innovation intensity – *R&D* and *Open Innovation* – also

yield the highest returns in terms of market novelties. The other two strategies are significantly worse off. While more than 50% of the enterprises pursuing the *Open Innovation* strategy or the *R&D* strategy have introduced a product that was new to the market between 2002 and 2004, this was only the case for less than 20% of the enterprises following a *Technology Adaptation* strategy (Figure 1.2). Despite its low innovative input, more than 40% of the enterprises in the *Internal Capabilities* sub-group developed a market novelty.

Looking at the corresponding turnover shares of new products (see Figure 1.2), the overall picture is similar: Turnover generated with market novelties is significantly higher for *Open Innovation* than for *Technology Adaptors* and *Internal Capabilities*. The difference to the *R&D* strategy is not significant.

Figure 1.2 Share of enterprises with new to market/firm products and share of these innovations on turnover, 2002 to 2004



Source: Eurostat CIS microdata, own calculations

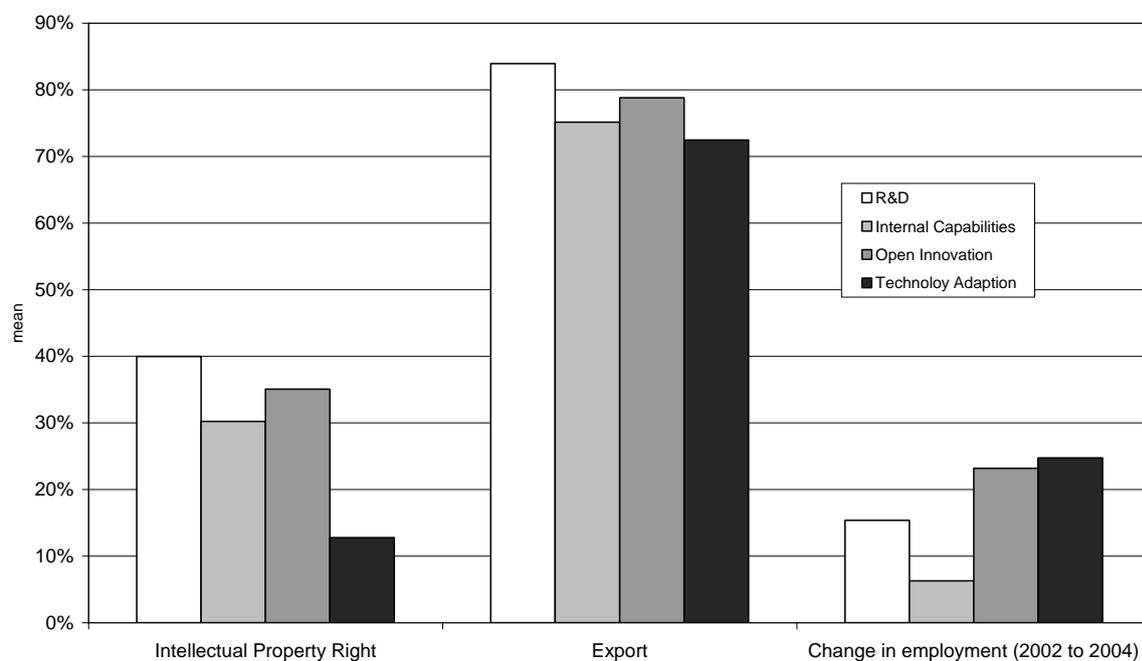
A different picture emerges when we turn to innovations that are only new to the enterprise. Again, *R&D* and *Open Innovation* firms perform superior compared to the other two sub-groups. However, differences are considerably smaller between the sub-groups and these differences are not significant anymore. The same can be said for differences between the four strategies in the share of turnover generated by innovations, which are not significant.

The protection of intellectual property rights (IPRs) is a key issue in innovative activities of T/C enterprises. Intellectual property is violated by product piracy, and many innovations, such as design novelties, cannot be protected adequately. There is no common strategy for the textile and clothing industry as a whole how enterprises could effectively protect their IPRs (Ożegalska-Trybalska and Winkler 2006). The choice of strategy (patent, trademark, industrial design or copyright) depends on the size of the enterprise, the degree to which its knowledge can be codified, the risk of unprotected knowledge to be copied etc.

Our results show that 30 to 40% of all enterprises in the *R&D*, *Internal Capabilities* and *Open Innovation* sub-groups have applied for an intellectual property right (patent, trademark, industrial design, or copyright). In the *Technology Adoption* sub-group in contrast, this share is only around 13%. We remember that this is also the sub-group which includes the lowest share of firms with products new to the market. The most usual protection strategy is to apply for a trademark (30% in the R&D sub-group).

Different innovation strategies create different outputs and different incentives to protect innovations. The choice of strategy, however, does not seem to influence the export potential of the enterprises. There are also only few differences in the share of enterprises exporting products which account for between 70 and 85% in all for strategies.

Figure 1.2 Protection intellectual property rights, export and change in employment, 2002 to 2004



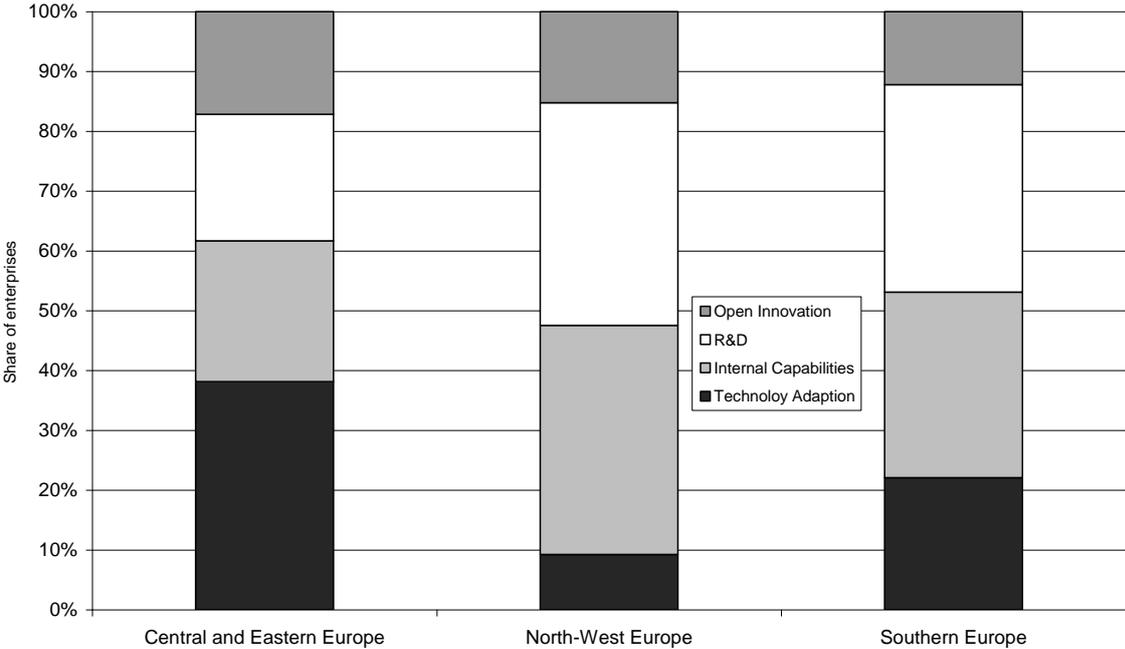
Source: Eurostat CIS microdata, own calculation

A surprising result yields a comparison of employment growth between the four sub-groups. There is a significant growth in employment for the average enterprise in each sub-group which corresponds to the result that innovative enterprises are more likely to expand employment than non-innovative enterprises (Pianta 2005, p. 576). Readers, however, should keep in mind that this outcome may be influenced by a selection bias. We can only include innovative enterprises in the analysis, because we don't have information on innovative inputs and outputs from non-innovative firms. Innovative firms, however, may have a higher employment growth compared to non-innovative enterprises. Moreover, we have no information about enterprises which failed and left the market.

Employment Growth is highest for *Technology Adaptors* and *Open Innovation*, followed by enterprises in the *R&D* sub-group and the *Internal Capabilities* enterprises lacking behind. The slow growth in the *Internal Capabilities* sub-group may be a result of the considerably lower innovation intensity. It is,

however, difficult to explain why enterprises that pursue the *Technology Adoption* strategy are superior to *R&D*-focussed enterprises in terms of employment growth. There may be a third factor not taken into consideration. Pianta (2005 p. 576), for example, suggests that positive employment effects of innovations are linked to organisational change in the enterprise. Another factor that has to be remembered is that the data only indicates employment changes between 2002 and 2004, while the effects of innovations on employment may only be observable in the following years.

Figure 1.3 Geographical distribution of innovation strategies in the T/C sector



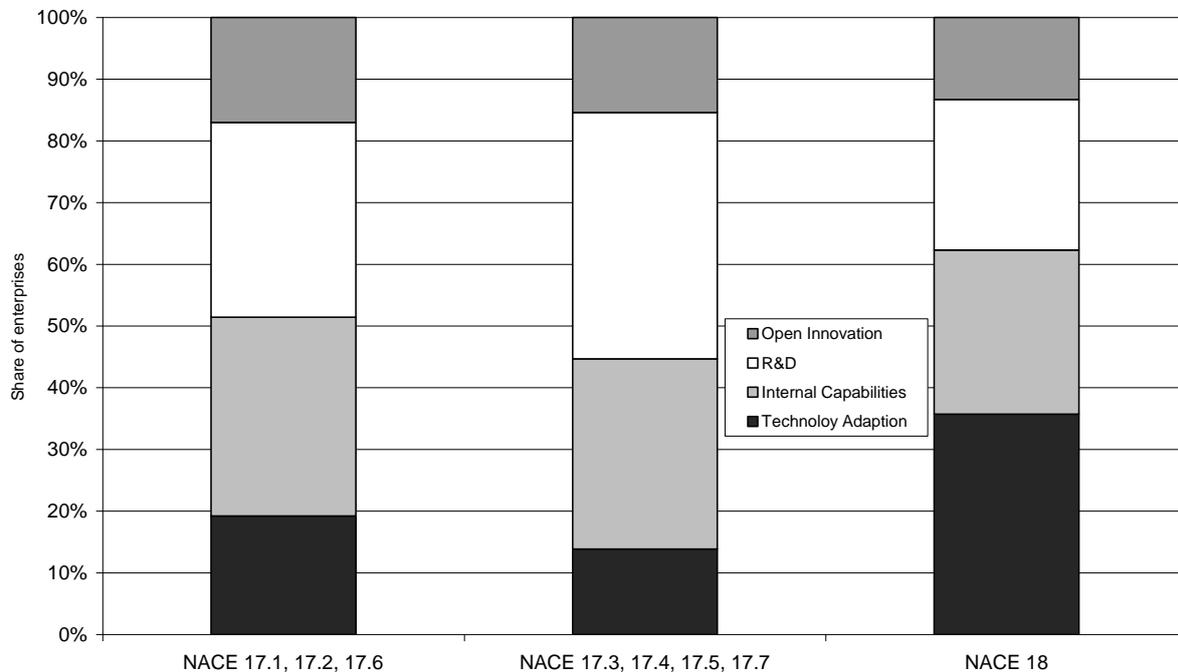
Source: Eurostat CIS microdata, own calculation

Another possible explanation is linked to different opportunities for innovation in different parts of the European Union. For enterprises located in Central and Eastern Europe (CEE), the *Technology Adoption* strategy is by far the most important strategy and can be found in nearly 40% of all enterprises (see Figure 1.3). Hence, employment gains in these countries may be fuelled by imported technology (*Technology Adoption*), wage differences and a surge in T/C to Western and Southern Europe due to offshoring. Differences in employment growth between European regions may therefore reflect the fact that the opportunities for *Technology Adoption* have not been fully exploited in this region compared to other regions. In North Western Europe, in contrast, *R&D* strategies and the *Internal Capabilities* strategy are dominating. More than ¾ of all enterprises in this region are following one of these two innovation strategies, while another 15% make use of the *Open Innovation* strategy. *Technology Adoption* plays a very limited role in this region. *R&D* and *Internal Capabilities* are also the two most important strategies in Southern Europe, with a share slightly below the corresponding shares in North Western Europe. Here, also *Technology Adoption* is of importance, with almost one quarter of all enterprises following of this strategy.

Finally, we investigate how the innovation strategies differ by T/C sub-sector (see Figure 1.4). We divided the T/C sector into three groups: The first group, including NACE classes 17.1, 17.2 and 17.6,

roughly equals the processing of textile fibres into intermediate products. The second group (NACE 17.3, 17.4, 17.5 and 17.7) consists of producers of final textile products of any kind. The third group contains all clothing enterprises (NACE 18).

Figure 1.4 Innovation strategies in T/C sub-sectors



Source: Eurostat CIS microdata, own calculations

Open Innovation, the smallest of the four strategies, plays only a niche role in all three sub sectors. For producers of intermediate textile products, *R&D* and *Internal Capabilities* are the two most important strategies with one third of the enterprises making use of each. In case of the producers of textile final products, *R&D* is the most common strategy (about 40%), followed by *Internal Capabilities* with 30%.

The picture changes when looking at the clothing sector. Here, *Technology Adoption* is by far the most important strategy. But we also find also a considerable share of enterprises which pursue *R&D* and *Open Innovation* strategies. Their share may be smaller than in the textiles sector, but together these two R&D-oriented strategies account for around 40% of all innovators in the clothing sector.

To sum up, there is a considerable variety in the innovation strategies of T/C enterprises. Innovation in T/C is more than just 'Low-Tech'; there are a considerable number of R&D-oriented enterprises, enterprises which make frequent use of external knowledge etc. Surprisingly, these different strategies have only little significant influence on innovative output and turnover growth.

1.4.2 The role of non-technological innovation in textiles and clothing

The of the preceding section results clearly demonstrate that 'Low technology' – often associated with 'low innovation' - is hardly a correct description for innovative activities in T/C. Innovation strategies in the textiles and clothing industry follow more complicated patterns. We have identified four of these

strategies, and demonstrated that *R&D* and *Open Innovation* strategies are also pursued in the clothing industry. There is, however, an uneven distribution of strategies over textiles and clothing industries that leads to the lower average values for the innovation indicators at NACE 2-digit levels presented in Table 1.2 and the following tables.

There is also second, more fundamental reason why 'Low technology' is a misleading; our empirical analysis of CIS data in Table 1.2 - has revealed that a lower innovation expenditure in the clothing industry has only little effect on innovative output, measured by the share of sales due to products new to the firm. Clothing enterprises also make frequent use of trademarks; this indicates that there has to be an innovative outcome worth to be protected. Both facts indicate the existence of other innovation activities and inputs to the innovation process the CIS may not measure correctly (Djellal and Gallouj 1999; Salazar and Holbrook 2004).

Previous Europe INNOVA studies have already highlighted this issue. Michael Böheim (2008, p. 22 and 106) points out that both, the textiles and clothing industry invest heavily in non-technological innovation. These investments, however, remain invisible in official statistics, and the sector therefore suffers from quantitative underestimation of its innovative efforts. Peters, Gottschalk and Rammer (2007) tried to establish a link between innovation inputs, innovation output and productivity with regression analysis for a number of sectors. In the T/C sector, the results of this exercise were disappointing. Statistically significant association could only be identified in a small number of input/output variable pairings (Peters et al. 2007, p. 15 and 16). Results with respect to economic performance were even more disappointing. Peters et al (2007, p. 18) discuss possible reasons for this outcome. Besides different sample size and time lags in the relationship between input, output and performance, they conclude that innovative output and economic performance may also be influenced by factors not measured by CIS.

We suggest that these missing inputs and activities are of non-technological nature. They fall rather into the definition of design, than into the definition of R&D, although design also includes some technological aspects (see European Commission 2009, p. 9 for some definitions of design). Non-technological innovation is important in the T/C sector because textiles and clothing goods not only deliver tangible, physical functionality (covering and protecting the body). They have also a symbolic value, a non-tangible, emotional component (Ravasi and Lojcono 2005; Di Maria and Finotto 2008). Textiles and clothing allow the consumer to express personality and identity, to distinguish oneself from others or to demonstrate membership in a certain group. These characteristics can satisfy consumer demand, help enterprises to distinguish their products from those of their competitors and create economic impact by increasing significantly the value added of the products.

This type of non-technological innovation constitutes a considerable part of the innovation activities in textiles and clothing, but also other sectors dealt with in Europe INNOVA such as food and drink. Most of these innovations, although extremely important for the success of the enterprise, hardly match the criteria for technological product or process innovation activity proposed by the OECD. The OECD defines product innovation as:

“... the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics” (OECD 2005, p. 48).

Process innovation is:

“... the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software” (OECD 2005, p. 49).

The focus of these two definitions is clearly on technological innovation and on improvements in functionality (Stoneman 2007, p. 5). In contrast, many activities associated with new products in clothing fall in the category marketing innovation, which is *“the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing”* (OECD 2005, p. 49). A change in the characteristics of a product “is a marketing innovation but not a product innovation, as long as the functional or user characteristics of the product are not significantly changed” (OECD 2005, p. 54).

Marketing innovation has a paramount importance in T/C sector and the OECD refers to textiles and clothing when discussing marketing innovation (OECD 2005, pp. 48, 57 and 149). The problem with marketing innovation, however, is that data on expenditure for or the effects of marketing innovation (for example, turnover from marketing innovation) is not available. In the recent version of the Community Innovation Survey (CIS) similar questions are only included for product and process innovation. The CIS questionnaire also includes marketing innovation, but treats it separated from product and process innovation. This leads to an underestimation, because marketing innovation is neither included in innovative expenditure nor in innovative output. As a result, there is an underestimation of marketing innovation efforts, which leads to the low shares of enterprises with marketing innovation reported in Table 1.2 and lower overall innovation expenditure in the T/C sector.

Why is marketing innovation not fully covered by the CIS and other innovation surveys? It is certainly not because marketing innovation is regarded as inferior type of innovation by the OECD and others – the OECD Oslo manual devotes considerable space to discuss it. Rather, this underestimation may be the result of measurement issues. The literature has discussed some characteristics of non-technological innovation which are related to these measurement issues (Tether 2006; Harris and Halkett 2007; Stoneman 2007; Miles and Green 2008):

First, it is often difficult to measure the degree of novelty of a non-technological innovation. Is a jacket in a different colour an innovation? The Oslo manual states that an innovation has to be a *“new or considerably improved product (good or service), or process, a new marketing method, or a new organisational method in business practices”* (OECD 2005, p. 47). Marketing innovation have to be a *“significant departure from the firm’s existing marketing methods”* (OECD 2005, p. 49). The minimum requirement for an innovation is that it must be new to the enterprise, but not necessarily new to the market or the world (OECD 2005, p. 48). This new-to-the-firm criterion reflects the fact that economic

growth not only results from an invention, but also from the subsequent diffusion of a new product. Besides novelty, the OECD focuses on the *economic effects* to judge if a product or process change is an innovation. The essential criterion for an innovation is that it has been implemented, which is, introduced to the market.

In the context of textiles and clothing, these definitions mean that new products, even if they lack technological novelty, can be an innovation. They have to constitute, however, a significant departure from previous products and must have been introduced the market, which is, unfortunately, a rather vague criterion. Unlike in science and technology, metrics for judging significant aesthetic novelty are arguably less well established. A product change can be an innovation for one enterprise, and no innovation for the other. The innovating enterprise may have a different opinion on this than outside observers, like in the case of ad-hoc innovation and customisation. Customisation means that enterprises create an item which is a specific solution to a particular problem posed by a customer. The OECD does not regard customisation as an innovative activity until it includes “significantly different attributes compared to products made for other clients” (OECD 2005, p. 56). Customisation nevertheless constitutes a considerable part of the creative activities in the clothing industry, but also in client-centred services (Miles 2005, p. 435).

Another important characteristic of non-technological innovation is that it is often intimately conjoined with technological innovation. Non-technological and technological product and process innovation are not rivals, but can also complement each other. Changes in the functionality of a product often go hand in hand with aesthetic changes, because new materials incorporate potential for changes in both dimensions. It is very rare that an enterprise in T/C only pursues technological or non-technological innovation, and advances in one field may promote activities in the other field.

The sub-group analysis on innovation strategies clearly shows that technological innovation (R&D and acquisition of new machinery occur in a large number of cases together with non-technological innovation (design, which is in the terminology of the CIS “market introduction of innovations” and may catch some of the expenditures for non-technological innovation activities). The R&D strategy contains the largest number of enterprises with intramural R&D activity, but also the largest share of enterprises with design activities. ICT-based manufacturing technologies such as customized textiles printing or rapid prototyping, for example, can simplify the design process and trigger new forms of aesthetic creation. Box 1.1 and 1.2 give illustrations of how the relationship between technological and non-technological in two enterprises.

This joint appearance of technological and non-technological innovation may be a major hampering factor for the measurement of non-technological innovation, because it leads to an underestimation of non-technological innovation in input (it is not included in the expenditure categories asked by the CIS questionnaire), and allows no distinction between the effects of technological innovation on innovation output (the CIS just asks for shares of new products on turnover, but not if these new products are the result of technological or non-technological innovation).

Box 1.1 The linkage between technological innovation and creativity in clothing design

Lena Hoschek² is a clothing enterprise located in Graz, Austria. The firm consists of Lena Hoschek, who is also the designer, and three other employees. The firm has no own production – this is outsourced to another Austrian company – and focuses solely on design of clothing. Lena Hoschek sells its products through two own shops in Austria and various retailers in Austria, Germany, Switzerland, the Netherlands.

Creating new products is very much an emotional process for Lena Hoschek, which may be not very rational and cannot be planned. However, even her artisan approach is influenced by new technology. Her designs often use printed fabrics, and due to advances in digital fabric printing in recent years, customized fabric prints can not be produced in very small bulk sizes at reasonable prices. This has enabled her to have more influence on the fabrics and therefore allowed more possible variations for design. The prints are created in co-operation with a textiles designer who is can be regarded as a part of a wider network which is not part of the firm, but regularly contribute to its activities.

Source: Interview with Lena Hoschek

Finally, non-technological innovation is often associated with seasonal changes – products may only alter their aesthetic appearance, but stay unchanged in their functional characteristics. This is an essential characteristic of the clothing industry. The OECD, however, does not regard seasonal changes as an innovation. The Oslo Manual clearly states that changes and “... routine changes in design are generally neither product nor marketing innovations” (OECD 2005, p. 57). But how to distinguish routine changes from ‘real’ innovations? And what if these seasonal changes satisfy the implementation as well as the novelty criterion? Sticking to this rule inevitably reduces innovation expenditure T/C firms report, even if they include non-technological innovation.

Box 1.2 Technological and non-technological aspects in textiles development

Getzner Textil AG³ is a weaving company located in Bludenz, Austria with subsidiaries in Germany and Switzerland. The main products are shirting and of damask fabrics. Main clients for shirting include a number of well-known European clothing companies. Although Getzner is a weaving company and invests heavily in machinery, the importance of design and other non-technological innovation is high and non-technological and technological innovation is very closely related. Getzner regards design activities as very important and sees that their importance has increased in recent years. If the don't change the design of their products for three years, the company will not exist anymore.

The development of new shirting is a combination of technological and non-technological innovation. Mr Komplj describes a the development of a new shirting as working with a ‘construction kit’ consisting of different treads, garments, colours, fabric constructions (for example densities) and weaving techniques. This allows a very large number of theoretical combinations, only limited by production technology. For each season, the company decides what components are in this construction kit, and the designers can combine whatever they want. This is the creative part. Getzner has its own design department and only works with in-house designers and the design team consists of people with design and technical skills. The number of people dealing with design is roughly equal to the number of people dealing with technological innovation.

The technological aspect of developing shirting is to change the physical propensities of the shirting, for example to improve the appearance of white shirting. Black is also very challenging, in particular to create deep black shirting and black shirting that resists washing. There are also some activities to add anti-bacterial propensities to textiles with silver threads and other things. Another technical aspect is to add new components to the construction kit, for example new garments made of new threads (for example elastic threads) or new weaving techniques. These potential improvements are tested and then made available to the in-house designers. Finally, another type of innovative activity is market observation and market development. Here, the question is what other things can we do with our competencies? Only recently, the company has discovered the market for corporate wear, which is becoming more and more important in a number of industries and also in the service sector. The firm was not aware of this market which is, in many ways, different from the shirt manufacturers, and will see how they can enter it.

Source: Interview with Mr Georg Complj, Member of the Board and Chief Technical Officer, Getzner Textil AG

² <http://www.lenahoschek.com/>

³ <http://www.getzner.at>

Attempts to improve in the measurement of non-technological innovation should regard these characteristics. We suggest that a modification in the way innovation effort is measured is needed to get a more realistic picture of innovation in T/C.

In the framework of the OECD Oslo Manual, this would at first require to make non-technological, marketing innovation more visible. Design activities, for example, are included in product innovation efforts only when they significantly change the product's functional characteristics. If they change the product's sensory perception and aesthetic appearance, it is marketing innovation. This distinction may be quite unfamiliar to firms and difficult to implement in answering the questionnaire. It may therefore be advantageous to implement additional questions on design, or run a separate survey on design compatible with the CIS. Various surveys, such as the 2007 Innobarometer or the UK Community Innovation Survey have incorporated separate questions on design (European Commission 2009).

A first, basic question on design would be if the enterprise has a design department, and, if not, which department covers tasks related design. It would also be quite easy to complement a question on the size of R&D personnel by a question that asks for the number of persons employed with design and non-technological innovation and give examples for it.

A second suggestion relates to the output side of non-technological innovation. Stoneman (2007; 2008) proposed to focus on the its market impact when judging if a single non-technological innovation is an innovation: "If a soft innovation has a large impact upon the demand curve (perhaps proxied by sales) it is considered to be significant, whereas if it has little impact it is considered not significant" (Stoneman 2007, p. 8). This approach also reflects that the concept of innovation has been introduced to explain economic change, not the creation of scientific novelty. It is, however, only applicable for single innovation and cannot be used to measure the complete innovative efforts of an enterprise. A basic question that evaluates the enterprise dimension could be if the enterprise regards design as important determinant of its success.

Empirical evidence at the impact of non-technological innovation on enterprise output may also be given by questions that relate changes in product range to changes in turnover. A questionnaire could, for example, ask what changes in turnover the respondents expect if the enterprises does not change its product range. More generally, respondents could also be asked to judge the importance of non-technological vis-à-vis technological forms of innovation and the weight both forms have in their firm strategy.

Another approach which may measure the quality or radicalness of a single non-technical innovation is its external reputation and influence. Marzal and Esparza (2007) have proposed to use the external influence of a product change, the number of imitators, or the extent of copying as proxies for quality. Again, this only works for individual innovations, but may help to overcome the problem of how to evaluate the novelty in areas where a lot of innovative activity is customization and bespoke production.

1.4.3 Globalization and innovation

Textiles and clothing represent a significant sector in world trade with the EU27 being a main player. Today, the EU27 is the world's largest exporter of textiles, the second largest exporter of clothing, but also the second largest importer of textiles and clothing (EUROSTAT 2008, p. 76). The European T/C industry is among the industries most open to globalization and, therefore, also strongly affected by globalization in recent years. Imports from China, Bangladesh and other developing countries surged after the removal of quotas in 2005 and put considerable pressure on producers located in the EU. T/C is among the industries with the highest share of foreign direct investment (FDI), offshoring and production relocation (OECD 2007, p. 50 and 51). But competitive pressure comes also from within the EU: almost three quarters of the total exports by the EU-27 Member States are intra-EU trade and go to another EU-27 Member State. This is a higher share than for many other products (EUROSTAT 2008, p. 76).

This high degree of international economic integration calls for a thorough discussion of the effects of globalization on the technological and non-technological competencies of the European T/C industry. Globalization links in various ways to R&D, technological and non-technological innovation of enterprises. Rising *imports* and *incoming* FDI may impose a stronger competitive pressure on domestic enterprises and force them to specialise on more innovative segments of the market. The host country may also benefit from information and knowledge spillovers from foreign-owned enterprises. A stronger competitive pressure due to a higher degree of internationalisation, however, may also cause market exits by enterprises which did not manage to adapt.

There is also a strong link between innovation and *outward internationalisation* – the effects of exports and outward FDI. The relationship between innovation and *exports* is straightforward. Rising exports indicate an increasing demand for the products of the firm and are a major incentive to innovate because of higher sales expectations. Moreover, innovative efforts of exporting enterprises may also be higher compared to non-exporting enterprises, because the former need to adapt products to the export markets.

The link between innovation and investments of domestic firms abroad is more difficult to see. Both factors are positively related for two reasons. First, it is assumed that the most innovative and productive enterprises have the biggest incentives to go abroad. These enterprises possess superior products, brands, or technological and design capabilities and want to commercialise these assets at foreign markets (Dunning 1973; 1995). Exports and foreign investment may help to cover considerable fixed costs for the development of new products, which do not seem economical when sales are restricted to one country. The expansion of LVMH and other major European fashion producers to Asian markets is an example for this incentive. This selection effect that drives the most productive enterprises to internationalisation can also be found in the results of Camuffo et al (2008) on Italian textiles producers. Hence, a high domestic productivity is an important prerequisite for internationalisation, even if cost-cutting is the main motive for going abroad (Barba Navaretti and Venables 2004).

Second, outgoing internationalisation is also associated with higher knowledge and information *requirements* of the firm. Enterprises need to know the local markets in their host countries in order to adapt their products to local tastes, environmental conditions, regulation etc (von Zedtwitz and Gassmann 2002; Narula and Zanfei 2005). Clothing, as has been stated above, is a product with a number of connotations to status, identity and culture. This may imply that differences between countries have to be reflected in the product range offered by clothing enterprises or at least in the way goods are offered. Knowledge about local markets is often tacit and 'localized', which means that it can only be accessed locally and cannot be transferred over distance (Breschi and Lissoni 2001). This adaptation, however, ends at the point when it touches the unique brand identity of the firm.

Foreign investment, therefore, is likely to lead to a higher level of innovative activities. The question, however, is *where* these additional innovative activities show up. Additional innovative activities will be located in the home country when the company sees higher benefits from a *concentration of these activities in the home country*. These benefits may include scale advantages, a higher degree of specialization, less co-ordination cost and higher spillovers from the home country innovation system (Sanna-Randaccio and Veugelers 2003; Gersbach and Schmutzler 2006 - see also the box below). Moreover, enterprises usually have strong ties to the innovation systems of their home countries (Narula (2003) that pose another diseconomy for the offshoring of innovation activity.

Box 1.3 The benefits of centralizing R&D at home

Lenzing AG⁴ is a producer of cellulose fibres for the textile and non-wovens industries located in Lenzing, Austria. Cellulose fibres are a niche product in the global fibre business which is dominated by cotton or synthetic fibres. In this niche, Lenzing is the most important player with a market share of 24% in the global cellulose staple fibre market. Production activities are located in Austria, Indonesia, China, the US and the UK.

In 2007 Lenzing spent 18.3 Mio. EUR (or 1.5% of turnover) on R&D. Product development is centralized at the headquarters in Austria. This is, at first, a consequence of the need to integrate product development and testing. These stages of product development are connected through multiple feedback loops to see if a new technical principle or a new substance is also suitable for industrial production. This concentration allows fast product development because development and testing happens at the same place. Second, Lenzing has to take care that its fibres are also suited for the production processes of its clients (threading, spinning, dyeing, weaving etc.). The firms finds it easier to test this at its own development facilities, which include a test spinning mill, weaving mill, dyeing mill, etc. It would be too costly to duplicate these facilities somewhere else and run two development centres. Third, the concentration of skills and development activities helps to protect knowledge from being copied. Forth, as a fibre producer, Lenzing stands at the beginning of the T/C value chain and has no direct contact with the final consumer. So, there is no point in co-operation with clothing firms etc. External partners (lead customers) are included in the development process not until the main propensities of new products are fixed.

Source: Interview with Mr Wilhelm Feilmair, Head of Quality Management and Process Innovation, Lenzing Textil AG

A major factor that favours a decentralized organisation of innovation activities, in contrast, is the need to develop products in the main target markets explained above. Enterprises with a considerable share of turnover in China, for example, may find it very difficult to develop products for this market in Europe, because they don't have access to context-specific, local knowledge for the Chinese market. Moreover, enterprises with centralized design and innovation activities may find it hard to bring

⁴ <http://www.lenzing.com/>

products in a short time to the market, because the transfer of knowledge takes considerable time due to a lack of proximity to main clients. Other reasons for foreign-located innovation activities include proximity to competitors or universities, skills shortage at home or cost advantages in innovation. If these factors prevail, foreign investment may lead to a stagnant or even lower level of innovative activity in the home country.

Investment abroad may therefore have a substitutive and/or a complementary relationship with innovative activities at home. We may assume that this relationship will be mostly complementary for some reasons. First, there is a large literature that shows that being innovative (and thus more productive) is a pre-requisite for internationalisation. This selection effect implies that only the most productive enterprises go abroad while less productive enterprises solely focus on domestic markets (Helpman 2006; Greenaway and Kneller 2007).

Second, empirical research has shown that innovation is a typical complementary 'headquarters activity' and innovative activities are still largely concentrated in the home country (le Bas and Sierra 2002). If the demand for the products of the enterprise rises due to internationalisation, it is likely that demand for these headquarter functions also increases. This may even offset job losses from offshoring as could be seen in the case studies on cluster restructuring in Denmark and Catalonia (EMCC 2008a; European Cluster Mapping Project 2008) As a result of international expansion, jobs in the home office become more knowledge-intensive. Third, empirical evidence on the relationship between FDI and other economic activities at home such as production finds mostly no substitutive relationship (Brainard and Riker 1997; Braconier and Ekholm 2000; Bruno and Falzoni 2003). In the long run, most authors find no association or a complementary relationship between production activities at home and abroad.

We will now examine the relationships between technology, innovation and globalisation empirically. In the previous chapters of this report we employed data from the Community Innovation Survey (CIS); this data source, however, is not suitable for this task since internationalisation is not a topic in the CIS. We will therefore employ data from the European Manufacturing Survey (EMS), a survey conducted in a number of European countries by a group of institutes co-ordinated by Fraunhofer ISI⁵. EMS includes data on manufacturing strategies including investment in advanced production technologies and new organisational concepts.

The EMS also includes a question on offshoring of production activities, which allows us to study the effects of offshoring on innovation and investment at the enterprise level. The last round of the EMS took place in 2006 and included more than 3,500 manufacturing enterprises. For the first time, EMS also covered textiles and clothing sectors in this round. Data is available from 121 enterprises in the textiles and clothing sectors. A short inspection of the data, however, revealed that offshoring is very rarely found in a number of countries including Turkey, Greece or Spain. We therefore decided to use

⁵ Data has been provided by Austrian Institute of Technology for Austria, Fraunhofer ISI (Germany), Radboud University Nijmegen (Netherlands) and Lucerne University of Applied Sciences (Switzerland). Additional information on the EMS is available at www.european-manufacturing-survey.eu

a smaller dataset which only includes countries with a noticeable level of offshoring activity. These countries are Austria, Germany, the Netherlands and Switzerland.

The smaller sample includes 64 enterprises, 52 of them are in the textiles sector. The enterprises have on average 110 employees (range is 10 to about 1,000), and export about 40% of their products. The enterprises are, on average, 60 years old (4 years the youngest). The majority of them is R&D-active. They spend on average 3.8% of their turnover on R&D. 60% of the have introduced an innovation to the market in the last two years. These innovations account for 21% of turnover on average. A comparison with the CIS results on the innovative behaviour reported in Table 1.2 shows that this sample is certainly not representative for the T/C sector. The sample, however, is appropriate to study the effects of offshoring on innovation and technological investment since these effects can only be studied on enterprises the use technologically advanced equipment and invest in innovation and R&D.

Offshoring of production activities is frequently found in the T/C sector. The data show that 35% of all T/C enterprises relocated some parts of their production activities to foreign locations between 2004 and 2005. This is considerable more than the average in the manufacturing sector in Austria (25%) or in Germany (15%; Kinkel and Maloca 2008).

We have assumed that innovation activities at home and investment abroad have a complementary relationship, and, thus, offshoring enterprises have a higher propensity to innovate. Due to the small sample it is not possible to evaluate this assumption in a multivariate framework. However, a simple comparison of offshoring and non-offshoring enterprises and a T-test show that the data support this assumption.

On average, 82% of the offshoring enterprises introduced innovations in the last two years, compared to a share of only 50% for the non-offshoring enterprises. The difference is significant at the 5% error level (table 1.6) Offshoring enterprises also achieve a higher turnover generated by innovations than non-offshoring enterprises. Moreover, they also introduce significantly more often market novelties and spend on average more for research and development. There is, however, also a downside of offshoring; offshoring enterprises reduced staff at a considerably faster rate than non-offshoring enterprises (table 1.6 last row). This means that a higher innovativeness in offshoring enterprises and more headquarter functions due to internationalisation did not create enough additional jobs to compensate job losses due to offshoring.

Table 1.6 Indicators of innovative behaviour for offshoring and non-offshoring T/C enterprises

	<i>Non-offshoring enterprises</i>	<i>Offshoring enterprises</i>	<i>T-value and significance</i>
Share of enterprises with innovations	50%	82%	0.01 **
Share of turnover generated by innovations	19%	24%	0.37
Share of enterprises with market novelties	26%	67%	0.01 **
Share enterprises with old products	88%	100%	0.09
R&D expenditure on turnover	3.7%	4%	0.91
Employment growth (persons)	- 2.92	- 34.71	0.02 **

Source: EMS 2006, own calculations; countries included are Austria, Germany, the Netherlands, Switzerland.

A second question we want to discuss is the relationship between offshoring and technological competencies of the firm measured by investment in advanced production technologies at home. We have seen from the CIS data and the sub-group analysis that the acquisition of new equipment is a very important source for innovation in the T/C sector. If offshoring enterprises attempt to substitute these expensive investments by production in low-cost countries, this may lead to a considerable weakening or 'hollowing out' of the technological competencies of the European T/C industries.

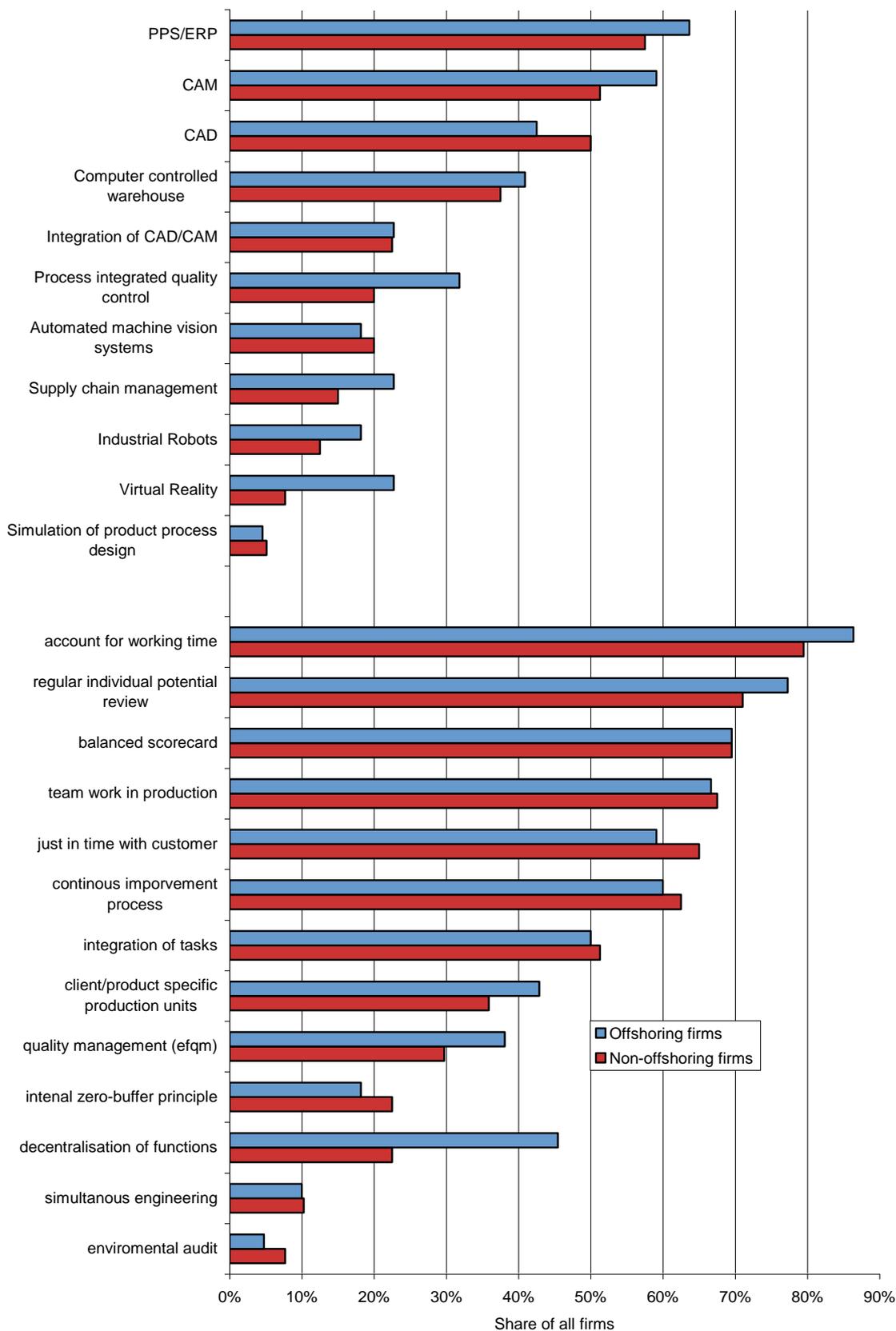
The EMS results show that enterprises do not substitute advanced technologies for cheap labour. Offshoring enterprises have a higher or similar propensity to invest in advanced technologies in most cases compared to non-offshoring enterprises (see Figure below). The differences, however, are small and not significant in many cases and it is difficult to relate them to internationalisation. Fears that offshoring may lead to a 'hollowing out' of the technological competencies of European T/C enterprises are therefore not justified. But we cannot say that offshoring promotes the technological competencies of T/C enterprises, either. There may be other factors not accounted for which affect both, offshoring and the incentives to employ advanced technologies.

A similar result can be found when we compare the utilization of various organisational concepts in offshoring and non-offshoring enterprises. Differences are small and not significant, with the exception of decentralisation of functions which is significantly more often found among offshoring enterprises. Offshoring is indeed a fundamental organisational change in the firm with alters many firm functions.

We conclude from the analysis that offshoring enterprises have a higher incentive to innovate and invest in R&D. Moreover, offshoring is not associated with a lower incentive to invest in advanced production technologies or organisational concepts in the home country. This result is also confirmed with a dataset including a broad range of manufacturing industries (Dachs et al. 2008). However, we have to stress the fact that our analysis only covered one aspect of the internationalisation in T/C, leaving other important aspects, such as the effects of imports and price competition from Asia on innovation activities of European T/C enterprises aside.

From a policy perspective, fears that offshoring may lead to a 'hollowing out' of the technological competencies of European T/C enterprises are not justified. Job gains in innovation, R&D or other headquarter functions, however, are not sufficient to compensate for job losses due to offshoring.

Figure 1.5 Usage of different technologies and organisational concepts by offshoring and non-offshoring enterprises



Source: EMS 2006, own calculations; countries included are Austria, Germany, the Netherlands, Switzerland.

2 Carriers of innovation

2.1 People

The textiles and clothing industry differs from other sectors with respect to employment characteristics (EUROSTAT 2008, p. 74ff). First, it is the only industry at EU27 level that employs more women than men; in 2006 more than two thirds (69.1 %) of the workforce were women compared to about one third (35.0 %) in the non-financial business sector.

Second, the T/C industry is a low-wage sector; average personnel cost is about half of the average personnel cost in the non-financial business sector and below national average in every single member state where data is available. There are, however, considerable variations with respect to wage levels throughout Europe. In a recent study, the *Institut Français de la Mode* (IFM 2007) reports that the average cost per hour in spinning and weaving is about 30 USD in Belgium and Germany, whereas the cost in Poland, Slovakia or Estonia is only 3-4 EUD. In general, T/C enterprises located in the North-West parts of Europe have the highest average personnel costs, while Bulgaria, Romania and the Baltic states are at the lower end of the range. Average personnel costs in the latter countries are only slightly higher than in Turkey or Morocco, but still considerably higher than in China, Bangladesh or India (IFM 2007, p. 92).

Third, labour productivity in T/C is low and labour intensity is high compared to other industrial sectors. On average, each person employed in T/C sector creates about Euro 20.000 value added per year, which is only half of the average value added per employee in the whole business sector (EUROSTAT 2008, p. 75). Labour productivity in T/C can be compared to that of the hotels and restaurants industry. The SIW report on national specialisation finds out that textiles and clothing exhibits a decline in average TFP during the period 1996-2002.

Forth, average age of the workforce in T/C (including the footwear and leather industry) is higher than in the total manufacturing sector (Vogler-Ludwig and Valente 2009, p. 53). This can be explained, on the one hand, by a stronger legal protection for older workers. As a result, job cuts mainly affected younger workers. On the other hand, the high average age can be explained by a low level of recruitment in T/C, combined with the fact that graduates seem to think that career opportunities are brighter in another sector than in the T/C industry.

Fifth, T/C is a sector with a high share of low-skilled workers. According to Vogler-Ludwig and Valente (2009, p. 55), more than half of the workers in the textiles, clothing and leather sector in the EU15 have only basic formal education (ISCED 1, 2), one third has a medium level (ISCED 3, 4), and 9.3% have higher education (ISCED 5, 6). The situation is different in the EU10, where the majority of workers have a medium level (81.1%), and only 13.1% have a low level. 5.8% of T/C workers in the EU10 attain a high level. Since 2000, the share of employees with basic education has decreased throughout the EU, while the medium and high levels have risen.

As a consequence, various studies such as the EU Competitiveness Report 2007 (EC 2008, p. 93-101) indicate that there is a growing need for improving the skills of the workforce in the sector (see also EURATEX 2002; IFM 2007; EMCC 2008c; Vogler-Ludwig and Valente 2009) T/C enterprises may be challenged by skill shortages in the future even despite a shrinking total employment. Experts see possible shortages in technical skills, but also in marketing skills such as knowledge about external markets, creative and design skills (EC 2008). These shortages are a consequence of the change in the nature of employment in T/C which shifts away from physical production to more immaterial, ancillary activities – sales, design and marketing. This development is pronounced by offshoring which allows enterprises to focus on sales, design and marketing activities and the advance of business models that focus on brand development rather than on the production of goods.

The employment characteristics of the T/C sector have also consequences for the development of skills in the sector (IFM 2007). The decline of employment and the considerably lower wage level limits the inflow of new personnel for various reasons – indicated by the ageing of the workforce in the sector. First, enterprises that are faced with decreasing market shares may be reluctant to hire new staff. Second, it becomes difficult for enterprises to compete with other sectors for talent and convince graduates to start a career in T/C when the wage level in the sector is low. New personnel, however, is also the carrier of new knowledge and new ideas. Third, a high level of unskilled workers and an ageing workforce may also set considerable obstacles for training and the acquisition of new skills by the workforce. Moreover, the decline of the T/C sector has also led to an erosion of schools and training centres specialized on T/C which have existed – and still exist – in regions with a high share of T/C industry (IFM 2007, p. 100). The threat from skill shortages creates the need for policy responses such as new training programmes (EC 2004; EURATEX 2004; EMCC 2008c).

2.2 Organisations

In 2004, there were around 77,300 enterprises active in the textiles and 141,800 enterprises operating in the clothing sector of the European Union (EUROSTAT 2008, p. 85). If we combine this information with employment data, it follows that the average enterprise size in T/C is considerably smaller than in other sectors.

Another important feature of the T/C sector are high entry and exit rates in the enterprise population. According to the 2008 European Competitiveness Report, the annual entry rate in T/C is 8.4% for the period 1998 and 2003 (EC 2009, p. 138). This is an important observation if we consider that economic theory in the Schumpeterian tradition has identified market entrants as the carriers of new ideas and new business routines and as agents that could stimulate employment and competition in a sector (Nelson and Winter 1982; Marsili 2001; Aghion and Griffith 2005). There are, however, also a large number of market exits. Around 9.37% of all enterprises were leaving the sector annually between 1998 and 2003. As a result, the T/C sector has - as one of only a few sectors - a negative net entry rate between 1998 and 2003 which also corresponds to the decline in employment over this period.

One effect of these is a high number of gazelles. The analysis of high-growth companies (Horizontal Report 4) reveals that T/C firms are quite frequent among gazelles firms – the fastest growing 10% or 5% of all growing SMEs. T/C firms hold a share of 6.3% of the Top 10% fastest growing firms and a share of 6.6% Top 5% fastest growing firms. Both shares are well above the share T/C firms have on aggregate value added or employment in the business sector (EUROSTAT 2008, p. 73). There are more gazelles in T/C than in a number of medium- and high-tech sectors including machinery, manufacture of electrical and optical equipment, or manufacture of transport equipment. Gazelles in T/C are predominantly found in Southern Europe and in South-East Europe, in particular Romania and Bulgaria.

The prominent role of T/C firms among high-growth companies is presumably less due to their R&D and innovation efforts. The T/C sector reveals a considerably lower innovation performance compared to manufacturing average, despite some exceptional R&D and innovation intensive firms in the sector. The high number of gazelles in T/C is more likely to be related to high entry rates in T/C and low entry costs in the sector, and may also be explained by the predominant role of small and medium-sized firms in the sector.

Large firms and multinationals, in contrast, play only a limited role in the textiles and clothing industry compared to other sectors in manufacturing. Firm sizes tend to be larger in textiles than in clothing. There are, however, some large multinational firms in other sectors up or down the T/C supply chain which considerably influence innovation in the sector. These firms include, for example, multinationals in textiles trade or suppliers of machinery and materials.

In a wider perspective, the T/C sector consists not only of textiles and clothing enterprises, but also of suppliers, customers, and research and training organisations which all considerably shape innovative performance of the sector. Important actors in such a wider perspective are, at first, downstream activities in the value chain such as retail and distribution enterprises. The data on innovation co-operation presented in the preceding section of this chapter show the dominant role of customers for the innovation processes of T/C firms. In both, textiles and clothing, the share of firms that co-operate with customers is considerably above average of the business sector.

Some of these retailers (most notably Benetton, Zara and Hennes & Mauritz) have managed to reach a very tight integration of their upstream value chains by using technologies such as electronic data interchange (EDI) or the integration of computer-aided design with production (CAD-CAM integration). As a result, the result that time between the first idea for a new product and the final production has been shortened considerably (Böheim 2006, p. 27, Box 1). Moreover, real-time inventory registration and the integration of suppliers into the information systems of the retailer allowed to overcome the old seasonal system of production on stocks and reduced sales of overproduction (IFM 2007, p. 71).

A tighter integration of retailers and producers of textiles and clothing is not only beneficial for the retail chains. Producers may also gain, because this system is only feasible with long-term contracts. Moreover, we can assume that this integration created considerable demonstration effects and other spillovers, because suppliers were forced to adapt up-to-date communication technologies and have

to improve their internal processes. A severe disadvantage from such arrangements for suppliers is the fact that retailers now completely control the entire value chain and can exert considerable pressure on their suppliers (Dunkel et al. 2007; Saviolo and Ravasi 2007). It should be noted, however, that value chain integration was not only initiated by retailers, but also by some manufacturers who went downstream the value chain and established their own sales outlets.

Another important group of organisations that exert influence on innovation in the T/C sector are suppliers, in particular suppliers of equipment. Following the classical typology of Pavitt (1984) textiles and clothing are often described as sectors where innovation is “supplier-driven”, which means that a main impetus for new products and processes comes from new equipment and new raw materials. In the case of T/C the most important supplier industries are the producers of machinery and chemical industry. The relationships between T/C (and other supplier-driven sectors) and their “high-tech suppliers” are not just one-way, as the term may suggest. A number of case studies have indicated that information flows in both directions, in particular when equipment is tailored to the needs of T/C and other client industries (Bender 2006, p. 57).

Suppliers can contribute to innovation at their clients in two ways. First, by improving the efficiency in the production of existing goods (process innovation). A current example is the introduction of information and communication technologies such as EDI in the T/C sector described above, which shortens development cycles. Second, new production technologies may also allow to manufacture completely new products. Here, one of the most important trends is digital printing, which offers an economical alternative for small production batches of highly creative products and allows a high degree of customization (IFM 2007, p. 117).

Empirical results from the CIS do not fully reflect this complex relationship. The share of firms co-operating with suppliers is below average both textiles and clothing, as is the share of firms buying equipment in the innovation process. There is however, a slightly higher than average share in the firms which consider suppliers as their most valuable co-operation partner in textiles. Moreover, the share of firms that regard suppliers as a highly important information source in the innovation process is higher in T/C than in the business sector.

Besides customers and suppliers, there are also other service enterprises which influence innovation in T/C, for example enterprises which provide textiles rentals to hotels, restaurants or hospitals or supply knowledge-intensive and creative services. Other important drivers of innovation in T/C outside the sector include the suppliers of machinery, information and communication equipment or the chemical industry.

A traditional strength of the T/C sector is the availability of a training, education and research infrastructure specialised in knowledge relevant to the T/C industry (IFM 2007, p. 100f). According to the Institut Français de la Mode (2007, p. 101) the existence of schools focussed on T/C and higher education on related issues at the University of Iasi constitutes a considerable competitive advantage for the Romanian clothing industry. Similar evidence can be found for textiles machinery engineering in the Lyons region, for the Flanders region where IFM highlights co-operation between clothing

enterprises and design universities, or in Biella, Svenljunga or Brianza area (IFM 2007, p. 101). Such co-operations trigger knowledge exchange, but also increase the visibility of the T/C sector as a prospective employer for graduates. Despite this infrastructure, the willingness to co-operate in the T/C sector, however, is only average compared to other industries, as has been noted above.

2.3 Clusters and networks

2.3.1 The use of external information and knowledge in the T/C sector

Enterprises increasingly rely upon external actors in the innovation process, a strategy which has been labelled as “Open Innovation” in the literature (Chesbrough 2003). Chesbrough and other authors stress the importance of integrating the customer into the innovation process in particular. There is evidence that enterprises that pursue such a strategy perform better and have a higher probability to create market novelties (Laursen and Salter 2006).

Learning from external sources is essential in industries that have to deal with a high degree of uncertainty regarding changes in demand and/or technology. Anticipating changes in customer demand is of paramount importance in textiles and clothing sector, arguably even more important than in other sectors, because changes happen faster than, for example, in the production of investment goods or in food processing. Moreover we have seen that innovation in the T/C sector relies to a higher degree the acquisition of external technologies from suppliers.

It is therefore surprising that innovative enterprises in textiles and clothing co-operate less frequently than enterprises in other sectors (see Table on innovation co-operation below). While the share of co-operating enterprises in the textiles industry is close to the average of all industries in most dimensions, the clothing industry lies considerably below the industry average and below the values for the textile industry in most variables. Two areas where clothing enterprises perform particularly worse are international co-operation and co-operation with universities. The share of trans-border co-operation is considerably lower in clothing than in textiles and in the whole business sector. Only 2.2% of all clothing enterprises co-operate with universities or similar institutions. Differences between textiles and the business sector are considerably smaller.

The literature on innovation co-operation (Fritsch and Lukas 2001; Tether 2002; Abramovsky et al. 2009) offers some explanations for this low participation. Most important, besides the sector of the firm, are firm specific characteristics such as absorptive capacity and capabilities to manage co-operation over time. The lack of these abilities, in turn, is related to a low average firm size and poor access to financial resources, a lack of qualified personnel, and problems in enforcing intellectual property rights. Policy measures that want to foster co-operation in the T/C sector may find it necessary to help firms to improve on these factors.

Table 2.1 Textiles (NACE 17) and clothing (NACE 18) industries over CIS innovation dimensions; innovation co-operation

	<i>Average Textiles (2)</i>	<i>Average Core NACE (1)</i>	<i>% GAP (2/1)</i>	<i>Average Clothing (4)</i>	<i>Average Core NACE (3)</i>	<i>% GAP (4/3)</i>
All types of co-operation	22.9%	25.1%	91.1%	15.2%	24.8%	61.4%
Other enterprises within your enterprise group	6.4%	9.2%	69.8%	3.4%	7.8%	43.3%
Suppliers of equipment, materials, components or software	14.7%	16.1%	91.3%	10.2%	16.0%	64.0%
Clients or customers	11.3%	13.5%	83.8%	10.2%	13.4%	76.4%
Competitors or other enterprises of the same sector	6.9%	8.1%	86.1%	5.2%	7.3%	71.2%
Consultants, commercial labs, or private R&D institutes	8.3%	8.6%	96.7%	4.9%	7.8%	63.6%
Universities or other higher education institutions	7.5%	8.8%	85.3%	2.2%	8.1%	27.7%
Government or public research institutes	4.6%	5.6%	82.4%	3.0%	5.0%	59.7%
Enterprise engaged in any type of <i>national</i> innovation co-operation	19.0%	22.3%	85.6%	13.5%	21.9%	61.3%
Enterprise engaged in any type of innovation co-operation within other Europe	10.1%	10.0%	100.2%	6.9%	9.7%	70.5%
Enterprise engaged in any type of innovation co-operation with the United States and other countries	2.9%	4.3%	67.7%	3.3%	4.1%	80.2%

Source: CIS 4, own calculations, countries included see annex

The CIS questionnaire also asked which type of co-operation partner the enterprise did find most valuable for its innovation activities. This allows a ranking of external sources of information and knowledge by their importance as seen by the firms.

The most important co-operation partners in textiles are suppliers, while the most important partner of clothing firms are clients. This indicates that innovation in the textiles sector is rather driven by technology-related information and knowledge from suppliers, while market-related information and knowledge gathered from customers relatively more important in clothing. Both industries, however, are quite similar in the fact that clients have in both sectors a much higher importance than in the whole business sector. So both industries are client-driven, with the addition that the textiles sector seems to have another focus on suppliers as co-operation partners.

Formal co-operation, we conclude, is less important in the clothing sector compared to textiles and compared to the whole business sector. This, however, does not mean that clothing enterprises don't draw on external information and expertise as can be seen from the valuation of different information sources by enterprises in the two sectors (see table below).

Table 2.2 Textiles (NACE 17) and clothing (NACE 18) industries over CIS innovation dimensions; most valuable partners in innovation co-operation

	Average Textiles (2)	Average Core NACE (1)	% GAP (2/1)	Average Clothing (4)	Average Core NACE (3)	% GAP (4/3)
Other enterprises within your enterprise group	4.2%	4.5%	93.2%	1.5%	4.1%	37.9%
Suppliers of equipment, materials, components or software	8.4%	7.7%	108.8%	5.8%	7.4%	78.3%
Clients or customers	6.6%	5.2%	126.7%	6.0%	4.7%	126.9%
Competitors or other enterprises of the same sector	1.3%	1.7%	77.1%	0.2%	1.8%	10.3%
Consultants, commercial labs, or private R&D institutes	2.6%	1.7%	157.1%	1.2%	1.6%	70.8%
Universities or other higher education institutes	2.1%	2.0%	100.6%	0.7%	2.0%	35.4%
Government or public research institutes	1.0%	1.4%	67.9%	1.3%	1.4%	97.3%

Source: CIS 4, own calculations, countries included see annex

Table 2.3 Textiles (NACE 17) and clothing (NACE 18) industries over CIS innovation dimensions; sources of information enterprises regard as highly important

	Average Textiles (2)	Average Core NACE (1)	% GAP (2/1)	Average Clothing (4)	Average Core NACE (3)	% GAP (4/3)
Within the enterprise or enterprise group	44.3%	45.8%	96.7%	28.8%	45.6%	63.3%
Suppliers of equipment, materials, components or software	23.9%	23.1%	103.2%	27.2%	23.2%	117.2%
Clients or customers	25.5%	26.4%	96.4%	24.1%	26.4%	91.2%
Competitors or other enterprises of the same sector	8.8%	12.2%	72.0%	11.7%	12.3%	95.1%
Consultants, commercial labs or private R&D institutes	10.5%	6.1%	172.6%	7.4%	6.2%	119.0%
Universities or other higher education institutes	2.1%	3.7%	56.3%	4.8%	3.8%	126.1%
Government or public research institutes	4.4%	2.7%	160.2%	4.3%	2.8%	150.0%
Conferences, trade fairs, exhibitions	11.1%	11.4%	97.5%	14.4%	11.7%	123.4%
Scientific journals and trade/technical publications	7.0%	8.2%	85.9%	11.8%	8.4%	140.0%
Professional and industry associations	6.3%	5.7%	109.6%	7.8%	5.8%	134.5%

Source: CIS 4, own calculations, countries included see annex

In contrast to formal co-operation, these information sources indicate a more informal exchange of information. Here, the clothing sector lies at or above average in all but one (use of information within the enterprise or enterprise group – this may be explained by the high share of unaffiliated firms in clothing) categories. Universities, government or public research institutes, scientific journals and professional and industry associations, in contrast to internal sources, are even more highly valued in the clothing industry than in the total business sector. The high valuation of universities as an information source is also in sharp contrast to the low degree of co-operation between clothing firms and universities. Here, we have to ask if this is a result of the specific conditions for innovation in the sector or if this result is caused by market failure which may justify policy intervention. Since knowledge in the clothing industry may be less codifiable in patents or written instructions than in textiles, we may assume that the preference of clothing firms for informal information exchange is a

feature of innovation in the sector. The general attitude of the sector towards co-operation, however, could be fostered by increasing the organisational and absorptive capacities of firms which are a pre-requisite for innovation co-operation.

2.3.2 Local clusters in textiles and clothing

The importance of textile and clothing in terms of their share on GDP may be shrinking; the T/C sector, however, is still of paramount importance for a number of European regions due to its strong regional concentration. According to statistics provided by the European Commission (2006, p. 103), concentration is highest in Northern Portugal and in Flanders. Both regions encompass close to 80% of their respective national textile and clothing employment. In the Severočeský region (CZ) and Macedonia (GR) this figure is around 50%, in Catalonia (ES) it is 40%. Other important regional concentrations of T/C enterprises include East Hungary (36%), North-Rhine-Westfalia (DE - 28%), Lombardy (IT - 27%), North West and Yorkshire (UK - 27%) with, and Rhone Alpes (FR - 24%). More clusters in T/C can be found in the European Cluster Observatory⁶, which identified 29 textiles and 35 clothing clusters in the EU27. A considerable number of these clusters are located in the EU12: 15 of them are in Romania, 11 in Bulgaria and 9 in Poland. Moreover, all clusters which are considered to have a critical mass in terms of size, specialisation and focus are established in the EU12 with the exception of two Portuguese clusters.

It is also worth noting that out of these 64 clusters, only the textiles clusters in Rhône-Alpes (Lyon) and Vlaams Gewest (Flanders) are regarded as highly innovative⁷ - so, how will these clusters survive?

An answer to this question can be found in various case studies that analyzed cluster formation and cluster evolution in the textiles and clothing industry of Denmark, Catalonia and Italy (EMCC 2008a; EMCC 2008b; European Cluster Mapping Project 2008). All three clusters already exist for a long time, and each has been 'deemed dead' at least one time. They all have faced and still face similar challenges – the increasing pressure from international competition, combined with cost disadvantages to their foreign competitors which forced enterprises to restructure, rethink their products and strategies, or to leave the market.

CIS results reported in a previous section of this study show that propensity of clothing enterprises to co-operate for innovation is considerably lower than in other sectors, in particular when it comes to co-operation with universities and other higher education organisations. To a minor degree this finding is also confirmed for the textiles industry. The case studies show that co-operation and exchange within the clusters is highly informal to a considerable degree which may be the reason why these linkages are not reflected in the CIS results. Many of these exchanges are arranged and promoted by industrial associations, which are also driving forces in other aspects of cluster renewal.

⁶ <http://www.clusterobservatory.eu/>

⁷ In the context of the European Cluster Observatory, this means that they are situated in a region that scores high on a compound RIS index which itself consists of seven innovation indicators ranging from Participation in life-long learning to EPO patent applications, see <http://www.clusterobservatory.eu/index.php?id=50&nid=>

A common strategy that can be observed in all three clusters is brand building: a number of enterprises have gone from the production of textiles and clothing to the creation of brands by launching own labels. The most important of them is Mango, a Catalonian enterprise with no previous T/C history. Mango focussed on design and retailing of clothing and outsourced all production activities. The enterprise grows at double-digit rates. Today, there are 38 other significant brand enterprises in the Catalonian T/C clusters that follow this success (European Cluster Mapping Project 2008, p. 2).

An important part of the strategy from product to value chain control is to outsource the parts of the production process which are too labour intensive and to focus on activities with a higher value content such as design, engineering or marketing. We see national and international outsourcing in all three clusters, Danish enterprises started outsourcing already in the 1980s (EMCC 2008a). In Catalonia, there were even initiatives to co-ordinate production outsourcing for enterprises in the cluster (European Cluster Mapping Project 2008, p. 6). The case study on the Italian Valle del Liri cluster, however, also delivers arguments against international outsourcing: it is more costly to establish and maintain relations with international partners compared to national suppliers; it may reduce product quality; geographical proximity allows a higher flexibility. As a consequence, Italian enterprises have established Chinese workshops in Italy for the most labour-intensive stages of production. The move towards value chain control included also an intensified use of ICT and other technologies to allow faster design cycles and a more rapid response to changes in consumer demand. Market research is another tool implemented to know the customer better.

Business reorganisation has created a need for training in areas that were new to the enterprises, such as logistics, IT etc. This has been supported by a well-developed knowledge infrastructure of colleges, universities and other education organisations. Outsourcing and re-structuring has, of course, resulted in job losses; the case studies, however, also report about job gains in new areas. Mango, for example, employs 1,500 in their Catalan headquarters, which is a considerable part of total cluster employment (European Cluster Mapping Project 2008, p. 11). The Danish experience shows that a large number of employees which were laid off found a new job in the same industry and a small number of them – compared to other sectors – entered unemployment (EMCC 2008a, p. 8). Moreover, outsourcing also takes place within countries and Zara still produces 40% of its items in Spain (European Cluster Mapping Project 2008, p. 6).

3 Sectoral innovation futures

3.1 Emerging and future drivers of innovation between S&T and (market) demand

The European textiles and clothing sector is currently undergoing major changes. It is under severe pressure from external competition; increasing imports and relocation has eroded the market share of European producers at their home markets. At the same time, new technologies come into the industry, and the sector moves from a labour-intensive low-technology sector to a knowledge-intensive industry. This move, however, is still at an early stage.

A major impetus towards a more knowledge-intensive T/C sector comes from *new materials*. 'intelligent textiles/clothing' or 'smart materials' refers to materials that integrate non-textiles technologies into textiles and clothing to add additional features. Smart materials make use of embedded communication and information technologies, and/or new fibres, often based on findings in nanotechnology, biotechnology or chemistry. Examples of the new functions that can be obtained with smart materials are antimicrobial functionality and the possibility of embedding sensors for monitoring the wearer's health into clothing are important functions. First application areas are military and medical applications, but also leisure and sports clothing.

E-commerce and the increasing use of online shopping enables producers to introduce new business models that allow them to sell their products directly to customers. Business-to-Customer (B2C) e-commerce enables producers to bypass retailers and helps to reduce their influence. In addition, e-commerce also fosters information flows between consumers and producers and helps producers to watch closely market trends on the consumer side. E-commerce upstream the production chain can help to reduce time-to-the-market and allows a closer integration of production and supply.

New production technologies such as Rapid Manufacturing (RM) reduces the time between design and production, allows complex designs and reduces the minimum batch sizes of many production processes. This increases flexibility and the ability to react to market changes. Moreover, new production technologies can also help to reduce the amount of energy and natural resources needed, minimize the impact on the environment, and abolish substances harmful to employees and consumers.

Globalisation and the ongoing relocation of production out of Europe is also expected to change the textiles and clothing industry considerably. While new technological opportunities for the T/C sector are emerging, various user industries depend on a competitive textiles sector and emerging textile technologies can potentially help solve major economic, environmental and social challenges.

Major changes from the demand side that may create new market opportunities can be expected from different sources; first, increasing health awareness among European citizens may lead to a higher demand for functional clothing. This may be strengthened by long-term trends such as the ageing society. Moreover, it can be expected that niche clothing that represents a certain life-style will

become even more prominent due to a further differentiation in society. Textiles and clothing is also a sector where sustainability issues already have a prominent role. It can be expected that the trend towards ecologically, socially and economically sustainable textiles and clothing products will continue. Another major driver in textiles and clothing is globalisation. T/C is already one of the most open sectors in the European Union. Possible future developments considered for the scenarios are a) that significant parts of the supply chain remain in Europe, b) that a globalized supply chain within production emerges, and that c) in the long-run design moves away from Europe and goes hand in hand with a return to localized production chains.

3.2 Clothing scenarios

The drivers are the starting point for the development of different scenarios of future development in the T/C sector. Due to the huge inter-sectoral differences, we decided to propose a different set of scenarios for the clothing sector and for technical textiles.

The three clothing scenarios are constructed along the following five variables: Changes in consumer demand; globalisation of the supply chain; globalisation of markets; branding and sustainability. Plausible combinations of these variables result in three scenarios:

Scenario: “Sophisticated and high value”

The “Sophisticated and High Value” scenario has as a central point an educated, demanding consumer base demanding sophisticated high quality products that are produced in a sustainable way. In this scenario significant parts of the supply chain remain in Europe, and production occurs under carbon and water conscious production models. Unique brands play an important role in this scenario; these brands are often but not necessarily European. Consumers know that these brands ensure that their high expectations are met and are ready to pay a higher price for such products. The T/C market continues to be open and without serious barriers to trade, and at the same time basic international standards regarding health, safety and labour are introduced under the pressure of consumer demand for sustainable clothing.

The main driving force in this scenario is a demanding and educated consumer base. Such consumers are aware of the potential negative effects of clothes on the environmental, health and labour conditions in producer countries and are interested in new, sophisticated clothes. New technologies are applied in the clothing markets because producers know that there is a consumer base for these products in the sector. While the market perspective is clearly positive for European clothing producers under the assumptions of this scenario, generally speaking consumers want sophisticated products and low prices at the same time. Therefore, this scenario should be considered a best-case scenario, rather than a likely future. However, even with a consumer base willing to pay higher prices for sophisticated products and European producers able to meet this demand, the protection of intellectual property rights remains an important issue. Another risk for the European clothing industry under the assumptions of this scenario is the increasing level of skills, in design as well as technical skills, outside Europe. Therefore, producers outside Europe are also more and more

able to satisfy even the most sophisticated demand, and thus the competitive pressure from producers outside Europe remains very high.

Scenario: “Sustained globalisation”

In contrast, the “*Sustained Globalisation*” scenario is based on very price-sensitive consumers. They reject (expensive) mass brands and prefer cheaper and simpler products. Due to cost pressure, these cheaper clothing products are mainly produced in low-labour -cost countries outside Europe. As a low price is the main factor for consumer buying decisions, sustainable production plays a very limited role in this scenario due to the costs involved. Open markets with a very low level of regulation accelerate the shift of production to low wage countries.

The main demand side driver in this scenario is price. This demand is met by continued globalisation without regulation. Due to lack for sophisticated demand, clothing producers reduce their efforts to introduce new technologies and designs, and this slowdown in innovativeness again accelerates the move to low wage countries. The already ongoing loss in low-skilled jobs within T/C production will be complimented by a loss of high-skilled jobs in design and product development, which could lead to the reduction of the European clothing industry to an almost non-existing niche player in the global economy. This development would go along with a disappearance of today’s valuable global brands, and significant parts of the value chain would be permanently lost in Europe.

Scenario: “High risk, new options”

The third scenario, “*High Risk, New Options*” centres on the assumption that scarcity of resources is a serious problem. The potential scarce resources crucial for clothing production include water, energy, natural fibres and oil for the production of artificial fibres. A shortage in natural fibres can be caused by the rivalry in production between textile fibres, bio-fuel and food. This shortage of resources would force the T/C sector to more sustainable production models; an additional feature of this scenario would also be a return to localised production chains in combination with a closed market. With the return to local production chains international brands disappear and are replaced by local brands

The main element that distinguishes the “High Risk, New Options” scenario from the two others is the serious scarcity problem. Sustainable production models are not introduced because of consumer demand or regulative pressure they come about because of economic need. While we assume localised production, interaction with other sectors plays a vital role in solving scarcity problems. New production and recycling technologies are needed to replace fibres that are not locally available and also to enhance resource efficiency. As the outsourcing of labour-intense production processes is no longer possible, automation is another key issue.

While this scenario offers highly specialised niches in local production chains and the potential that production that has already moved out of Europe will be relocated back in proximity to local markets, the main challenge under the assumptions of this scenario is to safeguard the supply of raw materials

for clothing producers. Radical changes in the production methods, raw materials used and organisation of the supply chain are therefore of crucial importance.

Table 3.1 Clothing scenarios

	Sophisticated and High Value	Sustained Globalisation	High Risk, New Options
Consumer Demand	Educated, demanding consumers, sophisticated products, ethical, high quality	Low price , low quality, cheap, simple and standard	Diversity high
Globalisation of the Supply Chain	Significant parts of supply chain remain in Europe , mass customization, flexible production	Open, global supply chain Sensitive Shift from EU to 3rd countries	Localised production chains
Globalisation of markets	Basis standards "light": Health Safety Labour	Open	Return to more closed markets
Branding	Unique brands In Europe but also from elsewhere	Rejection of mass brands "value for money"	Disappearance of global brands
Sustainability Models	Carbon and Water conscious production models	Business as usual	Serious scarcity problems

Source: INNOVA SIW, Task 2

3.3 Technical textiles scenarios

The considerable differences between clothing and textiles calls for a separate set of scenarios for technical textiles. The technical textiles scenarios constitute of six variables: integration of new technologies; availability of skills; user industries/markets; competition; scarcity of raw materials and appropriability.

Scenario: "Evolutionary"

The "*Evolutionary*" scenario is built under the assumption that the ongoing integration of new technologies into the textiles sector is mostly incremental. The emphasis here lies on product development; these products compete with products and materials from other sectors. The Textile sector is not only competing on the market for products with other sectors but is also in competition for skilled workers. Scarcity of materials plays no role in this scenario; access to raw materials is unlimited. European companies keep the competitive edge, and they use mainly secrecy as a mode to maintain their technological advantage.

The focus of the "Evolutionary" scenario lies in the exploitation of the already existing knowledge base. New applications for technical textiles are likely to occur but only to the extent that they replace less advanced technical textiles or, if they compete with non-textile materials, they are most likely to be employed in industries that already have some kind of linkage to today's textiles industry. Access to funds is a main challenge in this scenario, as well as the needed skills.

Scenario: “Breakthrough”

The second technical textiles scenario, “*Breakthrough*”, is based on a more disruptive development of the technical textiles sector. New interactions with other sectors coincide with severe restriction on the supply side for raw materials. With a highly skilled labour force, breakthrough innovations are the dominating innovation type. Co-operation within the textiles industry and especially with partners outside the industry plays a vital role; patents are heavily used to protect the outcomes of research activities. In contrast to the “Evolutionary” scenario, the market potential of the “Breakthrough” goes far beyond today’s market for textiles. New markets for textiles open up in transport, medical, construction, aerospace or protective equipment. However, with the transition to the high tech materials used in various sectors, a dissolution of the textiles sector into other sectors is possible. As a result, textiles would no longer be considered an industrial sector, but rather a material used in and developed by other sectors. At the same time this dissolution of the textiles sector can also help to overcome two main problems the textiles sector is facing today: the lack of skills and the lack of access to funds. For today’s textiles manufactures a main challenge in this scenario is to identify these new potential applications and exploit these new markets.

Scenario: “Drag-out”

The “*Drag-out*” scenario can be considered the worst case scenario for technical textiles. Due to a lack of skilled personal, Europe is reduced to a research workbench for basic academic research; new products are developed and produced outside Europe. The result is a high dependence on foreign suppliers. Moreover the lack of state-of-the-art textiles industry would lead to a dragging effect on other technologies to move out of Europe.

Table 3.2 Technical textiles scenarios

	Evolutionary	Breakthrough	Drag-Out
Integration of new technologies	Incremental	Disruptive New interactions with other sectors	Dragging effect on other technologies to move elsewhere
Availability of skills	Competition for skilled workers	Attractive sector for highly skilled	Lack of skilled people
User industries/markets	Emphasis on Textiles in product development competition with products and materials from other sectors	Strong User sector in Europe Growing demand for new materials/ textiles Breakthrough innovation	High dependence on foreign/non-EU suppliers
Competition	Europe keeps the competitive edge	Europe keeps the competitive edge, world leader	Developed not in Europe
Scarcity of raw materials	Unlimited access	Severe restriction -User industries	-
Appropriability	Secrecy , single companies, competition	Co-operation , patenting of research	Oligopoly in control, limited to research workbench

Source: First Europe INNOVA Sectoral Innovation Watch -II Workshop

The “*Evolutionary*” and “*Breakthrough*” scenarios both offer a positive outlook for the European technical textiles sector. They follow different developing paths – incremental innovation with unlimited access to raw material and disruptive development with severe restriction in the raw material supply –

but their common assumption, the sufficient access to skills and a T/C in combination with (new) user industries to deploy advanced textile products, enables Europe to stay competitive or even improve Europe's position in the world market. In contrast, the "*Drag-Out*" scenario can be considered a worst case scenario, not only negatively affecting the European T/C industry but also significantly harming user and supplier industries of the T/C sector. Moreover, these negative effects would likely be of a permanent nature as it is very hard to regain a position at the competitive edge.

3.4 Future innovation themes and corresponding linkages with other sectors

The results of the drivers and scenarios exercise can further be broken down in innovation themes which result from the interaction of S&T opportunities and needs/demands. Innovation themes describe concrete applications that emerge in the sectors analyzed.

A first innovation theme are "Multifunctional materials" (MFM) which meet multiple needs at the same time by using advanced textile materials. Potential markets for MFM include applications in the textiles as well as in the clothing sector; including medical clothing, various kinds of protective clothing, sports and leisure clothing, but also the quantitatively important fashion market. Moreover, they can replace other materials, for example in the construction sector or as geo-textiles.

The more *efficient use of resources* is, in light of the potential scarcity of resources and the growing awareness of sustainability among consumers and producers, an important innovation theme for the T/C sector. Resource efficiency can be achieved in the production of T/C products as well as during the use of products; more efficient production methods and recycling are the two main modes for resource-efficient production. The market potential of resource efficiency includes at least three main dimensions: the increasing demand for sustainable products, maintaining or expanding markets in a situation of scarcity problems and a reduction in costs by using resources more efficiently.

The use of *renewable fibres* can contribute to the above discussed resource efficiency and therefore the two innovation themes are in many respects overlapping and interrelated in terms of markets, competitiveness and societal aspects. However, an important aspect of renewable fibres is that the growing of vegetable fibres (and, to a smaller extent, the production of some animal fibres as well) stands in competition with other agricultural products. Agricultural land is limited and needed for food production, and more and more frequently this land is used for bio-fuels as well.

Advanced machinery has a special role for the T/C sector; it is needed to unlock the potential of the other innovation themes. At the same time, European user industries for T/C machinery are needed to push forward the development, close collaboration between the machinery producers and the producers of T/C products is important as well as with research institutions and universities. Additional drivers for the development of advanced textiles machinery are findings in technologies outside the T/C sector, for example robotics. Machinery is therefore also an important mode to incorporate non-textile technologies into the T/C sector. The focus of today's textiles machinery producers is more on

the Asian market than on the European. While this market is big in volume, the machinery demanded has a rather low technological level. The medium to long run perspective of this Asia-centred business model is rather poor, for machinery producers as well as for European textiles companies. Producers are likely to face increasing competition from Asian machinery producers in this mass market of standard machinery, while at the same time European T/C companies need high-tech machinery to unlock the potential of other innovation themes. Europe has a traditionally strong position in the production of textiles machinery and, generally speaking, has the capacity to develop the next generation of machinery. Therefore the bottleneck in Europe is on the user side, rather than on the machinery producers' side.

Virtual prototyping enables firms to create fashion models that have enough realism to reproduce accurately the behaviour of real garments at lower costs and faster than traditional prototyping. Virtual prototyping is therefore of special importance for applications in which speed matters, for example in quick reaction market trends in the fashion industry. Another important application is mass customization; traditional prototyping is impossible or at least extremely expensive and inefficient for customized clothes. While virtual prototyping and design can also be applied on technical textiles, the most important applications (and therefore also the scope of this innovation theme) are in the clothing subsector.

New technological solutions for shortening the product life cycle have to be embedded in *new organisational concepts*. The main challenge in organisational terms, especially for the clothing industry, is to find the right balance between cost-efficient production and the flexible, fast-changing and high-quality products demanded. Mass customization is one important option to solve this challenge and, due to its importance, is considered as a separate innovation theme; the focus of this section lies therefore on organisation and distribution models for non-customized products. One way to react quickly is to ensure proximity to the market and vertical integration. Another successful organisational model is strategic brand segmentation: While luxury brands are produced in-house and sold in company-owned stores, the same companies outsource the production of their mass (diffusion) brand products, which are mainly sold by retailers.

Advanced production methods, consumer demand for unique clothes and e-commerce all drive production in T/C towards a higher degree of *customisation*. By using mass customization techniques, customized clothes can be produced at prices similar to the price of mass products. The market for customized products can be subdivided into customization in design and customization in fit (made-to-measure clothing). Fairly simple design customization is already a common practice and a variety of mostly internet-based producers are offering customized shirts, for example.

3.5 New requirements for sectoral innovation: new forms of knowledge, organisational and institutional change, regulatory frameworks

In order to turn these innovation themes into successful new markets some requirements are necessary. A first requirement relates to *skills in the T/C sector*. The skills demanded in the T/C sector will change significantly with the move from mass production to a more knowledge based production. With the growing importance of inputs from other technologies, a minimum basic knowledge of these input technologies is needed. New production methods replace a big share of the traditionally unskilled or low-skilled part of the textiles and clothing sector. At the same time, due to strong cost pressure from abroad, wages are rather limited in the sector, making it difficult to recruit the highly innovative engineering staff needed in particular for technical textiles.

Some tasks in clothing manufacturing remain difficult to automate, and will thus stay labour intense or at best semi-skilled. For the most part, these jobs have already moved to low-wage countries. A certain part of these jobs will remain in the European Union or at least at locations close to the EU as proximity to the market plays a role. Some of the new member states and the Mediterranean countries may benefit from this development, offering proximity (for example Morocco for Spanish companies) and low labour costs. The general reduction in the total labour force of the T/C sector and in particular of low-skilled workers is likely to continue; at the same time, it is expected that this reduction will slow down in the future.

The move from commodities to specialities and the costly investments necessary for this move make *intellectual property rights (IPR)* and the possibility to enforce them of crucial importance for the T/C sector. At the moment, trademarks and brands are the most commonly used IPRs in this sector, followed by patents. The use of IPR is highly influenced by the size of the company, as almost all large companies have a defined IPR regime. While clothing/fashion companies mostly use trademarks and brand, technical textiles and textiles processing companies rely more on patents. The domination of SMEs in the sector seems to be the main obstacle to an effective IPR strategy. For these companies, the costs and length of the procedure are the main reasons behind the lack of an IPR strategy, and a lack of information plays a main role as well. These costs are considerably higher in Europe than in the US and Japan.

Besides reducing barriers to implementing an IPR strategy for small companies, another main challenge is efficient enforcement. While the reduction of counterfeiting to zero is not likely, the reduction to an acceptable level is the target of a number of already implemented measures including international agreements and also improved customs procedures and public awareness.

Funding is one of the main factors hampering innovative activities in the T/C sector. CIS data (see previous sections of this report) indicates that this is the single most important factor hampering innovation in the textiles industry as well as in the clothing industry. For the clothing industry, this is not only the main restricting factor but also a limitation far above the average for all industries. This is

partly caused by the domination of SMEs in the sector; with a fragmented venture capital market and low level of equity funding in Europe the access to funds is especially difficult for SMEs.

3.6 Sectoral innovation policy in a scenario framework

The four requirements mentioned in previous section already point to various issues that require policy attention and should be taken up by policy.

Changes in the labour force of the T/C sector are one of the main challenges the sector is currently facing: with an ageing workforce, a permanently shrinking number of jobs, and a high share of low-skilled workers in the labour force, there is a strong need to attract highly skilled workers to make the move to a knowledge-based sector possible. Potential policy measures include educational initiatives, for example, by providing grants for PhD or master students. As the T/C sector is often considered a declining industry by the broader public, particularly in terms of job opportunities, such educational initiatives need to be complimented by measures improving the reputation of the sector, highlighting the opportunities for skilled workers. In the short run, the second main challenge is the sufficient access to funds. There is a need for more risk capital, seed financing and general research funding at all stages. This financial support is needed for start-ups as well as for existing companies moving to more innovative products.

The reputation of the T/C industry as a declining low-tech industry is another main hampering factor across all desirable scenarios and innovation themes. This negative image affects the attractiveness to the needed skilled workers, hardens the access to funds and also negatively influences the usage of textile fibres and products for applications outside the T/C sector as well as potentially fruitful cross-sectoral co-operations. A clear focus on high quality, high technology and at the same time high value products is the only possibility to successfully move from a cost-driven labour intense sector to a quality driven knowledge intense industry.

In order to foster dynamism in the T/C sector, closer cooperation with other user industries (e.g. construction, aeronautics, etc.) as well as supplier industries (e.g. electrical and optical) need to be reinforced and corresponding competencies be established, if T/C is to evolve into a more generic and higher technology sector than it is today.

In addition, more specific policies may also be needed to support the unfolding of single innovation themes. With respect to new materials, policy could support and foster their diffusion by promoting the innovative capacities of T/C firms. User industries are often unaware of the possibilities offered by textile fibres, and at the same time T/C companies lack information about the needs of other industries that could be addressed by textile products.

Sustainability in general and *resource efficiency* in particular will be key issues for the T/C sector in the medium and long run. While sustainable production models, such as the increased use of recycling and *renewable fibres*, are clearly favourable in terms of the social and environmental impact, an increased demand for sustainable produced goods can also lead to new markets and new applications

for T/C products. Moreover, as the emphasis on environmental, health and safety issues, the already relatively stringent European regulations can, in this regard, potentially be transformed into a competitive advantage. Therefore it is important to continue the already ongoing efforts and initiatives on the European level, even if some regulations are at the moment considered to be a cost factor rather than a competitive advantage.

As stated before, advanced *machinery* has a special role in the T/C sector and is needed to unlock the potential of the other innovation themes, while at the same time European user industries are needed to push forward the development of this machinery. As the lack of consumers of advanced machinery in Europe was considered the main hindrance for producers of such machinery, policies supporting the uptake of the other innovation themes could also benefit machinery producers.

The *move from volume to customized production and new organisation and distribution models* often go along with each other, and so flexible production and distribution processes and proximity to the market are of main importance in both cases. One specific problem of customized products is the need for adequate return policies. A clear and consumer friendly regulative framework can help to increase the acceptance of such products by consumers and ensure fair market conditions for all producers. At the same time, such rather stringent policies can put positive pressure on producers to focus on quality and advances in the new technologies regarding body measurement and made-to-measure production processes.

4 Barriers to innovation in textiles and clothing

The previous chapter has revealed considerable differences in innovative behaviour between textiles and clothing, which considerably lower innovation performance of the clothing sector. Textiles, in contrast, are on par with business sector average in most indicators.

One explanation for these differences may be the existence of sector-specific factors that constrain or hamper innovation activity. These factors may guide to possible fields for policy intervention, if the challenges and hampering factors identified by CIS can be addressed with adequate policy measures.

Table 4.1 presents an overview of these factors from the CIS. The most urgent challenge for innovative T/C enterprises is innovation financing: Compared to other industries, both, the textiles and the clothing sector are disproportionately strong affected by problems related to innovation financing (see also NetFinTex 2006).

Financial restrictions such as a lack of funds are by far a bigger restriction for the clothing industry compared to the textiles industry. 27% of all textiles and 29.7% of all clothing enterprises find that innovations costs are too high. Another 16.9% of all innovative textiles and 23.3% of all innovative clothing enterprises suffer from a lack of financial resources from outside the enterprise. Financial restrictions are typically more severe for small enterprises with limited access to external financing and less possibilities for internal risk diversification, so we assume that the problem of a lack of finance is also a result of the high share of small and medium enterprises in the sector.

Another area where enterprises in the textiles and clothing sector face on average more severe problems than other enterprises is the availability of qualified personnel. The lack of qualified personnel is an above-average factor hampering innovation in the clothing sector while the textiles sector is again at about all industries average level in this dimension. The CIS, however, does not tell about the reasons for shortage of skilled personnel in the T/C sector: if the reason is a general lack well-educated people for tasks such as design, this may be a field where public training and educational initiative. If it is because the T/C sector is less attractive than other sectors, this may call for a different set of measures. T/C enterprises in the UK, for example, face a shortage of designers although a considerable number of design graduates leave college each year (EC 2008, p. 94). A possible explanation for the low attractiveness of the T/C sector for graduates is the fact that wages in the T/C sector are considerably below the level of the whole business sector, which makes it difficult for T/C enterprises to attract talent (see below).

A third set of hampering factors which are stronger in textiles and clothing than in other industries are factors related to risk and uncertainty. This could be, for example, a lack of information on technology and on markets as well as the difficulty in finding co-operation partners for innovation and the uncertain demand for innovative goods. Policies to overcome these problems include all initiatives to connect individual actors and increase the exchange of knowledge and information among textiles and clothing enterprises, their suppliers and their customers.

Table 4.1 Factors hampering innovative activities, textiles (NACE 17) and clothing (NACE 18); only innovative enterprises

	<i>Average Textiles (2)</i>	<i>Average Core NACE (1)</i>	<i>% GAP (2/1)</i>	<i>Average Clothing (4)</i>	<i>Average Core NACE (3)</i>	<i>% GAP (4/3)</i>
Enterprise with innovation activity abandoned at the concept stage	15.4%	17.1%	90.5%	13.0%	16.8%	77.0%
Enterprise with innovation activity abandoned after it began	17.1%	12.9%	132.8%	6.6%	12.7%	51.9%
Enterprise with innovation activity seriously delayed	29.0%	33.1%	87.7%	28.5%	33.1%	86.2%
Lack of funds within your enterprise or enterprise group	19.8%	20.3%	97.3%	29.3%	20.5%	142.9%
Lack of finance from sources outside your enterprise	16.9%	16.0%	105.1%	23.3%	16.6%	140.3%
Innovation costs too high	27.0%	23.9%	112.8%	29.7%	24.5%	121.3%
Lack of qualified personnel	10.7%	10.9%	98.1%	15.1%	11.0%	137.9%
Lack of information on technology	8.1%	5.3%	153.3%	9.5%	6.0%	158.0%
Lack of information on markets	9.5%	5.8%	162.8%	8.6%	5.8%	147.8%
Difficulty in finding co-operation partners for innovation	10.9%	8.3%	130.2%	10.5%	8.3%	126.5%
Markets dominated by established enterprises	11.3%	13.5%	83.9%	12.9%	13.7%	94.5%
Uncertain demand for innovative goods or services	16.4%	12.1%	135.5%	15.8%	12.3%	128.2%
No need to innovate due to prior innovations	5.9%	5.8%	101.2%	4.7%	5.8%	79.9%
No need to innovate because no demand for innovations	4.5%	6.6%	68.9%	7.9%	6.5%	120.7%

Source: CIS 4, own calculations, countries included see annex

Additional hampering factors have been identified by the analysis of Task 3 of SIW. Some of these drivers and barriers are generic in character, and are likely to affect innovation not only in textiles and clothing, but in many parts of the economy. Examples are rising energy prices, the effects of the financial crisis, the need for constant optimisation, rising R&D costs and duration, or opportunities to secure the returns to innovation. Some of these factors, however, point to issues which are more specific to the textiles and clothing industry. A first of these specific sets of drivers and barriers are consumer tastes, which may be changing faster and be more prominent in this industry than in other sectors of the economy. The results clearly show the importance of changes in tastes, together with shorter life cycles, for innovation in textiles and clothing.

A second, more specific finding is the role of market structure. Producers of textiles and clothing seem to be hampered by both supplier and customer market power, which may be a result of the rise of retail chains on the one and rising prices for raw materials on the other hand. Competition from outside the EU is seen as a big obstacle to innovation. Labour costs outside the EU and relocation are seen as barriers to innovation in Europe. It is, however, also interesting to see that the effect of competition from inside the EU is regarded more positive, which a considerable number of respondents regard this factor as slightly or moderately positive. Moreover, the results of the survey confirm the importance of finance as an obstacle for innovation in T/C. It seems to be difficult for textiles and clothing firms to access public funds for innovation in particular. Collaboration, in contrast, seems to be less relevant for innovation in textiles and clothing. This may be explained by

the finding that a high share of respondents regard the threat of losing know-how in collaborations as serious.

The analysis also found that some drivers or barriers are strongly related to specific types of innovation. Regulatory uncertainty, an important barrier according to the survey, is highly and positively correlated to innovation in products and management systems. Duration of R&D (also a barrier according to the survey) is highly correlated to management systems. Growth opportunities, opportunities to secure benefits and pioneering advantages are positively correlated to innovation in products. In-house know-how is highly (positively) correlated with layout of production organization, and all types of funding exhibit positive correlations to at least one innovation type. Various forms of regulation, in contrast, exhibit only a moderate association to different types of innovation.

We can draw two conclusions for policy: first, the results highlight the importance of generic drivers and barriers that have relevance in a number of industries. This supports a horizontal approach to innovation policy which focuses on creating framework conditions rather than concrete policy intervention in one particular sectors. This horizontal approach should be accompanied by more sector-specific measures. The analysis has shown that innovation financing, competition and external trade are three fields where a sector-specific approach may be more appropriate. Problems with financing may also be related with the recognition of non-technological innovation by policy. Branding and design are important innovation activities for clothing enterprises in particular, but only rarely supported by many funding schemes which still focus on R&D. The results for the linkages between innovation and globalisation are mixed and contrast the findings from Task 1. As a message to policy, it seems clear that levelling the playing field is the way forward.

5 Horizontal issues relevant to the sector

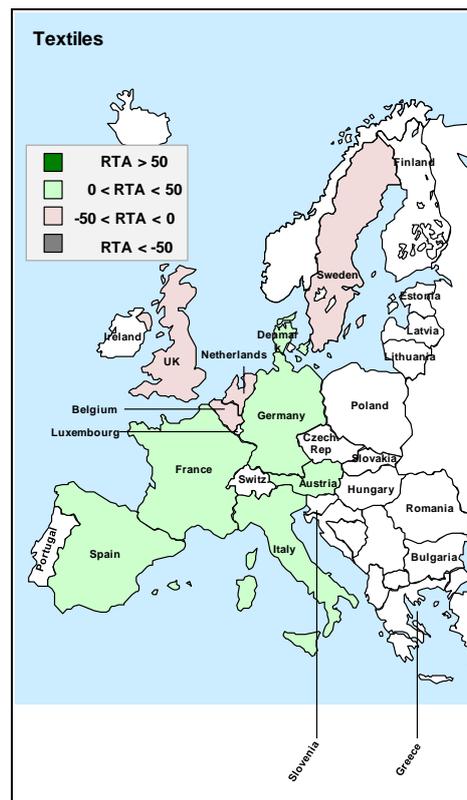
5.1 National specialisation patterns

Innovation and technological change in textiles and clothing can be studied in various ways. One approach is to use firm-level data, as has been demonstrated in the first sections of this report. An alternative approach is to employ patent data. The report on national specialisation patterns provides a comparative analysis of technological activity in the sectors covered by INNOVA SIW based on patent data.

The results indicate that patenting in textiles and clothing account for a very small share of overall patenting activity in the EU between 1978 and 2005. Only 0.52% of all patents are attributed to T/C. Moreover, the patent share of textiles and clothing has decreased continuously, in contrast to increases in biotechnology, electrical and optical equipment and automotive.

Nearly all T/C patents are held by EU 15 countries and countries outside the EU. Within the EU, the technological competences in the textiles and clothing sector – measured by an above-average specialisation - are mainly located in Denmark, Spain, Italy, and, to a lower extent, in Germany, Austria and France (see figure below). Most of the New Member States have very few patents in textiles and clothing and therefore have comparative technological disadvantages in this sector measured by patent counts.

This result reflects an important finding from the previous sections; T/C firms in North Western Europe predominantly pursue strategies which rely on internal R&D and the development of internal capabilities, while T/C firms in Central and Eastern Europe are often technology adaptors. Slovenia, for example performs well in terms of share of turnover with new products from CIS as well as cost reductions, but has almost no patents. Probably Slovenia's textile industry gains its competitive edge through cost advantages.

Figure 5.1 EU 27 specialisation patterns in textiles and clothing

Source: Sectoral Innovation Watch, Horizontal Report 1

The analysis can further be refined by employing patent citation data, which are references to other patent documents or non-patent literature. Patent citations are a measure for the quality of the patent. The literature assumes that valuable patents are cited more frequently. Citation data can be used to derive a specialisation index similar to the one for patent inventions. This analysis shows that in the T/C sector there are only two countries which have specialisation advantages in the patent and citation counts indicators: Denmark in the first period and Spain in the second period. This means that both countries have a higher specialisation both in terms of quantity and quality.

Innovation increasingly becomes a collaborative activity in many industries. The national specialisation report has tried to capture this trend by the analysis of co-inventor networks, where one patent inventions is related to two or more individual inventors, often residing in different countries.

The network analysis in the different sectors reveals that almost all countries with many patent applications (such as the United States and Germany) also have many network linkages. Japan, however, is an exception, with only few collaboration linkages. Especially in the case of countries focusing on export, linkages are necessary as products need to be adapted to local markets. The co-inventor network of textiles and clothing patent exhibit strong links between EU15 countries, but also between the EU and the United States which plays a central role in this network. In the first period 1994-1996 the US hold strong connections to the United Kingdom and Germany, but also have a strong linkage with Belgium. Within the EU 15 countries there is a lot of collaboration between France and Germany in the second period 2000-2002. Nevertheless connections within the EU increase in

2000-2002. While in 1994-1996 there is only one connection from a New Member State (Slovakia) to the EU 15 countries, in 2000-2002 two New Member States establish linkages (namely Hungary and Slovenia). Anyhow, the connections of New Member States do not play a significant role in the textiles and clothing sector.

The sectoral analysis also suggests that specialised countries tend to collaborate with each other. This pattern, however, cannot be found in T/C. The co-inventor network shows no clear relationship between collaboration and specialisation. All country pairs with strong connections (e.g. Germany - France, United States – Germany, Belgium - United Kingdom, United States–United Kingdom) have no clear specialisation in this sector. On the contrary, countries which are highly specialised in this sector (Portugal, Spain and Italy) do not have any outstanding collaboration record. The same holds for highly under-specialised countries. This result may resemble the finding from CIS data that co-operation with external partners is less frequently found in T/C and in clothing in particular than in other sectors, despite the fact that innovation in T/C often originates from outside the enterprise. Moreover, there is a preference for informal sources of information over formal innovation co-operation, which may also explain the patterns of co-inventorship observed in the national specialisation report.

5.2 Eco-innovation opportunities and eco-innovation clusters

Textiles and clothing is one of the industries where environmental and sustainability issues have a noticeable impact on innovation activity. This impact may even increase in the future. Environmental issues related to textiles and clothing include (Diaz Lopez et al. 2010; Zahradnik and Dachs 2010):

- Water and land consumption and the use of pesticides in the production of fibres;
- energy use associated with laundry (particularly of cotton products) and production equipment;
- Use of toxic chemicals and their release in waste water (particularly from pre-treatment of fibres, dyeing, bleaching, finishing and laundry), release of CHC emissions;
- Energy and water used in laundering and drying at different stages of manufacturing;
- Solid waste in textiles production;
- Seasonal and even faster-than-seasonal changes reduce life cycle of clothing and increase waste.
- Energy and water used for washing of textiles and clothing in use

If we add the social dimension to a more comprehensive definition of sustainability, additional issues arise from the increasing share of textiles and clothing imports from countries with weak workers protection, including the issue of child work, fair workers compensation, or the asymmetric effects of the decline of employment in T/C on regional labour markets in Europe. Corporate Social Responsibility (CSR) is often used to address these issues (Dickson and Eckman 2006).

Environmental and sustainability issues drive innovation in at least three ways (EMCC 2008c): First, European consumers increasingly take the environmental impact of their consumer choices and the

products they buy into consideration. Second, national and European policy try to push the T/C sector into more environmentally friendly production technologies. Third, environmental or social misbehaviour of companies, like the use of child labour, in any part of the value chain can significantly harm a brand and reduce sales.

From the producers' point of view a possible strategy to deal with the increasing demand for sustainable T/C products is to ensure that the complete value chain is in line with the social and ecological standards of the majority of consumers. A second way would be to target environmentally conscious consumers by setting higher voluntary standards than competitors

Montalvo et al (2011) have identified a number of eco-innovation opportunities in the textile and clothing sector. These include:

- Enzymes for textiles manufacturing
- Improved textile methods for dyes and auxiliary chemicals
- Eco-finishing of clothes
- Automated systems for monitoring and control
- Plasma technology for eco-wet processing
- Intelligent textiles
- Eco-fibres
- Reused and recycled textiles

Most interesting, Montalvo et al (2011) find that many of these or similar solutions to environmentally friendly production of textiles and clothing already exist, but are only slowly put into practice. This means that there may be the need for additional regulation. These measures, however, have to be balanced with the interest of the European producers of textiles and clothing, who, comprehensibly, fear that such measures may even further deteriorate their competitive position. Moreover, the degree of maturity of traditional textile manufacturing is relatively high which may further hamper change.

One way to foster eco-innovation in textiles and clothing may be regulation. The Integrated Pollution Prevention and Control (IPPC) directive (2008/1/EC) was introduced to foster organisational and technological change in the T&C sector. There is a number of reports that cite the IPPC directive (and the accompanying reference document for the textile industry) as a positive driver for compliance and technological change, especially for water and energy consumption of textile processing. The REACH regulation (EC 1907/2006) is expected to impact the innovative efforts, clearly aligned with environmental aims, of this sector. In addition to the IPPC and REACH, the European Emission Trading System (Directive 2009/29), the Biocides Directive (98/8) and the European Eco-label scheme are important and positive drivers for this sector. Waste and landfill regulation are also reported to act as both a driver and a barrier for eco-textiles.

5.3 Impact of innovation on new lead markets

Future innovation themes in textiles and clothing point to promising new development both in products and in production technologies that may shape the future development of the T/C sector. These future innovation themes have been discussed in section 3.4 of this report.

Societal developments and global trends are the main drivers for international diffusion of innovation designs. The textile and clothing sector is traditionally regarded as low-tech sector. However, a trend towards additional functionality and new applications of products (e.g. in medical clothing, protective clothing and sports clothing) is conceivable increasing the importance of technological developments and innovation. Making use of high-tech textile materials will provide new opportunities to exploit increasing demand in niche markets. Clothing is increasingly associated with lifestyle, especially among young persons, making knowledge and prompt reaction on global fashion trends more important. Growing purchasing power of the youth population provide potential to exploit high demand and opens up new models of distribution (e.g. e-commerce). Another emerging trend concerns environmental consciousness. Consumers will become more demanding in terms of renewable fibres, environmental friendly production methods and supply chains providing potential for European countries to meet high demand (e.g. for eco labels) and becoming a Lead Market in the respective fields. Additionally, stringent EU regulations in terms of environmental, health and safety issues may additionally boost the demand for resource efficient and sustainable production of textiles and clothing as well as high-tech material. This can positively contribute to gains in competitive advantages.

Future innovations, however, need a favourable environment to flower. The literature of Lead Markets (for example Beise 2004) has identified these environmental conditions and applied this concept to various sectors (Cleff et al. 2007).

Domestic demand is one of the decisive factors within the Lead Market approach. A high degree of demand specialization (i.e. a comparatively high share of the automotive sector on total consumption within a country) indicates a demand advantage of a country compared to other countries. Demand specialisation is high in the *Greece, Portugal, Italy, Cyprus, UK, Malta and Austria* compared to the EU-25 average. These countries most likely gain competitive advantage with respect to domestic demand in the textile and clothing industry and might become a Lead Market in specific innovation designs.

If innovative products or services can be sold at a low relative price on a Lead Market, the probability of diffusion to other markets increases. *Competitive market structures* favour the realization of price advantages. Relative price reductions of innovative products can be achieved either by cost reductions of production and input factors or by economies of scale of mass productions. Resource efficiency with respect to production (e.g. by the reuse of fibres, recycled clothing and materials) and distribution of products promise potential for reductions in costs, and thus, improving competitiveness of specific innovation designs. Additionally, cost reductions can be achieved by high-tech and automated production methods. Technological developments for virtual prototyping and design

provide new application methods in the context of mass customization, as traditional prototyping would be extremely expensive for customized clothes. With the ongoing reduction in length of fashion cycles and increasing variety of designs the costs of prototyping are of growing importance. Low relative prices in the textile and clothing industry can be found in *Denmark, Ireland, France and the Netherlands* in the EU-25.

Cultural, social and economic similarities between countries facilitate the *exportability of innovative designs*. Orientation on foreign customers' needs and preferences increases the sensibility towards global trends and developments. The cycles of global fashion trends are getting shorter and fast moving. Thus, an established position on foreign markets may facilitate a fast identification of emerging trends creating first-mover advantages in the home market. Additionally, new export opportunities for European countries arise from high-tech machinery for the production of textiles and clothing. Lead market potentials can be received from a high degree of export orientation especially in conjunction with high domestic demand for a specific product. The home markets in *Italy, Great Britain and Austria* provide favourable conditions for exporting innovation designs successfully tested at home to other countries.

A country's *transfer advantage* arises from a high degree of internationalisation and close interactions with other countries (e.g. by MNEs). New organisational and distribution models lead to more flexible processes and higher proximity to different markets. E-commerce is one example in this context, enabling the reception of feedback from all over the world. A market and demand specific adaption of products is possible within a short time. Moreover, information about the specific foreign demand can be received more easily due to strong communication ties to other countries. Worldwide distribution channels and globally operating retailers achieve advantages by new organisational models such as vertical integration, including design, just in time production, marketing and sales. Innovative business models promise more flexible processes reducing the time span between production and sales. *Germany and UK* show an above-average proportion of foreign direct investment in the textile and clothing industry and thus, have a transfer advantage compared to other EU member states.

Competition is traditionally high in the textile and clothing industry. This is especially the case in mass and low price segments with particular pressure from low-wage countries. However, competitive pressure comes from within the EU as well. In this regard, European countries have to establish a successful position in high-tech machinery and products with advanced materials (multi-functional materials) in order to gain competitive advantages. Furthermore, niche markets for medical clothing and protective clothing show promising conditions. Competitive markets have a higher probability to become a Lead Market, as more innovative designs have to be created in order to persist in a competitive environment. Domestic market structure advantages can be measured by the entry rate of new firms in the specific industry. A highly competitive market structure can be found in *Baltic countries, Slovakia, the Czech Republic, France and Hungary* compared to the EU-25 average.

6 Policy conclusions

This report has analyzed innovation in the textiles and clothing industry and sketches a possible transformation of textiles and clothing from a labour-intensive low-technology sector to a knowledge-intensive industry. The report has drawn different scenarios of this change. Policy can support this transformation by fostering an innovation culture in textiles and clothing and removing barriers to innovation:

First, the analysis has shown that a lack of skilled workers is a serious problem in the sector. In a dynamic scenario perspective, experts relate a lack of skilled personnel with a steady decline of the sector, even with potentially negative dragging effects on other industries. Continuous efforts to upgrade the skill level combined with an increasing focus on resource efficient and environmental friendly produced high quality products are therefore needed to maintain and increase the competitive position of the European T/C sector. Educational initiatives need to be complimented by measures improving the reputation of the sector, highlighting the opportunities for skilled personnel in the T/C sector.

A second main challenge is the sufficient access to funds. Survey results indicate that a lack of funding hampers innovation in T/C considerably more than in other sectors. There is a need for more risk capital, seed financing and general research funding at all stages. This financial support is needed for start-ups as well as for existing companies moving to more innovative products. Policy should consider the importance of non-technological forms of innovation and value creation for innovation in T/C. Branding and design are important innovation activities for clothing enterprises in particular, but only rarely supported by many funding schemes which still focus on R&D. These activities are, however, less well supported by public innovation funding than technological activity, as can be learned by the low share of firms in clothing that receive public funding for innovation. A stronger promotion of these types of innovation would also facilitate innovation in textiles and clothing.

Third, our results illustrate a variety of innovation strategies in the textiles and clothing sector. Policy should account for this variety by creating favourable framework conditions rather than concrete policy intervention, because there is always the danger of adverse effects; measures targeted to one group inevitably leave many enterprises aside which pursue another strategy. This is also supported by an analysis of barriers to innovation in textiles and clothing. The results highlight the importance of generic barriers that have relevance in a number of industries. This supports a horizontal approach to innovation policy which focuses on creating framework conditions rather than concrete policy intervention in one particular sectors. Hence, policy should foster the innovative capacities of T/C firms and the creation of novelty in the sector in a very general sense. This also includes branding and design which are important innovation activities for clothing enterprises in particular, and measures to foster intellectual property rights.

This horizontal approach should be accompanied by more sector-specific measures. The analysis has shown that innovation financing, competition and external trade are three fields where a sector-

specific approach may be more appropriate. With respect to globalisation, levelling the playing field and creating equal conditions for EU and non-EU competitions is the way forward.

The scenario analysis indicates that textiles products will more and more incorporate information, communication and nanotechnologies and textiles will increasingly find applications in non-clothing environments. In order to foster dynamism in the T/C sector, closer cooperation with these user industries (e.g. construction, aeronautics, etc.) as well as supplier industries (e.g. electrical and optical) need to be reinforced and corresponding competencies be established, if T/C is to evolve into a more generic sector than it is today.

Sustainability in general and resource efficiency in particular will be key issues for the T/C sector in the medium and long run. While sustainable production models, such as the increased use of recycling and renewable fibres, are clearly favourable in terms of the social and environmental impact, an increased demand for sustainably produced goods can also lead to new markets and new applications for T/C products. Moreover, as the emphasis on environmental, health and safety issues, the already relatively stringent European regulations can, in this regard, potentially be transformed into a competitive advantage. Therefore it is important to continue the already ongoing efforts and initiatives on the European level, even if some regulations are at the moment considered to be a cost factor rather than a competitive advantage.

Finally, the results confirm the current approach of economic policy with respect to globalisation and offshoring. Offshoring and international expansion does not threaten innovation and technological capabilities in Western Europe but can constitute an incentive for innovation. It is, however, clear that globalisation implies broad changes in value chains and markets that affect EU countries in different domains and create winners and losers. T/C is one of the sectors where the losers of globalisation are most visible. Policy should therefore help that benefits of globalisation spread among all groups affected by the process, rather than try to slow down or block globalisation.

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Annex - Overview SIW deliverables

Overview of the deliverables from the Europe INNOVA Sectoral Innovation Watch

Deliverables can be downloaded from www.europe-innova.eu

Task 1 Innovation Performance Sectoral Reports

Ploder, M., C. Hartmann, E. Veres, B. Bertram (2010) Sectoral Innovation Performance in the Automotive Sector, Final Report Task 1, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, June 2010, revised December 2010

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Broek, van den T. and A. van der Giessen (2010) Sectoral Innovation Performance in the Electrical and Optical Equipment Sector, Final Report Task 1, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, June 2010

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Dachs, B. and G. Zahradnik (2010) Sectoral Innovation Performance in the Textiles and Clothing Sector, Final Report Task 1, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, May 2010

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Task 2 Foresight Reports

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Brandes, F. and M. Poel (2010) Sectoral Innovation Foresight – Space and Aeronautics Sectors, Final Report Task 2, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, December 2010, revised April 2011

Zahradnik, G., B. Dachs and M. Weber (2010) Sectoral Innovation Foresight - Textiles and Clothing Sector, Final Report Task 2, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, December 2010

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Task 3 Market and Regulatory Factors

Montalvo, c. and O. Koops (2011) Analysis of market and regulatory factors influencing innovation: Sectoral patterns and national differences, Final Report Task 3, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, December 2011

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Montalvo, C., K. Pihor and B. Dachs (2011) Analysis of market and regulatory factors influencing sector innovation patterns – Textiles and Clothing Sector, Final Report Task 3, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, December 2011

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Task 4 Horizontal Reports

H. Grupp[†], D. Fornahl, C.A. Tran, J. Stohr, T. Schubert, F. Malerba, Montobbio F., L. Cusmano, E. Bacchiocchi, F. Puzone, (2010) National Specialisation and Innovation Performance, Final Report Task 4 Horizontal Report 1, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, March 2010

H. Grupp[†], D. Fornahl, C.A. Tran, J. Stohr, T. Schubert, F. Malerba, Montobbio F., L. Cusmano, E. Bacchiocchi, F. Puzone (2010) Appendix to National Specialisation and Innovation Performance, Final Report Task 4 Horizontal Report 1, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, March 2010

Rubalcaba, L., J. Gallego, C. Hipp, and M. Gotsch (2010) Organisational Innovation in Services, Final Report Task 4, Horizontal Report 2, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, February 2010

Dachs, B., I. Wanzenböck, M. Weber, J. Hyvönen and H. Toivanen (2011) Lead Markets, Final Report Task 4, Horizontal Report 3, for DG Enterprise and Industry, European Commission, March 2011

Montalvo, C., Diaz Lopez F.J., and F. Brandes, (2011) Potential for eco-innovation in nine sectors of the European economy, Final Report Task 4, Horizontal Report 4, Europe INNOVA Sectoral Innovation Watch, DG Enterprise and Industry, European Commission, December 2011

Mitsch K. and A. Schimke (2011) Gazelles – High-Growth Companies, Final Report Task 4, Horizontal Report 5, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, January 2011

Task 5 Input and Output Papers

Mitsch, K., C.A. Tran, J. Stohr, F. Montobbio, L. Cusmano and F. Malerba (2010) National Specialisation Report, Input Paper to the workshop 'Tomorrow's innovative industries: Regional and national specialisation patterns and the role of the regional business environment', Task 5, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, May 2010

Mitsch, K., C.A. Tran, F. Montobbio, L. Cusmano and F. Malerba (2010) National Specialisation Report, Output Paper to the workshop 'Tomorrow's innovative industries: Regional and national specialisation patterns and the role of the regional business environment', Task 5, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, June 2010

Rubalcaba L., J. Gallego and Hipp C. (2011) Organisational innovation, service innovation, and the value chain: New trends and policy implications. Input paper for the Workshop on the 25th of January 2011, Task 5, Europe INNOVA Sectoral Innovation Watch, DG Enterprise and Industry, European Commission, January 2011

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Final Sectoral Reports

Ploder, M. (2011) Sectoral Innovation Watch – Automotive Sector, Final Sector Report, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, December 2011

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Giessen, van der A. (2011) Sectoral Innovation Watch – Space and Aeronautics Sectors, Final Sector Report, Europe INNOVA Sectoral Innovation Watch, for DG Enterprise and Industry, European Commission, December 2011

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Final Synthesis Report

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