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***IPTS WORKING PAPER on
CORPORATE R&D AND INNOVATION - No. 08/2009***

R&D in Low-Tech Sectors

Lesley Potters



The ***IPTS Working Papers on Corporate R&D and Innovation*** sheds light on economic and policy questions related to industrial research and innovation. Mainly addressed to policy analysts and the academic community, these are scientific papers (policy relevant, highlighting possible policy implications) and proper scientific publications which will be typically issued at the moment they are submitted to peer-reviewed scientific journals. The working papers are useful to communicate to a broad audience the preliminary research findings of the work we develop, to generate discussion and to attract critical comments for further improvements. The working papers are considered works in progress and are subject to revision.

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Such Working Papers Series are issued in the context of the ***Industrial Research Monitoring and Analysis (IRMA)***¹ activities that are jointly carried out by the European Commission's Joint Research Centre (JRC) – Institute for Prospective Technological Studies (IPTS) and the Directorate General Research - Directorate C, European Research Area: Knowledge-based economy.

IRMA activities aim to improve the understanding of industrial R&D and Innovation in the EU and to identify medium and long-term policy implications. More information, including activities and publications, is available at: <http://iri.jrc.es/> and <http://ec.europa.eu/invest-in-research/>

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¹ IRMA activities correspond to the implementation of the approach set out in "Investing in research: an action plan for Europe" (COM, 2003) and in further Communications of the Commission: "More Research and Innovation – Investing for Growth and Employment – A common approach", COM (2005) 488 final, "Implementing the Community Lisbon Programme: A policy framework to strengthen EU manufacturing – Towards a more integrated approach for industrial policy", COM (2005) 474 final.

Abstract

The 3% Action Plan of the Lisbon Agenda was adopted with the aim of making Europe more innovative through increases in both private and public R&D spending. R&D forms an important part of innovation activities, but ignores many other activities. However, the policy focus on R&D investment means little attention for firms that perform little R&D, but innovate in other ways, specifically firms from low-tech sectors. This chapter deals with firms from these sectors, their role in the economy, innovation strategies and recent trends.

The term 'low-tech sectors' is widely used and often refers to a wide range of mature sectors, such as textiles and wood. These sectors form an important part of the EU economy.

Low-tech sectors are important for employment, economic growth and knowledge formation in European economies. Firms (and the products produced) in these sectors are very often the key to the innovative ability of other firms and for the design, fabrication and application of various high-tech products, through innovation spillovers.

The importance of these sectors can be seen by their share of value added. In the EU15, the low tech sectors account for about 32% of total value added of the whole manufacturing sector, while the high-tech sectors only account for about 6%. Logically, the role of R&D is much smaller. In the EU-15, R&D investment in medium-low and low tech sectors account for about 11% of all manufacturing R&D in 2002, while high-tech sectors account for about 48%.

Looking at the relative role of R&D and other innovation activities in low-tech sectors, we see that the acquisition of machinery, equipment and software plays a very important role. R&D and the acquisition of knowledge play a much less important role. As such, high-tech sectors can be seen as suppliers of technology. Low-tech sectors are therefore not less innovative, but spend the money on ready-to-use technology acquisition rather than on research.

Three main trends can be identified in the low-tech sectors. Firstly, innovation in low-tech sectors does not stop at R&D. Although non-R&D innovation also plays a role in high tech firms, this type of innovation is especially important for low tech firms. Secondly, R&D inputs from other sectors to contribute more and more to the innovative power of low-tech sectors. Thirdly, firms have become important generators of new technologies by developing new materials and high-end products in order to respond to low-wage competition.

JEL Classification: O33

Keywords: R&D, low-tech sectors, trends

1 Introduction and Methodology

This document emerged from the *Digest of Industrial R&D*², whose objective is to provide a review of the recent literature on industrial R&D in a policy-maker friendly format, aiming for a better understanding of industrial³ R&D investment in Europe⁴. The *Digest* uses systematic information screening, selection and processing activities in order to develop a “bottom-up” picture of the most relevant issues surrounding this subject.

Publicly-available sources, including academic books and papers, documents produced by national governments and international organisations (such as the OECD, the UN and the EU), in-house research at the IPTS and other EC-related working groups, and reports by private organisations were covered in the *Digest* activities.

Four main topics emerged in the first edition of the *Digest*⁵: the impact of business R&D, levels and patterns of business R&D investment, factors that influence those investments, and the internationalisation of business R&D. Following the experience with the first edition, the methodology was improved through incorporating a wider range of sources, in-depth expert discussions for trend identification, and the use of standard templates to structure the information. The most relevant topics have been selected according to the degree of relevance for the following issues:

- (a) **Problématique**: the issue at stake and its economic and policy relevance of issues.
- (b) **State of the art**: the novelty of literature on this topic.
- (c) **Divergence**: the different points of view on the issue, based on existing literature.
- (d) **Blind spots**: areas where there is a lack of policy relevant information.

The process was designed to make the exercise as comprehensive, up-to-date and policy-relevant as possible. Given the “bottom-up” character of the process and the quality of the resulting reports, the most interesting reports are published as a self-standing document.

The present report, Business R&D in SMEs, aims to be a useful reference work for policy-making, research and business alike. Comments, feedback and other input are welcome and can be sent by email to: JRC-IPTS-IRI@ec.europa.eu.

² The Digest was an activity within the Industrial Research and Innovation Monitoring (IRIM) project carried out jointly by the Joint Research Centre (JRC) and the Directorate General Research (DG RTD) of the European Commission. The other IRIM activities are the EU Industrial R&D Investment Scoreboard, the EU Survey on R&D Investment Business Trends, and the Economic and Policy Analysis Report.

³ The terms *industrial*, *corporate*, *business*, and *private-sector* R&D are used interchangeably throughout this document.

⁴ IRIM activities are undertaken at the JRC's Institute for Prospective Technological Studies (JRC-IPTS) and are co-funded by DG Research.

⁵ The pilot Digest is available at http://iri.jrc.es/research/docs/annual_digest_ird.pdf

2 R&D in Low Tech Sectors

This working paper concentrates on the significance and impact of R&D performed by firms in the so-called low-tech sectors. First, it offers a short overview of the role and scale of low-tech sectors in the European economy. Then it briefly discusses the role of R&D in low-tech sectors and factors that determine R&D investment in these sectors (stimuli and barriers). Finally, some important trends in R&D in these sectors are presented.

2.1 THE ISSUES

The 3% Action Plan of the Lisbon Agenda was adopted with the aim of making Europe more innovative through increases in both private and public R&D spending. R&D is an important input to innovation, but does not capture the whole phenomenon. However, the policy focus on R&D investment means little attention for low-tech sectors that nevertheless have potential for innovation. Innovation policy has recently received much criticism for this. It is stated that 95% of all the innovation subsidies are supporting R&D investment only (Arundel 2007). It has become clear that low-tech sectors also offer an important base for innovation, although primarily through other inputs than R&D investment and much of the knowledge formation must be found in activities that fall outside R&D statistics.

This chapter will deal with (1) the importance of the low-tech sectors in the EU economy, (2) the role and importance of R&D in low-tech sectors and (3) trends in R&D in low-tech sectors. The goal is to formulate some messages for R&D policies in low-tech sectors.

2.2 CLARIFICATION: LOW-TECH SECTORS

The term 'low-tech sectors' is widely used by researchers and policy-makers. It often refers to a wide range of mature sectors (e.g. textiles, wood, mining, metals), without taking into account any official sector classification. The original low-tech vs. high-tech classification was aimed at manufacturing industry and was made after ranking the industries according to their average R&D intensity (R&D/total output) over the period 1991-1999 (see Table 1). The main advantage of the classification is its ease of use: it consists of four clearly defined groups of which the only variable used (R&D intensity) is fairly simple to measure and publicly available. However, nowadays, new and old technologies are used in combination. This means that low-tech products might also consist of high-tech technologies and vice-versa (for example biotechnology among food producers). Therefore, this classification is becoming less and less useful for academic analyses (von Tunzelmann and Acha, 2005). However, data gathering and policy-makers still make wide use of this classification.

Table 1: OECD Classification of innovativeness based on R&D intensity

<i>Technology group</i>	<i>R&D intensity</i>
High-tech industries	R&D intensity: > 5%
Medium high-tech industries	5% > R&D intensity > 3%
Medium low-tech industries	3% > R&D intensity > 0.9%
Low-tech industries	0.9% > R&D intensity > 0%

Source: Hatzichronoglou, T. (1997)

The sectors that fall into the group of low-tech sectors are Textiles (textile products, leather & footwear), Wood (products of wood & cork), Pulp (paper, paper products) and Manufacturing (recycling and others). These industries have fairly standardised production processes and product design. In this context set-up costs are low and a large number of firms compete fiercely on price (Scarpetta and Tressel, 2004).

Pavitt (1984) defined another sector taxonomy that takes into account the sources of technological change, user requirements and possibilities of appropriation. In contrast with the OECD classification that considers the product characteristics, Pavitt's taxonomy looks at processes and inter-industry links. Firms are classified into four groups: 1) supplier dominated, 2) scale intensive, 3) specialised suppliers and 4) science based. Sectors that we consider low-tech (or low R&D intensity) can be found mostly in the first group. This supplier dominated group is characterised by firms that are generally small with weak in-house R&D and engineering capabilities. Professional skills, aesthetic design, trademarks and advertising play a more important role for innovation and technological trajectories are therefore defined in terms of cutting costs. Supplier dominated firms make only a minor contribution to their process or product technology. Most innovations come from suppliers of equipment and materials, although in some cases large customers and government-financed research and services also make a contribution.

This chapter will focus on the traditional OECD classification, since all data from the OECD and other sources are organised in this way. This means that some low R&D intensity sectors, such as Oil & Gas producers and Utilities, are left out of the descriptive data, unless they comprise a big asset for the EU economy.

2.3 THE IMPORTANCE OF LOW-TECH SECTORS FOR THE EU ECONOMY

Low R&D-intensity sectors are important for employment, economic growth and knowledge formation in European economies. Products and companies in these sectors are very often the key to the innovative ability of whole value chains and for the design, fabrication and application of various high-tech products, through innovation spill-overs.

Between 90 and 97 percent of GDP in EU countries is accounted for by activities which are classified as non-high-tech. Moreover, in many countries, a significant part of growth and employment is based on low- and medium-tech sectors.

Share of low tech sectors in total Value Added of the economy

As can be seen in Figure 1, in the EU15, the low tech sectors account for about 32% (58% when medium-low tech sectors are included) of total VA of the manufacturing sector, while the high-tech sectors only account for about 6% (42% when medium-high tech sectors are included). In a historical overview, there is not much change in these figures over the last three decades. The sector structure differences with the US (see Figure 2) are minimal, although high tech sectors have account for a higher part of total VA. As in the EU, there is little change over the last three decades.

Figure 1: EU15 - Value added per sector group as part of manufacturing value added 1979-2003

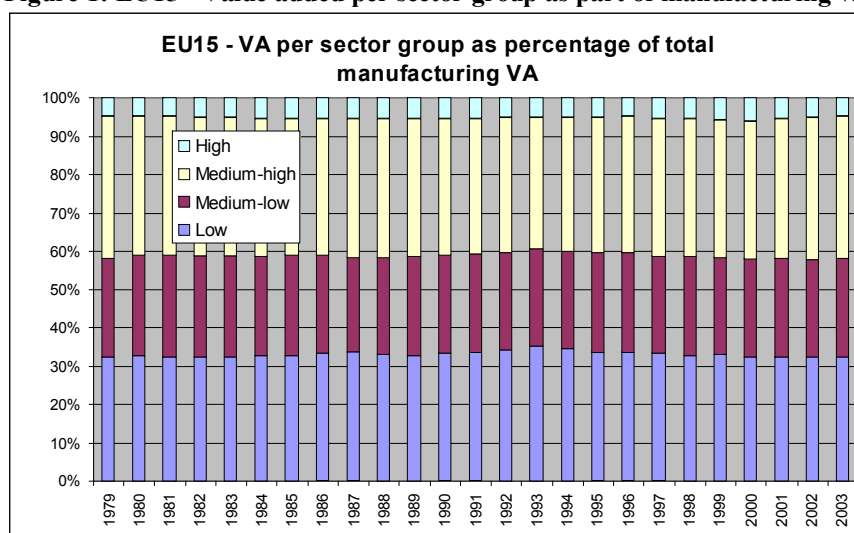
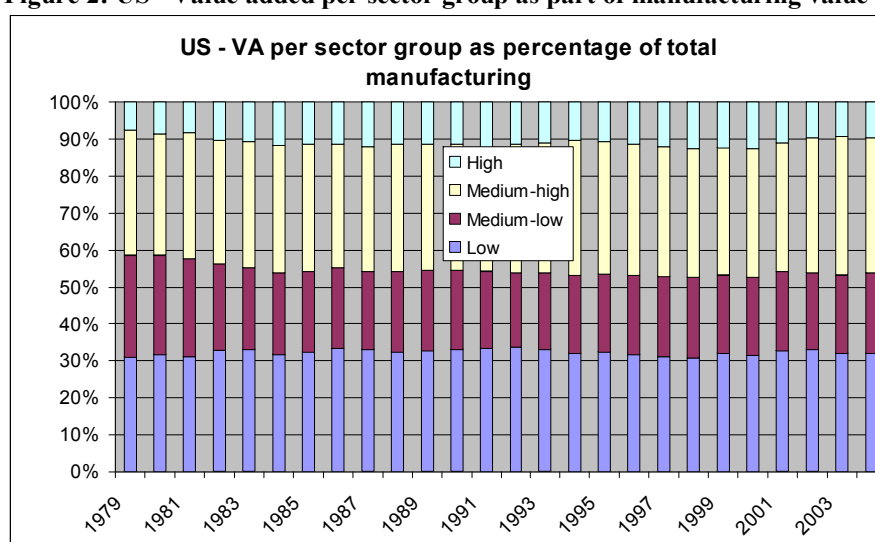


Figure 2: US - Value added per sector group as part of manufacturing value added 1979-2004

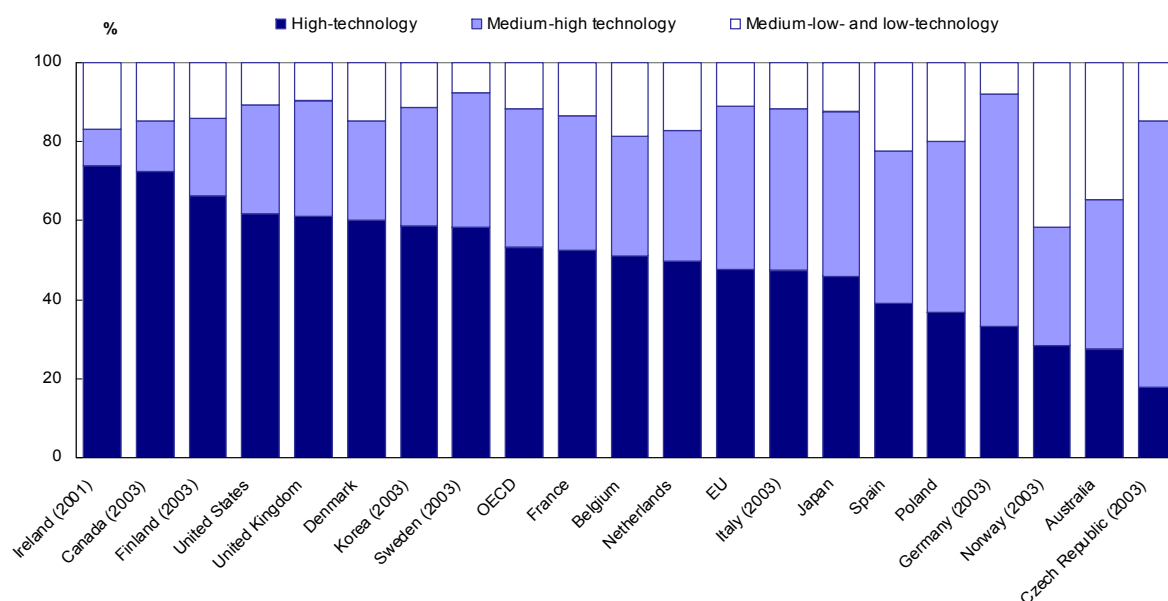


Source: own compilation and GGDC database

Share of low tech sectors in R&D investment

In the EU-15, R&D investment in medium-low and low tech sectors account for about 11% of all manufacturing R&D in 2002, while high-tech sectors account for about 48% (see Table 2). Compared to the US, there seems to be a difference especially in the R&D spending in high tech sectors that account for more than 60% of total manufacturing R&D.

Table 2: Share of business R&D in manufacturing by technological intensity, 2002



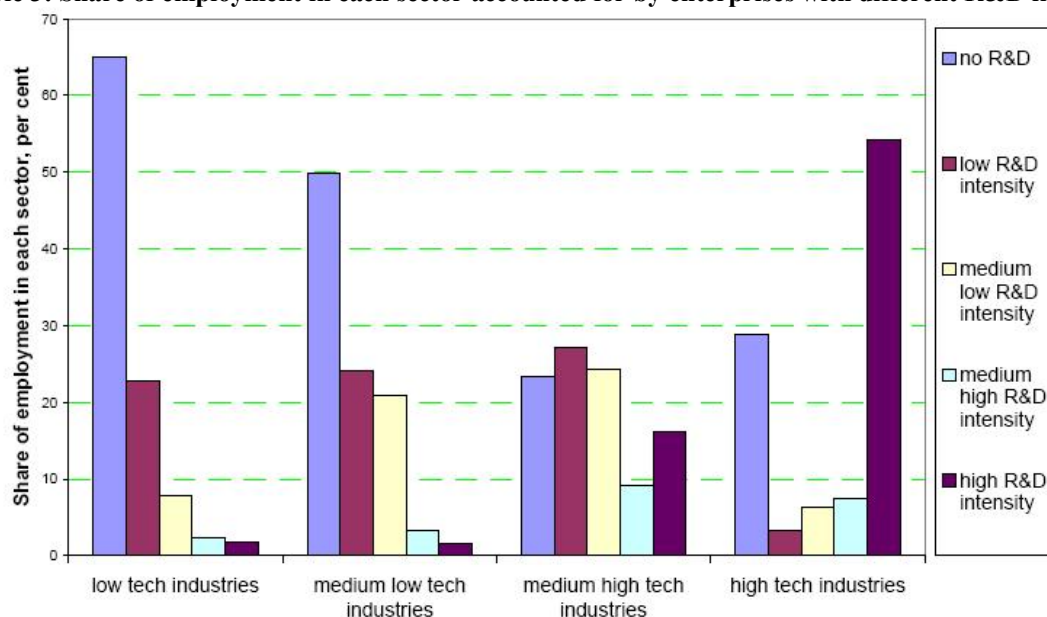
Source: (OECD, 2005)

Share of low-tech sectors in employment

The traditional view of using industry level analysis of R&D as an indicator hides the fact that the four technology groups all include both low-tech and high-tech firms. Within high-tech sectors, almost one third of total turnover is accounted for by firms with no R&D, while only about 54% of turnover is accounted for by firms with high R&D levels. The share of turnover in low-tech sectors accounted for by firms with no R&D is 65%.

Table 3 shows the share of employment along the high-tech – low-tech dimension accounted for by each of the categories of firms, defined by R&D intensity. It shows (for Norway) that within high-tech industries about 54% of total employment is accounted for by firms with more than 5% R&D intensity and almost 30% of employment is accounted for by firms with no R&D. On the other hand, within low-tech sectors about 65% of employment is accounted for by firms with no R&D and only 1.9% of employment is accounted for by firms with an R&D intensity of more than 5%.

Table 3: Share of employment in each sector accounted for by enterprises with different R&D intensities



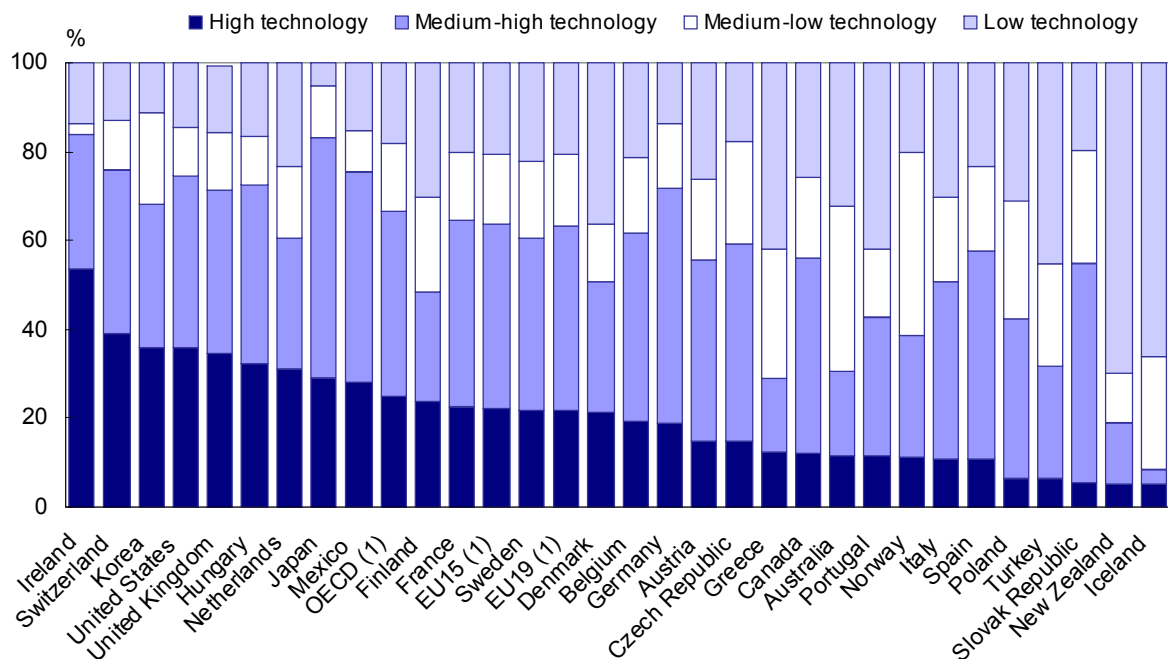
Source: Laestadius et al., 2006

The shares of employment for the different sector groups change due to structural changes in the economy. Growth depends to a large extent on service activities. The service sector is heterogeneous: some service industries are highly R&D intensive (such as Computer and Software services), while others are somewhat low R&D intensive (e.g. Banking). None of the growing service sectors is particularly R&D intensive. Besides, more than fifty percent of service employment is in two sectors: wholesale and retail trade, and community and social services. These are not highly R&D intensive (Sandven, Smith, and Kaloudis 2005).

Share of low-tech sectors in trade

The importance of low-tech sectors in the European economy is demonstrated by the share these sectors account for in EU manufacturing exports of around 20 per cent. This is around the same level (22 per cent) as exports from high-tech sectors (see Figure 3). Differences among countries are substantial: the share of low-tech sectors ranges from over almost 40% in Portugal and Greece to around 15% in Ireland, Germany and UK.

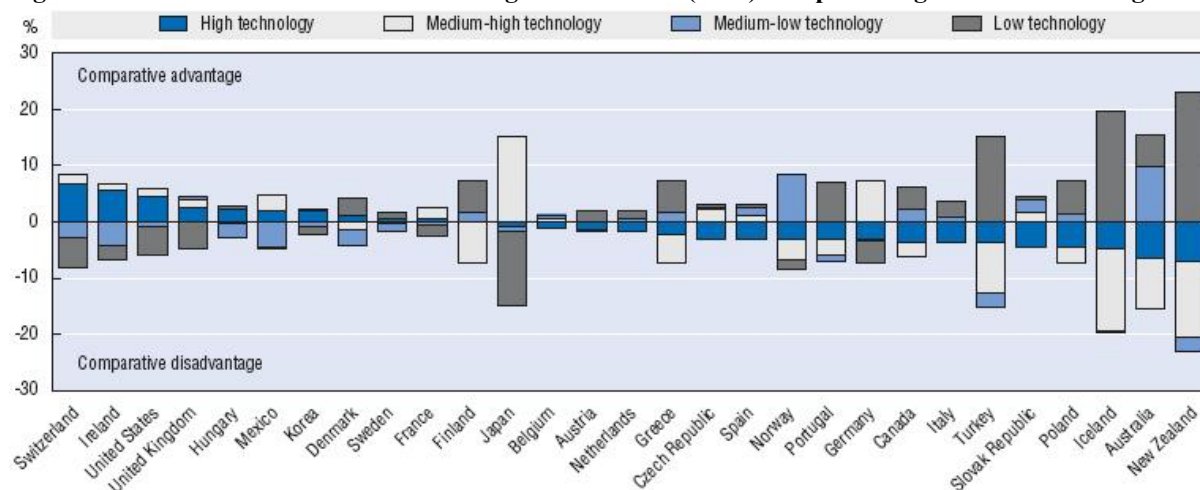
Figure 3: Share of technology industries in manufacturing exports, 2003



Note: EU(15), EU(19) and OECD figures do not include Luxembourg
 Source: OECD (2005)

Looking at the contribution to the trade balance shown in Figure 4 we see that only a few countries specialise in high-technology manufacturing (Switzerland, Ireland, the US and the UK). The importance of the low-tech sectors in European trade is shown by the trade surpluses in countries like France, Denmark, Sweden, Greece, Portugal and Poland.

Figure 4: Contribution to the manufacturing trade balance (2003) as a percentage of manufacturing trade



Source: OECD 2005

2.4 THE ROLE AND IMPORTANCE OF R&D INVESTMENT FOR LOW-TECH SECTORS

Reasons for, and barriers to, investing in R&D in low-tech sectors

As in other sectors, drivers to innovate can be either 'market pull' or 'technology push'. For low-tech sectors, demand factors are especially important for innovation, because the maturity of the markets – with well-established products and brands – forces firms to either open up new markets or look for new market niches. However, product development in low-tech sectors is often not R&D intensive. The R&D intensity of products is mainly related to the industry's market structure. Products in low-tech sectors are relatively uniform and product differentiation often requires little R&D (e.g. textiles). On the other hand, high-tech sectors tend to be younger (e.g. biotechnology) and thus more heterogeneous and might have valuable innovation opportunities that require considerable R&D.

Process innovations in low-tech sectors have more technological content requiring R&D than product innovations. Firms in low-tech sectors invest in new equipment and machinery offered by high-tech sectors instead of performing process innovation themselves. New technologies often spill over (through acquisition) from other industries to mature industries. Thus low-tech firms provide a demand pull for technological development in high-tech firms. Examples include information and communication technologies and specialised machinery, which are widely used in low-tech sectors. In order to absorb these technologies, low-tech industries need learning capabilities that allow them to use them productively. These capabilities can be partly developed through R&D investment (von Tunzelmann and Acha, 2005). The effect of investment spending on new machines on the probability of introducing a process innovation is enhanced by R&D spending. This implies that there may be an important role for R&D in favouring the absorption of new more advanced technologies. Once they have been introduced, however, R&D does not play a significant role in its effective use; a skilled workforce is then a precondition for its effective use (Parisi, Schiantarelli, and Sembenelli, 2002). Low-tech sectors play an important role in the application of technologies developed in high-tech sectors and particularly, in the ICT sector, where they may be one of the main factors shaping demand and technological developments (Sandven and Smith, 2005).

As such, the low R&D intensity can mainly be explained by the little necessity for product development (R&D), on the one hand, and technology acquisition (with the combination of R&D for absorbing this technology), on the other.

The importance of R&D in total innovation expenditures

Community Innovation Survey (CIS) 3 data on four sectors give an overview of total innovation expenditures. When we look at the importance that R&D plays in total innovation expenditures, we see that the acquisition of machinery, equipment and software plays a very important role in innovation in the low-tech sectors, while R&D (both intra- and extramural) and the acquisition of external knowledge play a much less important role. This confirms that high-tech sectors are suppliers of technology, while the low R&D intensive sectors are therefore not less innovative, but spend the money on ready-to-use technology acquisition rather than on research (see Table 4).

It may well be the case that a high tech firm is always "on the frontier" as far as the installed capital is concerned (for instance, using the latest vintages of machineries incorporating the most recent process innovations). In this context, marginal productivity gains only come from the R&D activities and the correlated product innovations. In the low-tech sectors, the opposite

can happen, with productivity gains mainly associated with the process innovations associated with a gradual renewal of the installed capital (embodied technological change).

Table 4: Expenditures on different types of innovation per sector

Innovation expenditure as a percentage of total innovation expenditures	Manufacture of textiles	Manufacture of basic metals	Manufacture of chemicals and chemical products
Intramural R&D	27.4%	31.0%	55.2%
Extramural R&D	3.0%	4.8%	14.0%
Acquisition of external knowledge	6.7%	2.4%	9.5%
Acquisition of machinery, equipment and software	46.9%	53.6%	12.8%
Total *	84.2%	91.8%	91.5%

Note: *Totals do not always add up to 100% due to incomplete answers in the CIS questionnaire
Source: European Commission (2004)

2.5 THE IMPACT OF R&D PERFORMED IN LOW-TECH SECTORS

Macro-level impact

The main goal of the Lisbon strategy for Europe is to create economic value, jobs and to become more productive by raising the level of investments in R&D. In this section, a short overview of the relationship between R&D and economic value, employment and productivity in literature is provided. The main problem for testing this relationship on a macro level is the aggregation of R&D.

Employment

R&D efforts in low-tech sectors are mainly aimed at product innovations, as mentioned. Process innovations are mainly acquired from high-tech sectors (for which they are product innovations). To what kind of innovations does R&D investment lead in low-tech sectors? If it leads to process innovations, then a negative relation with employment can be assumed. If R&D in low-tech sectors leads to product innovations, then a positive relationship with employment can be assumed. However, the relationship becomes more complex when the employment compensation mechanisms of the economic system are taken into consideration. The most important are:

- ♦ Via decrease in prices – lower prices, through innovation – leads to increased competitiveness and increased employment.
- ♦ Via new machines – loss of jobs through process innovations, in the sense of new machines, may lead to new jobs in the sector where these machines are made (medium/high-tech sectors).
- ♦ New investments – extra profits caused by innovations are invested in new businesses that may create new employment opportunities.

Innovation is a sector- and firm-specific process, through specific and intentional investments and strategy, so that a shift towards lower levels of analysis is needed. The direct impact of innovation on the sector level is measured by the redistribution of jobs within sectors from firms that do invest in R&D and firms that do not. For this reason, this level of analysis might be the most suitable level for the relationship between R&D and employment. Results on this level of analysis show a positive employment effect for sectors where there is a high demand

growth and where product innovations play a big role. High demand growth gives a chance to more firms' strategies while low or no demand growth will lead to a selection process among firms. However, in order to expand employment, demand has to grow faster than productivity. There is a negative relationship in sectors where innovations are mainly process-related.

The direct effects of innovation on employment for individual firms tend to be positive. A distinction needs to be drawn here between product and process innovations. The former shows more positive results than the latter, because process innovations often have as a reduction in manpower (per unit output) as one of their effects. However, both show positive relationships with innovation, because of the ability to grow innovating firms compared with non-innovative firms. The problem with studies at the firm level is that it is not possible to show whether job creation in innovating firms is at the cost of other firms, such as competitors.

Spill-overs

An important share of the products manufactured by highly R&D-intensive sectors is efficiency-enhancing innovations for other sectors. Low R&D-intensity sectors are receivers and thus beneficiaries of these new technologies. The market potential for high R&D-intensive sectors depends on the demand for their innovations from the low R&D-intensive sectors (pull), but also the other way around: innovation in the high R&D-intensive sectors creates new purposes/markets for low R&D-intensive products and thus increases their market output (push). The strong competition in highly R&D-intensive sectors will encourage firms to stay innovative. The impact of government funding for R&D in these sectors is unclear (see David, Hall and Toole, 1999) since government financed R&D may serve as a substitute for business funded R&D, thereby contributing to firms' short term profits instead of their innovative output. Policy-makers could therefore also usefully pay attention to enhancing the absorptive capacity of low R&D-intensity sectors as a means of creating stronger demand for new technologies from high R&D-intensive sectors.

Impact on micro level

Sales

For innovative firms, a one percent increase in R&D intensity increases the share of sales of 'products new to the firm' by 3.7 percentage points, the share of sales of 'products new to the market' by about twice as much, and the share of patented products by 13 percentage points. This effect is even more marked in low-tech sectors. Here, a one percent increase in R&D increases the propensity to innovate in 'products new to the firm' by about the same amount as in the high-tech sectors, but it increases the propensity to introduce a 'product new to the market' or a new process, as well as the probability of patent ownership by twice the amount in the high-tech sectors. In the low-tech sectors, R&D increases the share in total sales of 'new to the firm' products more than the share in sales of 'new to the market' products (7.9 vs. 2.2 percent). The latter confirms that firms in low-tech sectors try to look for new markets for their existing products rather than develop new products.

Profits

Cefis and Ciccarelli (2005) found evidence that the effect of innovation on firms' profit margins is greatest 2-3 years after patenting an innovation and then gradually declines. Furthermore, the research shows that the profitability of firms reaches a plateau at a higher level for innovators than for non-innovators.

High-tech industries are often dominated by large, established firms and the presence of barriers for new innovators. Returns to R&D in these industries are likely to be larger than those in low-tech ones, possibly leading to lasting technological leadership.

Firm survival

Characteristics of demand (market size, growth rates, technological characteristics and the life cycle) have been found to be important determinants of the probability of survival. Looking at the separate and combined effects of product and process innovations, product innovations influence firms' survival only in combination with process innovations. However, many studies fail to look at the role of innovation in the firm and its relationship to firm survival. Cefis and Marsili (2004) show that innovation increases firms' probability of survival, with process innovation as the most important type of innovation. They also find that product innovation only affects survival in combination with process innovation. Among non-science-based firms, innovation increases the chances of survival by more than 13% in the case of product innovation and by as much as 25% in the case of process innovation. For science-based firms, innovation itself is not enough to increase firm survival, leaving space for other firm-specific capabilities for appropriating innovations.

Productivity

The link between R&D activity and productivity partly depends on industries' technological characteristics: while there is no evidence of R&D boosting productivity in low-tech industries, the effect is strong in high-tech industries. However, the technology leaders tend to enjoy higher returns on R&D expenditure compared with followers (Scarpetta and Tresselt, 2004).

It is noticeable that technology convergence seems to take place mainly in low-tech industry, while in the high-tech group of manufacturing industry there is evidence of divergence: i.e. technology leaders tend to enjoy higher productivity growth, *ceteris paribus*, than followers. It is also interesting to note that R&D has a stronger (and statistically significant) effect in high-tech industries than in low-tech industries. Moreover, unlike the case of manufacturing industry overall, there is evidence of an interaction between R&D and the technology gap in high-tech industries, but the sign is positive, suggesting greater returns from R&D in the leading countries compared with the followers.

The influence of R&D on output (as estimated by the output-elasticity of the R&D-stock), is more significant in the high-tech sectors. In the cases of the medium-tech and low-tech sectors, the estimated elasticities are less positive and become non-significant. This result corresponds to some of the results of similar analyses at the firm-level. For example, Griliches and Mairesse (1984) find that the R&D-elasticity of output varies considerably between firms in the scientific and other sectors, Cuneo and Mairesse (1984) find a slightly higher output-elasticity for scientific firms, and Potters, Ortega-Argilés and Vivarelli (2008) found a monotonically decreasing impact of R&D on productivity when going from high-tech sectors to medium-tech and finally low-tech sectors.

Trends in low-tech sectors

Three main trends can be identified in the low-tech sectors. Firstly, innovation in low-tech sectors does not stop at R&D. Although non-R&D innovation also plays a role in high tech firms, this type of innovation is especially important for low tech firms. Recent research has deepened the understanding that the sectoral knowledge base, which is crucial for driving innovations, in low-tech sectors goes far beyond R&D activities. Other factors, such as design, logistics and organisation, have proved to be at least as important for successful innovations, if not more so, than sectoral R&D. A good example is that of oil and gas companies. The rising number of scientific publications and PhD qualified staff in these companies indicate a growing commitment to research, but costs are captured under different

headings, particularly exploration costs (von Tunzelmann and Acha, 2005). Therefore, only a small part of technological innovation is measurable by R&D investments, while technology transfer and non-technological innovation are more difficult to measure. Non-technological innovation based on sophisticated non-codified knowledge plays an important role for competitiveness and entrepreneurial success.

The second trend is for R&D inputs from other sectors to contribute more and more to the innovative power of low-tech sectors. There are numerous examples: low-tech sectors in particular use technological innovations that are largely generated in other industries, above all in machinery, software and technological hardware (computer-aided design systems).

Thirdly, firms in the low-tech sectors are responding to low-wage competition from mainly Asia. This means that the situation is evolving and some enterprises in these sectors have become important generators of new technologies by developing new materials (e.g. technical textiles in the textile industry), enabling them to obtain new high added-value products for multi-sector applications. These firms typically serve the high-end of the market.

3 CONCLUSIONS

Although R&D as an input to innovation (output) plays a smaller role in the so-called low-tech sectors, interesting conclusions can be drawn from a deeper analysis of its role in low-tech sectors. Low-tech sectors are mature sectors where many (small) producers operate at marginal cost. These sectors play an important role in the European economy, but firms in some sectors are noticing low-wage competition from developing countries. Therefore, innovation can be of vital importance to the performance of these firms. However, much of innovation policy in Europe is only aimed at R&D, which leaves the low-tech sectors out from its benefits. Innovation in low-tech sectors goes well beyond R&D investments and is therefore more difficult to observe on the surface. Important inputs to innovation output – other than R&D – are technology acquisition, organisational and managerial innovation, design and marketing. The R&D that is performed within these sectors is mainly aimed at product innovation still due to demand and absorption of acquired knowledge. Some important trends can be distinguished. Firstly, firms in low-tech sectors do perform basic research, but this is often not considered to constitute an R&D cost (e.g. exploration by oil companies). Secondly, technology acquisition becomes more and more an important innovation input for firms in low-tech sectors (e.g. computer aided design). Thirdly, some firms from low-tech sectors are increasingly investing in R&D and are aiming at serving the high-end of the market in order to compete with firms from low-wage countries. These three trends contain important policy messages, especially concerning the aim of innovation policies.

A practical remark concerns the use of the term low-tech sectors and the classification that is used. Due to the blurring boundaries between high-tech and low-tech sectors, this classification might not serve for future policy-making, since it misses out critical parts of innovation.

4 REFERENCES

- Arundel, A. 2007. 'Better Indicators for Policy Analyses; Under-exploitation of the CIS at micro-data level.' in *Innovation Indicators - More than Technology?* Åarhus, Denmark.
- Becker, B. and N. Pain. 2002. 'What Determines Industrial R&D Expenditure in the UK?' National Institute of Economic and Social Research.
- Bender, G. 2004. 'Innovation in Low-tech - Considerations based on a few case studies in eleven European countries.'
- Böheim, M. 2004. 'Some thoughts about the importance of sophisticated non-codified knowledge and non science based innovation in 'low-tech' industries.' WIFO, Vienna.
- European Commission, 5004: *Innovation in Europe, Third Community Innovation Survey*, ISBN 92-894-7262-6
- Hatzichronoglou, T. 1997. 'Revision of the High-technology Sector and Product Classification.' Organisation for Economic Co-operation and Development, Paris.
- Hirsch-Kreinsen, H., D. Jacobson, and S. (eds.) Laestadius. 2005. *Low-tech Innovation in the Knowledge Economy*. Frankfurt am Main: Peter Lang.
- Hirsch-Kreinsen, H., D. Jacobson, S. Laestadius, and K. Smith. 2003. 'Low-Tech Industries and the Knowledge Economy: State of the Art and Research Challenges.'
- Laestadius, Staffan; Pedersen, Trond Einar and Sandven, Tore 2006: Towards a new understanding of innovativeness – and of innovation based indicators. In: Bender, G.; Jacobson, D.; Robertson, P. L. (eds.), *Non-Research-Intensive Industries in the Knowledge Economy. Perspectives on Economic Political and Social Integration*, Special Issue 1. Lublin: Catholic University
- OECD. 1999. 'Science, Technology and Industry Scoreboard: Benchmarking Knowledge-based Economies 1999.' OECD, Paris.
- . 2005. 'Science, Technology and Industry Scoreboard: Benchmarking Knowledge-based Economies 2005.' OECD, Paris.
- Parisi, M.L., F. Schiantarelli, and A. Sembenelli. 2002. 'Productivity, Innovation and R&D: Micro Evidence for Italy.' *Journal of Economic Literature*.
- Pavitt, K. 1984. 'Sectoral patterns of technical change: Towards a taxonomy and a theory.' *Research Policy* 13:343-373.
- Potters, L., R. Ortega-Argilés, and M. Vivarelli. 2008. "R&D and Productivity: testing sectoral peculiarities with micro level data", *IZA Working Paper Series*, No 3335, Bonn, Germany.
- Sandven, T., K. Smith, and A. Kaloudis. 2005. 'Structural change, growth and innovation: The roles of medium and low-tech industries 1980-2000.' in *Low-tech Innovation in the Knowledge Economy*, edited by H. Hirsch-Kreinsen, D. Jacobson, and S. Laestadius. Frankfurt am Main: Peter Lang.
- Scarpetta, S. and T. Tressel. 2004. 'Boosting Productivity via Innovation and Adoption of New Technologies: Any Role for Labor Market Institutions?' The World Bank.
- von Tunzelmann, N. and V. Acha. 2005. 'Innovation in "Low-Tech" Industries.' in *The Oxford Handbook of Innovation*, edited by J. Fagerberg, D. C. Mowery, and R. R. Nelson. New York: Oxford University Press.

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Title: R&D in low-tech sectors

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Abstract

The 3% Action Plan of the Lisbon Agenda was adopted with the aim of making Europe more innovative through increases in both private and public R&D spending. R&D forms an important part of innovation activities, but ignores many other activities. However, the policy focus on R&D investment means little attention for firms that perform little R&D, but innovate in other ways, specifically firms from low-tech sectors. This chapter deals with firms from these sectors, their role in the economy, innovation strategies and recent trends.

The term 'low-tech sectors' is widely used and often refers to a wide range of mature sectors, such as textiles and wood. These sectors form an important part of the EU economy.

Low-tech sectors are important for employment, economic growth and knowledge formation in European economies. Firms (and the products produced) in these sectors are very often the key to the innovative ability of other firms and for the design, fabrication and application of various high-tech products, through innovation spillovers.

The importance of these sectors can be seen by their share of value added. In the EU15, the low tech sectors account for about 32% of total value added of the whole manufacturing sector, while the high-tech sectors only account for about 6%. Logically, the role of R&D is much smaller. In the EU-15, R&D investment in medium-low and low tech sectors account for about 11% of all manufacturing R&D in 2002, while high-tech sectors account for about 48%.

Looking at the relative role of R&D and other innovation activities in low-tech sectors, we see that the acquisition of machinery, equipment and software plays a very important role. R&D and the acquisition of knowledge play a much less important role. As such, high-tech sectors can be seen as suppliers of technology. Low-tech sectors are therefore not less innovative, but spend the money on ready-to-use technology acquisition rather than on research.

Three main trends can be identified in the low-tech sectors. Firstly, innovation in low-tech sectors does not stop at R&D. Although non-R&D innovation also plays a role in high tech firms, this type of innovation is especially important for low tech firms. Secondly, R&D inputs from other sectors to contribute more and more to the innovative power of low-tech sectors. Thirdly, firms have become important generators of new technologies by developing new materials and high-end products in order to respond to low-wage competition.

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