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RESEARCH, DEVELOPMENT AND INNOVATION IN FLANDERS 2004

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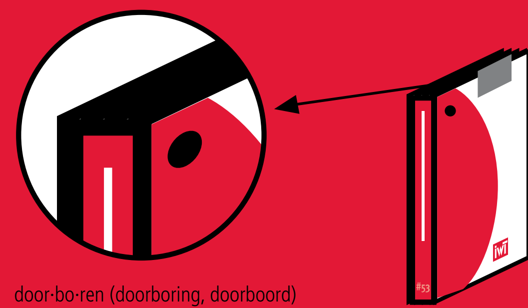

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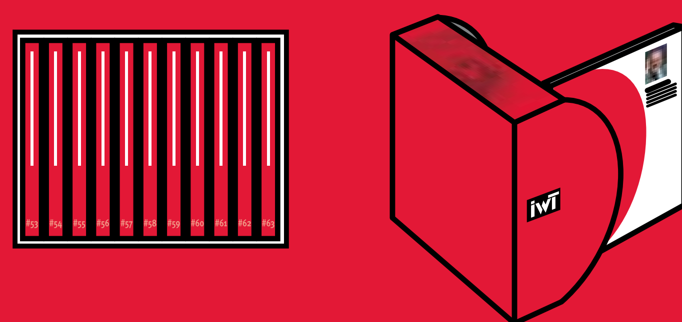

BEWAARDOOS

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Voorwoord

Deze studie gaat dieper in op de resultaten van de klassieke O&O-enquête uitgevoerd in opdracht van de OESO en de meer brede en reeds vierde Innovatie-enquête die onder auspiciën van de Europese Commissie werd gevoerd. Het gaat telkens over cijfers tot en met het jaar 2004, een spiljaar zo blijkt bij nader toezicht. Beide enquêtes leggen de vinger op de dalende aandacht van het bedrijfsleven voor O&O en voor innovatie over de jaren 2001 tot 2003, die in 2004 tot stilstand is gekomen, ja zelfs, weer een lichte heropleving laat optekenen. Meer recente, maar nog zeer voorlopige gegevens van de O&O-enquête over 2005 bevestigen deze heropleving.

Deze heropleving doet echter niks af van de centrale vaststelling van de voorliggende analyse. De overheidsmiddelen die naar de ondersteuning van O&O en innovatie gaan zijn niet gering en zijn gestaag gestegen de voorbije 15 jaar. Deze overheidsinspanningen zijn nog verder versterkt in het licht van de Europese Lissabonstrategie en de Barcelonadoelstelling van 3% van het BNP. Als diezelfde overheid dan met lede ogen moet toezien hoe de private O&O-uitgaven en de O&O-werkgelegenheid gedurende een periode van 2 à 3 jaar dalen met meer dan 10%, dan is er reden genoeg om zich een beetje zorgen te maken. Positief evenwel blijft dat de inspanningen in de KMO-omgeving zijn blijven stijgen gedurende dezelfde periode. De reden is bijgevolg vooral te zoeken in de hoek van een aantal grote herstructureringen bij grote bedrijven, meer bepaald in de ICT-wereld, die doorgaans grote O&O-spenders zijn. Vermits de bedrijfswereld met 86% nog zelf grotendeels instaat voor de financiering van haar O&O-inspanningen, hebben grote verschuivingen in dit uitgavenpatroon ook onmiddellijk grote effecten op de totale O&O-intensiteit. De Vlaamse overheid heeft van haar kant dan weer een grote impact op de externe financiering van het O&O-gebeuren, waarvan ze meer dan 2 derden voor haar rekening neemt.

Toch moeten we deze periode ook niet te somber bekijken. Niet alleen bleven de KMO's het over het algemeen goed doen inzake O&O-inspanningen, maar de enquête laat ook uitschijnen dat de Vlaamse bedrijven hun O&O-inspanningen zeer actief en strategisch inzetten en interne O&O combineren met extramurale O&O en allerlei partnerships. Onze Vlaamse bedrijven zijn zich ook meer en meer bewust van hun intellectuele eigendom en gaan er alsmaar verstandiger mee om. Dit zijn positieve trends die we enkel kunnen toejuichen.

Ook de ruimere Innovatie-enquête (CIS4) brengt een minstens even interessant en fijnmazig inzicht in de innovatiestrategieën en innovativiteit van de Vlaamse bedrijven. Door het opnemen van een aantal nieuwe traditioneel minder innovatieve sectoren zoals transport, handel en de bouwsector in de steekproef biedt ze evenwel een vertekend beeld over de toename van de innovatiekracht van de Vlaamse economie. Deze studie werpt ook een hoopgevend licht op de zogenaamde open innovatiemanagementstijl van de Vlaamse bedrijven: bijna een kwart doet een beroep op derden voor hun O&O-activiteiten en één op drie bedrijven heeft één of meerdere onderzoekspartnerships. Innovatie stopt ook niet bij technologie: ook organisatiestructuur, marketing, kennismanagement, design, verpakking en distributie drukken hun stempel op het Vlaamse innovatiegebeuren. Niettemin blijven een aantal zaken de bedrijven in hun innovatiestreven nog parten spelen: de hoge verwachte innovatiekosten en een tekort aan financiering, het niet vinden van gekwalificeerd personeel en de onzekerheid van de markt zijn de meest geciteerde kopbrekens. Aan het eerste euvel probeert het IWT samen met andere spelers op de markt, zoals het Innovatiefonds VINNOF en de Arkimedes-regeling, iets te doen. De zoektocht naar de juiste mensen en het gat in de markt komt dan weer het ondernemerschap toe.

De rijkdom van beide enquêtes heeft absoluut een belangrijke waarde voor het verder uitstippelen van het innovatiebeleid. We kijken al uit naar de volgende enquêtes.

Paul Zeeuwts
Directievoorzitter IWT

Executive Summary

> “De totale O&O-uitgaven gingen achteruit tussen 2002 en 2003 hoewel bij de KMO’s de uitgaven nog gestaag bleven toenemen. Volgens de recente CIS4-enquete is er sinds 2004 een ommekeer merkbaar. De totale O&O-uitgaven stegen (in prijzen van 2000) met 1 procent tot 2,2 miljard euro.”

In het eerste deel stelt dit rapport de resultaten van het Vlaamse luik van de O&O-enquête van 2004 voor. Het Steunpunt O&O Statistieken verbonden aan de K.U.Leuven voerde de enquête uit en maakte tegelijk een beschrijvende analyse van de O&O- en innovatie-activiteiten in de Vlaamse bedrijvensector tussen 2002 en 2003/04. De resultaten tonen meteen aan dat het innovatiebeleid voor een grote uitdaging staat. Sinds 2001 zijn de totale O&O-uitgaven en de O&O-werkgelegenheid immers gedaald. Terwijl de totale O&O-uitgaven van de Vlaamse bedrijven in 2001 nog 2,5 miljard EUR bedroegen, is dit cijfer in 2003 gezakt tot 2,1 miljard EUR. De O&O-enquête van 2002 gaf reeds een vertraagde groei aan. Deze vertraging heeft zich nu vertaald in een daling. De cijfers over het O&O-personeel bevestigen deze trend. In 2001 telde Vlaanderen nog ongeveer 19.800 werknemers in O&O-activiteiten, wat in 2003 reeds was teruggevallen op 17.600 werknemers. Deze negatieve trend plaatst het Vlaamse innovatiebeleid tegen de achtergrond van de 3%-doelstelling van het Europese Actieplan 2010, voor een grote uitdaging om de O&O-investeringen bij Vlaamse bedrijven te stimuleren. Een positieve noot ligt evenwel nog in het feit dat de O&O-uitgaven voor kleine en middelgrote bedrijven wél toegenomen is tussen 2002 en 2004. De daling van de O&O-uitgaven in Vlaanderen heeft dus vooral te maken met de herstructureringen die in sommige grote bedrijven werden doorgevoerd , meer bepaald in de ICT sector.

De Vlaamse O&O-activiteiten concentreren zich vooral in ICT hardware, farmaceutische en chemische producten en telecom. Deze sleutelsectoren nemen twee derden van de totale O&O-uitgaven voor hun rekening. De gemiddelde O&O-intensiteit (gemeten als de verhouding van O&O-uitgaven tot de omzet) varieert van 1% in de papier- en drukkerijsector tot meer dan 15% in sectoren als farmacie, software-ontwikkeling, telecom en andere zakelijke dienstverlening. Tussen 2001 en 2003 daalde de gemiddelde O&O-intensiteit van 7,5% tot 6,4%.

De bedrijven financieren hun O&O-uitgaven vooral met interne bronnen (86%); slechts voor 14% doen ze hiervoor een beroep op externe bronnen. De Vlaamse Overheid is de belangrijkste verstrekker van externe O&O-financiering in de bedrijvensector: 69% van de externe O&O-financiering is afkomstig van de Vlaamse Overheid. Buitenlandse overheden, en vooral de Europese Commissie, zijn eveneens een belangrijke bron van bijkomende financiering (9%).

De analyse toont verder aan dat de Vlaamse bedrijven hun O&O-inspanningen zeer actief en strategisch inzetten. Interne O&O-activiteiten worden aangevuld met kennis uit extramurale O&O-activiteiten en O&O-samenwerkingsverbanden met verschillende partnertypes. Ook het internationale karakter van O&O-activiteiten neemt duidelijk toe. Deze strategieën worden aangevuld met een professioneel management van intellectuele activa door beschermingsmethoden zoals patenten en met de uitwisseling van kennis in het kader van licentieakkoorden. Maar wat zorgen baart is echter de recente daling van de totale O&O-uitgaven tussen 2001 en 2004.

In het tweede deel van deze studie worden de resultaten van de vierde Vlaamse Community Innovation Survey (CIS4) voorgesteld. Een van de kernresultaten is dat 46% van de bedrijven in de populatie ten minste één nieuw product of proces geïntroduceerd heeft tussen 2002 en 2004, of lopende innovatieactiviteiten in die periode verder- of stopgezet heeft. Dit totale aandeel wordt evenwel beïnvloed door enkele sectoren die groot zijn, maar slechts beperkt actief zijn in innovatieactiviteiten, zoals transport, handel, de bouwsector of niet-technologie-intensieve zakelijke diensten.
In een aantal industrieën is het aandeel innovatoren significant hoger dan het gemiddelde, o.a. in elektronica (84%), chemicaliën/plastics (79%), machines/voertuigen (75%) en IT/O&O en technologie-intensieve zakelijke diensten (78%).

“Slechts 14% van de O&O-uitgaven worden extern gefinancierd. Hiervan neemt de vlaamse overheid meer dan twee derden voor haar rekening.”

Het aandeel productinnovatoren loopt op tot 30%. Van deze bedrijven heeft 58% ten minste één product geïntroduceerd dat niet alleen nieuw was voor het bedrijf, maar ook nieuw voor de markt. 60% van de procesinnovatoren realiseerde een lagere eenheidskost en 68% van hen kon de kwaliteit verhogen.

De enquête toont ook aan dat de meeste innovatieve bedrijven hun producten (73%) en processen (65%) liever intern ontwikkelen. Toch hangt een groot deel van de Vlaamse bedrijven ook een open innovatiemanagementstijl aan: aan de ene kant doet 48% van de innovatoren intern aan O&O, maar aan de andere kant blijkt dat 23% van deze bedrijven ook O&O-activiteiten uitbesteedt aan een derde partij om externe kennis te verkrijgen. 34% van de innoverende bedrijven werkt in het innovatieve proces ook op een of andere manier samen met anderen voor onderzoeksdoeleinden. Samenwerkende bedrijven blijken meestal ook meerdere partners te hebben: vooral met leveranciers (27%) en klanten (21%), maar ook met consultants (16%) of commerciële O&O-laboratoria. Deze samenwerking blijft niet beperkt tot België: 21% van de bedrijven werkt samen met Europese partners en 6% met V.S.-partners .

Innovatie gaat verder dan puur technologische vooruitgang. Bedrijven passen ook hun organisatorische structuur en marketingstrategieën aan met betrekking tot innovatie: dit gaat over aanpassingen in de werkorganisatie (24%), verbeteringen in het kennismanagement (19%), belangrijke veranderingen in ontwerp of verpakkingen (12%) of nieuwe verdelingsmethodes (12%).

Toch gaat de technologische vooruitgang in Vlaanderen nog gebukt onder een aantal hindernissen. Hoge verwachte innovatiekosten (16%) en het gebrek aan financiering, zowel intern (14%) als extern (8%) worden het meest geciteerd. Ook het gebrek aan gekwalificeerd personeel blijft voor 11% van de bedrijven een obstakel om te kunnen innoveren. Tot slot kunnen ook de onzekere vraag voor innovatieve goederen of diensten (10%), of marktdominantie (13%) roet in het innovatie-eten gooien.

De CIS4 enquête laat tot slot ook nog toe om de totale interne O&O-uitgaven te vergelijken met de gegevens uit de O&O-enquête. De daling van de O&O-uitgaven met 5% tussen 2002 en 2003 (in constante prijzen van het jaar 2000) stopt echter in 2004. In vergelijking met 2003 is er zelfs opnieuw sprake van een kleine stijging. De totale O&O-uitgaven van Vlaamse bedrijven stegen hiermee in 2004 tot ongeveer 2,2 miljard EUR (in prijzen van 2000), wat . met een lichte groei van 1% toch weer een positief licht aan de horizon laat schijnen.

PART 1.

RESEARCH
AND
DEVELOPMENT
IN FLANDERS

Chapter 1

INTRODUCTION

Economic growth and competition are nowadays driven by innovative technological progress, preceded by a continuous process of performing research and development (R&D). Both incumbents and start-up firms have to look ahead and search for incremental and radical innovations. Incumbents, in particular, have to be alert of emerging disruptive technologies that possibly replace existing products. Improved products and more efficient processes lead to better market positions and, in general, to national economic growth.

“To reach the 3% goal both public and private R&D-investment need to be encouraged tremendously.”

The European Commission recently introduced the Lisbon-strategy and the Barcelona-objective, stating that the R&D expenditures of EU member states should reach 3% of GDP by 2010. Flanders translated these objectives into the “Innovationpact” in 2003, a formal engagement of the different actors involved (the government, the business sector, the universities and public research institutes) to reach the 3%-goal. The 3%-goal can only be reached by intensively stimulating R&D activities and by diffusing new knowledge to stimulate ideas.

Conform to the propositions of the European Union, the Flemish private companies are recommended to increase their R&D-expenditures to reach 2% of the GDP. Additionally, the public expenditures on R&D should amount to 1% of the GDP in 2010. Consequently, both public and private R&D-investments need to be encouraged tremendously. Accurate data collection and reliable R&D-indicators are needed to determine the annual progress or decline in R&D-expenditures.

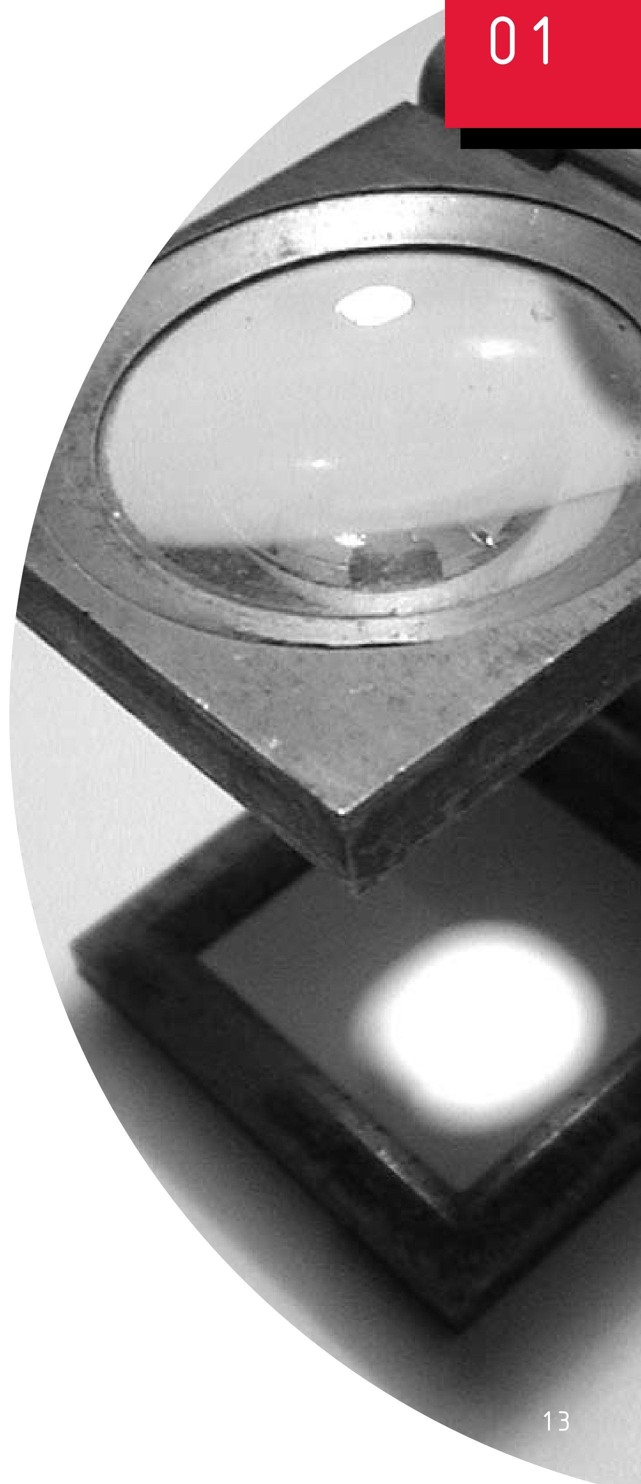
The different R&D-indicators are based on the answers of the surveyed companies which executed R&D in Flanders. In particular, this report contains observed data of the R&D 2004 survey conducted by Steunpunt O&O Statistieken at the K.U.Leuven. CFS-STAT, the federal consultation organ, established the methodological principles of the determination of the R&D statistics.

As in the earlier R&D surveys, the R&D 2004 survey uses an inventory methodology, which starts by defining an exhaustive list of companies conducting R&D. The inventory (or repertory) contains two categories of firms. A first category is the ‘permanent-inventory’ (P), the companies conducting R&D on a regular, permanent base. These selected firms correspond to one of the following groups:

- companies that defined themselves in the R&D-survey of 2002 as being a permanent R&D-performer that has at least one staff member, performing R&D (in full-time equivalents (FTE));
- companies that defined themselves in the CIS3-survey as being a permanent R&D-performer;
- companies of the previous ‘permanent-inventory’ list that did not fill out the R&D-survey 2004, but are a permanent R&D-performer (based on different information sources).

The second category is the ‘occasional-inventory’ (O), the group of firms that is filtered and not permitted in the ‘permanent-inventory’. This category contains firms that reported in the R&D survey that they occasionally conduct R&D. Furthermore, firms are included, which possibly conduct R&D on a permanent base, but did not prove it, for example, by indicating in a previous R&D survey.
Some criteria, pointing companies to the O-category, are:

- companies of both categories that declared in the R&D-survey 2004 that they conduct R&D occasionally
- non-categorized companies that declared in the CIS3-survey that they perform R&D
- non-categorized companies that declared in the NIS (National Institute of Statistics) surveys of the last 2 years that they perform R&D
- non-categorized companies, identified as companies receiving subsidies, public R&D-contracts and tax exemptions for recently employed personnel, conducting R&D



- non-categorized companies found on another list, like spin-offs or companies identified as being an R&D-performer by another medium

The followed methodology rectifies the skewed distribution of the Flemish R&D efforts. It surveys the largest and the most R&D-intensive firms. In the end, those firms clearly conduct the largest amount of research.

The final R&D-indicators are calculated, based upon the R&D-data of the 'permanent-inventory' (P-group), the 'occasional-inventory' (O) and a correction for the R&D expenditures of non-sampled firms.

The inventory of Flemish companies of the R&D-survey 2004 was composed using the file of companies of the federal government (POD WB). This file was adjusted and corrected as a result of the knowledge of potential R&D-active companies or bankrupt companies. The final companies file contained 1967 firms. Firms that moved outside Flanders, firms that went bankrupt or merged and small firms (with less than 5 employers) of which no personnel data was found, were excluded (247 firms).

Furthermore, 4 companies were transferred to other regions (Brussels/ Wallonia) as a result of the location of R&D; oppositely, also 4 firms were transferred to the Flemish data set. Some companies with more than one VAT-number were included as one, because of their way of reporting.

The survey was sent to the selected companies. The respondents had the choice to reply electronically or to return the hard-copy of the survey. If the company did not respond, phone calls were carried out to convince people to answer and another copy of the survey was sent.

The survey questioned firms about their economic situation, their company structure, their R&D efforts and R&D personnel, about the distribution of R&D activities by sector and about the sources of R&D-

funding. All manufacturing and services sectors were examined to discover the sectors that invest most in R&D and the sectors that should be stimulated to invest more.

As a result of the combination of the R&D-survey 2004 and the previous R&D surveys, the R&D expenditures and personnel were available from 1993 to 2003 and some tendencies could be observed over time. Moreover, research and development could be subdivided in different ways: into internal and external R&D (research within the company or outsourced research), into product- and process-based research and into basic and applied research and experimental development.

The remainder of this report is organized as follows: Chapter 2 presents main indicators on intra-mural R&D spending and R&D personnel. The third Chapter discusses different ways to decompose R&D spending in the business sector, and Chapter 4 deals with decomposition of R&D personnel. Chapter 5 describes the financing of intra-mural R&D, and Chapter 6 discusses external R&D expenditures. The following Chapter describes collaborative R&D agreements by type of partners and their location, and Chapter 8 discusses the management of intellectual property rights in Flemish firms. Chapter 9 concludes.

Chapter 2

MAIN INDICATORS ON R&D EXPENDITURES AND EMPLOYMENT

"The drop in R&D activity between 2001 and 2003 is mainly due to the restructuring of the R&D activities of large firms. The share of R&D in the business sector was 76% in 2001, and 72% in 2003. Also the Netherlands and Sweden showed a decline of R&D activity during this time.While GERD/GDP peaked in 2001 at 2,43%, it went down to 2,14% in 2003."

This chapter presents survey results concerning total R&D spending and R&D employment (in full-time equivalents) in the business sector. These figures correspond to the expenditure and personnel, respectively, reported by the firms in the R&D survey plus intrapolated numbers for such firms that are known to be R&D-active, but did not respond to the survey. Note that this corresponds only to firms that are in the "inventory" (permanent and pseudo inventory), but not to the whole population of Flemish companies. This approach can be justified due to the skewed distribution of R&D in the economy. It is well-known that a few large companies account for the vast majority of R&D expenses in an economy – at least this is common in OECD countries. For instance, Cincera (2004) has shown that the TOP 200 R&D spenders in Flanders account for almost 100% of the total intra-mural R&D expenditure. Thus, although the "inventory" is not a representative sample of the economy, it will give an accurate picture of R&D spending in Flanders, since all large companies and other smaller firms known to be R&D active are included in the sample. In the remainder of this document, we will only be using information of the inventory firms. To obtain the final BERD it would be necessary to add an estimate of R&D activities of non-inventory firms in the population, and to include collective research centres. For such an exercise we refer the reader to Aerts et al. (2005: p.81).

2.1 TOTAL R&D EXPENSES AND R&D EMPLOYMENT

Table 2 1 shows the distribution of intra-mural R&D expenses and R&D employment by sector. Firms' R&D activities are strongly specialized in ICT hardware, pharmaceuticals and chemicals in the manufacturing sector. In the service sector, software development and telecommunication services account for a large fraction of R&D spending. These sectors account for 70% in 2002 (66% in 2003) of the total R&D in the Flemish business sector. In total, the survey yields a small decline in R&D spending from 2002 to 2003 from 2.2 billion EUR to 2.1 billion.

As a further indicator on R&D engagement in the business sector, R&D personnel can be used instead of expenses. R&D personnel includes all employees that are concerned with R&D activities, such as researchers, technicians, lab assistants and other support staff providing services directly linked to R&D projects. As Table 2 1 shows there is also a slight decline in R&D personnel from 2002 to 2003. A calculation of R&D activity by employment size classes underpins the skewness of R&D: about 70% of all R&D expenses are due to those firms that have more than 250 employees. In terms of R&D personnel, these account for roughly 60%. It is interesting to note that R&D expenditures (R&D personal) for small and medium sized firms did increase from 2002 to 2003. The drop in R&D activity is mainly due to the restructuring of the R&D activities of large firms.

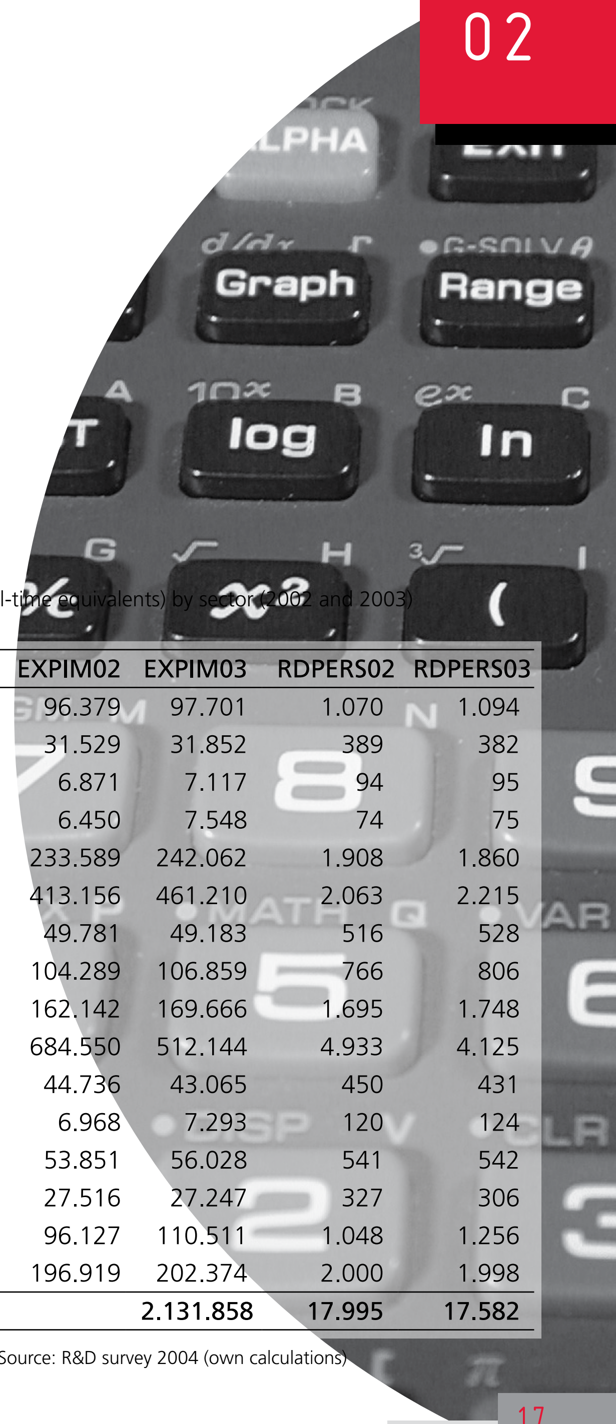


Table 2-1: Intrapolated intra-mural R&D expenses in thsd. EUR and R&D employment (full-time equivalents) by sector (2002 and 2003)

NACE	Description	EXPIM02	EXPIM03	RDPERS02	RDPERS03
15,16	Food & tobacco	96.379	97.701	1.070	1.094
17,18,19	Textiles, clothing & leather	31.529	31.852	389	382
20, 36.1	Wood & furniture	6.871	7.117	94	95
21, 22	Paper & printing	6.450	7.548	74	75
23, 24 (excl. 24.4)	chemicals & refineries	233.589	242.062	1.908	1.860
24.4	Pharmaceuticals	413.156	461.210	2.063	2.215
25	Rubber and Plastics	49.781	49.183	516	528
27, 28	metal and metal products	104.289	106.859	766	806
29, 31	machinery & equipment (incl. electric.)	162.142	169.666	1.695	1.748
30, 32, 33	ICT hardware & instruments	684.550	512.144	4.933	4.125
34+35	Transport	44.736	43.065	450	431
45	Construction	6.968	7.293	120	124
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	53.851	56.028	541	542
50...64.1	Trade & Transport Services	27.516	27.247	327	306
65...74 (excl. 64.2 & 72.2)	Other business services	96.127	110.511	1.048	1.256
64.2, 72.2	Software development & communication	196.919	202.374	2.000	1.998
Total			**2.131.858**	**17.995**	**17.582**

Notes: EXPIM = Intra-mural R&D expenditures; RDPERS = R&D personnel in full-time equivalent units. Source: R&D survey 2004 (own calculations)

Table 2-2: Intrapolated intra-mural R&D expenses in thsd. EUR and R&D employment (full-time equivalents) by size class (2002 and 2003)

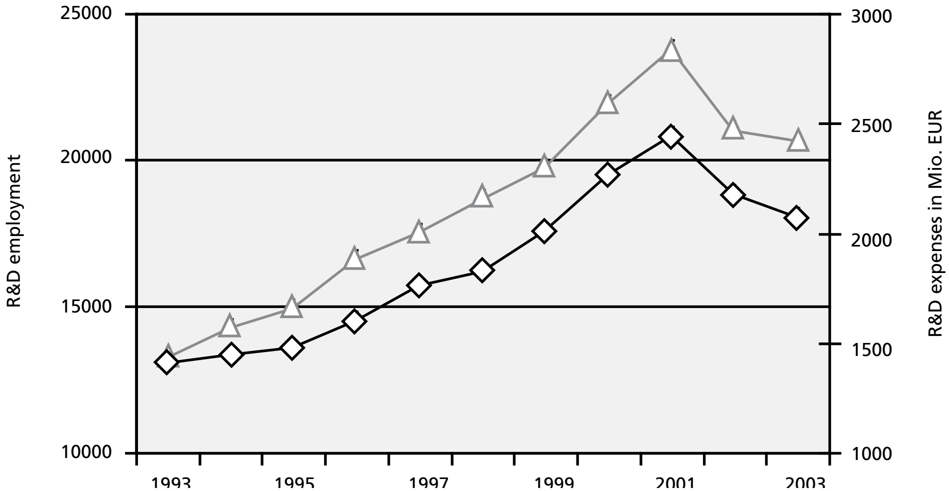
Size	EXPIM02	EXPIM03	RDPERS02	RDPERS03
1-49 employees	165.614	183.553	2.074	2.242
50-249 employees	452.842	465.788	4.613	4.809
250 and more employees	1.596.397	1.482.517	11.307	10.531
Total	**2.214.853**	**2.131.858**	**17.995**	**17.582**

Notes: EXPIM = Intra-mural R&D expenditures; RDPERS = R&D personnel in full-time equivalent units. Source: R&D survey 2004 (own calculations)

In a long term view, R&D activities rose steadily from 1993 and had its peak in 2001; since then both R&D expenses and employment are declining, though. In 2003, R&D activity in the business sector was only slightly higher than in 2000 (see Figure 2 1). On the background of the Agenda 2010, this development places some doubts on the question whether Flanders will achieve the 3% goal, where two thirds of R&D are due to the business sector. While GERD/GDP peaked in 2001 at 2,43%, it went down to 2.14% in 2003. The share of R&D in the business sector was 76% in 2001, and 72% in 2003.

An international comparison shows that Belgium as a whole is not performing very well recently (see Eurostat, 2005). While the average annual growth rate in the EU25 member states amounts to 1.3% between 2001 and 2004 in real terms, Belgium realized a negative growth of -2.3%. The other countries that also show negative growth during this time period are The Netherlands, Portugal, Slovakia and Sweden. The other member states achieve positive growth rates, where Estonia (15.6%), Cyprus (15.2%), Lithuania (12.2%) and Spain (10.2%) achieve the highest growth rates

Figure 2-1: Long-term development of R&D in the Flemish business sector



Source: Aerts et al. (2005: 81) and Vervliet and Viaene (2005: 89). Note that the 2002 and

2003 figures differ slightly from the numbers shown in Table 2 1, because they include estimates obtained from a sample of "non-inventory" firms.

2.2 R&D INTENSITY

As a further indicator – not of the absolute but the relative importance of R&D – the R&D intensity is often considered, that is, the ratio of R&D to sales. Figure 2 2 presents an overview of the distribution of R&D intensities in Flanders (based on observed values of R&D performing firms in the 2004 R&D survey only). Note that this is the distribution of firm-specific R&D intensities; it cannot be interpreted as the R&D intensity of a certain sector (or the economy)[1]. The figures show that the majority of firms has an R&D intensity

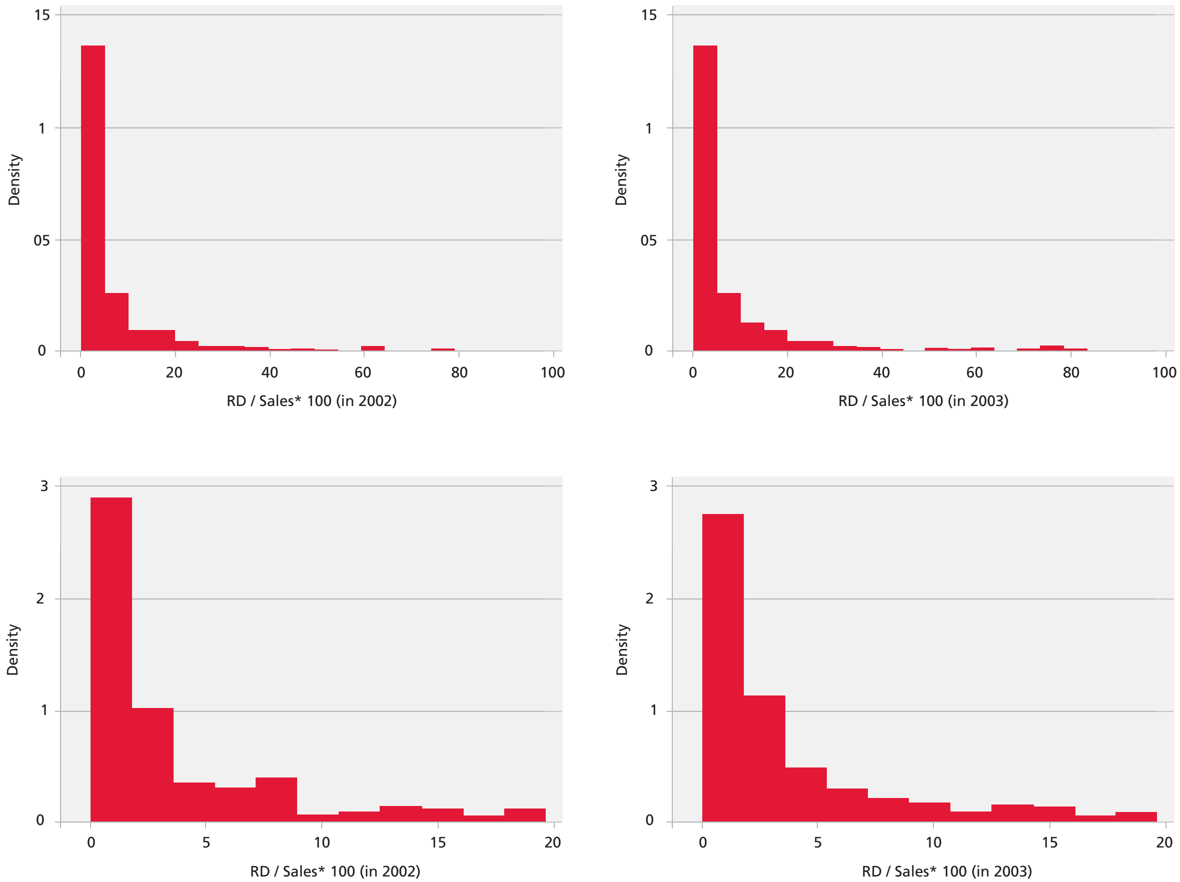
1. Such a statistics would involve summing up all sales of firms in a sector – including non-R&D firms.

> “Pharmaceuticals, software development, communication and other business services devote a large share of their returns to R&D and innovation, possibly in order to keep up with growing international competition in these markets.”

below 20%. Few firms have a very high R&D intensity o more then 40%. Such are small technology-intensive firms, and, of course, some firms whose business is mainly R&D services. Overall, they do not contribute significantly to the total R&D spending due to the small absolute size of those entities.

Calculating averages of the firm-level R&D intensities yields considerable differences over sectors (only obtained from observed data; not intrapolated): Average R&D intensity ranges from less than 1% in paper and printing to more than 15% in industries such as pharmaceuticals, software development and communication as well as other business services. Companies in such industries apparently devote a large share of their returns to R&D and finally innovation; possibly in order to keep up with growing international competition in these markets. While the total R&D spending in the chemicals sectors is high relative to other sectors, the R&D intensity fluctuating around 2% over the years is relatively low. As a comparison of tables shows, the absolute value of R&D activity in terms of expenses fell considerably between 2001 and 2003, and a similar picture is also seen in the R&D intensities: from 7,5% to 6,4%. However, as the R&D intensity at the firm-level exhibits a large variance and skewness, the average may be sensible to a few firms in the sample and, thus, these results should there is not over-interpreted in terms of absolute difference. The decrease in intensities confirms the decline in absolute expenses, though.

Figure 2-2: Distribution of R&D intensity in Flanders in 2002 and 2003



Note: Distribution of R&D intensities at the firm-level is based on observed values of R&D performing firms in the 2004 R&D survey.

Table 2-3: Average intra-mural R&D expenses: R&D intensity by sector (2000 – 2004e)

NACE	Description	RI00	RI01	RI02	*Repr. %*	RI03	*Repr. %*	RI04e	*Repr. %*
15,16	Food & tobacco	3,64	3,49	1,29	*95,35*	1,58	*90,70*	1,04	*90,70*
17,18,19	Textiles, clothing & leather	3,09	2,24	1,79	*83,33*	1,64	*80,56*	1,90	*80,56*
20, 36.1	Wood & furniture	0,75	0,69	0,97	*84,21*	1,01	*89,47*	1,05	*84,21*
21, 22	Paper & printing	0,42	0,54	0,22	*89,47*	0,35	*89,47*	0,28	*89,47*
23, 24 (excl. 24.4)	chemicals & refineries	5,20	2,56	1,98	*88,10*	2,13	*97,62*	1,50	*97,62*
24.4	Pharmaceuticals	9,70	8,51	15,86	*76,92*	15,60	*84,62*	16,82	*76,92*
25	Rubber and Plastics	1,94	1,98	1,73	*83,33*	1,81	*86,67*	1,73	*83,33*
27, 28	metal and metal products	2,19	1,86	1,17	*82,14*	1,86	*92,86*	1,81	*89,29*
29, 31	machinery & equipment (incl. electric.)	6,25	5,91	3,27	*88,37*	3,57	*89,53*	3,64	*86,05*
30, 32, 33	ICT hardware & instruments	6,75	7,75	10,54	*89,74*	8,97	*87,18*	7,60	*87,18*
34+35	Transport	1,12	1,37	1,36	*94,74*	1,41	*89,47*	1,34	*89,47*
45	Construction	4,93	3,78	1,71	*90,91*	2,21	*100*	1,32	*100*
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	7,01	7,96	2,29	*85,71*	2,51	*83,33*	2,38	*83,33*
50...64.1	Trade & Transport Services	4,10	4,44	1,00	*87,72*	0,93	*87,72*	2,88	*89,47*
65...74 (excl. 64.2 & 72.2)	Other business services	21,44	20,36	18,02	*69,30*	20,57	*71,05*	22,94	*71,93*
64.2, 72.2	Software development & communication	20,01	19,13	17,28	*91,49*	16,76	*93,62*	17,48	*95,74*
Total		**7,84**	**7,52**	**6,00**	***84,54***	**6,37**	***86,32***	**6,85**	***85,59***

Notes: RI = R&D intensity (R&D expenditure in % of sales); Repr. % = representativeness (% of R&D for which intra-mural R&D and sales are available with respect to total of survey respondents; e = provisional data.

2.3 R&D EXPENDITURES PER R&D EMPLOYEE

Table 2-4 displays the average R&D expenditures per R&D employee. While Cincera (2004) reported that firms allocated 80.556 EUR per R&D employee in 2001, on average, this figure declines to 76.300 EUR in 2002, and 77.300 in 2003. The expenses do not only reflect wages, but also investment costs and other working expenses per R&D employee. Large firms spend more than small firms: on average, 95.100 EUR per R&D employee, while small firms show an average value of 70.300 EUR in 2003. In line with earlier statistics, pharmaceutical firms have the highest ratio of R&D expenses to personnel amounting more then 98.000 EUR in 2003, on average.

Table 2-4: Average intrapolated R&D expenditures by R&D personnel by sector

NACE	Description	EXPIM02/ RDEMP02	EXPIM03/RDEMP03
15,16	Food & tobacco	60,8	61,3
17,18,19	Textiles, clothing & leather	68,8	69,6
20, 36.1	Wood & furniture	68,1	70,6
21, 22	Paper & printing	63,8	78,5
23, 24 (excl. 24.4)	chemicals & refineries	81,0	83,4
24.4	Pharmaceuticals	89,7	98,4
25	Rubber and Plastics	98,6	77,7
27, 28	metal and metal products	72,5	72,5
29, 31	machinery & equipment (incl. electric.)	86,2	90,1
30, 32, 33	ICT hardware & instruments	75,8	84,0
34+35	Transport	71,7	76,7
45	Construction	69,9	73,9
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	99,5	93,3
50...64.1	Trade & Transport Services	87,1	90,7
65...74 (excl. 64.2 & 72.2)	Other business services	62,8	63,6
64.2, 72.2	Software development & communication	71,7	72,2
	Total	76,3	77,3
	Size	EXPIM02/ RDEMP02	EXPIM03/RDEMP03
	1-49 employees	68,5	70,3
	50-249 employees	83,2	82,6
	250 and more employees	93,8	95,1
	Total	76,3	77,3

Notes: EXPIM = Intra-mural R&D expenditures; RDPERS = R&D personnel in full-time equivalent units.
Source: R&D survey 2004 (own calculations)

Chapter 3

DECOMPOSITION OF R&D EXPENDITURE

3.1 R&D BY TYPE OF COSTS: WAGES, INVESTMENT AND OTHER COSTS

As mentioned in the previous chapter, R&D expenses by R&D employee do not only consist of wages, but also include investments and other running costs like materials that incur due to R&D projects. Table 3 1 shows intra-mural R&D expenses by type of costs split up into personnel cost (CPERS), investment (CINV) and other costs (COTH). It turns out that personnel cost account for 67% of total intra-mural R&D expenditures. This share is almost constant over size classes, but varies among industries. For instance, in software development and communication services, personnel cost amount to 80% of total spending, while in pharmaceuticals wages only amount to 53%. Investments constitute 11% of total intramural R&D and other costs about 21%. Other costs are particularly high in pharmaceuticals where they constitute a share of 41%.

Table 3 1: Intra-mural R&D expenses by type of costs: wages, investment and other costs (by sector and size – 2003)

NACE	Description	CPERS	COTH	CINV	Repr%
15,16	Food & tobacco	61	21	17	74
17,18,19	Textiles, clothing & leather	65	26	10	64
20, 36.1	Wood & furniture	66	17	16	63
21, 22	Paper & printing	73	19	9	42
23, 24 (excl. 24.4)	chemicals & refineries	69	24	7	71
24.4	Pharmaceuticals	53	41	5	100
25	Rubber and Plastics	64	22	14	57
27, 28	metal and metal products	64	21	15	61
29, 31	machinery & equipment (incl. electric.)	70	18	12	77
30, 32, 33	ICT hardware & instruments	67	22	11	82
34+35	Transport	67	17	16	53

NACE	Description	CPERS	COTH	CINV	Repr%
45	Construction	65	17	19	73
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	63	29	8	45
50...64.1	Trade & Transport Services	66	24	10	46
65...74 (excl. 64.2 & 72.2)	Other business services	68	21	11	57
64.2, 72.2	Software development & communication	80	13	7	81
	Total	**67**	**21**	**11**	**64**
	Size	**CPERS**	**COTH**	**CINV**	**Repr%**
	1-49 employees	67	19	14	64
	50-249 employees	68	22	10	62
	250 and more employees	67	25	7	75
	Total	**67**	**21**	**11**	**64**

Notes: CPERS = share of wages; COTH = share of other running cost; CINV = share of investment. Repr% = share of firms that responded to the question with respect to total R&D.
Source: R&D survey 2004 (own calculations)

3.2 R&D FOR BASIC RESEARCH, APPLIED RESEARCH AND DEVELOPMENT

A further interesting decomposition if intra-mural R&D expenditure is the split into basic research, applied research, and development. While it is often assumed that firms do not conduct any basic research, Table 3 2 shows that basic research in the business sector amounts to a non-negligible share in total intra-mural R&D expenditure. In particular, the survey asked for the distinction between

- basic research, that is, the development of new knowledge without direct possibilities of the application of these discoveries;
- applied research, that is, the development of new knowledge with immediate potential applications;

"Firms assign about 8% to basic research, with the pharmaceutical sector on highest (about 19%). Small firms spend relatively double (10%) on basic research than larger firms. May be small firms are more likely to introduce radical innovations than larger firms who seek only incremental improvements in their existing markets."

- experimental development, that is, a systematic way to implement new knowledge into new products, processes or services.

It turns out that firms assign about 8% to basic research within their total intra-mural R&D budget. Most is devoted in the pharmaceutical sector to basic research (about 19%). Interestingly, small firms allocate about 10% to basic research, whereas larger firms achieve a figure of 5%. This may be a hint to the traditional Schumpeterian way of thinking: small firms are more likely to introduce radical innovations than larger firms who seek only incremental improvements in their existing markets. This is also in line with Arrow (1962) who hypothesized that larger firms (in his theoretical model he refers to monopolists) have less incentives to innovate drastically, because they would only replace themselves in an existing market. That may be true for large firms even if they are not monopolists, but products are not perfect substitutes in a market. However, one should keep in mind that basic research does not automatically translate into radical innovations, and that the Table below only refers to relative efforts within firms' total budgets.

Table 3-2: Intra-mural R&D by basic and applied research and development by size and sectors(2003)

NACE	Description	Basic research	Applied research	Experimental Development	Repr%
15,16	Food & tobacco	10	45	45	74
17,18,19	Textiles, clothing & leather	4	27	69	64
20, 36.1	Wood & furniture	1	39	59	63
21, 22	Paper & printing	6	33	62	47
23, 24 (excl. 24.4)	chemicals & refineries	4	33	63	71
24.4	Pharmaceuticals	19	39	43	100
25	Rubber and Plastics	7	41	50	60
27, 28	metal and metal products	8	48	46	57

NACE	Description	Basic research	Applied research	Experimental Development	Repr%
29, 31	machinery & equipment (incl. electric.)	4	39	57	78
30, 32, 33	ICT hardware & instruments	9	38	54	79
34+35	Transport	1	32	67	63
45	Construction	9	33	60	73
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	4	42	53	43
50...64.1	Trade & Transport Services	8	38	55	46
65...74 (excl. 64.2 & 72.2)	Other business services	12	45	43	53
64.2, 72.2	Software development & communication	9	51	39	83
	Total	**8**	**41**	**52**	**64**
	Size	**Basic**	**Applied**	**Dev.**	**Repr%**
	1-49 employees	10	42	48	63
	50-249 employees	5	41	54	62
	250 and more employees	6	37	57	76
	Total	**8**	**41**	**52**	**64**

Notes: Repr% = share of firms that responded to the question with respect to total R&D.

Furthermore, we see that firms spend most of their intra-mural R&D funds on experimental development that is directly meant to be implemented in current processes or to improve existing products (52%, on average).

> “More than half of R&D budget is spent on experimental development with direct implementation in production processes or improvement of existing products.”

3.3 INNOVATION

Since firms focus their research on applied research and experimental development, the question directly linked to this fact is how do they allocate their research to products and process. While process innovation allowing cost cutting may be essential for survival in mature industries, product innovations are necessary for most fir ms in order to differentiate their products from competitors. Sufficient distinction from others may well reduce the elasticity of demand for a firm's products so that realized prices at the market are higher. Radically new products may even result in temporary monopolies which allows the firms to earn high producer rents for some time.

Table 3-3: Intra-mural R&D expenses by type of activity: product, process vs. mix (by sector and by size – 2003)

NACE	Description	PD	PC	MIX	DK	Repr%
15,16	Food & tobacco	51	19	26	4	72
17,18,19	Textiles, clothing & leather	62	21	14	3	61
20, 36.1	Wood & furniture	55	30	12	3	63
21, 22	Paper & printing	52	42	6	1	47
23, 24 (excl. 24.4)	chemicals & refineries	61	25	7	6	69
24.4	Pharmaceuticals	53	29	17	0	100
25	Rubber and Plastics	57	13	26	4	57
27, 28	metal and metal products	45	26	26	3	59
29, 31	machinery & equipment (incl. electric.)	73	11	13	3	74
30, 32, 33	ICT hardware & instruments	81	9	6	4	69
34+35	Transport	57	29	6	8	63
45	Construction	56	31	13	1	73
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	34	27	28	12	43
50...64.1	Trade & Transport Services	56	12	31	1	42
65...74 (excl. 64.2 & 72.2)	Other business services	59	16	18	8	51
64.2, 72.2	Software development & communication	75	8	12	5	77
	Total	**61**	**18**	**17**	**4**	**61**
	Size	**PD**	**PC**	**MIX**	**DK**	**Repr%**
	1-49 employees	63	15	17	5	59
	50-249 employees	56	20	19	5	61
	250 and more employees	61	23	13	3	73
	Total	**61**	**18**	**17**	**4**	**61**

Notes: PD = share of R&D allocated to product innovations; PC = process innovations; MIX = not possible to differentiate between product and process; DK = "don't know". Repr% = share of firms that responded to the question with respect to total R&D. Source: R&D survey 2004 (own calculations)

Table 3-3 displays the shares intra-mural R&D devoted to product innovations and process innovations. The respondent's had the choice to indicate "mix", that is, if it is not possible to assign R&D to either one category of process and product innovation. This is not uncommon, because today's product innovations are complex so that a new product could imply several necessary process innovations. Furthermore, a fourth category is just "don't know". As we see, the focus in all industries is clearly on product innovation. On average, 61% of intra-mural R&D spending is allocated to product innovations. In more mature industries, we observe relatively high shares of process innovation, though. Examples are, paper and printing, wood and furniture, metal and metal products, construction and transport. Cost cutting seems to play an important role in such firms' innovation strategies.

"All industries focus clearly on product innovation for on average 61% of R&D spending. More mature industries as paper and printing, wood and furniture, metal, construction and transport show higher shares of process innovation, because cost cutting plays a more important role in their innovation strategies."

Chapter 4

DECOMPOSITION OF R&D PERSONNEL

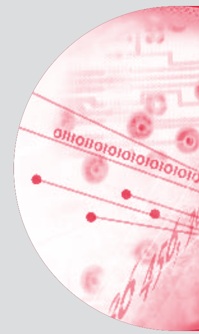
4.1 R&D PERSONNEL BY FUNCTION

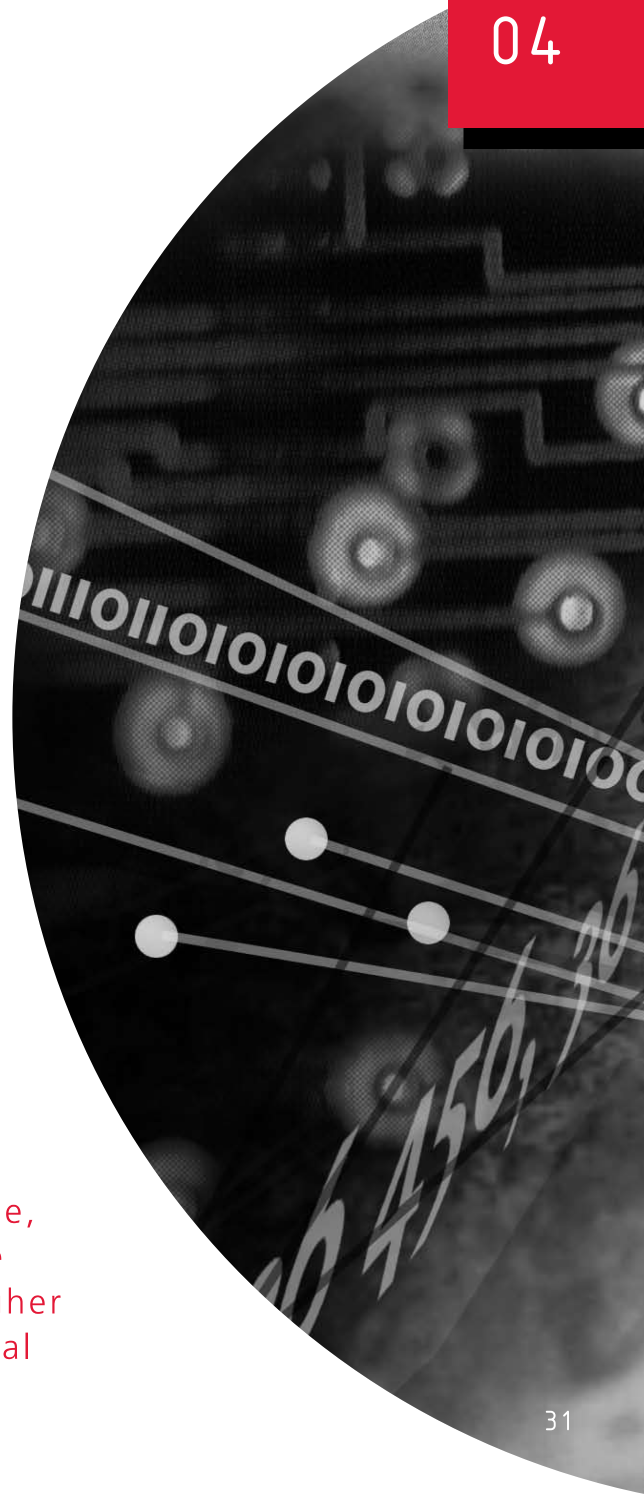
The R&D personnel can be decomposed into three main categories: researchers, technicians and other support personnel (cf. Table 4 1). Again, it should be pointed out that there is a large variance among firms. Researchers account for 55% of total R&D employees. 37% are technicians and 8% other support staff, on average.

Table 4 1: Total R&D personnel by function (by sector and size – 2003)

NACE	Description	RES%	TECH%	OTH%	Repr%
15,16	Food & tobacco	56	31	13	91
17,18,19	Textiles, clothing & leather	57	22	21	78
20, 36.1	Wood & furniture	38	42	20	89
21, 22	Paper & printing	54	34	12	84
23, 24 (excl. 24.4)	chemicals & refineries	49	46	5	88
24. Apr	Pharmaceuticals	59	32	10	100
25	Rubber and Plastics	47	42	10	77
27, 28	metal and metal products	42	48	10	80
29, 31	machinery & equipment (incl. electric.)	51	42	7	80
30, 32, 33	ICT hardware & instruments	62	32	6	87
34+35	Transport	41	45	14	95
45	Construction	51	49	0	91
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	65	26	9	79
50...64.1	Trade & Transport Services	58	36	5	95
65...74 (excl. 64.2 & 72.2)	Other business services	57	39	4	75
64.2, 72.2	Software development & communication	65	30	4	85
	Total	55	37	8	85
	Size	**RES%**	**TECH%**	**OTH%**	**Repr%**
	1-49 employees	60	33	7	85
	50-249 employees	47	45	9	80
	250 and more employees	53	37	10	88
	Total	55	37	8	8

Notes: PD = share of R&D allocated to product innovations; PC = process innovations; MIX = not possible to differentiate between product and process; DK = "don't know". Repr% = share of firms that responded to the question with respect to total R&D. Source: R&D survey 2004 (own calculations)





The distribution of functions among the R&D employment is more or less constant over time: Cincera (2004) reported that researcher constitute 53% of all employees concerned with R&D, for instance. In small firms, however, researchers have clearly the highest share of R&D personnel (60%). This indicates that research groups in smaller firms may not be organized in a way such that researchers are commonly supported by technicians and other adjunct personnel. In medium-sized and larger firms, researchers constitute on half of the R&D labor force in firms. There it seems to be more common that scientists can utilize support by technicians and other support staff.

4.2 R&D PERSONNEL BY LEVEL OF EDUCATION

Table 4-2 shows the distribution of R&D personnel by level of education: 9% of all R&D employees hold a doctoral degrees, and 49% have a university degree without a Ph.D.; 19% have some higher education, and 23% of R&D staff has no higher education.

The share of employees with a doctoral degree is highest in small firms. This also corresponds to the fact that the researcher share among R&D employees is highest in small firms as presented in Table 4 1. The pharmaceutical industry is again distinct from most other sectors. It has by far the largest share of R&D employees with a doctoral degree (24%). This also holds if one counts researchers with either a doctoral degree or a university degree: for pharmaceutical industry it yields a share of 77%. However, in software development and communication this number is also 77%. Another industry with a very high-skilled R&D labor force holding at least a university degree is other business services with 73%.

> “9% of all R&D employees hold a doctoral degree, 49% have a university degree, 19% have some higher education and 23% of R&D staff has no higher education. The share of employees with a doctoral degree is highest in small firms.”

Table 4-2: Total R&D personnel by level of education (by sector and size – 2003

NACE	Description	D%	U%	HE%	OTH%	Repr%
15,16	Food & tobacco	12	34	30	24	84
17,18,19	Textiles, clothing & leather	2	36	21	41	72
20, 36.1	Wood & furniture	3	41	30	26	89
21, 22	Paper & printing	4	36	44	16	74
23, 24 (excl. 24.4)	chemicals & refineries	5	36	27	32	74
24.4	Pharmaceuticals	24	53	15	7	92
25	Rubber and Plastics	9	44	24	23	80
27, 28	metal and metal products	5	36	27	33	68
29, 31	machinery & equipment (incl. electric.)	2	51	19	27	73
30, 32, 33	ICT hardware & instruments	5	59	15	21	82
34+35	Transport	3	50	16	32	84
45	Construction	0	57	5	38	91
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	12	52	9	27	71
50...64.1	Trade & Transport Services	9	55	17	19	82
65...74 (excl. 64.2 & 72.2)	Other business services	18	55	13	14	72
64.2, 72.2	Software development & communication	13	63	14	9	74
	Total	**9**	**49**	**19**	**23**	**88**
	Size	D%	U%	HE%	OTH%	Repr%
	1-49 employees	12	51	15	23	77
	50-249 employees	6	50	20	24	72
	250 and more employees	5	44	29	22	86
	Total	**9**	**49**	**19**	**23**	**88**

Notes: D% = share of R&D personnel with doctoral degree; U% = share with university degree; HE% = share with degree in higher education; OTH% = share of R&D personnel with other qualification. Repr% = share of firms that responded to the question with respect to total R&D.
Source: R&D survey 2004 (own calculations)

Chapter 5

THE FINANCING OF R&D

The financing of R&D is an important topic not only in a companies' everyday business, but also in economic literature. Arrow (1962) was the first who discussed the economic dilemma of financing R&D in detail. He hypothesized that there exists a financing gap for R&D due to information asymmetries about expected outcomes of R&D projects and the sunk-cost nature of R&D investments. Due to these information asymmetries potential lenders (e.g. banks) may be reluctant to finance R&D compared to investments in physical assets (cf. Hall, 2000, for a survey on empirical studies). Such market failures are often used as a justification for governmental interventions for R&D. In a recent study, Czarnitzki (2005) shows that public innovation policy significantly alleviates financial constraints for R&D in Germany

Table 5-1: Intra-mural R&D: internal vs. external funding (by sector and by size – 2003)

NACE	Description	INT%	EXT%	Repr%
15,16	Food & tobacco	93	7	74
17,18,19	Textiles, clothing & leather	95	5	64
20, 36.1	Wood & furniture	93	7	63
21, 22	Paper & printing	100	0	47
23, 24 (excl. 24.4)	chemicals & refineries	95	5	71
24.4	Pharmaceuticals	92	8	100
25	Rubber and Plastics	98	2	63
27, 28	metal and metal products	84	16	61
29, 31	machinery & equipment (incl. electric.)	90	10	77
30, 32, 33	ICT hardware & instruments	83	17	82
34+35	Transport	97	3	53
45	Construction	94	6	73

NACE	Description	INT%	EXT%	Repr%
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	89	11	48
50...64.1	Trade & Transport Services	91	9	47
65...74 (excl. 64.2 & 72.2)	Other business services	67	33	61
64.2, 72.2	Software development & communication	81	19	83
	Total	**86**	**14**	**66**
	Size	**INT%**	**EXT%**	**Repr%**
	1-49 employees	82	18	65
	50-249 employees	91	9	65
	250 and more employees	92	8	75
	Total	**86**	**14**	**66**

Notes: INT% = share of internally financed intra-mural R&D; EXT% = share externally financed.
Repr% = share of firms that responded to the question with respect to total R&D.
Source: R&D survey 2004 (own calculations)

Table 5-1 shows the source of financing for intra-mural R&D expenditure in 2003. Cincera (2004) reported an internal share of financing of 88%. In 2003, this figure amounted to 86% on average. The external financing of intramural R&D is most important in other business services, software development and communication, ICT hardware and instruments, and in metals and metal products. Smaller firms rely more on external financing of intramural R&D (18%) than larger firms (8-9%)

Table 5-2: Intra-mural R&D expenses by source of external funding (by sector and size – 2003)

NACE	Description	GF	GB	GA	CGF	CGB	CGA	CF	CB	CA
15,16	Food & tobacco	62	0	6	0	4	6	0	10	0
17,18,19	Textiles, clothing & leather	88	0	0	0	9	0	0	0	4
20, 36.1	Wood & furniture	67	0	0	0	0	0	0	0	0
21, 22	Paper & printing	100	0	0	0	0	0	0	0	0
23, 24 (excl. 24.4)	chemicals & refineries	74	0	14	0	0	0	13	0	0
24.4	Pharmaceuticals	70	0	0	0	0	30	0	0	0
25	Rubber and Plastics	88	0	0	0	0	0	0	0	0
27, 28	metal and metal products	69	1	1	4	0	5	5	0	0
29, 31	machinery & equipment (incl. electric.)	80	0	7	0	0	4	2	2	0
30, 32, 33	ICT hardware & instruments	72	0	3	0	0	14	5	0	1
34+35	Transport	100	0	0	0	0	0	0	0	0
45	Construction	50	0	50	0	0	0	0	0	0
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	45	0	31	11	0	0	0	0	13
50...64.1	Trade & Transport Services	100	0	0	0	0	0	0	0	0
65...74 (excl. 64.2 & 72.2)	Other business services	50	0	14	9	0	10	6	2	6
64.2, 72.2	Software development & communication	66	2	13	0	0	5	9	1	0
	Total	**69**	**0**	**9**	**3**	**1**	**6**	**4**	**1**	**2**
	Size	**GF**	**GB**	**GA**	**CGF**	**CGB**	**CGA**	**CF**	**CB**	**CA**
	1-49 employees	66	1	12	3	1	4	7	2	2
	50-249 employees	69	0	5	5	0	9	2	0	0
	250 and more employees	77	0	5	0	1	8	0	0	4
	Total	**69**	**0**	**9**	**3**	**1**	**6**	**4**	**1**	**2**

Notes: GF(B,A) = government in Flanders, Belgium and Abroad; CGF(B,A) = companies of the group in Flanders, Belgium and Abroad; CF(B,A) = other companies in Flanders, Belgium and Abroad. Shares do not add up to 100%, because there was also the possibility of indicating "other sources" in the survey that are not presented in the table in further detail. Source: R&D survey 2004 (own calculations)

The sources of external finance for intra-mural R&D are presented in Table 5 2. In line with the financial constraints argument in economic theory, it turns out that the government is the most important source of external finance for R&D: on average, governments fund 78% of externally financed R&D, where the Flemish government is most important with 69%. Companies within the group supply additional 10%, and 7% are financed by companies outside the group. The rest is financed by other sources (not presented in table)

“Government remains with 78% the most important source of external finance for R&D. Flemish government is good for 69%. Companies within the group supply additional 10%, and another 7% comes from companies outside the group. The rest is financed by other sources.”

Chapter 6

EXTERNAL R&D EXPENDITURES

"Extra-mural R&D rose from 29% in 2002 to 33% in 2004. It seems that heavy R&D-active firms such als pharmaceutical, communication services and software development need to source in third party knowledge to stay at the technological frontier while maintaining well organized R&D departments. This share is highest for the largest firms."

The previous chapters discussed several indicators of total intra-mural R&D spending and R&D employment. This chapter refers to another dimension of R&D: extra-mural R&D expenditures. There have been several studies in economic literature that deal with different aspects of external R&D. First, Cohen and Levinthal (1989) discuss the concept of absorptive capacity, that is, firms require some threshold amount of own internal in order to utilize the knowledge from external R&D. Other studies focus on the determinants of external R&D. For instance, Audretsch et al. (1996) find in an empirical study that the decision between internal and external R&D depends on asset specificity and technological opportunities. Love and Roper (2002) emphasize the relevance of plant size, R&D input and appropriability conditions as crucial factors. In this line, Veugelers and Cassiman (1999) confirm the importance of firm size and the appropriation regime using Belgian data. Recently, Bönte (2003) attempted to derive an optimal share of external R&D with respect to productivity growth in German manufacturing. His results on optimal share of external R&D are somewhat inconclusive due to several different estimation strategies and model set-ups, but he concludes that total factor productivity is growing with increasing extra-mural R&D. Furthermore, Cassiman and Veugelers (2005), using Belgian CIS data show that internal R&D and external R&D are complementary indicating that the performance of the innovation process is much higher for firms combining both types of R&D activities.

Table 6 1 shows the share of extra-mural R&D expenditure in total R&D [= extra-mural R&D / (intra-mural R&D + extra-mural R&D)] in the Flemish business sector. The share of extra-mural R&D in total R&D is slightly increasing recently from 29% in 2002 to 33% in 2004 (provisional number). Industries with a high R&D intensity such as pharmaceuticals and software development and communication services also show a high share of extra-mural R&D spending. As mentioned above, it is often argued that firms which rely heavily on

R&D need to source in knowledge from third parties constantly to stay at the technological frontier even if they maintain well organized R&D departments. This is reflected here as well, because the more R&D intensive industries also show higher shares of extra-mural R&D. Moreover, we also find that the share of extra-mural R&D is highest for the largest firms.

Table 6 2 presents the different types and locations of subcontractors in terms of shares of total extra-mural R&D spending. The most important subcontractors of R&D are firms within the group located in Flanders with 20% of the amounts contracted out, on average, and Flemish universities with 21%. Further important suppliers of R&D are Flemish research centers, but also companies abroad. As a general pattern, it can be observed that the smaller the firm the more it relies in regional or national sources. Larger firms show higher shares of amounts subcontracted out to partners in other countries. Although increasing globalization is a frequently discussed topic in the public nowadays, we do not find an increase in the importance of international partners for extra-mural R&D over time; the results of the R&D 2004 survey are basically equal to previous results obtained from the R&D 2002 survey (see Cincera, 2004).

Table 6-1: Share of extra-mural R&D expenditures in total R&D *(2002-2004e)*

NACE	Description	EXT02	Repr%	EXT03	Repr%	EXT04	Repr%
15,16	Food & tobacco	18	95	19	95	19	95
17,18,19	Textiles, clothing & leather	18	86	16	86	19	86
20, 36.1	Wood & furniture	2	89	2	89	3	89
21, 22	Paper & printing	7	84	5	89	4	84
23, 24 (excl. 24.4)	chemicals & refineries	4	83	4	90	3	93
24.4	Pharmaceuticals	56	85	55	92	55	100
25	Rubber and Plastics	11	90	11	90	11	93
27, 28	metal and metal products	39	79	20	91	14	91
29, 31	machinery & equipment (incl. electric.)	10	90	11	91	10	93
30, 32, 33	ICT hardware & instruments	9	87	9	92	10	92
34+35	Transport	17	95	19	95	15	95
45	Construction	23	82	23	73	23	91
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	15	88	17	88	22	88
50...64.1	Trade & Transport Services	12	96	10	98	10	98
65...74 (excl. 64.2 & 72.2)	Other business services	17	84	18	88	22	87
64.2, 72.2	Software development & communication	25	87	23	94	42	94
	Total	**29**	**88**	**31**	**91**	**33**	**92**
	Size	**EXT02**	**Repr%**	**EXT03**	**Repr%**	**EXT04**	**Repr%**
	1-49 employees	28	88	22	92	16	93
	50-249 employees	20	89	21	91	20	92
	250 and more employees	30	89	33	91	36	92
	Total	**29**	**88**	**31**	**91**	**33**	**92**

Source: R&D survey 2004 (own calculations)

Table 6-2: Extra-mural R&D expenses by source of subcontractor in percent (by size and sector - 2003)

NACE	Description	CGF	CGB	CGA	CF	CB	CA	RCF	RCB	RCA	UF	UB	UA
15,16	Food & tobacco	21	0	22	12	3	0	9	0	5	17	1	4
17,18,19	Textiles, clothing & leather	27	0	0	6	0	13	28	0	10	10	0	0
20, 36.1	Wood & furniture	0	0	0	33	0	0	8	32	0	2	0	0
21, 22	Paper & printing	24	0	29	0	0	0	3	1	3	21	0	0
23, 24 (excl. 24.4)	chemicals & refineries	28	6	9	5	0	0	14	0	1	31	2	2
24.4	Pharmaceuticals	9	0	9	5	0	18	0	4	0	42	1	13
25	Rubber and Plastics	5	0	19	6	0	18	2	11	0	35	4	1
27, 28	metal and metal products	27	0	6	16	1	5	20	1	1	16	1	5
29, 31	machinery & equipment (incl. electric.)	24	0	3	22	4	10	8	0	1	21	2	0
30, 32, 33	ICT hardware & instruments	29	1	10	4	6	16	8	0	2	16	0	1
34+35	Transport	24	4	12	10	0	41	6	0	0	4	0	0
45	Construction	33	0	0	23	0	0	3	0	0	40	0	0
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	8	0	4	6	0	14	31	11	4	15	0	0
50...64.1	Trade & Transport Services	23	0	2	16	3	9	8	0	1	29	2	1
65...74 (excl. 64.2 & 72.2)	Other business services	14	2	10	18	0	14	5	0	4	28	0	4
64.2, 72.2	Software development & communication	5	2	13	44	0	23	7	0	0	7	1	0
	Total	**20**	**1**	**9**	**14**	**1**	**11**	**11**	**2**	**2**	**21**	**1**	**2**
	Size	**CGF**	**CGB**	**CGA**	**CF**	**CB**	**CA**	**RCF**	**RCB**	**RCA**	**UF**	**UB**	**UA**
	1-49 employees	28	1	5	19	1	9	5	0	1	22	1	2
	50-249 employees	19	0	11	10	3	11	19	5	2	16	1	1
	250 and more employees	6	3	15	11	0	15	10	1	4	26	1	4
	Total	**20**	**1**	**9**	**14**	**1**	**11**	**11**	**2**	**2**	**21**	**1**	**2**

Notes: CGF, CGB, CGA = companies within the group in Flanders, Belgium and Abroad; CF, CB, CA = companies outside the group in Flanders, Belgium and Abroad; RCF, RCB, RCA = Research Centers in Flanders, Belgium and Abroad; UF,UB,UA = Universities in Flanders, Belgium, and Abroad. Figures do not add up to 100%, because there are also "other sources" possible.
Source: R&D survey 2004 (own calculations)

Chapter 7

R&D COLLABORATION

Closely related to external R&D are R&D collaborations. On one hand, alliances in R&D could possibly internalize the knowledge spill-overs and improve appropriability conditions. This argument goes back to Arrow (1962) who stated that knowledge has a public good character, since something intangible as information cannot be thorough appropriated, even in presence of intellectual property protection. Thus a firm that conducts R&D is not able to fully utilize the returns of the creation of knowledge. There will be always third parties who benefit from others knowledge creation. One potential solution is the formation of research joint-ventures that internalize such spill-overs among partners who may appropriate the returns of R&D projects. As described earlier, on the other hand, firms can nowadays not only rely on their own knowledge. Companies need to source in external knowledge in order to keep a position at the technological frontier. Management literature has stressed that R&D collaborations aim at minimizing transaction cost and exploiting complementary know-how between partners (e.g. Kogut, 1988, Das and Teng, 2000). Recent contributions distinguish between vertical collaboration and horizontal collaboration, or even differentiate between vertical relations with suppliers and customers, on the one hand, and with universities and public research institutions, on the other (see e.g. Kaiser, 2002, Cassiman and Veugelers, 2002, Belderbos et al., 2004). Belderbos et al. have shown that there is much heterogeneity in the decision to engage in collaboration with a particular partner. For instance, collaboration with a certain type of partner (supplier, customer, competitor, research institution) is more likely if the incoming spill-overs of this partner is important for the firm’s innovation process. Incoming spill-overs from universities and research institutes stimulate cooperation of all types, suggesting that this knowledge is more generic and improves technological opportunities and general effectiveness of firms’ own R&D.

Table 7 1 presents the observed collaboration patterns in Flanders. The numbers represent the share of collaborating firms within the total sample by types of collaboration partner, on the one hand, and the location of partners, on the other hand. As suggested by Belderbos et al. (2004) universities seem to be an important knowledge supplier for the business sector: 18% of surveyed firms report collaborations. If one considers the public (scientific) sector as a whole, it turns out that in addition to the universities, 14% of firms collaborate with research centers, and 4% with other public institutions (these numbers should not be added up, though, as firms can collaborate with multiple partners). Aside from the public sector, customers (not within own group) are important collaboraters (17%) and also suppliers (not within the group) (14%).

Furthermore, the results show that collaboration with any kind of partner is more likely with increasing firm size. In terms of geography, it turns out that Flanders is important for R&D partnerships: 24% of firms report that collaboration takes part with partners located within Flanders. However, globalization apparently plays an important role for R&D collaborations, too. Partners outside of Belgium are almost equally important collaborators as Flemish entities: 23% report collaborations with partners located outside of Belgium.

“18% of firms collaborate with universities as an important knowledge supplier, 14% of firms do it with research centers and 4% with other public institutions. Multiple partnerships do exist of course. At the private side customers (17%) and suppliers (14%) are the most important knowledge suppliers. The bigger the firm the more collaboration on this front. 24% reports only partners within Flanders, but 23% also look behind the Belgian frontier.„

Table 7-1: R&D cooperation agreements (type of partners as well as geography of partnerships by sector and

NACE	Description	CLG	OCL	SG
15,16	Food & tobacco	14	12	2
17,18,19	Textiles, clothing & leather	8	28	6
20, 36.1	Wood & furniture	0	5	0
21, 22	Paper & printing	11	26	11
23, 24 (excl. 24.4)	chemicals & refineries	10	21	2
24.4	Pharmaceuticals	15	15	15
25	Rubber and Plastics	20	20	7
27, 28	metal and metal products	16	18	9
29, 31	machinery & equipment (incl. electric.)	7	12	7
30, 32, 33	ICT hardware & instruments	13	23	10
34+35	Transport	0	11	16
45	Construction	0	9	0
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	7	12	7
50...64.1	Trade & Transport Services	7	7	2
65...74 (excl. 64.2 & 72.2)	Other business services	10	18	3
64.2, 72.2	Software development & communication	4	28	4
	Total	**9**	**17**	**5**
	Size	**CLG**	**OCL**	**SG**
	1-49 employees	4	14	3
	50-249 employees	13	16	5
	250 and more employees	19	27	14
	Total	**9**	**17**	**5**

Source: R&D survey 2004 (own calculations)

l size – 2002+2003

Type of collaboration partner							Location of partners		
OS	COMP	CONS	PI	UNI	RI	OTH	FL	BE	ABR
14	2	2	7	19	21	0	19	9	16
25	3	3	0	19	19	8	33	14	36
5	0	5	5	0	5	0	5	5	5
21	0	5	0	5	5	0	26	16	21
19	2	2	2	21	17	5	29	12	29
15	15	8	15	31	15	0	31	8	23
23	0	3	7	13	17	0	17	7	27
14	0	9	2	23	16	0	25	9	20
15	5	5	2	16	12	0	23	5	21
18	13	10	10	23	15	3	33	13	28
21	11	11	0	21	11	0	21	11	21
9	9	9	9	18	9	0	18	0	18
10	2	7	2	14	12	0	24	14	19
9	2	4	0	14	7	0	14	7	11
8	5	11	4	20	11	1	26	12	25
19	6	11	4	21	19	2	23	4	32
14	**4**	**7**	**4**	**18**	**14**	**1**	**24**	**9**	**23**
OS	COMP	CONS	PI	UNI	RI	OTH	FL	BE	ABR
11	4	6	3	15	11	1	21	8	19
12	2	5	2	13	9	1	21	8	20
30	9	12	10	40	30	4	42	19	42
14	**4**	**7**	**4**	**18**	**14**	**1**	**24**	**9**	**23**

Chapter 8

INTELLECTUAL PROPERTY

Scherer (1965) was possibly the earliest study on the profits from innovation, and at the latest, since Griliches (1981) intellectual property and its valuation has received broad attention in the literature. While Scherer discusses the profitability of patented inventions, Griliches was the first to show that intellectual property in broader sense increases firms' profits. He related R&D (and also patents) to the market valuation of firms' assets; a strand of literature that has considerably grown since then (see Czarnitzki et al., 2005, for a recent survey). In many studies it has been confirmed that intellectual assets either measured by R&D stocks or patents stocks, can be seen as an asset being in several ways similar to tangible capital.

"A professional management of intellectual property rights is not only common in the US. Also Flemish firms participate in the strategic business of intellectual asset management. 56% of large firms report patent applications, 25% in small firms. Large firms more likely sell their intellectual property (33%), generating some income through IPR-trading, than small firms (19%)."

Today, professional management of intellectual property has become an important skill in firms' business conduct. As a recent survey on patents and technology points out, "intellectual asset management now figures as a strategic business issue" (Economist, 2005). For instance, technology licensing revenue accounts for an estimated US$ 45 billion annually in the United States only. Worldwide it is estimated around US$ 100 billion and growing fast. Large companies start to treat intellectual property as a business asset not very different from a product on a shelf.

Table 8 1 presents the engagement of Flemish companies in IPR management: 16% report that they bought at least one license, patent of other intellectual property rights; 21% indicate that own intellectual property has been licensed out or sold; 32% report that they applied at least for one patent during 2002 and 2003, and 56% state that seminars or training with respect to R&D projects have been organized. It turns out very clearly that the importance of these issues in IPR management increases with firm size. For instance, 56% of large firms report patent applications, where that number only amount to 25% in small firms. Furthermore, large firms are more likely to sell intellectual property (33%) – or more precisely, able to generate income through trading own IPR – than small firms (19%).

At the sectoral level, we find that the pharmaceutical industry is sourcing in knowledge heavily: 54% of firms report buying of licenses, patents or other IPR. The multi-purpose character of software development and communication services is reflected in the share of IPR transfers: 60% of firms indicate that they generated income by licensing out or selling own IPRs. This is by far the largest share over all industries. Pharmaceutical firms and companies in ICT hardware and instruments rely extensively on patents for the protection of their intellectual property (54% and 50%, respectively). Seminars and training are popular instruments to enlarge the companies knowledge base. They are most prominent in software development and communication (74%) and in the chemicals sector (72%).

Such figures demonstrate that a professional management of intellectual property rights is not only common in the US (cf. Economist, 2005). Flemish firms participate in the strategic business of intellectual asset management extensively.

Table 8 1: Buying and Selling of patents/licenses, patent applications, and R&D training (by sectors and by size – 2002+2003)

NACE	Description	BIPR	Repr%	SIPR	Repr%	PAT	Repr%	EDU	Repr%
15,16	Food & tobacco	3	74	9	74	16	72	53	74
17,18,19	Textiles, clothing & leather	4	72	15	72	30	75	40	69
20, 36.1	Wood & furniture	7	74	14	74	21	74	21	74
21, 22	Paper & printing	17	63	8	63	17	63	50	63
23, 24 (excl. 24.4)	chemicals & refineries	12	62	19	62	38	62	72	60
24.4	Pharmaceuticals	54	100	23	100	54	100	62	100
25	Rubber and Plastics	16	63	32	63	42	63	58	63
27, 28	metal and metal products	20	54	13	55	32	55	58	55
29, 31	machinery & equipment (incl. electric.)	13	73	8	73	44	73	56	73
30, 32, 33	ICT hardware & instruments	30	69	21	72	50	72	61	72
34+35	Transport	0	68	8	68	23	68	54	68
45	Construction	13	73	0	73	25	73	38	73
1, 10, 26, 36.5, 37, 40, 41	Other industries incl. Agriculture	15	62	19	62	12	62	50	62
50...64.1	Trade & Transport Services	15	47	7	47	24	51	45	51
65...74 (excl. 64.2 & 72.2)	Other business services	18	57	36	58	37	57	59	58
64.2, 72.2	Software development & communication	29	74	60	74	23	74	74	74
	Total	**16**	**65**	**21**	**65**	**32**	**65**	**56**	**65**
	Size	**BIPR**	**Repr%**	**SIPR**	**Repr%**	**PAT**	**Repr%**	**EDU**	**Repr%**
	1-49 employees	14	63	19	64	25	64	48	64
	50-249 employees	16	64	16	64	29	64	56	64
	250 and more employees	22	76	33	78	56	78	75	77
	Total	**16**	**65**	**21**	**65**	**32**	**65**	**56**	**65**

Notes: BIPR = share of firms that report buying of licenses/patents and other intellectual property; SIPR = selling licenses/patents and other IPR; PAT = share of firms that applied for at least one patent; EDU = share of firms that organize seminar or training with respect to R&D. Repr% = share of firms that responded to the question with respect to total R&D.
Source: R&D survey 2004 (own calculations)

Chapter 9

CONCLUSIONS ON THE R&D SURVEY 2004

This report presents the results of the Flemish R&D Survey 2004 conducted by the Steunpunt O&O Statistieken at KU Leuven, Belgium. It provides a descriptive analysis of R&D and innovation activities carried out in the Flemish business sector from 2002 to 2003/04.

One main finding implies a challenge for future innovation policy: since 2001, total R&D spending and employment is declining in Flanders. While firms spent EUR 2.4 billion in 2001 for R&D, this figure decreases to EUR 2.1 billion in 2003 (see Aerts et al., 2005, p. 81). The results of the R&D 2002 survey already indicated a slowdown in growth of R&D that actually turned into negative growth recently. This development is also confirmed by a decline in R&D personnel. While about 23.700 people where employed in R&D in 2001, the number decreases to about 20.600 in 2003. On the background of the 3%-goal of the European Action Plan 2010, innovation policy faces the challenge to stimulate R&D investment in the business sector to recover positive growth of innovation activities in the near future. On a positive note we notice that the R&D expenditures for small and medium firms did increase during these years and conclude that the drop in R&D expenditures in Flanders between 2002 and 2003 is really related to the restructuring of the R&D activities of large firms, particularly in ICT.

R&D in Flanders is concentrated in ICT hardware, pharmaceuticals and chemicals in manufacturing, and in software development and telecommunications in the service sector. Altogether these focal sectors account for about 66% of total R&D in the Flemish business sector. The average firm’s R&D intensity (R&D to sales ratio) ranges from less than 1% in paper and printing to more than 15% in industries such as pharmaceuticals, software development and telecommunications as well as other business services. Between 2001 and 2003, the average R&D intensity fell from 7,5% to 6,4%.

A description of the financing of intra-mural R&D expenditure yields that 86% of total intra-mural R&D are financed by internal resources of the firms, and the other 14% are financed externally. The Flemish Government is the most important supplier of external R&D funds in the business sector. It accounts for 69% external funds, on average. Foreign Governments, especially the European Commission, are an important source of additional funding (9%).

An analysis of extramural R&D and R&D collaborations shows that Flemish firms do not only rely on own knowledge resources, but seek for new information through several different types of partners. Universities are the most important type of organization for both extra-mural R&D and for R&D collaborations. While Flanders is still the most important source of knowledge in terms of geography, a large share of firms source knowledge globally. Internationalization of innovation activities is more pronounced for R&D collaborations than for extra-mural R&D, though. For example, 23% of firms report collaboration with partners abroad. This share is not significantly smaller than the share of firms indicating collaborations with Flemish partners (24%).

Finally, the professional management of intellectual property rights seems to be a solid part of today's business strategies in Flemish companies. 16% report that they bought at least one license, patent of other intellectual property rights; 21% indicate that own intellectual property has been licensed out or sold; 32% report that they applied at least for one patent during 2002 and 2003, and 56% state that seminars or training with respect to R&D projects have been organized. Some industries show high rates of IPR management: for instance, 54% of pharmaceutical firms report patent applications between 2002 and 2003, and 60% of firms in software development and telecommunication services report that they generated income through licensing out technologies or selling intellectual property rights.

In conclusion, the vast majority of indicators point to highly sophisticated R&D strategies in the Flemish business sector with

respect to combining internal R&D with sourcing for additional knowledge through extra-mural R&D and R&D collaborations both with multiple types of partners. Furthermore, such indicators show the importance of globalization in R&D in the economy. These strategies are complemented by professional management of intellectual assets by protection through patenting, and knowledge exchange through licensing technology in and out. The only alarming fact turns out to be the recent decline in total R&D spending between 2001 and 2004. This slowdown of innovation activities constitutes a challenge for future innovation policy towards the Barcelona objectives of the European Action Plan 2010.

09

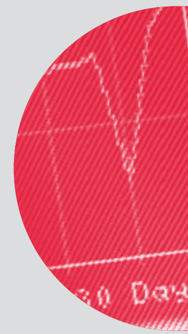
PART 2

INNOVATION
IN FLANDERS

Chapter 10

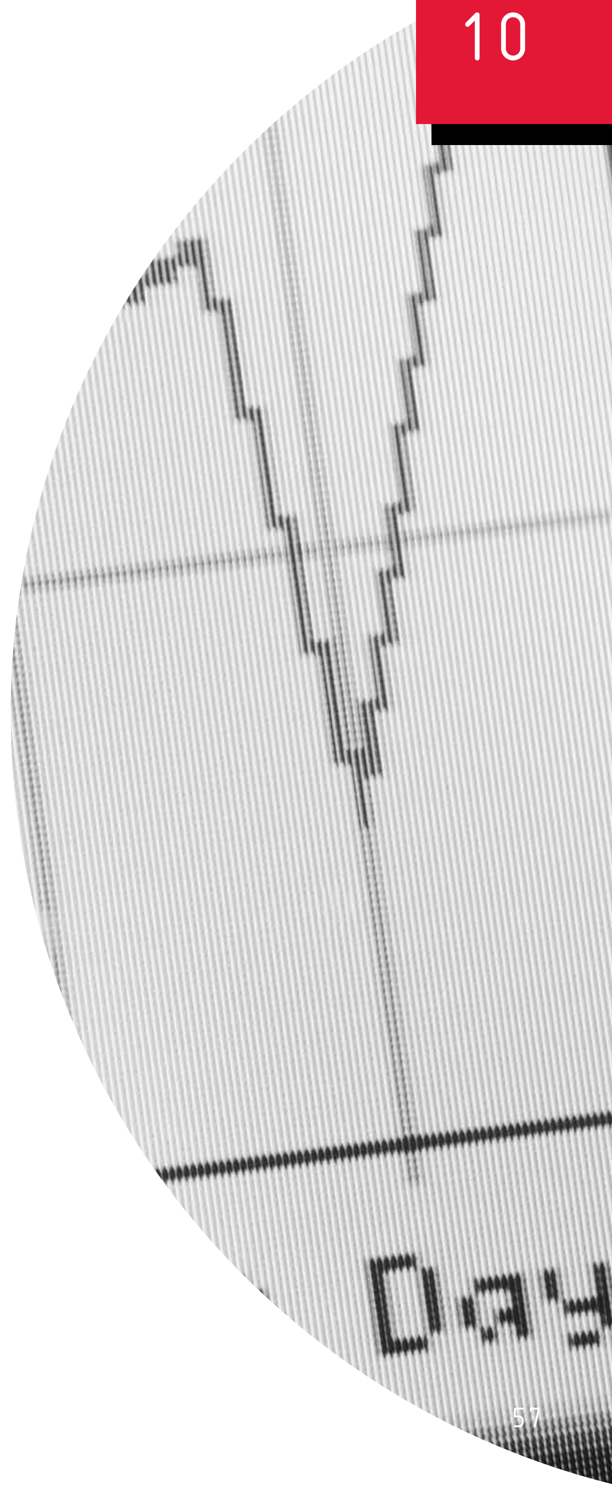
INTRODUCTION

This report presents the results of the Fourth Community Innovation Survey (CIS4) in Flanders. The CIS survey is a large-scale survey designed for collecting quantitative data on the innovative behavior and performance of firms. It is jointly initiated by the EU member states and the European Commission. The survey applies a harmonized questionnaire and survey methodology across EU member states. While the OECD R&D surveys focus on various dimensions and decompositions of firms' R&D activities, the CIS aims at a broader understanding of innovation activities undertaken in the business sector. The CIS4 has been conducted in the year 2005, surveys innovation behavior of firms in the period 2002-2004, and is based on a stratified random sample of firms active in the business sector. The full questionnaire can be found in the appendix.



While the aim of the European Action Plan 2010 is raising the EU ratio of research and development (R&D) expenditure to GDP to 3% by 2010 (see European Commission, 2003), this should only be understood as an intermediate goal to increase Europe's competitiveness and future growth opportunities. The CIS allows to look at other innovation indicators that are important to assess the technological performance of countries, such as the shares of firms that engage in product or process innovation, the share of firms introducing market novelties which could possibly become important drivers of export performance, unit production cost reductions or quality improvements due to new production technologies which may increase international competitiveness, and the ownership of intellectual property. Besides such measures of innovation outcome, the survey offers a broad range of indicators helping to understand how firms translate innovation input such as R&D into output. One important question is how innovation activity is composed of internal and external R&D activities, and how that goes along with investment in prototyping, new machinery, training and sourcing further knowledge through technology acquisition. Among other factors, the questionnaire also asks where innovations mainly originated (internal or external development), how firms seek new knowledge through various information sources and with whom they form research alliances. The survey also sheds light on governmental support for innovation, and obstacles firms are facing when engaging in innovation activities, or which factors deterred them from doing so, respectively. Furthermore, it was the first time in the CIS history that organizational and marketing innovations were taken into account. Organizational innovations may go hand in hand with important technological innovations, and new marketing strategies clearly aim at enhancing the success of newly introduced products on the market.

The remainder of this report is organized as follows: Chapter 11 describes the survey design, the data collection and preparation in more detail. Chapter 12 looks at basic innovation indicators in the population of firms, and chapter 13 is devoted to a closer look of the composition of activities of innovating firms. The fourteenth chapter reports some indicators on the management of intellectual property in Flanders, and chapter 15 considers the occurrences of organization and marketing innovations and their outcomes. Chapter 16 focuses on obstacles to innovation and the final chapter concludes.

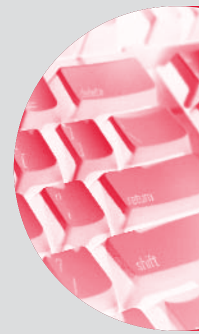


Chapter 11

SURVEY METHODOLOGY

This chapter briefly summarizes the sampling methodology and how the survey results are presented in this report. Mostly, the methodological recommendations Eurostat issued for the survey to be carried out in each of the EU member states (see appendix B in Hamel, 2005) were followed at the level of the Flanders region. Note that the current report is not fully comparable to reports on earlier rounds of the CIS in Flanders, e.g. the main report for CIS3 of 2001 (see Delanghe et al., 2003). First, the surveyed sectors have changed (among sectors recommended as “optional” by Eurostat, CIS4 includes more sectors than CIS3; more precisely NACE sectors 45, 50 en 52, which represent construction, motor trade and retail trade, respectively, were included now as well, and together they account for nearly 30% of the population). Second, the data preparation of CIS4 more closely followed the guidelines by Eurostat with respect to data cleaning, missing value imputations, non-response surveying, and the construction of weights for extrapolation from sample to population results. Third, firms were offered the possibility to respond online rather than sending back the questionnaire by regular mail.

“The surveyed sectors have changed: CIS4 includes more sectors than CIS3, such as NACE sectors 45, 50 en 52, which represent construction, motor trade and retail trade, which together account for nearly 30% of the population, consisting out of 15.775 firms.”



11.1 SAMPLING

The frame population was taken to be the most up to date version available of the Employer Inventory of the Belgian National Office for Social Security (NOSS), i.e. the version of December 31, 2004. This inventory includes all entities registered as employing persons (and hence paying social security for their employees).

Further cleaning of this dataset was done. Information provided by Statistics Belgium was used to remove firms known to be bankrupt or no longer active from the population, as well as a few small firms known to be so closely linked with other firms in the population that only one of the set could be retained.

For a major bank that uses a franchising system for its local branches, only its major locations were retained in the population. The smaller local branches were removed from the population.

Information provided by Statistics Belgium, from Belfirst and from the internet were also used to make the NOSS firm size classification compatible with the firm size classification required by Eurostat: for one size class the lower boundary was lower in the NOSS data than in the classification required for Eurostat reporting.

The population of firms listed as having headquarters in Flanders and having 10 or more employees in the NACE sectors that Eurostat considered as core for the CIS-4 survey, plus some of the non-core sectors that we elected to include as well, consisted of 15.775 firms.

The NACE sectors considered as core for Eurostat reporting are NACE sectors 10-14, 15-37, 40-41, 51, 60-64, 65-67, 72, 74.2 and 74.3. Non-core industries that we elected to include as well are NACE sectors 45, 50, 52, 73, and the other services of NACE 74.

The methodological recommendations issued by Eurostat for the CIS4 survey state that the sample taken from the population should be stratified according to the economic activity of the firm (in accordance with the NACE coding) and the firm size. Regional aspects should also be considered.

Besides firm size and sector a third stratification variable was taken into account for sampling in the Flanders region, i.e. whether or not a firm was known to have continuous R&D spending. The inventory of firms with continuous R&D spending as obtained from the 2004 R&D survey was used as a base for this variable. This stratifying variable was included because of the interest to obtain additional data for R&D active firms that could later be used in panel studies.

For the same reason a few firms were included that had less than 10 employees, and/or that fell outside of the NACE sectors that were considered as either core or optional by Eurostat, as well as some firms that had headquarters in Brussels but were known to have major (R&D) activity in Flanders.

Five criteria are mentioned in Eurostat's methodology guidelines that need to be monitored in the sampling, all five in terms of minimum precision (confidence intervals) preferred for a set of core variables. These core variables are:

(1) percentage of innovation active enterprises;
(2) percentage of innovators that introduced new or improved products to the market;
(3) new or improved products as a percentage of total turnover;
(4) percentage of innovation active enterprises involved in innovation cooperation;
(5) total turnover per employee.

To combine the five criteria, the stratum sample sizes considered optimal according to each criterion, were averaged over the five criteria. Estimates of stratum variances were obtained from the CIS3 results.

Aiming for responses of about 1,000 firms to meet the Eurostat precision criteria, and taking into account the expected response rate, a sample of about 4000 firms was targeted. Census sampling was done for large size firms, i.e. firms with 250 or more employees. For small and medium-sized firms (i.e. having 10-49 employees, and 50-249 employees, respectively), first sampling rates were set that would meet the Eurostat precision criteria for NACE sectors grouped according to their technology level (high-tech industry, high-tech services, low-tech industry and low-tech services, see Table 11- 1 below). These were then applied proportionally to each of the NACE sectors belonging to those technology level groupings, as well as to each NUTS 2 (province) level grouping within each NACE sector. The NACE sectors considered were at the 2-digit level, except for NACE sectors 24.4, 72.2, 74.2 and 74.3. Cells that corresponded to a combination of NACE sector and size class of firms without continuous R&D spending and that consisted of 12 or fewer firms were for the most part completely included in the sample (exhaustive sampling).

Table 11-1: Classification of NACE sectors according to technology level

Technology Level	NACE sectors
High-tech Industry	24 (excl. 24.4), 24.4, 29, 30, 31, 32, 33, 34, 35
High-tech Services	72 (excl. 72.2), 72.2, 73, 74 (excl. 74.2 & 74.3), 74.2, 74.3
Low-tech Industry	14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 36, 37, 40, 45
Low-tech Services	50, 51, 52, 60, 61, 62, 63, 64, 65, 66, 67

For small (10-49 employees) and medium-sized (50-249 employees) firms of NACE sectors 45, 50 and 52, which Eurostat considers as non-core for CIS-4, and that were not in the inventory of firms with continuous R&D spending, fixed sampling rates were used. For the small firms of NACE sectors 45, 50 and 52 these were, respectively, 10%, 12% and 12%. For the medium-sized firms of NACE sectors 45, 50 and 52 these were, respectively, 15%, 20% and 20%. These fixed sampling rates were applied as lower precision was allowed for these non-core sectors. Similarly, for small size low-tech services firms that were not in the inventory of firms with continuous R&D spending, a fixed sampling rate of 15% was applied.

The final sample consisted of 4,024 firms. 72 of those had fewer than 10 employees, 61 had 10 employees or more and headquarters in Brussels but major activities in Flanders, and 11 firms had 10 employees or more and were in sectors not to be covered for Eurostat reporting; (hence, as indicated above, these firms were not required for Eurostat reporting but were included for research purposes).

Table 11 2 and Table 11 3 show the distribution of the population of firms in Flanders (now including the 144 firms that were not needed for Eurostat reporting but were included for research purposes) and of the sample drawn over the NACE sectors and size classes.

Table 11-2: Population of firms in Flanders

NACE	Less than 50 empl.		50-249 empl.		250 or more empl.		Total
	Other	Continuous R&D	Other	Continuous R&D	Other	Continuous R&D	
1	1	2		3			6
14	10					1	11
15	666	13	137	22	21	20	879
16	6		5	1	1	1	14
17	265	15	69	24	6	13	392
18	112	2	22	2	1		139
19	14		1			1	16
20	133		20	4	3	1	161
21	67	2	26	3	5	4	107
22	256	1	49	2	7	1	316
23	1		4		1	3	9
24 (excl. 24.4)	63	24	41	27	15	14	184
24.4	9	4	3	4	2	2	24
25	144	7	44	28	4	11	238
26	193	1	52	9	4	4	263
27	28	2	16	5	3	8	62
28	656	18	125	20	7	5	831
29	215	22	42	20	4	12	315
30	4	4		2			10
31	59	12	12	11	1	8	103
32	13	6	8	5	3	5	40
33	44	15	5	3	2	3	72
34	80	2	37	8	14	7	148
35	31	1	10	3	3		48
36	283	5	56	10	6	3	363

NACE	Less than 50 empl.		50-249 empl.		250 or more empl.		Total
	Other	Continuous R&D	Other	Continuous R&D	Other	Continuous R&D	
37	38	4	7				49
40	2		1		1		4
41						2	2
45	1983	3	282	4	17	4	2293
50	683		62	3	7		755
51	2302	35	274	17	22	2	2652
52	1517	3	80		34		1634
60	1114		141		4	2	1261
61	18		3		1		22
62	8		4		3		15
63	364		109		17		490
64	41	1	9		6	1	58
65	33		20		5		58
66	6		6	1	3	1	17
67	59	1	6	1	2		69
72 (excl. 72.2)	120	20	19	3	4	1	167
72.2	119	38	26	16	5	1	205
73		34	1	8		4	47
74 (excl. 74.2 & 74.3)	849	7	154	4	46	2	1062
74.2	171	33	25	9	5		243
74.3	40	4	7	2	4		57
85		3					3
90		1		2		1	4
92		1					1
Total	**12820**	**346**	**2020**	**286**	**299**	**148**	**15919**

Table 11-3: Sample drawn of firms in Flanders.

NACE	Less than 50 empl.		50-249 empl.		250 or more empl.		Total
	Other	Continuous R&D	Other	Continuous R&D	Other	Continuous R&D	
1	1	2		3			6
14	10					1	11
15	197	9	36	13	21	20	296
16	6		5	1	1	1	14
17	83	7	19	14	6	13	142
18	33	1	7		1		42
19	5		1			1	7
20	39		6	2	3	1	51
21	19	2	7	2	5	4	39
22	75	1	14	1	7	1	99
23	1		4		1	3	9
24 (excl. 24.4)	28	14	15	14	15	14	100
244	9	4	3	4	2	2	24
25	43	3	10	18	4	11	89
26	58	1	15	5	4	4	87
27	9		3	5	3	8	28
28	191	14	36	9	7	5	262
29	91	14	11	16	4	12	148
30	4	4		2			10
31	24	7	4	9	1	8	53
32	5	5	1	4	3	4	22
33	20	10	5	3	2	3	43
34	33	1	15	2	14	7	72
35	13	1	1	2	3		20

NACE	Less than 50 empl.		50-249 empl.		250 or more empl.		Total
	Other	Continuous R&D	Other	Continuous R&D	Other	Continuous R&D	
36	84	3	15	6	6	3	117
37	12	2	7				21
40	2		1		1		4
41						2	2
45	196	2	42	2	17	4	263
50	82		12	1	7		102
51	344	23	84	14	22	2	489
52	184	1	16		34		235
60	165		45		4	2	216
61	2		3		1		6
62	8		4		3		15
63	55		35		17		107
64	7	1	9		6	1	24
65	6		7		5		18
66	5		5	1	3	1	15
67	10		5	1	2		18
72 (excl. 72.2)	37	15	7	2	4	1	66
722	37	31	7	8	5	1	89
73		19	1	8		4	32
74 (excl. 74.2 & 74.3)	275	4	47	1	45	2	374
742	52	27	8	8	5		100
743	13	3	7	2	4		29
85		3					3
90		1		2		1	4
92		1					1
Total	**2573**	**236**	**585**	**185**	**298**	**147**	**4024**

11.2 DATA CLEANING, MISSING VALUE IMPUTATION, NON-RESPONSE SURVEY AND WEIGHTING

> "More than 4000 firms were targeted for the mail survey, after which 1727 responded, with a final response rate of 41%. Another non-response survey was performed on another 244 firms, with a response rate of 83%."

In total 1,727 firms responded, 58 of which responded to the general questions only, but not to any of the core questions on innovation. Discarding these 58 firms we are left with 1,669 usable responses, or a final response rate of 41%.

Data from the Belfirst database and the Trends Top 100,000 database were used to correct and complete data on the questions for general background information (turnover, number of employees, group structure). Further data cleaning was done using the SAS Windows application provided by Eurostat. For questions with multiple options this mostly entailed that when at least one option was chosen, all missings to the other options are assumed to be "no" or "not relevant". Consistencies between responses were also monitored. For example, when a firm filled in a non-zero number for a certain category of innovation expenses, but earlier on indicated that it did not perform that type of innovation activity (e.g., R&D, or acquisition of machinery), the earlier response is changed to "yes, this type of innovation activity is applicable". Slight modifications were made to the SAS application to accommodate additional options that were included in the Flemish questionnaire but not in the original Eurostat questionnaire, as well as to correct some SAS macros that upon closer scrutiny either yielded incorrect or inconsistent results (e.g., responses given to the expenses question that were inappropriately set to missing) or consistency corrections that were considered too strict (e.g., when an innovation active firm indicated no effects of innovation, this response was initially overwritten and it was assumed that some effects had to be estimated; however, it may take some time for innovations to show effects, especially when the innovations have been introduced near the end of the three-year reference period).

The SAS Windows application provided by Eurostat was also used to impute any missing responses that were left after the consistency checks had been done. For metric variables (turnover, number of employees and innovation expenses) the application imputes weighted ratio means. For ordinal and nominal variables nearest-neighbor imputation by hot deck is used. More details can be found in the user guide provided by Eurostat for the SAS Windows application (Hamel, 2005). Some modifications to these routines were also made to accommodate additional questions that were included in the Flemish survey but not in the original Eurostat survey, as well as to correct some macros that appeared not to function very well on the data. A few values that were missing after applying the Eurostat routines were replaced by stratum mean values.

As the overall (non-weighted) response rate was less than 70%, Eurostat methodological recommendations for CIS4 were followed and a non-response survey was performed. A stratified sample of roughly 10% of non-respondents was contacted by phone for a non-response survey. The same three stratifying variables were used as before, i.e. technology level, firm size and presence of continuous R&D activities. Only firms from the core industries for Eurostat reporting were included. Firms were given the possibility to respond over the phone, by fax or by e-mail. The non-response survey contained four questions (see Appendix):

(1) average number of employees (head count) in 2002 and in 2004;
(2) whether the firm had product innovation in 2002-2004;
(3) whether the firm had process innovation in 2002-2004;
(4) whether the firm had intramural R&D in 2002-2004, and if so, whether those R&D activities were performed continuously or occasionally.

In total 244 firms were contacted, 194 of those were assumed to not have continuous R&D spending, whereas the remaining 50 firms were sampled from the set of firms with continuous R&D spending. The overall response rate to the non-response survey was 83%, which was sufficiently high to allow for these data to be used to adjust the weights used to extrapolate the sample results to the target population.

Table 11-4 shows the innovation rates obtained in the mail survey and in the non-response survey. The higher innovation rates obtained in the non-response survey are apparent. A z-test on the innovation rates for the firms without continuous R&D spending indicates that the difference between the two is significant: the weighted percentage of innovators in the respondent population is 41%, the weighted percentage of innovators in the non-respondent population is 59%, yielding a z-statistic of -3.75, which is significant at the $\alpha = 0.01$ level. The sample sizes for the firms with continuous R&D spending are too small to compute a z-test statistic, but the high innovation rates in both the mail survey and the non-response survey are apparent.

Table 11-4: Innovation rates for firms in core industries in mail and non-response survey

Firm Size	Technology Level	Other		Continuous R&D	
		Mail Survey	Non-response Survey	Mail Survey	Non-response Survey
Less than 50 empl.l	HTI	.49	.90	.88	1.00
	HTS	.58	.75	.77	1.00
	LTI	.36	.57	.83	1.00
	LTS	.35	.48	1.00	1.00
	Total	**.39**	**.59**	**.85**	**1.00**
50-249 empl.	HTI	.59	.71	.94	1.00
	HTS	.64	.56	.67	1.00
	LTI	.61	.70	.89	1.00
	LTS	.41	.80	1.00	.60
	Total	.52	.69	.90	.88
250 or more empl.	HTI	.64	.75	.92	1.00
	HTS	.44	.75	1.00	-
	LTI	.74	.90	.96	1.00
	LTS	.53	1.00	1.00	-
	Total	.63	.85	.94	1.00

Note. HTI: high-tech industry, HTS: high-tech services, LTI: low-tech industry, LTS: low-tech services.

The non-response survey results could be used to calculate weights for the mail survey results, in order to adjust for the sampling design and for unit non-response and to produce valid results for the target population. A weighting class adjustment was done, where the weighting classes correspond to groups of innovators versus non-innovators (see e.g. Lohr, 1999). The following weights are obtained:

$$w_{h,1} = \frac{N_h}{n_h} \cdot \frac{inn_h}{inn_{R,h}} \quad \text{and} \quad w_{h,0} = \frac{N_h}{n_h} \cdot \frac{(n_h - inn_h)}{(r_{R,h} - inn_{R,h})},$$

where $w_{h,1}$ is the weight for innovator firms in cell h (each cell consists of firms that have the same values for the three stratifying variables), and $w_{h,0}$ is the weight for non-innovator firms in cell h,

- N_h is the total number of firms in cell h in the target population,
- n_h is the total number of firms in cell h in the original sample for the mail survey,
- $r_{R,h}$ is the number of firms in cell h that respond to the mail survey.
- $inn_{R,h}$ is the number of innovators in cell h among the respondents to the mail survey.
- inn_h is the number of innovators in cell h in the original sample for the mail survey, and is calculated as follows:

$$inn_h = inn_{R,h} + \frac{inn_{NR,h}}{r_{NR,h}} \cdot n_{NR,h}$$

with $inn_{NR,h}$ being the number of innovators in cell h among the respondents to the non-response survey.

- $r_{NR,h}$ the number of firms in cell h that respond to the non-response survey. and
- $n_{NR,h}$ the total number of firms in cell h in the original sample that did not respond to the mail survey.

As one can see it is assumed that the responding firms in the non-response survey are representative of all other firms in the original sample that did not respond. The weights were further adjusted to take into account the extremely skewed distribution of R&D spending. This was done by excluding firms with R&D spending above a certain threshold, i.e., 10 million Euro, from the extrapolation and assigning them a weight of one, in order to avoid overestimation of R&D expenses.

11.3 COMPOSITION OF SAMPLE FOR THIS REPORT

Table 11 5 shows the sectoral breakdown of the data that is applied to all following survey results throughout the report. The description of the surveyed NACE sectors can be found in in the appendix.

Table 11-5: Composition of industries

Industry	Industry definition according to NACE sectors
Textiles	17, 18, 19
Paper/Wood	20, 21, 22
Chemicals/Plastics	23, 24, 25
Metal	27, 28
Machinery/Vehicles	29, 34, 35
Electronics	30, 31, 32, 33
Other Industries	1, 14, 15, 16, 26, 36, 37, 40, 41, 45
Trade	50, 51, 52
Transport	60, 61, 62, 63, 64
Information Services	72, 73, 74.2, 74.3
Other Services	65, 66, 67, 74 (except 74.2, 74.3), 85, 90

11

Chapter 12

BASIC INNOVATION INDICATORS

In this section the basic innovation indicators will be presented. The main indicator is the share of innovating firms. Next, innovation activity is disentangled into the two dimensions of product and process innovation. The main actors in the innovation process are analyzed. For product innovation, the novelty of products is discussed and the impact of process innovation is studied. The basis for the analyses are all firms in the surveyed sector. All results are weighted statistics.

12.1 SHARES OF INNOVATING FIRMS

Table 12-1 shows the share of innovating firms by sector and firm size. The share is computed based on the presence of finished (product or process) or ongoing/abandoned innovation activity. The definitions of innovation activities are in line with the Oslo Manual (OECD/Eurostat, 1997). Product innovation is defined as the market introduction of new or significantly improved goods or services. The introduction of new or significantly improved production methods, logistics, supply or distribution methods or supporting activities constitute a process innovation. Innovation activities that did not (yet) result in a product or process innovation are measured as ongoing or abandoned innovation activities and they are also taken into account in the calculation of the share of innovative companies.

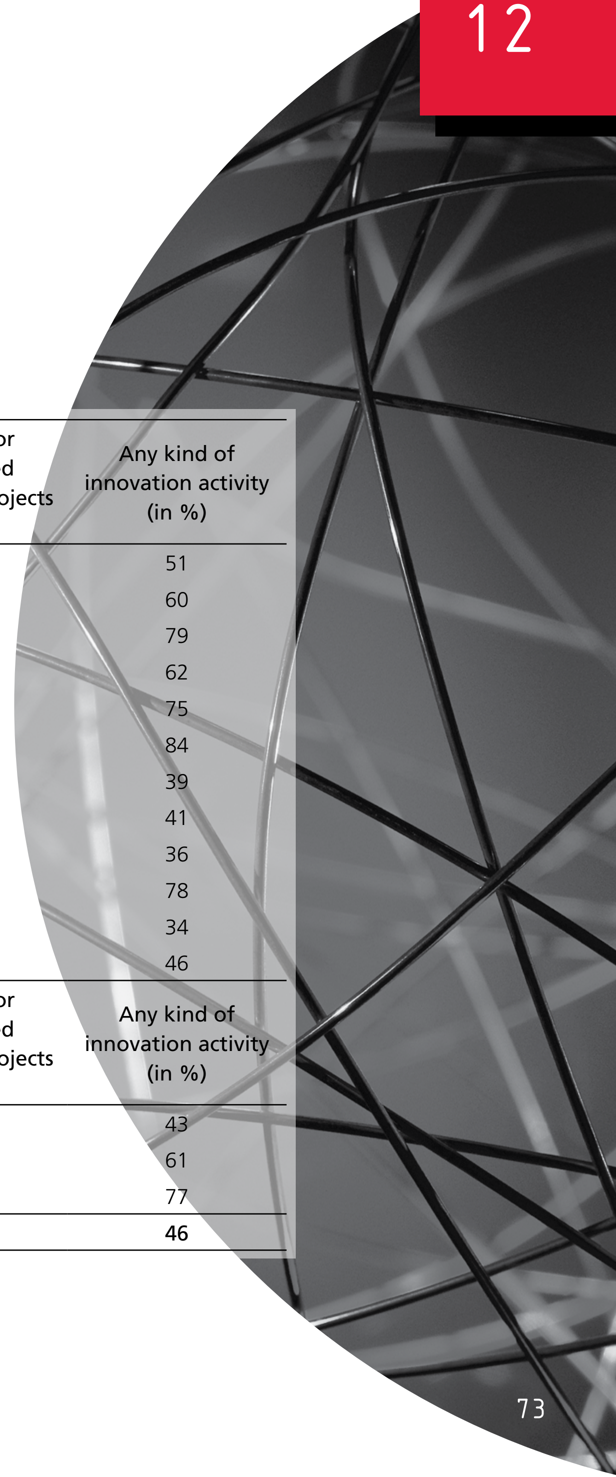
In the manufacturing industry, electronics (84% innovators) is the most innovative sector. Also chemicals/plastics and machinery/vehicles are innovative (79% and 75% innovators respectively). The share of innovative companies in the services industries can mainly be found in the information services sector (78% innovators).

Schumpeter (1942) stated that innovation activity is typically correlated with size. This is also confirmed in the CIS4 results. The largest share of innovators (77%) can be found in companies with 250 employees or more. Due to a large share of small companies (less than 50 employees), however, the total share of innovative companies in the Flemish private sector amounts to 46%. This illustrates the classical skewed distribution of innovation activities: a limited number of companies is responsible for the largest share of the innovative activity. This result also emerged from the R&D 2004 survey (see Aerts et al., 2005).

Table 12-1: Share of innovators by sector and firm size

Sectors	Product Innovators (in %)	Process Innovators (in %)	Ongoing or abandoned innovation projects (in %)	Any kind of innovation activity (in %)
Textiles	31	38	35	51
Paper/Wood	43	50	37	60
Chemicals/Plastics	57	55	59	79
Metal	31	41	46	62
Machinery/Vehicles	57	53	48	75
Electronics	71	53	62	84
Other Industries	22	25	24	39
Trade	26	25	20	41
Transport	22	31	19	36
Information Services	61	49	63	78
Other Services	23	21	21	34
Total	30	31	28	46
Firm Size	**Product Innovators (in %)**	**Process Innovators (in %)**	**Ongoing or abandoned innovation projects (in %)**	**Any kind of innovation activity (in %)**
less than 50 empl.	27	28	25	43
50-249 empl.	41	45	39	61
250 and more	59	62	64	77
Total	**30**	**31**	**28**	**46**

Note: Sample results are extrapolated to the target population.



“The share of innovators (46%) is lower than in CIS3 because of the different target populations including low innovating sectors like construction, retail trade or sewage and refuse disposal.”

If one compares the shares of innovative firms to the report on the CIS3 survey (see Delanghe et al., 2003), the share of innovators seems to be lower recently. It is important to note, however, that the target populations are different. The CIS4 included additional, moderately innovating sectors like construction, retail trade or sewage and refuse disposal. As construction and retail trade reflect a large share of the population of firms, the overall shares of innovators are lower than in CIS3. Suppose we group the sectors differently, for example, into (a) Manufacturing and Mining, (b) Energy, Water Supply and Construction, and (c) Services. The total population of firms is 15,919, and out of those the shares of Manufacturing/Mining are 30%, Energy, Water Supply and Construction 15%, and Services 55%. As can be seen in Table 12 2, the share of innovators in Energy, Water and Construction is low (25%). This lowers the share of innovators in the CIS4 population considerably as this sector corresponds to 15% of firms. We see that is the least innovative sector with 25% of innovators. In Services the share of innovators is 42% and in Manufacturing/Mining 64%. As the share of firms in the service sector population is almost twice as big as in Manufacturing, the total share of innovators comes down to 46% (see Table 12 1). The share of innovators in Services is to a large extent determined by the Trade sector (NACE 50-52) which has 5,041 firms in the population corresponding to about 58% of the service sector. As trade is only moderately innovative, the total share of innovators in services in lower than in the CIS3, where only NACE 51 was included. For those reasons, we prefer to use the more detailed sectoral decomposition as presented in Table 12 1 throughout the remainder of this report.

Table 12-2: Share of innovators by broad sectoral definition

Broad Sectors	Product Innovators (in %)	Process Innovators (in %)	Ongoing or abandoned innovation projects (in %)	Any kind of innovation activity (in %)
Manufacturing/Mining (= NACE 14-37)	43	46	44	64
Energy/Water/Construction (= NACE 40, 41, 45)	9	12	13	25
Services (= NACE 50-52, 60-67, 72-74, 80, 85, 90)	28	28	23	42

Note: Sample results are extrapolated to the target population.

12.2 PRODUCT INNOVATION

The total share of product innovators in the Flemish private sector is 30%. The following table sheds some light on how these innovations are realized: is the origin of product innovations mainly within the firm, are they developed in collaboration with others, or do firms rely mostly on external knowledge? These questions are closely related to the paradigm of "open innovation" as suggested by Chesborough (2003). He argues that firms have to source external knowledge nowadays in order to remain at the edge of technological developments in the industry (or world) and to secure competitiveness by staying at the fast moving technological frontier. The joint development of product innovation can be interpreted as the most extreme form of an open innovation management. Seeking knowledge outside the firm can also happen through R&D collaborations or using external information sources where the process of knowledge collection is not necessarily linked to the development of a particular product. The latter forms are considered in chapter 4 of the report. First, we turn to the origin of new products.

"46% of business is involved in some kind of innovation activity, but only 30% really are product innovators respectively process innovators."

Most product innovations are developed by the company or within the group the company belongs to. However, to some extent, the innovations are developed in collaboration with other enterprises or institutions or even mainly by these other enterprises or institutions. Table 12 3 shows that the origin of development can shift somewhat, depending on the sector and firm size. The most innovative sectors, electronics, chemicals/plastics and machinery/vehicles mainly develop the innovations themselves. Note that this does not necessarily imply that high-tech firms in Flanders do not follow the open innovation paradigm. One has to take into account that innovation constitutes a core element of such firms’ business strategy. They may well seek external knowledge, but when it comes to product development which is supposedly a late stage in the innovation process, they may prefer a certain level of secrecy ensuring some advantages in lead time to markets in order to be protected against immediate imitation and reverse engineering attempts of rivals.

In textiles, other enterprises or institutions are an important partner to develop product innovations. Small companies rely relatively more on other enterprises or institutions. The fact that innovative activities are associated with a lot of risk, may be one of the reasons for this collaboration profile. On the one hand, small firms may lack sufficient financial resources for a continuous development of products within the firm. On the other hand, they may not have the necessary human capital to come up with sound new products regularly.

Table 12-3: Origin of development of product innovations by sector and firm size

Sectors	Mainly by enterprise/ group (in %)	In collaboration with other enterprises/ institutions (in %)	Mainly other enterprises/ institutions (in %)
Textiles	64	36	0
Paper/Wood	75	25	0
Chemicals/Plastics	84	15	1
Metal	71	21	8
Machinery/Vehicles	74	20	6
Electronics	80	14	6
Other Industries	83	10	7
Trade	69	11	20
Transport	52	20	28
Information Services	76	20	5
Other Services	87	5	13
Total	**73**	**15**	**12**
Firm Size	**Mainly by enterprise/group (in %)**	**In collaboration with other enterprises/ institutions (in %)**	**Mainly other enterprises/ institutions (in %)**
less than 50 empl.	70	15	15
50-249 empl.	81	16	3
250 and more	86	13	2
Total	**73**	**15**	**12**

Note: Sample results are extrapolated to the population of product innovators.

Aside of looking into the development phase of products, the CIS also offers the opportunity to look at the nature of new products: there are two degrees of novelty considered in the CIS framework. First, a product can be new only to the firm. This innovation already existed in the market place, but the company newly introduced it into the company. Second, a product can be new to the market (and by definition also new to the firm). Companies were asked if products that

“The big difference in the innovative nature of small and medium sized versus large firms lies in the introduction of new to the firm innovations.”

have recently been introduced were new to the market or new to the firm. The shares of innovators that introduced market novelties between 2002 and 2004 is shown in Figure 12 1. In large companies, the proportion of market novelties is relatively larger than in small and medium sized companies. In total, 58% of product innovators have introduced at least one market novelty. The most innovative sectors, electronics, chemicals/plastics, machinery/vehicles and information services introduce market novelties most frequently. As we have seen in Table 12 3, firms in such industries prefer to develop products themselves. Yet, they show the highest shares of firms bringing market novelties to the market, and thus they may seek external knowledge for innovation, but do not necessarily include third parties in such sensible areas like product development due to competitive reasons.

Figure 12-1: Share of product innovators with market novelties by sector and firm size

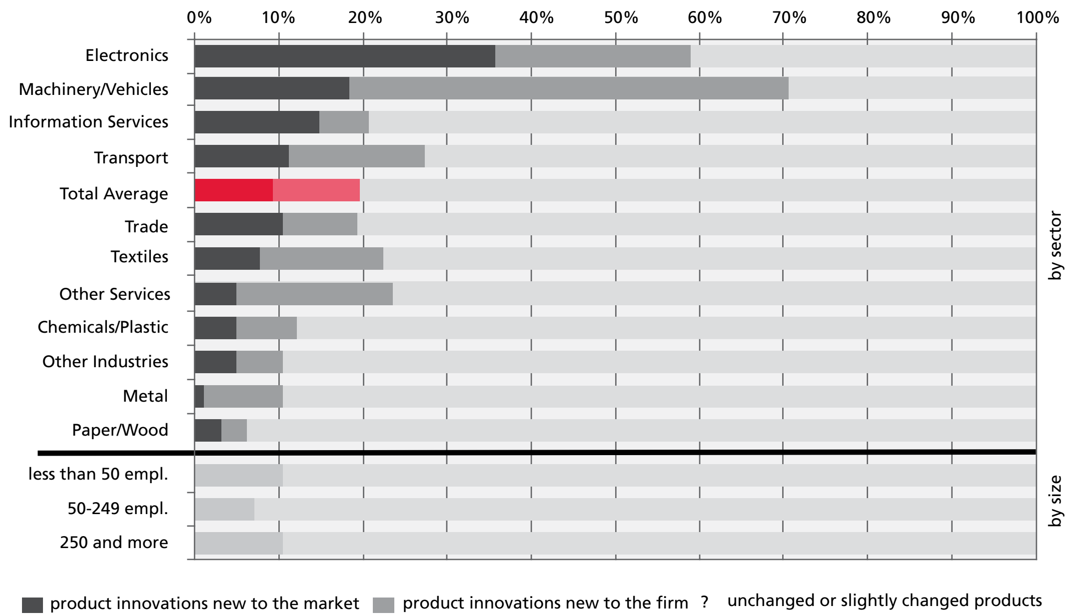
Note: Sample results are extrapolated to the population of product innovators.

Alternatively, Figure 12 2 depicts the proportion of product novelties (including the two dimensions of novelty new to the market versus new to the firm) as a share of the total turnover per sector and size class in the population of Flemish product innovators. On average, product innovations that are new to the market represent 9% of the turnover, while 15% of the turnover is realized based on the introduction of a product innovation that is new to the firm. 76% of the turnover comes from products that are unchanged. As we mentioned before, electronics, machinery/vehicles, chemicals/plastics and information services are very innovative sectors, but Figure 12 2 shows different innovation profiles: in electronics, new to the market innovations constitute a large share (35%) of the turnover, while this is only 4% in chemicals/plastics, 17% in machinery/vehicles and 14% in information services. Electronics and especially Machinery/Vehicles also introduce relatively many product innovations that are new to the firm (23% and 54%).

10% of the total sales of small firms is achieved with new to the market product innovations and 11% of the sales is represented by products that are new to the firm. For medium sized companies, the share of new to the market and new to the firm product innovations in the total sales is somewhat smaller (7% and 10%). In larger firms, also 10% of the turnover comes from new to the market product innovations and 19% of total sales is realized with unchanged products. We see that the big difference in the innovative nature of small and medium sized versus large firms is pronounced in the introduction of new to the firm innovations; for the new to the market product innovations, small and medium sized companies are as strong as large companies.

“Product innovations that are new to the market represent on average 9% of the turnover, while 15% is realized based on the introduction of a product innovation that is new to the firm. The rest or 76% of the turnover comes from products that are unchanged.”

Figure 12-2: Product novelty as a share of the turnover by sector and firm size



Note: Sample results are extrapolated to the population of product innovators.

"Processes are much more developed in collaboration than products, which can be interpreted as a higher degree of open innovation management when cost reductions or other aspects of the production process are at stake."

12.3 PROCESS INNOVATION

In the total population of surveyed sectors, 31% have introduced a process innovation. For process innovation activities, companies rely more on other enterprises or institutions than for product innovations. Processes are much more developed in collaboration than products which can be interpreted as a higher degree of open innovation management when cost reductions or other aspects of the production process are at stake. Table 12 4 summarizes the results. There are no large differences in the behavior with respect to firm size classes. At the sectoral level more interesting details are found: 32%

of firms in Chemicals/Plastics and 33% in Metal developed their process innovations mainly in collaboration with other enterprises or institutions. The highest share of collaborative development of new processes is found in Electronics (37%), though. The transport sector relies most on other enterprises with respect to their process innovation: 23% report an external origin of process innovations. Also high shares of external development are found for Textiles (15%) and Paper/Wood (17%). Possibly the closest form of process innovation is found in Machinery/Vehicles, as those firms mainly develop their processes internally (78%).

Table 12-4: Origin of development of process innovations by sector and firm size

Sectors	Mainly by enterprise/group (in %)	In collaboration with other enterprises/ institutions (in %)	Mainly other enterprises/institutions (in %)
Textiles	59	25	15
Paper/Wood	60	23	17
Chemicals/Plastics	63	32	5
Metal	54	33	13
Machinery/Vehicles	78	19	2
Electronics	63	37	0
Other Industries	68	22	10
Trade	73	23	4
Transport	44	32	23
Information Services	76	24	0
Other Services	71	18	12
Total	65	25	9
Sectors	**Mainly by enterprise/ group (in %)**	**In collaboration with other enterprises/ institutions (in %)**	**Mainly other enterprises/ institutions (in %)**
less than 50 empl.	65	24	10
50-249 empl.	65	28	7
250 and more	71	25	5
Total	**65**	**25**	**9**

Note: Sample results are extrapolated to the population of process innovators.

With respect to outcome of process innovation the Flemish CIS offers two indicators: unit cost reduction in production and quality improvements. Table 12 5 shows that process innovations yield a quality improvement and cost reduction in 41% of process innovating firms. Quality improvement without cost reductions are achieved in 26% of the firms. An average unit cost reduction without quality improvement is realized in 18% of companies. Note that the firms that neither report quality improvements nor cost reductions may have innovated for other reasons, such as improving work safety or complying to regulatory standards and the like. The outcomes of innovations will be considered in more detail in chapter 4.

At the sectoral level, firms in metal and information services are most successful in joint quality improving and cost reducing implementations of new processes. In large firms, process innovations more often bring along both quality and cost improvements than in small and medium-sized firms. They also have fewer process innovations that result in quality improvements only. Otherwise there are little differences over size classes.

Table 12-5: Results of process innovation by sector and firm size

Sectors	Unit cost reduction and quality improvement (in %)	Unit cost reduction only (in %)	Quality improvement only (in %)	Neither cost eduction nor quality improvement (in %)
Textiles	45	13	27	15
Paper/Wood	49	10	37	4
Chemicals/Plastics	46	18	24	12
Metal	54	23	12	11
Machinery/Vehicles	43	28	20	9
Electronics	46	22	16	16
Other Industries	40	15	35	10

Sectors	Unit cost reduction and quality improvement (in %)	Unit cost reduction only (in %)	Quality improvement only (in %)	Neither cost eduction nor quality improvement (in %)
Trade	32	21	24	23
Transport	38	22	21	19
Information Services	54	12	29	5
Other Services	44	12	29	15
Total	41	18	26	15
Firm Size	**Unit cost reduction and quality improvement (in %)**	**Unit cost reduction only (in %)**	**Quality improvement only (in %)**	**Neither cost eduction nor quality improvement (in %)**
less than 50 empl.	41	18	27	14
50-249 empl.	39	17	27	17
250 and more	55	20	13	12
Total	**41**	**18**	**26**	**15**

Note: Sample results are extrapolated to the population of process innovators.

12.4 SUMMARY OF BASIC INNOVATION INDICATORS

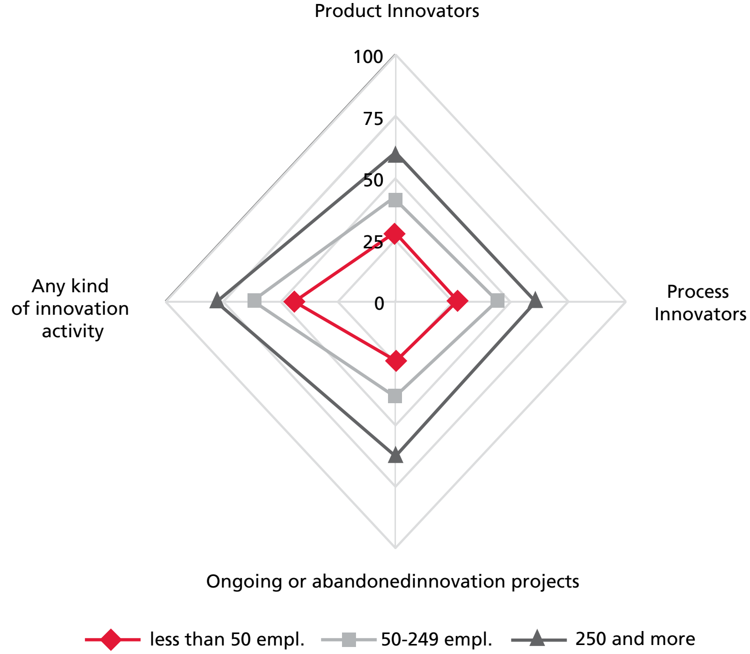
Figure 12 3 clearly confirms the relationship between size and innovation: on every dimension of innovativeness the large companies are on the exterior radar, that is, larger firms achieve higher shares of innovators in all criteria: product and process innovation, ongoing or abandoned innovation activity.

In Figure 12 4 the shares of firms with corresponding innovation outcome are summarized. Note that the basis for this comparison is the total number of innovators (not product and process innovators separately). Large firms also achieve most results in terms of both product and process innovation outcome. Large firms are mainly responsible for the introduction of market novelties, and put highest emphasis on cost reductions through innovative activity. In terms of

“Larger firms achieve higher shares of innovators in all criteria: product and process innovation, ongoing or abandoned innovation activity. Large firms also achieve most results in terms of both product and process innovation outcome: they are mainly responsible for the introduction of market novelties and put highest emphasis on cost reductions and quality improvements.”

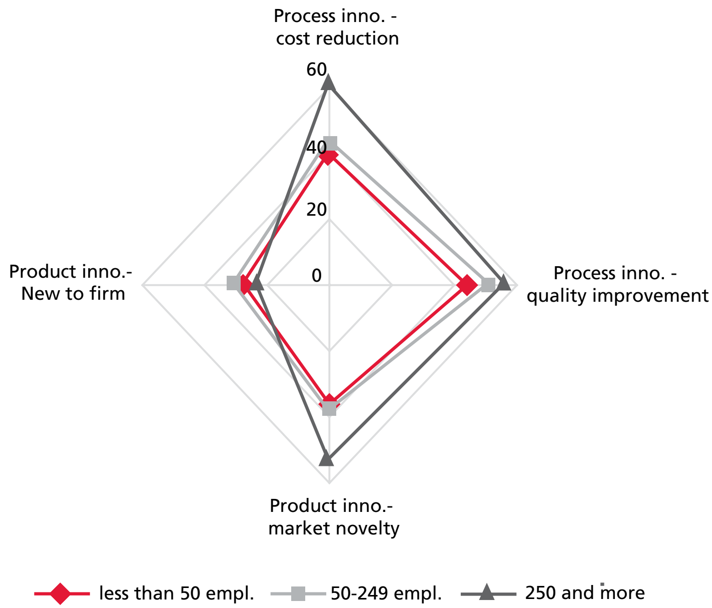
quality improvements through process innovation large firms also gain the highest score followed by medium size firms, and finally small firms. For products only new to the firm, the ranking is reversed as this is the “residual share” of innovators that did not introduce a single market novelty.

Figure 12-3: Shares of innovating firms by size



Note: Sample results are extrapolated to the population of firms.

Figure 12 4: Results of product and process innovation by size



Note: Sample results are extrapolated to the population of innovators.

Chapter 13

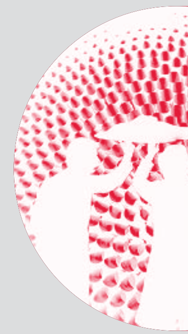
ACTIVITIES OF INNOVATING FIRMS: A CLOSER LOOK

In this section the subset of innovating firms is analyzed more in detail. The composition and nature of innovation activities are investigated as well as sources of information, public funding, the effects of innovation and collaboration profiles.

13.1 COMPOSITION OF INNOVATION ACTIVITIES

"Total innovation expenditure amounts to 7,4 billion EUR where most is spent in the chemical sector including pharmaceuticals. As expected, the few large firms spent about as much on innovation as the small and medium-sized firms altogether."

Innovation activities comprise a broad spectrum of engagement, going from R&D (internal or external) to the acquisition of equipment and knowledge. These different levels of engagement and their relative importance are presented in Table 13 1. We find that firms in sectors with a high proportion of internal R&D-performers also tend to be more engaged in external R&D. On the one hand, that may be seen as a confirmation of the notion of absorptive capacity (cf. Cohen and Levinthal, 1982). A firm needs to conduct own internal R&D to be capable of using knowledge that is produced outside the firm. On the other hand, it also supports the open innovation paradigm that innovation intensive firms cannot rely only on internal R&D, but have to source knowledge externally.



Furthermore, it turns out that the acquisition of machinery is the most frequent channel for the implementation of innovations: 71% of innovators report such investments. Another important factor is the training of employees linked to innovations. Training is reported by 60% of innovative firms.

What also stands out is that large companies engage heavily in most activities, especially in R&D; only the acquisition of external knowledge is less important. This again confirms the skewed distribution of R&D and innovation activities. 75% of the large innovative companies conducts intramural R&D.

Instead of looking just at the fact whether firms engage in some particular mode of innovation activity, the survey allows to calculate the total budget that is spent on various innovation activities in Flanders (see Table 13 2). Total innovation expenditure amounts to 7,414 million EUR, where most is spent in the chemical sector including pharmaceuticals. As expected, the few large firms spent about as much on innovation as the small and medium-sized firms altogether.

Table 13-1: Composition of innovation activities by sector and firm size

Sectors	Intramural R&D (in %)	Extramural R&D (in %)	Acquisition of machinery (in %)	Acquisition of other external knowledge (in %)	Training (in %)	Market introduction cost (in %)	Other preparations (in %)
Textiles	71	27	91	9	53	37	36
Paper/Wood	44	19	93	9	63	37	36
Chemicals/Plastics	81	50	70	16	68	40	52
Metal	57	30	73	13	52	25	30
Machinery/Vehicles	59	28	67	19	66	28	32
Electronics	72	42	83	27	72	58	43
Other Industries	43	18	64	16	62	30	22
Trade	34	17	69	18	55	39	30
Transport	32	18	76	24	40	19	25
Information Services	82	28	68	30	88	57	46
Other Services	44	24	71	28	71	35	36
Total	**48**	**23**	**71**	**19**	**60**	**35**	**32**

Sectors	Intramural R&D (in %)	Extramural R&D (in %)	Acquisition of machinery (in %)	Acquisition of other external knowledge (in %)	Training (in %)	Market introduction cost (in %)	Other preparations (in %)
less than 50 empl.	43	19	70	15	56	32	29
50-249 empl.	62	31	76	27	71	41	37
250 and more	75	58	81	41	84	57	61
Total	**48**	**23**	**71**	**19**	**60**	**35**	**32**

Note: Sample results are extrapolated to the population of innovators

Table 13-2: Expenditure on innovation activities by sector and size (in million EUR)

Sectors	Intramural R&D	Extramural R&D	Acquisition of machinery	Acquisition of other external knowledge	Total innovation expenditure
Textiles	41	4	94	1	140
Paper/Wood	21	2	278	2	303
Chemicals/Plastics	664	642	482	3	1792
Metal	128	20	614	12	774
Machinery/Vehicles	248	70	439	12	770
Electronics	516	87	68	4	676
Other Industries	205	76	465	26	773
Trade	129	27	809	17	983
Transport	29	7	189	62	286
Information Services	450	53	190	29	722
Other Services	111	27	49	9	197
Total	**2544**	**1015**	**3678**	**177**	**7414**

Firm Size	Intramural R&D	Extramural R&D	Acquisition of machinery	Acquisition of other external knowledge	Total innovation expenditure
less than 50 empl.	493	77	1828	45	2444
50-249 empl.	653	110	511	60	1334
250 and more	1397	828	1339	72	3637
Total	**2544**	**1015**	**3678**	**177**	**7414**

Note: Sample results are extrapolated to the population of firms.

Most numbers in the above table are difficult to interpret, however, as the number of firms varies considerably over the different industries or size classes. Therefore, it is preferable to calculate the average spending per firm per sector or size class. This is presented in Table 13 3. It turns out – as before when the shares of innovating firms where analyzed – that firms in Chemicals/Plastics, Electronics, Machinery/Vehicles and Information Services are amongst the most innovative. In those sectors firms spends more than 1 million EUR on innovation per year, on average.

Large firms spend on average 8.1 million EUR on innovation per year, while the average small firm spends less than 200 thsd. EUR. We also see that, on average, firms in electronics show the highest intramural R&D spending, followed by firms in Chemicals/Plastics. Information Services are also investing heavily in intramural R&D.

Table 13-3: Average expenditure on innovation activities per firm (in million EUR)

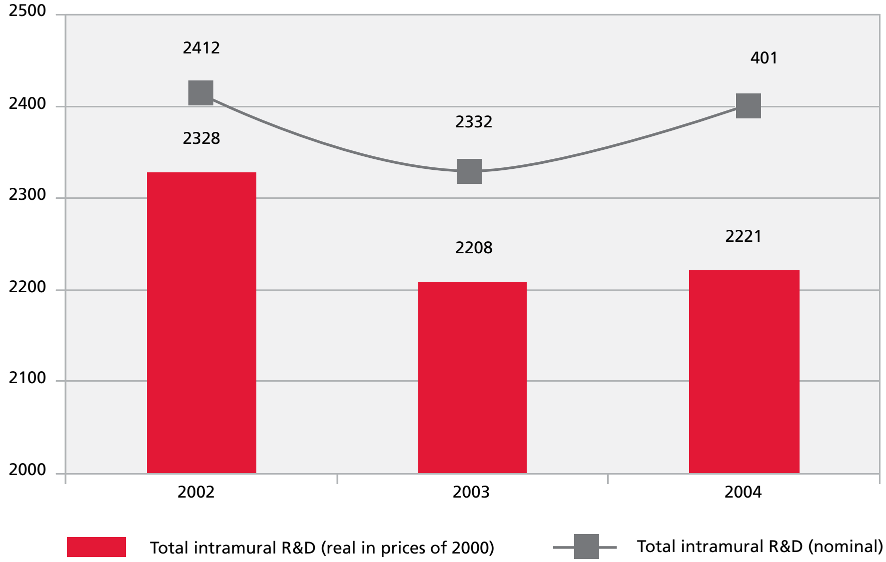
Sectors	Intramural R&D	Extramural R&D	Acquisition of machinery	Acquisition of other external knowledge	Total innovation expenditure
Textiles	0.071	0.006	0.164	0.001	0.243
Paper/Wood	0.035	0.003	0.461	0.003	0.501
Chemicals/Plastics	1.425	1.379	1.035	0.007	3.846
Metal	0.145	0.022	0.694	0.013	0.875
Machinery/Vehicles	0.496	0.140	0.878	0.025	1.539
Electronics	2.066	0.350	0.274	0.017	2.707
Other Industries	0.054	0.020	0.121	0.007	0.201
Trade	0.027	0.006	0.167	0.004	0.203
Transport	0.015	0.003	0.100	0.033	0.151
Information Services	0.625	0.074	0.264	0.040	1.003
Other Services	0.083	0.020	0.036	0.007	0.146
Total	**0.160**	**0.064**	**0.231**	**0.011**	**0.466**
Firm Size	**Intramural R&D**	**Extramural R&D**	**Acquisition of machinery**	**Acquisition of other external knowledge**	**Total innovation expenditure**
less than 50 empl,	0.037	0.006	0.139	0.003	0.186
50-249 empl,	0.283	0.048	0.222	0.026	0.579
250 and more	3.126	1.852	2.996	0.162	8.136
Total	**0.160**	**0.064**	**0.231**	**0.011**	**0.466**

Note: Sample results are extrapolated to the population of firms.

Our survey design allows to adjust the CIS population so that it becomes possible to compare the total intramural R&D spending in Flanders with the R&D surveys that are conducted in even years while the CIS data have been conducted in odd years. Thus, total R&D spending for Flanders can be calculated for 2004 from the most recent CIS which can be compared to the numbers from 2002 and 2003 from the R&D survey. The population of CIS firms has to be adjusted, though. For instance, the CIS also includes not-for-profit entities that have to be removed.

Figure 13 1 shows the development of total R&D spending in Flanders, where the 2002 and 2003 figures are obtained from the 2004 R&D survey. Intramural R&D expenditures peaked in 2002 at 2,412 million EUR nominal and declined to 2,332 million EUR in 2003. According to the CIS results, the slowdown in R&D spending stopped in 2004: firms spent about 2,401 million EUR again. However, taking into account recent price developments, we find that R&D spending declined by about 5% in real terms from 2002 to 2003. Although the slowdown stopped in 2004, there is almost no increase compared to 2003. The growth of R&D spending between 2003 and 2004 has been less than 1% (in constant prices of 2000)

Figure 13-1: Total intramural R&D spending from 2002 to 2004 (in million EUR)



Note: Population adjusted to R&D report (excl. not-for-profit entities). Numbers from 2002 and 2003 are obtained from the R&D survey 2004.

When the nature of the R&D activities is considered, in Table 13 4, we see that most of the large innovative companies (84%) engage in their internal R&D activities on a permanent basis. However, also a large proportion of the small and medium sized R&D-performing firms (66 and 73% respectively) maintains continuous R&D activities. R&D activities are often capital intensive, which may clarify this result: once a firm decides to start up R&D activities, it is more beneficial to conduct R&D on a permanent basis instead of occasionally. There are however large discrepancies between the industries: in the metal sector for example, companies are more likely to set up occasional R&D projects.

Table 13 4: Permanent and occasional intramural R&D by firm size and sector

Sectors	Continuous R&D (in %)	Occasional R&D (in %)	Sum
Textiles	58	42	100
Paper/Wood	82	18	100
Chemicals/Plastics	72	28	100
Metal	40	60	100
Machinery/Vehicles	78	22	100
Electronics	88	12	100
Other Industries	69	31	100
Trade	71	29	100
Transport	72	28	100
Information Services	75	25	100
Other Services	66	34	100
Total	69	31	100
Firm Size	**Continuous R&D (in %)**	**Occasional R&D (in %)**	**Sum**
less than 50 empl.	66	34	100
50-249 empl.	73	27	100
250 and more	84	16	100
Total	69	31	100

Note: Sample results are extrapolated to the population of R&D-performing firms.

13.2 SOURCES OF INFORMATION

The sources of information that constitute the basis for innovation activities are also evaluated in the CIS survey. Typically, the most important information source is the company's group itself (49%). Other important sources are suppliers (31%) and clients/customers (36%). Their direct link to the company clarifies the valuable information that they can offer. Suppliers can induce a company to innovate through the so-called technology push, in which they develop a new technology which diffuses to their customers. Customers may act in the mechanism of demand pull. The company sees a market opportunity and develops innovations to satisfy a market demand. Another view on the importance of customers has been suggested by von Hippel (1988) in his "lead user" concept. Von Hippel pointed out that it is worthwhile to involve some main clients in the innovation process of a firm. While the involvement of customers is surely a fruitful way to target market demand, Christensen (2000) also pointed out a trade-off between listening to customers and overshooting market demand. If products satisfy the needs of a few very advanced users, but most of the market is not interested in the comprehensive features of a product, an established product line may be driven out of the market by so-called disruptive technologies, that is, simpler technologies that satisfy the (lower) needs of a broader market.

Competitors are also a source of information, but to a smaller extent: 16% of innovators gain important knowledge from rivals. Flemish innovative companies also get information from indirect sources, such as conferences/trade fairs (14%), professional/industry associations (10%), journals/publications (10%), consultants (4%), universities (4%) and government/not-for-profit institutions (3%). Table 13-5 gives more details. The limited importance of universities as a source of information stands out. Universities conduct rather basic research, while companies are more active in the field of applied research. However, both kinds of research are important in an economy.

> "Universities are not considered to be a rich source for innovation activities for a broad range of firms. For some, however, universities may actually be crucial for innovation. Large firms more often indicate universities as highly important for innovation (10%) than smaller firms (3%)."

Table 13-5: Use of information sources by sector and firm size

Sectors	Within firm/ group	Suppliers	Clients/ Customers	Competitors	Consultants	Universities	Government/ Not-for-profit inst.	Conferences/ Trade Fairs	Journals/ Publications	Professional/ Industry Associations
Textiles	53	51	48	8	1	4	0	25	9	5
Paper/Wood	49	49	33	24	0	1	4	26	24	9
Chemicals/ Plastics	61	21	38	9	1	1	2	8	7	5
Metal	47	26	34	20	1	11	4	10	9	4
Machinery/ Vehicles	55	26	51	19	6	5	1	12	7	7
Electronics	56	30	46	19	5	10	3	13	8	7
Other Industries	42	37	27	13	5	3	2	25	17	12
Trade	50	29	36	19	3	2	2	13	6	13
Transport	33	25	35	11	8	0	0	3	2	9
Information Services	71	23	41	8	6	10	5	8	10	8
Other Services	57	24	32	28	8	5	7	6	11	17
Total	49	31	36	16	4	4	3	14	10	10
Firm Size	**Within firm/ group**	**Suppliers**	**Clients/ Customers**	**Competitors**	**Consultants**	**Universities**	**Government/ Not-for-profit inst.**	**Conferences/ Trade Fairs**	**Journals/ Publications**	**Professional/ Industry Associations**
less than 50 empl.	45	30	33	14	4	3	3	14	9	10
50-249 empl.	61	33	44	24	5	4	2	13	12	10
250 and more	78	34	43	26	9	10	4	22	18	10
Total	49	31	36	16	4	4	3	14	10	10

Note: Sample results are extrapolated to the population of innovators.

Therefore, the link between them is vital: basic research has to be translated into applications. However, the use of information sources seems to indicate that universities are not considered to be a rich source for innovation activities for a broad range of firms. For some, however, universities may actually be crucial for innovation. A hint is found when looking at size classes. Large firms that maintain the necessary absorptive capacity for making use of basic research do much more often indicate universities as highly important for innovation (10%) than smaller firms (3%). The metal, electronics and information services sector report most frequently that universities are important sources for innovation. It should be noted, however, that knowledge generated at universities is often publicly available in journals or through conference participations. Thus, it remains somewhat unclear how much of basic research knowledge produced in the public sector is "consumed" through direct interaction with universities, and how much is utilized indirectly through other channels such as journal publications, patent databases, and conferences.

13.3 PUBLIC FUNDING OF INNOVATION PROJECTS

Of the Flemish innovative companies, 12% benefited from public funding for innovation activities of the local or regional authorities between 2002 and 2004. The federal government funded 9% of the companies. EU funding was received by 3% of the Flemish companies, of which 2% received this EU funding through the fifth (1998-2002) or sixth (2003-2006) framework programme. Table 13-6 shows some differences in size and sector. The local and regional authorities subsidize especially the paper/wood, metal, machinery/vehicles, electronics and information services sector. The textile industry receives relatively more funding from the federal government than the other sectors. Electronics, metal and information services are more likely to obtain EU funding. Large companies receive relatively more funding from the Flemish and EU government.

"Between 2002 and 2004 12% of the Flemish innovative companies benefited from public funding for innovation activities of the local or regional authorities. The federal government funded 9% of the companies. EU funding was received by 3% of the Flemish companies, of which 2% received this EU funding through the fifth or sixth framework programme."

Table 13-6: Public funding of innovation activities by sector and firm size

Sectors	**Local or regional authorities (in %)**	**Federal government (in %)**	**EU funding (in %)**	**out of EU funding: 5th/6th framework programme (in %)**
Textiles	12	23	1	1
Paper/Wood	25	15	1	1
Chemicals/Plastics	13	19	3	0
Metal	19	14	7	6
Machinery/Vehicles	19	13	0	0
Electronics	22	7	8	8
Other Industries	9	7	4	1
Trade	6	6	1	0
Transport	3	3	0	0
Information Services	29	10	14	10
Other Services	5	6	1	1
Total	**12**	**9**	**3**	**2**
Firm Size	**Local or regional authorities (in %)**	**Federal government (in %)**	**EU funding (in %)**	**out of EU funding: 5th/6th framework programme (in %)**
less than 50 empl.	11	8	2	1
50-249 empl.	13	11	4	2
250 and more	23	10	13	9
Total	12	9	3	2

Note: Sample results are extrapolated to the population of innovators.

13.4 EFFECTS OF INNOVATION

To complete the innovation profile of Flemish companies, not only the input side, but also the output side can be evaluated: do innovation efforts bring the expected results? The innovation output is measured in three categories: product oriented effects, process oriented effects and other effects. In Table 13 7, the importance of these effects is presented. Product oriented effects seem to be most obtained. Quality improvement of goods and services is the most frequent innovation effect in general (42%). Innovation efforts also lead to an increased range of goods/services (29%) or an increased market share (28%). The process oriented effects are mainly increased production capacity (25%) and improved production flexibility (22%), but also reduced labor (16%) or material/energy (9%) unit cost. Sectors like paper/wood or electronics experience more often product or process oriented effects than other sectors. When the effects are split up according to size, we see that especially large companies gain a lot from their innovation output: more large companies indicated product, process and other effects. This stems probably from the fact that large companies attribute larger budgets to innovation activities, which increases the chances of success and output effects.

As a general result one can summarize that firms put significantly less emphasis on cost reducing process innovations decreasing unit labor, material or energy cost. However, larger firms indicate more often that labor costs have been reduced through process innovation. That could imply that – in the short run – capital is substituted for labor by process innovation in large enterprises. It remains to be investigated whether process innovation leads to less employment, or if – in the medium term – it increases employment as cost reducing firms achieve higher sales or growth as they preserve their competitiveness on international markets through cost advantages. Recently, Harrison et al. (2005) conducted a cross-country study for France, Germany, Spain and the UK. They related employment growth to process and product innovation using CIS data. Results for manufacturing showed that, although process innovation tended to displace employment, compensation effects were prevalent. Process innovation had a positive impact on future growth. Overall the results were similar across countries. It would be interesting to investigate if similar effects can be found for Flanders.

Table 13-7: Effects of innovation activity by sector and firm size

Sectors	Product oriented effects			
	Increased range of goods/ services (in %)	Increased market share (in %)	Improved quality of goods/ services (in %)	Improved production flexibility (in %)
Textiles	39	32	42	23
Paper/Wood	25	28	53	43
Chemicals/Plastics	23	35	37	27
Metal	20	15	31	24
Machinery/Vehicles	37	30	46	32
Electronics	50	50	53	26
Other Industries	24	17	38	21
Trade	31	31	48	14
Transport	32	37	38	29
Information Services	39	34	43	19
Other Services	18	20	37	19
Total	29	28	42	22
Firm Size	Increased range of goods/ services (in %)	Increased market share (in %)	Improved quality of goods/ services (in %)	Improved production flexibility (in %)
less than 50 empl.	29	28	42	21
50-249 empl.	27	26	43	25
250 and more	30	39	47	25
Total	**29**	**28**	**42**	**22**

Note: Sample results are extrapolated to the population of innovators.

Process oriented effects			Other effects	
Increased production capacity (in %)	Reduced labor unit cost (in %)	Reduced material/ energy unit cost (in %)	Improved environmental impact/ health safety (in %)	Met regulations/ standards (in %)
23	8	11	7	5
50	25	10	20	18
19	18	10	34	18
22	19	8	14	13
27	22	11	8	7
31	14	8	8	6
23	8	8	18	16
26	21	10	9	13
21	15	12	10	15
20	15	2	4	11
24	11	7	10	15
25	16	9	13	14
Increased production capacity (in %)	Reduced labor unit cost (in %)	Reduced material/ energy unit cost (in %)	Improved environmental impact/ health safety (in %)	Met regulations/ standards (in %)
25	16	8	12	13
24	14	10	12	13
30	23	13	19	19
25	**16**	**9**	**13**	**14**

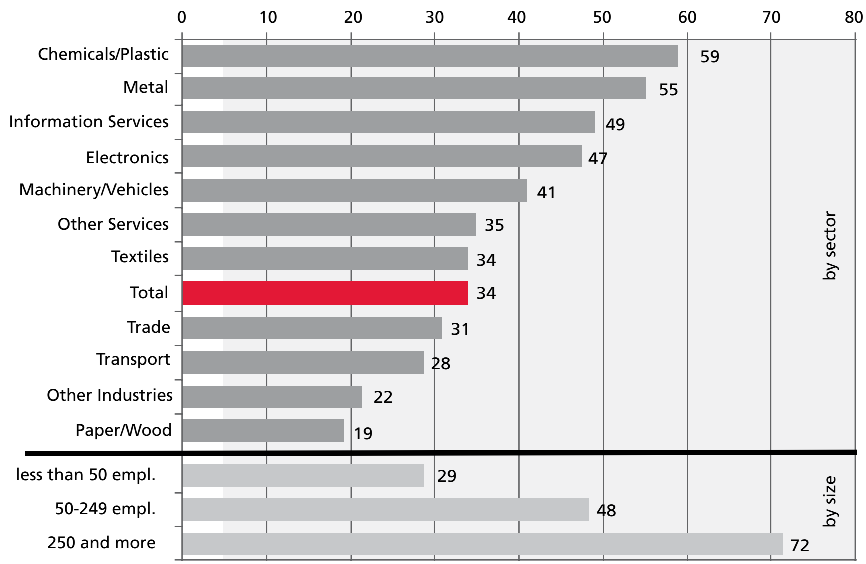
13.5 INNOVATION COLLABORATION IN FLANDERS

A rising trend in innovation activities is collaboration with other organizations. This is also in the notion of open innovation management. Collaboration in the CIS4 context can range from informal contacts to formal arrangements.

As can be seen in Figure 13-2, 34% of all innovating firms engaged in some kind of collaboration within their innovation process. Most collaborative arrangements occur in Chemicals/Plastics: 59% of firms in that sector co-operate with other companies or institutions. Then follows the Metal industry (55%), Information Services (49%) and Electronics (47%).

The propensity to collaborate in innovation projects is related to firm size. The smaller the firm, the less likely it is involved in collaborative research. Note that collaboration does not include the mere contracting out of R&D. Thus, each partner must be actively involved and consequently should have some knowledge or other specific skills to offer to the prospective partner. It may be the case that in small firms such characteristics are missing so that they either do not find a collaboration partner or they do not seek for collaboration due to the lack of absorptive capacity.

Figure 13-2: Share of innovators with collaborative research by sector and firm size



Note: Sample results are extrapolated to the population of innovators.

13.6 COLLABORATION PATTERNS

In this section, we explore the distribution of collaborations over different types of partners. Collaborations with suppliers (27%) and clients/customers (20%) are most important for Flemish firms. In section 13.2, we already found that they are an important source of information for innovative activities. Within group collaboration and collaboration with consultants/commercial labs/private R&D institutions account for 16% and 15%, respectively. Collaboration with universities is a little bit more important than universities as innovation source, but the involvement of universities still is limited. Again, this can be explained with the fact that firms need sufficient absorptive capacity for utilizing basic research results generated by university scientists. Collaboration with competitors (12%) and government/public research institutions (10%) close the ranking. Collaboration seems especially important in sectors like chemicals/plastics, electronics and information services. Also large companies are heavily involved in collaboration agreements. Table 13-8 contains more details.

In Table 13-9, the collaboration profile is analyzed in the regional context. Most collaboration agreements take place within Belgium (30%). Other EU countries are relatively frequently involved in collaboration. The collaboration with the United States (5%) and other countries (4%) is limited. Again, the large companies are an exception to the general profile: they strongly collaborate with institutions in Belgium (61%) and the EU (63%), but also in the United States (28%) and other countries (19%). This is partly due to group membership or the fact that large firms maintain foreign subsidiaries.

Firms in the chemicals/plastics sector report the highest frequency of EU collaborations (44%). Moreover, there is a high degree of internationalization (within the EU context) of innovation collaboration in Textiles, Metal, Machinery Vehicles (30% in each sector), and Information Services (31%). The Electronics sector is leading with respect to collaboration overseas: 16% of these firms collaborate with the US.

"1 of 3 innovating firms engage in some kind of collaboration. The more innovative and the bigger ones actively engage in open innovation management arrangements. There is a high degree of internationalization of innovation collaboration in textiles, metal, machinery vehicles (30% in each sector), and information services (31%)."

Table 13-8: Collaboration partners by sector and firm size

Sectors	Within Group (in %)	Suppliers (in %)	Clients/ Customers (in %)	Competitors (in %)	Consultants/ Commercial labs/ private R&D inst. (in %)	Universities (in %)	Government/ Public Research Inst. (in %)
Textiles	8	34	24	6	18	14	13
Paper/Wood	7	19	11	4	13	4	6
Chemicals/Plastics	33	45	33	9	28	20	15
Metal	19	39	25	8	19	24	17
Machinery/Vehicles	18	30	26	17	14	16	9
Electronics	23	29	27	9	21	27	19
Other Industries	8	19	12	8	10	6	6
Trade	17	25	19	13	17	13	9
Transport	20	25	20	11	13	5	3
Information Services	24	31	35	23	17	24	18
Other Services	18	28	19	18	13	12	6
Total	16	27	20	12	15	13	10

Firm Size	Within Group (in %)	Suppliers (in %)	Clients/ Customers (in %)	Competitors (in %)	Consultants/ Commercial labs/ private R&D inst. (in %)	Universities (in %)	Government/ Public Research Inst. (in %)
less than 50 empl.	11	22	16	10	13	10	8
50-249 empl.	29	40	31	13	19	17	12
250 and more	53	59	44	29	41	38	28
Total	16	27	20	12	15	13	10

Note: Sample results are extrapolated to the population of innovators.

Table 13-9: Regional distribution of collaboration partners by sector and firm size

Sectors	Belgium (in %)	EU (in %)	United States (in %)	Other countries (in %)
Textiles	34	30	8	6
Paper/Wood	19	12	0	0
Chemicals/Plastics	49	44	13	6
Metal	48	30	5	2
Machinery/Vehicles	35	30	10	6
Electronics	41	23	16	10
Other Industries	21	16	2	1
Trade	27	19	5	6
Transport	25	18	4	3
Information Services	45	31	13	7
Other Services	29	15	3	2
Total	30	22	5	4
Firm Size	**Belgium (in %)**	**EU (in %)**	**United States (in %)**	**Other countries (in %)**
less than 50 empl.	26	16	3	2
50-249 empl.	42	34	11	8
250 and more	61	63	28	19
Total	**30**	**22**	**5**	**4**

Note: Sample results are extrapolated to the population of innovators.

In the previous tables, the collaboration occurrence was the subject of analysis; Table 13-10 zooms in on the most important collaboration partners. The importance of suppliers and clients/customers is confirmed. However, large companies rely more on other collaboration partners, especially within the group (40% versus 26% in general). Collaboration with consultants/commercial labs/private

R&D institutions (7%), universities (6%), competitors (5%) and government/public research institutions (2%) takes place, but they are often not the most important collaboration partner. One exception here is the textile sector: universities appear to be an important collaboration partner (25%).

Table 13-10: Most important collaboration partners by sector and firm size

Sectors	Within Group (in %)	Suppliers (in %)	Clients/ Customers (in %)	Competitors (in %)	Consultants/ Commercial labs/ private R&D inst. (in %)	Universities (in %)	Government/ Public Research Inst. (in %)
Textiles	15	37	23	0	0	25	0
Paper/Wood	9	50	35	0	0	5	0
Chemicals/Plastics	43	18	27	5	0	4	4
Metal	17	43	24	0	5	7	3
Machinery/Vehicles	15	25	24	21	10	5	0
Electronics	34	13	16	12	9	15	0
Other Industries	23	43	12	8	1	10	3
Trade	29	38	12	4	15	3	0
Transport	34	33	11	0	21	0	0
Information Services	29	13	37	5	2	10	4
Other Services	21	44	27	2	0	2	5
Total	**26**	**33**	**20**	**5**	**7**	**6**	**2**

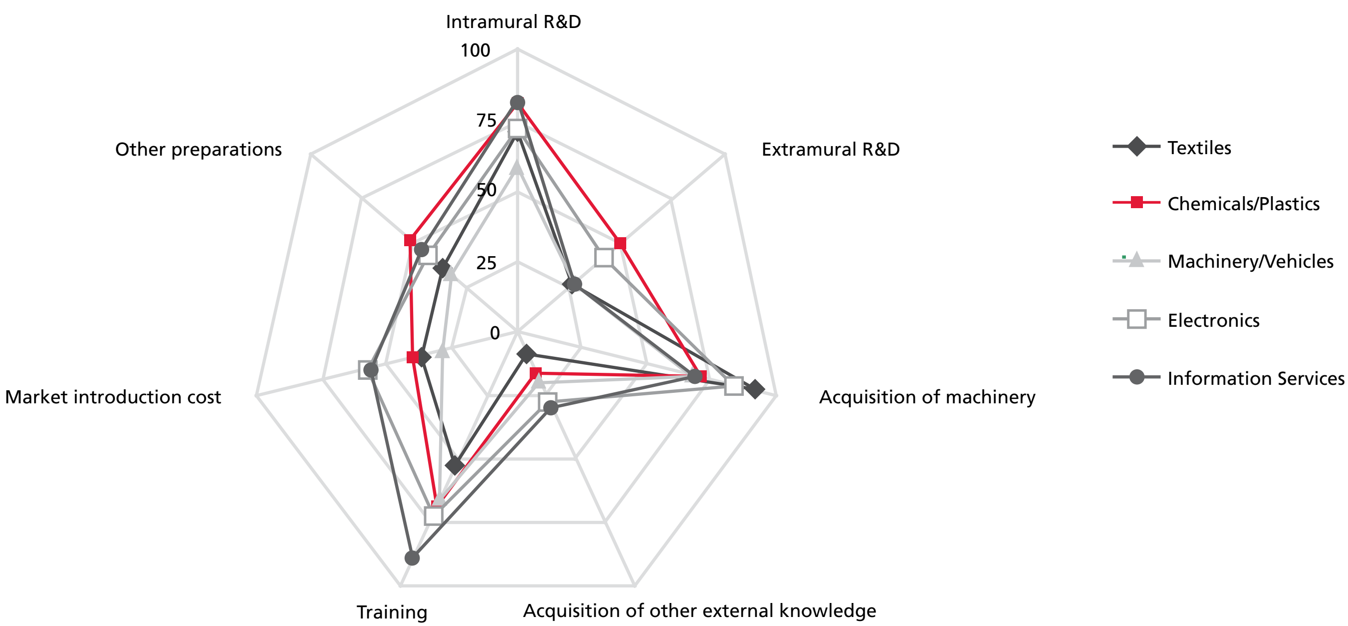
Sectors	Within Group (in %)	Suppliers (in %)	Clients/ Customers (in %)	Competitors (in %)	Consultants/ Commercial labs/ private R&D inst. (in %)	Universities (in %)	Government/ Public Research Inst. (in %)
less than 50 empl.	25	34	18	6	10	6	1
50-249 empl.	24	36	25	3	4	5	2
250 and more	40	20	19	4	2	9	5
Total	**26**	**33**	**20**	**5**	**7**	**6**	**2**

Note: Sample results are extrapolated to the population of collaborating firms

13.7 SUMMARY OF INNOVATION PROFILES

Figure 13-3 indicates the main points of innovation engagement in the most innovative sectors in Flanders. Intramural R&D activities are very important in most sectors. Extramural R&D occurs frequently in the chemicals/plastics and electronics sector. Textile companies engage heavily in the acquisition of machinery. Although we found that many firms follow an open innovation management style, the graph illustrates that with respect to external R&D, the openness is less important then intramural R&D. However, the acquisition of machinery and equipment may also be seen as an external means of sourcing in knowledge and technology. Training is most important in the information services sector. Electronics and information services invest relatively more in market introductions of their innovations.

Figure 13-3: Composition of innovative activity for selected sectors



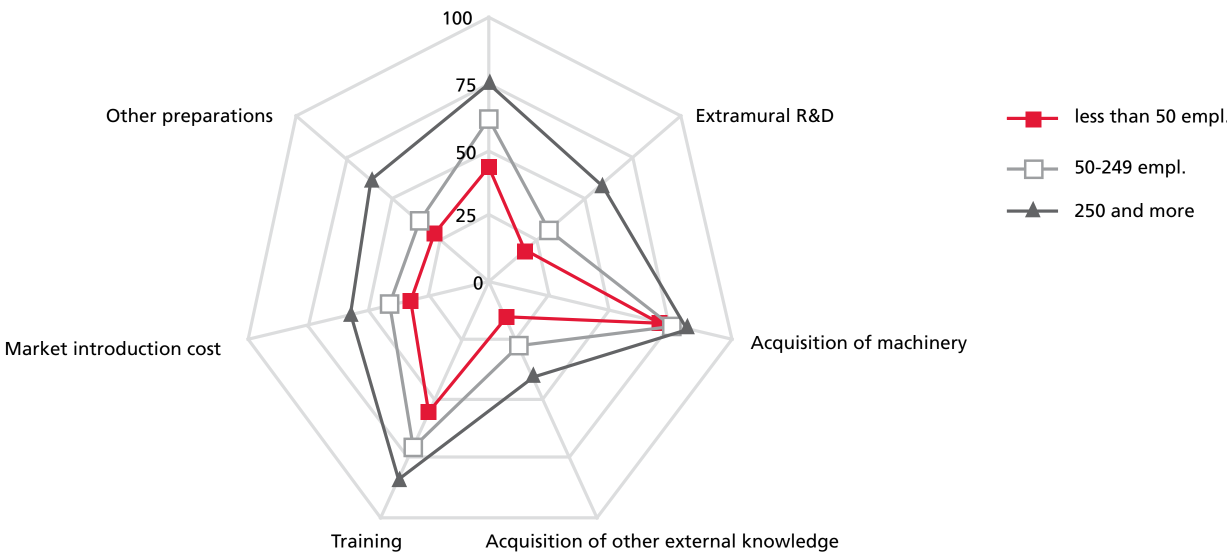
Note: Sample results are extrapolated to the population of innovating firms.

“Cost reductions are only realized by a small fraction of firms, and it does not seem to be a primary goal in the Flemish business sector.”

Figure 13-4 illustrates that the large companies engage most in innovative companies. When the different components are compared, the relative importance of each component is more or less equal. Most important for all innovating companies are intramural R&D, the acquisition of machinery and training.

When openness is considered, we find again that large companies make most use of external knowledge, such as contracting-out of R&D and acquiring other external knowledge through licensing or other channels. Small firms still follow a relatively closed innovation management style which is either due to financial constraints or lack of absorptive capacity within the firm. Another possibility could indeed be that innovation management is underdeveloped in small firms compared to larger companies.

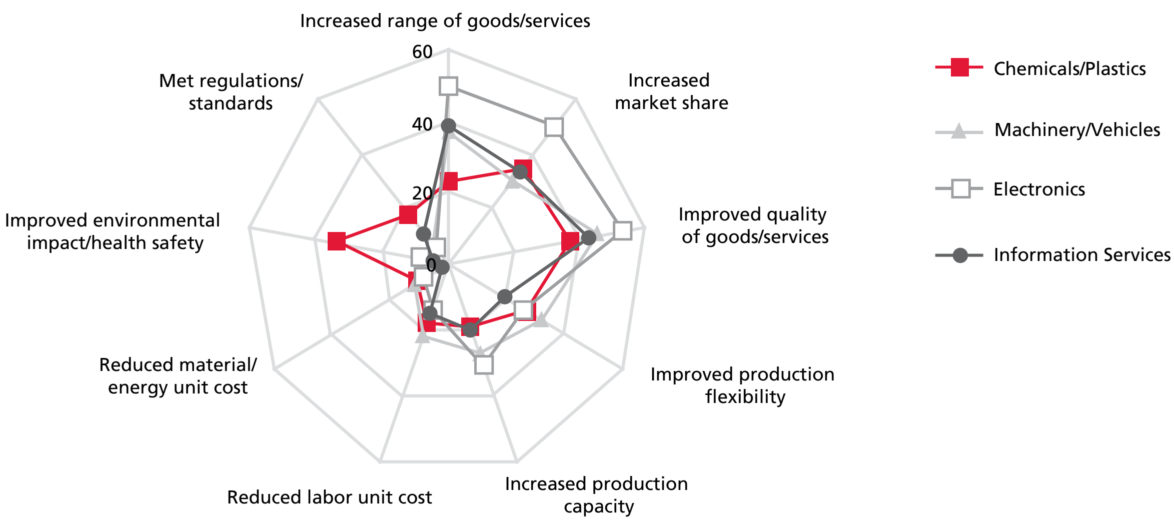
Figure 13-4: Composition of innovative activity by size



Note: Sample results are extrapolated to the population of innovating firms.

Figure 13-5 summarizes the effects of innovative activity for the most innovative sectors. Firms in the electronics sector belong to the most innovative ones in Flanders. The Electronics sector achieves the highest shares of firms that increased the range of goods and services, increased their market share, improved the quality of goods and services and also increased their production capacity. Furthermore, the graph makes clear that there is considerable variation among Chemicals/Plastics, Information Services and Machinery/Vehicles. It becomes clear, however, that firms in Chemicals/Plastics realize most technological progress when it comes to meeting governmental regulations or standards and improving environmental effects and health safety. Those issues are of minor importance in the other sectors. Again, we find that cost reductions are only realized by a small fraction of firms, and that reducing cost – relative to other achievements – does not seem to be a primary goal in the Flemish business sector

Figure 13-5: Effects of innovative activity for selected sectors (in %)



Note: Sample results are extrapolated to the population of innovating firms.

Chapter 14

MANAGEMENT OF KNOWLEDGE CAPITAL

In this section we investigate the management of knowledge capital. Due to the structure of the questionnaire, from here onwards both innovative and non innovative companies are the subject of analysis.

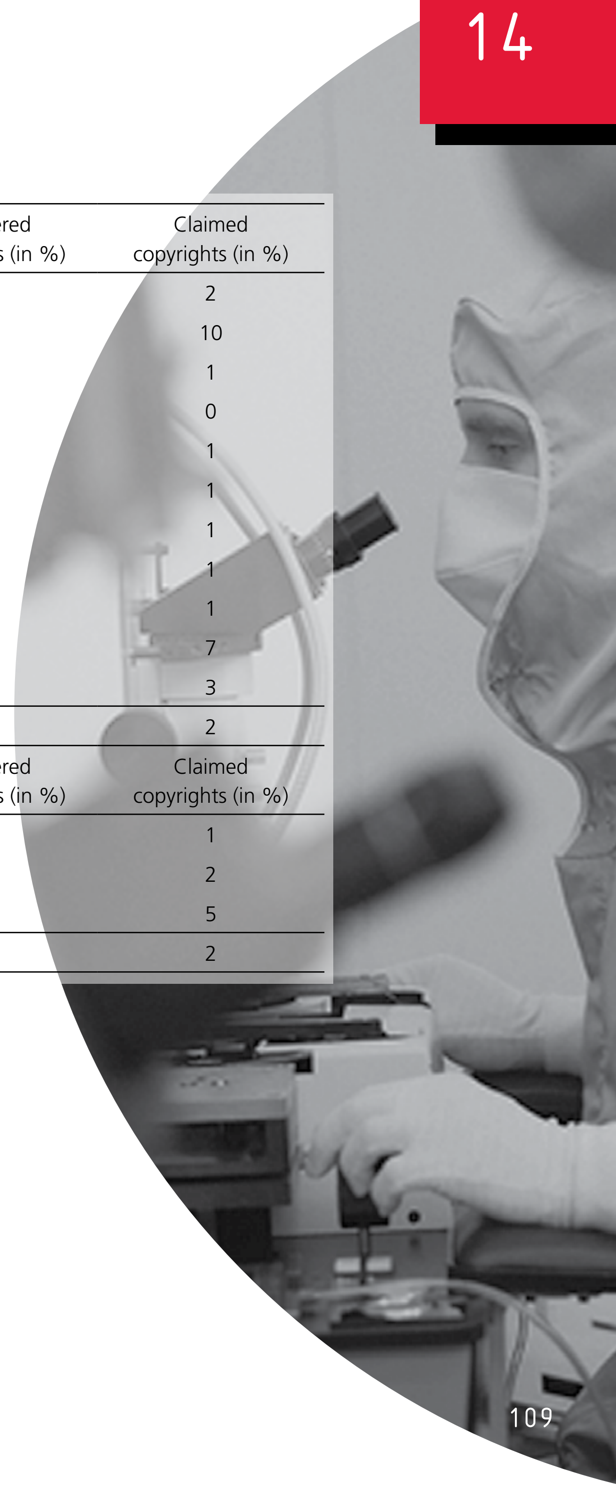
Innovation efforts are essential in an economy, and it is important that firms have an incentive to innovate. The most common public policy creating innovation incentives are intellectual property rights that grant the inventor a temporary monopoly right for the economic exploitation of newly developed products or processes. If no intellectual property rights were in place, other companies could easily free ride on one company's investments. Hence, the investment in innovation would most probably be less. The following table illustrates how Flemish companies make use of different means of intellectual property protection: patent applications, industrial designs, trademarks, and copyrights. There are large discrepancies over sector and size (see Table 14-1). In sectors like electronics, chemicals/plastics, machinery/vehicles or information services patent applications are important. Electronics is also leading in registering industrial designs., and trademarks. Registering trademarks is also a common practice in Textiles. Copyrights are most frequent in the "Paper/Wood" sector which includes publishers. There copyrights are the regular form of protection. In other sectors, other ways of protection may be more common. Examples are secrecy or the complexity of design. Large companies make more use of intellectual property protection more frequently.

"In electronics, chemicals/plastics, machinery/vehicles or information services patent applications are important. Registering trademarks is a common practice in electronics and textiles. Copyrights are most frequent in the "Paper/Wood" sector including publishers."

Table 14-1: Intellectual property management by sector and firm size

Sectors	Applied for patents (in %)	Registered industrial designs (in %)	Registered trademarks (in %)	Claimed copyrights (in %)
Textiles	8	7	21	2
Paper/Wood	2	1	11	10
Chemicals/Plastics	20	3	13	1
Metal	6	4	4	0
Machinery/Vehicles	18	6	5	1
Electronics	19	12	24	1
Other Industries	2	1	4	1
Trade	4	3	7	1
Transport	0	0	3	1
Information Services	13	1	12	7
Other Services	1	0	4	3
Total	5	2	7	2
Firm Size	**Applied for patents (in %)**	**Registered industrial designs (in %)**	**Registered trademarks (in %)**	**Claimed copyrights (in %)**
less than 50 empl.	3	2	5	1
50-249 empl.	9	4	15	2
250 and more	24	11	23	5
Total	5	2	7	2

Note: Sample results are extrapolated to the population of firms.



Chapter 15

MARKETING AND ORGANIZATIONAL INNOVATIONS

A novelty in the CIS4 survey is the inclusion of questions on marketing and organizational innovation. Marketing innovation is defined as the implementation of new or significantly improved designs or sales methods to make goods or services more attractive or to conquer new markets. An organizational innovation is the implementation of new or significant changes in the corporate structure or in management methods to improve the use of knowledge, the quality of the products or the efficiency of workflows.

The results are presented in Table 15-1. 12% of the Flemish companies introduced significant design or packaging changes and 13% introduced significantly changed sales/distribution methods. The most important organizational innovation is a change in the work organization (24%). Companies also improved their knowledge system (19%) or changed their relationship to other firms, e.g. through alliances, partnerships or outsourcing (9%).

The sectors and size classes that had more product and process innovators (large companies and companies in electronics, machinery/vehicles, chemicals/plastics and information services) also have higher scores on both marketing and organizational innovation. This seems to indicate that technical and non-technical innovation activities go hand in hand.

> “The most important organizational innovation is a change in the work organization (24%), but also improvement of knowledge systems (19%) or changes in the relationship to other firms, e.g. through alliances, partnerships or outsourcing (9%) seems to indicate that technical and non-technical innovation activities go hand in hand.”

Table 15-1: Organizational and marketing innovations by sector and firm size

	Marketing innovation		Organizational innovation		
Sectors	Introduced significant design/ packaging changes (in %)	Introduced significantly changed sales/ distribution methods (in %)	Improved knowledge management system (in %)	Changed work organization (in %)	Changed relationship to other firms (in %)
Textiles	20	22	25	25	12
Paper/Wood	14	17	23	21	12
Chemicals/Plastics	25	18	23	30	13
Metal	10	7	22	32	9
Machinery/Vehicles	22	12	35	36	18
Electronics	23	19	28	37	18
Other Industries	11	8	13	16	4
Trade	13	16	17	23	6
Transport	5	13	15	22	13
Information Services	20	17	42	40	24
Other Services	7	7	25	29	8
Total	12	13	19	24	9

	Marketing innovation		Organizational innovation		
Firm Size	Introduced significant design/ packaging changes (in %)	Introduced significantly changed sales/ distribution methods (in %)	Improved knowledge management system (in %)	Changed work organization (in %)	Changed relationship to other firms (in %)
less than 50 empl.	10	12	17	21	7
50-249 empl.	19	14	30	33	14
250 and more	34	27	49	49	20
Total	12	13	19	24	9

Note: Sample results are extrapolated t o the population of firms.

Table 15-2 shows the effects of organizational innovation. As a result of changes in the knowledge management system, the work organization or the relationships with other companies or public institutions, companies were able to improve the quality of their goods/services (51%) and to reduce the time to respond to customer needs (49%). Also unit cost reduction (20%) and improved employee satisfaction (20%) were realized.

Again, we find that companies put less emphasis on cost reductions in their innovation efforts. Quality of goods and services and reduced time to respond to customer needs seem to be more important. However, it may be beneficial, especially for small and medium-size firms, to investigate whether cost can be reduced. Price reductions could enhance the competitiveness of firms which finally allows to access new (international) markets offering growth opportunities, or contributes to survival which may be a primary goal of very small firms in the business sector.

Table 15-2: Effects of organizational innovations by sector and firm size

Sectors	Reduced time to respond to customer needs (in %)	Improved quality of goods/services (in %)	Reduced unit costs (in %)	Improved employee satisfaction (in %)
Textiles	40	36	15	11
Paper/Wood	50	63	36	23
Chemicals/Plastics	49	29	10	9
Metal	37	43	16	12
Machinery/Vehicles	43	52	32	11
Electronics	56	55	43	29
Other Industries	61	47	26	30
Trade	48	55	16	16
Transport	51	56	20	17
Information Services	38	45	16	17
Other Services	47	56	19	29
Total	49	51	20	20
Firm Size	Reduced time to respond to customer needs (in %)	Improved quality of goods/services (in %)	Reduced unit costs (in %)	Improved employee satisfaction (in %)
less than 50 empl.	48	52	19	22
50-249 empl.	48	48	24	15
250 and more	56	49	28	12
Total	49	51	20	20

Note: Sample results are extrapolated to the population of firms with organizational innovation.

Chapter 16

OBSTACLES TO INNOVATION

For both innovative and non-innovative companies, the survey asked for impediments to innovation activities. Four categories were distinguished: cost, knowledge, market and other obstacles. Also reasons not to innovate were investigated (see Table 16-1).

Table 16-1: Obstacles to innovation by sector and firm size

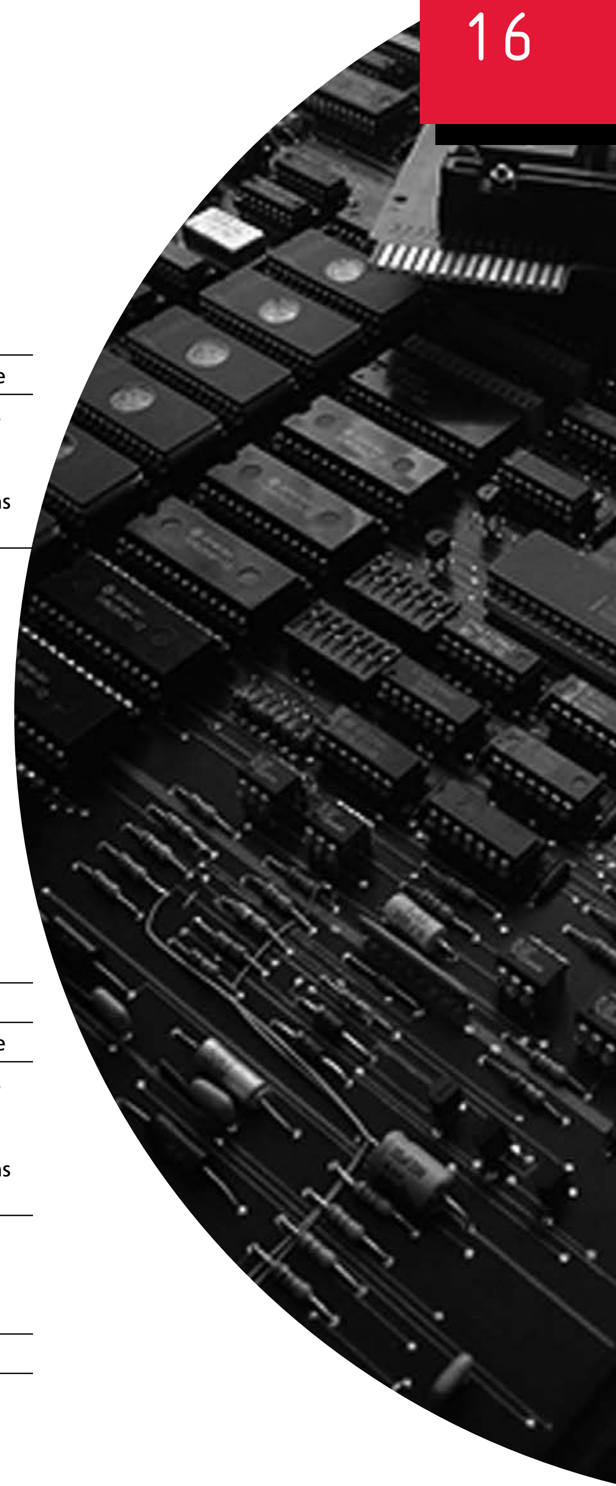
	Cost obstacles			Knowledge obstacles			
Sectors	Lack of f unds within group (in %)	Lack of external funds (in %)	Inno. costs too high (in %)	Lack of qualified personnel (in %)	Lack of tech. info. (in %)	Lack of market info (in %)	Difficulty in finding collabo-ration partners (in %)
Textiles	13	14	14	8	0	1	10
Paper/ Wood	26	16	20	18	3	4	8
Chemicals/ Plastics	18	12	21	12	4	9	7
Metal	21	13	16	13	5	4	4
Machinery/ Vehicles	17	9	16	14	6	2	5
Electronics	18	15	25	17	8	6	13
Other Industries	18	7	15	16	7	3	10
Trade	10	5	13	6	1	4	4
Transport	10	8	19	13	4	5	7
Information Services	22	17	21	13	2	5	6
Other Services	8	5	15	9	3	2	3
Total	14	8	16	11	4	4	6
	Cost obstacles			Knowledge obstacles			
Firm Size	Lack of f unds within group (in %)	Lack of external funds (in %)	Inno. costs too high (in %)	Lack of qualified personnel (in %)	Lack of tech. info. (in %)	Lack of market info (in %)	Difficulty in finding collabo-ration partners (in %)
less than 50 empl.	15	8	17	12	4	3	7
50-249 empl.	12	8	11	9	5	6	6
250 and more	16	9	12	8	1	3	3
Total	**14**	**8**	**16**	**11**	**4**	**4**	**6**

Note: Sample results are extrapolated to the population of firms. A hampering factor was counted when the firm indicated that the particular obstacle was "impor

Market obstacles		Other obstacles			Reasons not to innovate	
Market dominated by establ. firms (in %)	Uncertain demand for innovative goods/services (in %)	Problems with regulation/ standards (in %)	Resi-stance to changes within firm (in %)	Inno. can be copied too easily (in %)	No inno. due to prior activity (in %)	No inno. due to market conditions (in %)
20	19	5	3	26	2	22
6	11	8	2	5	7	11
23	12	17	1	6	2	5
12	5	2	4	5	6	10
11	14	10	2	9	3	7
19	12	1	4	12	0	14
16	11	17	6	15	11	18
10	6	15	2	7	2	16
20	14	11	5	7	7	18
10	17	6	3	4	2	9
12	9	6	2	3	6	16
14	10	12	4	9	5	15

Market obstacles		Other obstacles			Reasons not to innovate	
Market dominated by establ. firms (in %)	Uncertain demand for innovative goods/services (in %)	Problems with regulation/ standards (in %)	Resi-stance to changes within firm (in %)	Inno. can be copied too easily (in %)	No inno. due to prior activity (in %)	No inno. due to market conditions (in %)
13	10	13	4	8	5	16
15	10	7	3	13	6	11
15	15	8	4	6	4	11
14	**10**	**12**	**4**	**9**	**5**	**15**

tant”.



“If we look at firms that did not innovate between 2002 and 2004, we see that 13% find the innovation cost too high, and 11% mention the lack of funds within the firm/group as an important hurdle for innovation. The lack of qualified personnel affected 10% of non-innovating firms.”

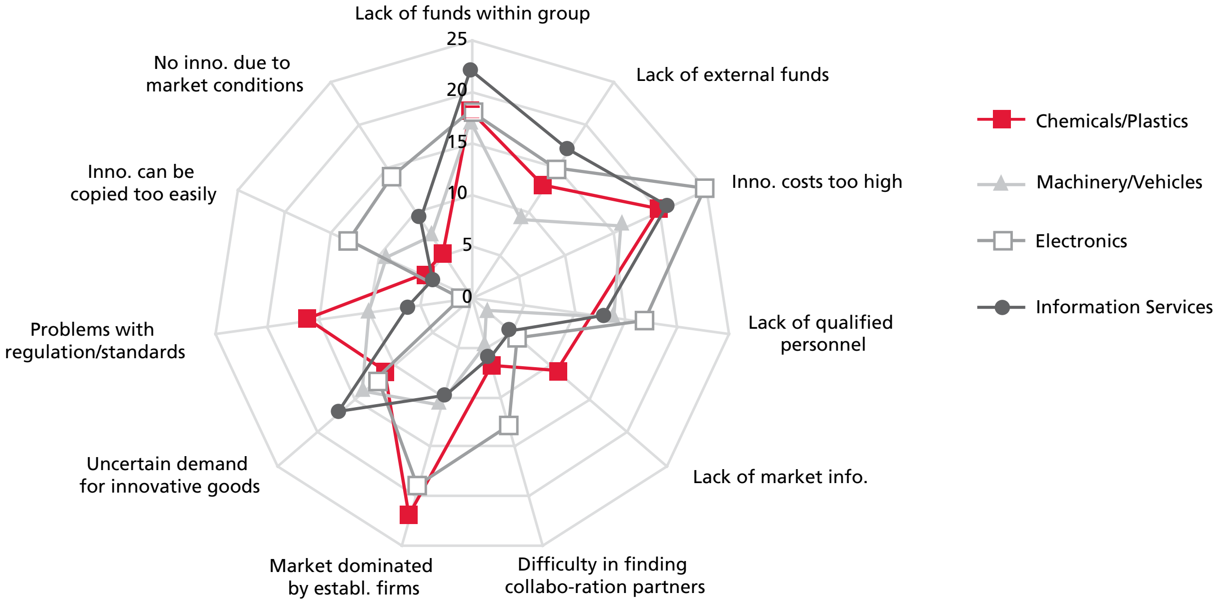
Cost obstacles seem to put a strong limitation on innovation activities: the innovation costs are too high (16%) or within group (14%) or external (8%) funds are lacking. Market obstacles, like domination by established firms (14%) or uncertain demand for innovative products (10%), arise too. Lack of qualified personnel (11%) is the most common knowledge obstacle, but there is also a lack of technological (4%) or market (4%) information or difficulties in finding collaboration partners (6%). Some companies experience problems with regulation/standards (12%). Resistance to changes within the firm (4%) and the fact that the innovation can easily be copied (9%) impose another barrier to innovation activities.

Reasons not to innovate are for example the limited demand for innovations (15%) or no need because of prior innovations (5%).

Figure 16-1 displays important hampering factors for innovation in Flanders for selected sectors. While the electronics sector is one of the most innovative sectors in Flanders, firms in this sector also indicate several obstacles to innovation most frequently amongst these highly innovative sectors. For instance, firms in electronics report most frequently that the innovation costs are too high, that there is a lack of qualified personnel, that firms did not innovate due to market conditions, that firms have difficulties in finding collaboration partners, and that innovations can be copied too easily. Despite the high innovation efforts ongoing in this sector, there seems to be room for improvement, though.
Firms in the chemical sector state that innovation is hindered by problems with regulation and standards most frequently, that the market is dominated by established firms and that they lack sufficient market information. Information services are subject to financial constraints most frequently and also by an uncertain demand for innovative goods/services. Although most obstacles to innovation arise through a firm’s individual behavior and environment, there may be room for public policies to improve the Flemish innovation system. However, it has to be taken into account that most problems with

regard to innovation cannot be solved on the state level necessarily – many aspects of the obstacles occur on an international level, such as the search for collaboration partners, meeting EU regulations and standards, and the market domination by established firms, for instance.

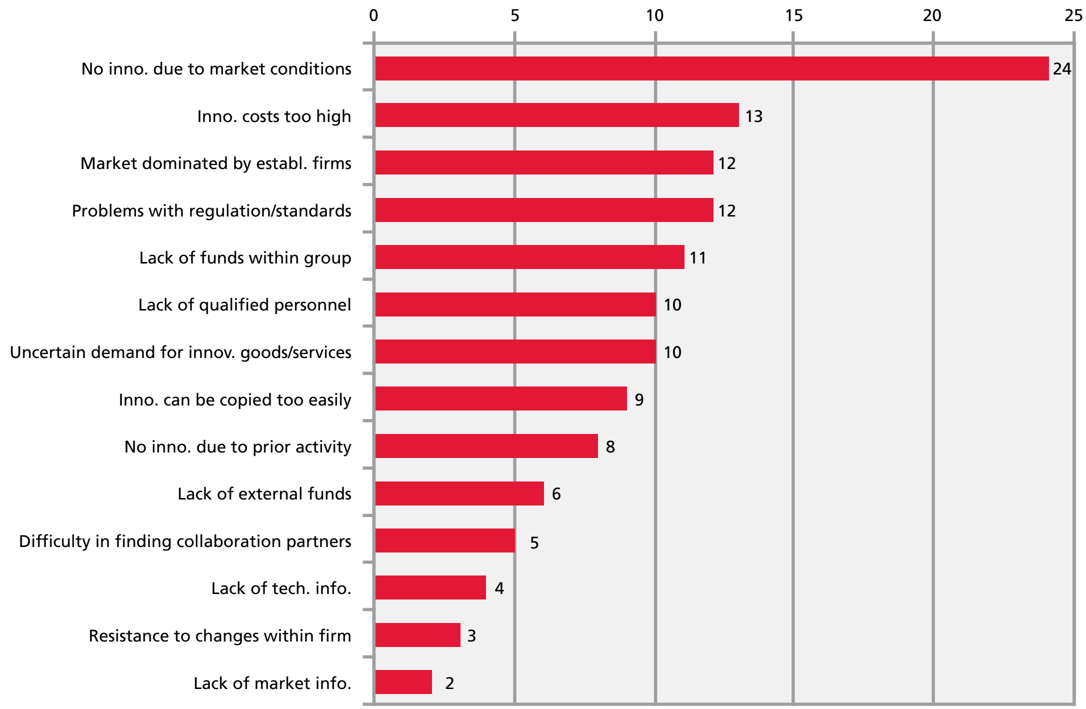
Figure 16-1: Important hampering factors for selected industries



Note: Sample results are extrapolated to the population of firms. A hampering factor was counted when the firm indicated that the particular obstacle was "important".

It is also interesting to look at firms that did not innovate between 2002 and 2004. The hampering factors could shed some light on reasons why such firms did not engage in innovation, and if there are possible approaches for innovation policy to reduce some obstacles to innovate. Figure 16-2 shows the hampering factors for the population of non-innovating firms. The majority of firms did not innovate due to bad market conditions (24%). This gone in line with the fact that 12% of non-innovative firms feel that the markets are dominated by established firms. Besides the product market, the financing of innovation places restrictions on firms' activities: 13% of non-innovators find the innovation cost too high, and 11% mention the lack of funds within the firm/group as an important hurdle for innovation. The lack of qualified personnel affected 10% of non-innovating firms.

Figure 16-2: Hampering factors of non-innovating firms (in %)



Note: Sample results are extrapolated to the population of non-innovative firms. A hampering factor was counted when the firm indicated that the particular obstacle was "important".

Chapter 17

CONCLUSIONS ON THE INNOVATION SURVEY

This report presents the results of the Fourth Community Innovation Survey (CIS4) for Flanders. As baseline result, it is found that about 46% of firms in the population introduced at least one new product or process in the time period from 2002 to 2004, or have ongoing or abandoned innovation activity. The total share, however, is influenced by some sectors that are large, but exhibit only moderate innovation activity, such as Transport, Trade, the Construction Sector or non-technology intensive business services. In several industries the share of innovators is substantially higher. Among those are Electronics (84%), Chemicals/Plastics (79%), Machinery/Vehicles (75%), and IT/R&D and technology-intensive business services (78%).

The share of product innovators amounts to 30%. Among those, 58% of firms have at least introduced one product that was not only new to the firm, but new to the market. 59% of process innovators achieve unit cost reductions, and 67% realize quality improvements.

The survey also shows that most innovating firms prefer an internal development of products (73%) and processes (65%). However, it also turns out that a large share of Flemish companies follow an open innovation management style. While 48% of innovators conduct internal R&D, for example, 23% also contract-out R&D to third parties in order to utilize external knowledge, and collaborate frequently within innovation projects. In total, 34% of innovating firms engage in some kind of collaborative research within the innovation process. The numbers also show that firms that collaborate are typically involved with multiple partners. With respect to the type of partner, for instance, 27% collaborate with suppliers, 20% with customers, and 15% with consultants or commercial R&D labs. Collaboration is not restricted to Belgium: 22% of firms collaborate with firms in other countries of the EU, and 5% with US-based firms.

Innovation is not only restricted to purely technological progress. Firms also change their organizational structures and marketing strategies with respect to innovation. For instance, 12% of firms have introduced significant design or packaging changes and 19% improved their knowledge management systems. The work organization has been changed in 24% of firms, and 13% introduced new distribution methods.

Obstacles to innovation are possibly slowing down technological progress in Flanders. Firms most frequently suffer from the lack of funds for innovation; either within the firm or group (14%) or external funding (8%). Another frequent reason is that innovation cost are expected to be too high (16%). The lack of qualified personnel hampers innovation in 11% of firms. Finally, obstacles induced by the product market are other reasons. For instance, an uncertain demand for innovative goods or services (10%) or the fact that the market is dominated by established firms (13%).

Our survey design of CIS4 allows a comparison of total intramural R&D spending obtained from the CIS survey to the one year earlier R&D survey. While Flanders suffered from a reduction of R&D spending in the business sector of about 5% from 2002 to 2003 (in constant prices of the year 2000), the decline stopped in 2004. Compared to 2003, there is a slight increase in business R&D spending. The growth rate compared to 2003 is below 1% in real terms, though.

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Wat is M&A ?

De nieuwe IWT-unit Monitoring & Analyse ondersteunt de verdere professionalisering en performantieverbetering van het IWT en haar diensten en producten.

Meten = weten
M&A wil in Vlaanderen voldoende strategische intelligentie ontwikkelen door:

- het evalueren en ondersteunen van het innovatiebeleid
- het verzamelen en opvolgen van innovatie-indicatoren en het ontwikkelen van een monitoring-apparaat ten behoeve van het IWT en de innovatie-intermediairen
- het vertegenwoordigen van het IWT in Vlaamse, federale en internationale organen of netwerken

Return on Innovation Investment
M&A organiseert op regelmatige tijd workshops over innovatiethema's met beleidsrelevantie en publiceert grondige studies van het Vlaams Innovatiesysteem, maar ook kortere analyses en evaluaties van innovatie-programma's. Dit doet ze op eigen kracht alsook in samenwerking met een netwerk van onderzoeksgroepen en organisaties in binnen- en buitenland.

Kortom, M&A onderneemt alle activiteiten die kunnen bijdragen tot het meten en het verhogen van de Return on Innovation Investment (ROI^2) in Vlaanderen.

Since January 2005 **Dirk Czarnitzki** is a Senior Researcher at the Steunpunt O&O Statistieken at K.U. Leuven. His research interests are mainly in the field of the economics of innovation and applied microeconometrics. He has published widely on topics such as the evaluation of public innovation policies, corporate governance and innovation, the valuation of intellectual assets, as well as knowledge and technology transfer.