

# THE KNOWLEDGE BASE OF BRUSSELS

A REPORT FOR VOKA METROPOLITAN



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## Table of Contents:

<b>Introduction</b> .....	4
<b>Part 1: Defining Knowledge-intensive Activities</b> .....	5
<i>1.1 Knowledge intensive activities</i>	5
<i>1.2 Four Classifications</i>	6
<i>1.3 The knowledge base in Brussels</i>	9
<b>Part 2: Mapping knowledge-intensive activities in and around Brussels</b> .....	14
<i>2.1 Assessing the concentration and specialisation of knowledge intensive sectors in Brussels</i> <i>Assessment of employment data through ONSS-RSZ+ INASTI-RSVZ</i> <i>Defining Brussels</i> <i>Concentration and specialization in Brussels</i>	
<i>2.2 Identification of major clusters in Knowledge intensive sectors</i>	19
<b>Part 3: The Employment Effect of Knowledge-Intensive jobs in Brussels: Multipliers Based on Regression Analysis</b> .....	25
<i>3.1 Introduction</i>	25
<i>3.2 Employment Data</i>	26
3.2.1 <i>Employment types</i>	
3.2.2 <i>Dynamics of total employment</i>	27
3.2.3 <i>Total sector employment</i>	29
<i>3.3. Evolution of knowledge-intensive employment</i>	32
<i>3.4. Dynamics of total employment: shift-share analysis</i>	33
<i>3.5. Calculation of the multiplier effects: panel regression analysis</i>	37
<i>3.6. The knowledge-intensive employment multiplier</i>	39
3.6.1. <i>The employment multiplier without control variables</i>	
3.6.2. <i>The extended employment multiplier: accounting for other factors influencing total employment</i>	
<b>Part 4: Multiplier Effects as Identified through Interregional Input-Output Tables</b> .....	44
<i>4.1 Introduction: why use interregional Input-Output Tables?</i>	44
<i>4.2. Method</i>	46
<i>4.3. Job creation by knowledge intensive industries located in the Brussels Capital Region</i>	49
4.3.1. <i>Sector-specific examples</i>	
4.3.2. <i>Aggregate multiplier effects for all (knowledge-intensive) sectors</i>	
<i>4.4 Limitations of the approach</i>	55
<b>Part 5: Summary</b> .....	57
<b>References</b> .....	60
<b>Appendices</b> .....	62

### ***List of tables:***

- 1.1 Four classifications of Knowledge Intensive sectors
- 1.2 Knowledge intensive jobs in the Brussels Capital Region – average 2008-2020 – according to four scenarios
- 1.3 Key figures on the knowledge base by spatial scales – year 2020 and evolution 2008-2020
- 2.1 Concentration (1) and specialization (2) in 2018
- 3.1 Positioning employment types in the Brussels Capital Region
- 3.2 Evolution of total employment by province
- 3.3 Sector shares of the employment in the Brussels Capital Region and the rest of Belgium
- 3.4 Shift-share analysis based on total employment data – 2008-2020
- 3.5 Industry-mix effects capturing the growth effect of economic structure
- 3.6 Sector growth effects capturing the growth effect of sectoral performance
- 3.7 Multiplier analysis without control variables: fixed-effects panel regression results 2008-2020
- 3.8 Impact on the evolution of total employment: results of the fixed-effects panel regression
- 4.1. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels (NACE 62) Computer programming, consultancy and related activities-sector
- 4.2. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels (NACE 64) Financial service activities, except insurance and pension funding-sector
- 4.3. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels (NACE 69) Legal and accounting activities-sector
- 4.4. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels Activities of head offices; management consultancy activities (NACE 70)
- 4.5. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels Arts, entertainment and recreation sector (NACE 90)
- 4.6. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels Scientific research and development-sector (NACE 72)
- 4.7. Aggregate employment impact (jobs generated) of a 10 million euro increase in final demand using global intra- and interregional multipliers
- 4.8. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the OECD definition)
- 4.9. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the Eurostat definition)
- 4.10. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the KI Jobs-BEint definition)
- 4.8bis. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the OECD definition BUT EXCLUDING NACE 84re – Public Sector)
- 4.11. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all Brussels sectors
- 4.12. Intra- and interregional impact (value added generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the OECD definition)
- 4.13. Intra- and interregional impact (value added generated) of a 1% increase in final demand of all sectors in Brussels

### ***List of figures:***

- 1.1 - Knowledge-intensive employment: education and occupation
- 1.2: Intensity of knowledge jobs (education and occupation) in the primary industry, average 2010-2020, by geographical territory
- 1.3: Intensity of knowledge jobs (education and occupation) in the manufacturing industry, average 2010-2020, by geographical territory
- 1.4: Intensity of knowledge jobs (education and occupation) in the business services, average 2010-2020, by geographical territory
- 1.5: Intensity of knowledge jobs (education and occupation) in administrative and public services and education, average 2010-2020, by geographical territory
- 2.1 The Brussels metropolitan area based on functional employment area.
- 2.2 Knowledge intensive jobs by municipality in 2018
- 2.3. Manufacture of Pharmaceutical products
- 2.4. Jobs in Telecommunications
- 2.5 Jobs in Computer, consultancy and related activities
- 2.6. Jobs in Legal and accounting services
- 2.7 Jobs in financial services
- 2.8. jobs in head offices and management activities
- 2.9. Jobs in administration
- 2.10. Jobs in human health
- 2.11. Jobs in Creative activities
- 3.1 - Annual evolution of total employment between 2008 and 2020
- 3.2 – Evolution of knowledge-intensive employment and other employment, BCR
- 3.3 - Annual evolution of the knowledge-intensive employment between 2008 and 2020
- 4.1: basic structure of the interregional IO table

# THE KNOWLEDGE BASE OF BRUSSELS

## Introduction

This study provides some insights in the presence and the geographical spread of knowledge intensive jobs in the Brussels-Capital Region and the larger Brussels metropolitan area, and the contribution of these knowledge-intensive jobs to the creation of less-skilled jobs in the Brussels economy.

The report consists of four parts. A first part defines knowledge-intensive sectors and activities. As the focus of this study lies on employment, with special attention to the distinction between knowledge-intensive jobs and less knowledge-intensive jobs, both employment in the knowledge-intensive sectors, as well as knowledge jobs or knowledge workers – defined by combined occupation and education level – in each sector are considered. Attention is paid to the particularities of Brussels compared to other parts of the country.

In the second part of the report, based on the definitions proposed in part 1, a mapping is presented of knowledge-intensive activities in and around Brussels (metropolitan area). Next to a quantification in terms of shares and a specialization index, we consider the geographical distribution of the direct employment offered by knowledge-intensive activities. This distribution is presented at the level of the municipality, in Brussels as well as in its periphery and other parts of the Belgian territory, and allows to visualize clusters of various knowledge intensive activities.

The third part focuses on the dynamics of total and knowledge intensive employment in the Brussels Capital Region and compares this with evolutions elsewhere in Belgium. It includes a shift-share analysis to decompose the observed employment growth differential. It further uses an econometric approach to identify an employment multiplier, teasing out the effects of knowledge-intensive jobs on total employment. As total employment changes are obviously not only driven by (exogenous shocks in) knowledge-intensive employment, we also provide an econometric model that controls for other relevant influences.

In Part 4, based on the Federal Planning Bureau's regional input-output tables and multipliers, we analyse employment effects of demand shocks in knowledge intensive activities located in Brussels. The regional multiplier approach as such allows to decompose these employment effects in direct and indirect as well as intra- and interregional employment effects. Moreover, and directly building on our findings in part 1, we complement this framework with a further decomposition of the various employment effects in knowledge-intensive and non-knowledge activities.

## **Part 1: Defining Knowledge-Intensive Activities**

### ***1.1 Knowledge-intensive activities***

Knowledge-intensive activities (or industries) can be defined in different ways and according to different classifications (Galindo-Rueda & Verger, 2016; Marsili & Verspagen, 2002). In view of a workable definition of knowledge-intensive activities for the objectives of this study, we take as a starting point a sectoral approach looking at the technological intensity in industries. We complement this with a job approach that focuses on the skills and competences needed for a job to be qualified as a knowledge job.

For technology intensity at industry level, we follow the internationally harmonized OECD and Eurostat definitions. Based on the OECD Frascati Manual (OECD, 2015) the share of R&D expenditure in gross domestic product of a sector is relied upon as a conventional classification criterion to identify knowledge intensive sectors. These are composed of high-tech manufacturing and knowledge intensive services. Eurostat defines knowledge-intensive activities by using the share of highly skilled employees in total sector employment to identify it as a sector with knowledge-intensive activities (Eurostat, 2021)<sup>1</sup>.

The knowledge intensity of a specific sector could, however, be gauged on the basis of other criteria as well. Specifically, rather than building on R&D expenditures, one could directly look at the typical qualifications of employees. Specifically, we can look at the education and occupation of employees for each sector.

This information is drawn from the Community Labour Force Survey (LFS hereafter), a harmonized survey among European countries that collects data both for employed and unemployed persons. As we focus on actual knowledge activities, we target the so-called 'occupied population', including two categories of employment: (i) the employed population which represents workers, employees and civil servants; (ii) the self-employed population which represents the self-employed and helpers.<sup>2</sup> It should thus be noted that, when looking at the knowledge intensity within a sector, a combination is made of both the educational attainment levels and the occupational status of persons employed in a specific sector.

We measure individual educational levels by looking at an individual's highest ISCED (International standard classification of education) level successfully completed, the successful completion of an education programme being validated by a recognised qualification. To get an idea of the occupational status of employed persons, we build on the International Standard Classification of Occupations (ISCO) as developed by the International Labour Organisation.

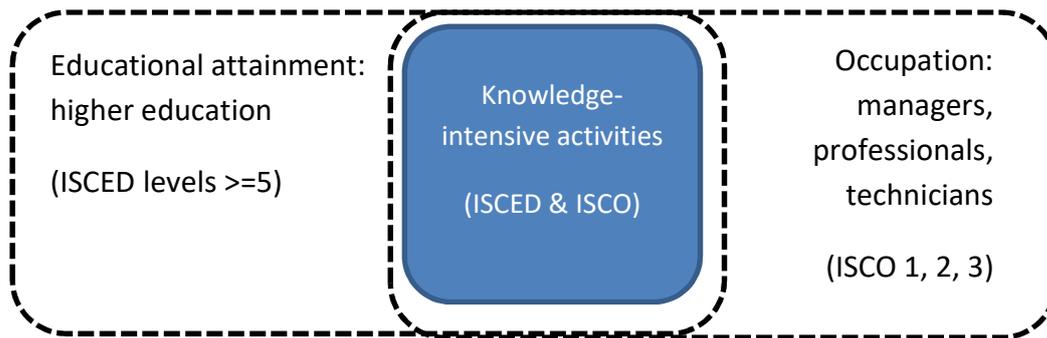
We applied this logic to the LFS dataset for the period 2010-2020, and consider the intersection of education levels 5 and more (i.e. at least short cycle higher education) and occupation (including categories 1 (Managers), 2 (Professionals), and 3 (Technicians and associate professionals) as representing knowledge-intensive employment; Figure 1.1 captures this logic.

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<sup>1</sup> More detailed information about the sector classifications can be found in Appendix 1.1.

<sup>2</sup> More detailed information about the Labour Force Survey can be found in Appendix 1.2.

**Figure 1.1 - Knowledge-intensive employment: education and occupation**



Source: Author's adaptation of OECD (1995). ISCED: International Standard Classification of Education; ISCO: International Standard Classification of Occupations. More details on the classifications can be found in Appendix 1.3.

## 1.2 Four classifications

As there is no unique definition of knowledge intensive activities or jobs, we present four scenarios for measuring the Brussels knowledge base. These scenarios are as follows:

- One can restrict the knowledge industries to the official classification of OECD. The sectors designated as such can be found in the “KIS-OECD” column of Table 1.1. Note that, to measure the actual shares of knowledge-intensive jobs within these sectors we will still apply our definition of a knowledge worker (based both on education and occupation – cf. Figure 1.1) to this classification;
- One can identify knowledge intensive industries as defined by Eurostat (based on the Labour Force Survey). This yields the results in the “KIA-Eurostat” column of Table 1.2. Again, one can apply the definition of knowledge worker to the so identified sectors to measure the actual shares of knowledge-intensive jobs within these sectors;
- A third variant uses essentially the same identification method as the previous one (knowledge intensive industries are defined based on whether at least 33% of the employees attain the short cycle tertiary education level or higher), but uses the Labour Force Survey results for Belgian sectors to check whether that criterion indeed holds. This leads to the classifications in column “KI Jobs-BEint”. Similarly as with the previous two, our knowledge worker definition allows for a further identification of KI jobs within the sectors
- Finally, one can take the position that all industries have a knowledge component (so no selection is made based on classification of industries) and apply the definition of knowledge worker on every industry in Brussels, based on Labour Force Survey data for Brussels for the period 2010-2020. This yields the column “KI-jobs\_BCRint”.

Table 1.1 thus applies these four scenarios to identify *which specific* sectors in Brussels can be deemed knowledge intensive (in scenarios 1-3) or, alternatively, quantifies to what extent *each* of these sectors uses knowledge intensive jobs (scenario 4). Clearly, no identification as such says anything about the

actual importance of a specific sector. Thus, the table also reports the (2020) share of the sector's jobs in the Brussels total.<sup>3</sup>

**Table 1.1: Four classifications of Knowledge Intensive sectors**

<b>NACE 2</b>	<b>Description</b>	<b>KIS-OECD</b>	<b>KIA-Eurostat</b>	<b>KI jobs-BEint</b>	<b>KI-jobs-BCRint *</b>	<b>Share of jobs in BCR 2020</b>
1	Crop and animal production, hunting and related service activities	0	0	0	0,448	0,43
2	Forestry and logging	0	0	0	0,792	0,01
3	Fishing and aquaculture	0	0	0	0,486	0,00
5	Mining of coal and lignite	0	0	1	1,000	0,00
6	Extraction of crude petroleum and natural gas	0	0	1	0,620	0,00
7	Mining of metal ores	0	0	0	0,382	0,00
8	Other mining and quarrying	0	0	0	0,710	0,01
9	Mining support service activities	0	1	1	0,486	0,00
10	Manufacture of food products	0	0	0	0,183	0,49
11	Manufacture of beverages	0	0	0	0,480	0,12
12	Manufacture of tobacco products	0	0	0	0,383	0,00
13	Manufacture of textiles	0	0	0	0,085	0,02
14	Manufacture of wearing apparel	0	0	0	0,174	0,04
15	Manufacture of leather and related products	0	0	0	0,334	0,01
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	0	0	0	0,126	0,03
17	Manufacture of paper and paper products	0	0	0	0,581	0,03
18	Printing and reproduction of recorded media	0	0	0	0,193	0,15
19	Manufacture of coke and refined petroleum products	0	1	1	0,787	0,00
20	Manufacture of chemicals and chemical products	1	0	0	0,657	0,08
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	1	1	1	0,678	0,27
22	Manufacture of rubber and plastic products	0	0	0	0,273	0,04
23	Manufacture of other non-metallic mineral products	0	0	0	0,557	0,22
24	Manufacture of basic metals	0	0	0	0,403	0,04
25	Manufacture of fabricated metal products, except machinery and equipment	0	0	0	0,145	0,15
26	Manufacture of computer, electronic and optical products	1	1	1	0,734	0,01
27	Manufacture of electrical equipment	1	0	0	0,462	0,08
28	Manufacture of machinery and equipment n.e.c.	1	0	0	0,455	0,12
29	Manufacture of motor vehicles, trailers and semi-trailers	1	0	0	0,177	0,44
30	Manufacture of other transport equipment	1	0	1	0,575	0,07
31	Manufacture of furniture	0	0	0	0,262	0,02
32	Other manufacturing	0	0	0	0,484	0,07
33	Repair and installation of machinery and equipment	0	0	0	0,238	0,10
35	Electricity, gas, steam and air conditioning supply	0	0	1	0,604	0,58

<sup>3</sup> A sector in Brussels can be characterized by a very high knowledge intensity -even considerably higher than if one would hold on to classifications that are based on international averages- but still may represent a very small weight in the total Brussel economy. NACE 5, the mining of coal and lignite provides an illustration

36	Water collection, treatment and supply	0	0	0	0,273	0,21
37	Sewerage	0	0	0	0,767	0,01
38	Waste collection, treatment and disposal activities; materials recovery	0	0	0	0,135	0,24
39	Remediation activities and other waste management services	0	0	1	0,139	0,01
41	Construction of buildings	0	0	0	0,202	2,34
42	Civil engineering	0	0	0	0,339	0,30
43	Specialised construction activities	0	0	0	0,076	2,14
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	0	0	0	0,270	1,02
46	Wholesale trade, except of motor vehicles and motorcycles	0	0	0	0,397	3,20
47	Retail trade, except of motor vehicles and motorcycles	0	0	0	0,178	5,54
49	Land transport and transport via pipelines	0	0	0	0,157	3,75
50	Water transport	1	0	0	0,229	0,01
51	Air transport	1	1	0	0,486	0,02
52	Warehousing and support activities for transportation	0	0	0	0,458	0,30
53	Postal and courier activities	0	0	0	0,226	0,77
55	Accommodation	0	0	0	0,159	0,69
56	Food and beverage service activities	0	0	0	0,082	3,78
58	Publishing activities	1	1	1	0,736	0,36
59	Motion picture, video and television programme production, sound recording and music publishing activities	1	1	1	0,703	0,27
60	Programming and broadcasting activities	1	1	1	0,714	0,58
61	Telecommunications	1	1	1	0,528	1,15
62	Computer programming, consultancy and related activities	1	1	1	0,802	1,64
63	Information service activities	1	1	1	0,770	0,54
64	Financial service activities, except insurance and pension funding	1	1	1	0,547	4,27
65	Insurance, reinsurance and pension funding, except compulsory social security	1	1	1	0,513	1,91
66	Activities auxiliary to financial services and insurance activities	1	1	1	0,541	0,94
68	Real estate activities	0	0	1	0,520	1,02
69	Legal and accounting activities	1	1	1	0,780	1,81
70	Activities of head offices; management consultancy activities	1	1	1	0,794	1,99
71	Architectural and engineering activities; technical testing and analysis	1	1	1	0,781	1,77
72	Scientific research and development	1	1	1	0,814	1,04
73	Advertising and market research	1	1	1	0,665	2,10
74	Other professional, scientific and technical activities	1	1	1	0,740	0,15
75	Veterinary activities	1	1	1	0,865	0,03
77	Rental and leasing activities	0	0	0	0,499	0,12
78	Employment activities	1	1	0	0,521	2,43
79	Travel agency, tour operator reservation service and related activities	0	1	0	0,297	0,31
80	Security and investigation activities	1	0	0	0,119	0,67
81	Services to buildings and landscape activities	0	0	0	0,024	4,73
82	Office administrative, office support and other business support activities	0	0	1	0,468	0,73
84	Public administration and defence; compulsory social security	1	1	0	0,421	14,23
85	Education	1	1	1	0,765	9,99

86	Human health activities	1	1	1	0,710	5,88
87	Residential care activities	1	0	1	0,341	2,17
88	Social work activities without accommodation	1	0	0	0,360	2,67
90	Creative, arts and entertainment activities	1	1	1	0,605	0,97
91	Libraries, archives, museums and other cultural activities	1	1	0	0,402	0,31
92	Gambling and betting activities	1	0	0	0,325	0,14
93	Sports activities and amusement and recreation activities	1	0	0	0,329	0,51
94	Activities of membership organisations	0	1	1	0,666	2,88
95	Repair of computers and personal and household goods	0	0	0	0,209	0,09
96	Other personal service activities	0	0	0	0,077	1,18
97	Activities of households as employers of domestic personnel	0	0	0	0,061	0,08
98	Undifferentiated goods- and services-producing activities of private households for own use	0	0	0	-	0,00
99	Activities of extraterritorial organisations and bodies	0	1	1	0,724	0,37
All sectors		36	30	33	0,472	100

Notes: NACE 2: nomenclature of economic activities in the European community- Sector code at 2 digit level; KIS: Knowledge-intensive sectors (Based on technological intensity (high share of R&D-intensity in the sector); KIA: Knowledge-intensive activities (Based on a share of >33% of higher educated (i.e. ISCED 5-8) employees in total employment (source: Labour Force Survey) - (htec\_asms\_an8); KI-jobs: employees with education ISCED\_5-8 active in knowledge jobs (ISCO\_1-3). The self-employed for which no sector could be identified are deleted in the calculations underlying Table 1.1

\* The reference period for the Labour Force Survey is 2010-2020.

### 1.3 The knowledge base in Brussels

The Labour Force Survey is based on a questionnaire which represents the population, but is evidently still an estimation. Hence, to calculate the number of knowledge workers (i.e. the Brussels knowledge base) we combine the shares of knowledge workers as based on the Labour Force Survey with the existing administrative databases from social security.

Table 1.2 is thus calculated using three separate data sources: decentralised social security data on wage employment (RSZ-ONSS), social security data on self-employment (RSVZ-INASTI), and labour force survey (LFS) data combining education and occupation to identify the knowledge-intensiveness at sector level (NACE2-digit).

Consistent with the four scenario approach in Table 1.1, we present *average* employment numbers in Table 1.2. The numbers indicate that in the period 2008-2020, there were on average 411,388 employees in the Brussels Capital Region at work in sectors defined as knowledge intensive by the OECD. Of these employees, 238,199 fulfilled the definition of being a knowledge worker according to education and occupation profile (Figure 1.1). The figures for the “Eurostat” scenario and the scenario in which we call a sector knowledge-intensive based on a 33%-threshold of employers with at least a tertiary cycle education level can be interpreted likewise. Thus, depending on the way in which one defines sectors as being knowledge intensive or not, total employment in these sectors was on average somewhere between 343,000 (third scenario) and 420,000 (second, Eurostat-scenario) in the period

2008-2020. The number of KI jobs within the so-defined sectors revolve around 240,000. Finally, if we broaden the perspective and change the dichotomous view for one in which we take it that every sector can host knowledge intensive jobs, the estimated knowledge base in Brussels equals 323,677 KI jobs on average in the period 2008-2020<sup>4</sup>.

**Table 1.2: Knowledge intensive jobs in the Brussels Capital Region – average 2008-2020 – according to four scenarios**

	KIS-OECD	KIA-Eurostat	KI jobs-BEint	KI-jobs-BCRint
Total sector	411,388	420,795	343,468	
of which KI jobs	238,199	261,588	229,973	323,677

It is of course of interest to look at similar figures for the broader Brussels agglomeration as well as to compare the data for Brussels (and the broader Brussels agglomeration with the rest of Belgium). Thus, in Table 1.3, we present similar data for six different spatial scales for the reference year 2020. Specifically, Table 1.3 builds on the scenario in which we consider that there is a presence of knowledge intensive jobs in each industry (“KI-jobs-BCRint” scenario).

First, as a core focus, we look at the administrative Brussels-Capital Region (BCR). However, as demonstrated by many scholars, the economic activity of Brussels is very closely intertwined with the adjacent municipalities in a way that the economic system of Brussels maintains a synergetic relation with its surroundings. As we are working with spatially aggregated data at provincial level, we consider the provinces of Flemish Brabant and Walloon Brabant as adjacent<sup>5</sup>. Adding these provinces to Brussels the old province of Brabant can be interpreted as a close proxy for the functional Brussels Metropolitan Area (BMA) - see also further on in this study. For the benchmarking with other territories, we subsequently look at a comparison with Belgium, which includes Brussels itself, the rest of Belgium correcting for the Brussels Capital Region or the Brussels Metropolitan Region impact<sup>6</sup>.

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<sup>4</sup> Note that in these numbers there’s an underestimation in activity code “99 - Activities of extraterritorial organisations and bodies” (Dotti, F., Spithoven, A., and Ysebaert, W. (2022). ‘The benefits of being a multi-capital: The economic impact of the international and European institutions and interest groups’, *European Urban and Regional Studies*, 29(2) 255–277)). Whereas the official numbers (RSZ data 2020 = 3304 employees for Belgium in total, of which 2729 in 2020 in Brussels Capital Region, Dotti et al. (2022) estimated the community of international and European institutions and interest groups in Brussels at 39,508 full-time equivalent employees in the period 2016-2017. However, as we do not have information on employment of other international organisations in the rest of Belgium (e.g. JRC in Mol or SHAPE in Mons),<sup>the</sup> national registered employment data are likely to underestimate the exact employment on the territory.

<sup>5</sup> This largely corresponds with the more fine-grained territorial approach in part 2 of this report.

<sup>6</sup> Because of lack of data for a combined education-occupation classification (Figure 1) a comparison with other capital regions in Europe as a benchmark is not possible.

**Table 1.3 - Key figures on the knowledge base by spatial scales – year 2020 and evolution 2008-2020**

Spatial scale	Total employment			Knowledge-intensive employment				Weighted knowledge-intensity
	Employment in 2020	Absolute growth 2008-2020	Compound annual growth rate 2008-2020 (in %)	Knowledge-intensive employment in 2020**	Share knowledge-intensive employment in total (in %)	Absolute growth 2008-2020	Compound annual growth rate 2008-2020 (in %)	
Brussels Capital Region (BCR)	751,396	46,642	0.54	339,571	45.2	20,135	0.51	47.2
Periphery (Flemish and Walloon Brabant)	706,743	92,640	1.18	273,312	38.7	43,550	1.46	39.4
Brussels metropolitan area (BMA)	1,458,139	139,282	0.84	613,628	42.1	63,632	0.92	43.6
Belgium	5,223,996	532,859	0.90	1,736,125	33.2	215,085	1.11	34.4
Belgium minus BCR	4,472,600	486,217	0.96	1,391,965	31.1	190,890	1.24	32.1
Belgium minus BMA	3,765,857	393,577	0.92	1,116,964	29.7	147,055	1.18	30.8
Flemish Region	3,077,914	345,029	1.00	964,835	31.3	138,905	1.30	32.2
Walloon Region	1,394,686	141,188	0.89	431,309	30.9	52,188	1.08	31.9

\*Based on average LFS ratio 2010-2020 for 88 NACE2 sectors.

\*\* All data on knowledge employment (annual employment data 2008-2020) have been weighted by the sector knowledge-intensity of 88 NACE2 sectors before summing up. This causes a difference between the spatial scales in the case of the employment in the knowledge intensive sectors: e.g. BCR and periphery do not sum up to BMA. They are, however, considered more accurate, even though they are not spatial invariant, because sector employment numbers differ as well as the sector knowledge-intensity.

In 2020, employment in the Brussels Capital Region, wage and self-employment, equals 751,396 persons (14.4% of the Belgian total), which is 46,642 more persons than in 2008, or a compound annual growth rate of 0.54%. With a knowledge-intensive employment of 339,571 its share in total Brussels' employment in 2020 reaches 45.2%: nearly half of the employees in the Brussels Capital Region have a function that is knowledge-intensive. As the absolute growth of knowledge-intensive employment since 2008 is 20,135, the compound average growth rate is, with 0.51%, slightly lower than that of total employment, implying a faster growth rate of non-knowledge-intensive employment. An interesting observation is that the sector-weighted knowledge-intensity in the Brussels Capital Region has an average of 0.472. This 47.2% of knowledge jobs is about 15% higher than the national average (minus Brussels Capital Region).

The immediate periphery of Brussels – the provinces of Flemish and Walloon Brabant - counted a total employment of 706,743 persons in 2020, but their absolute and annual growth is much higher: an

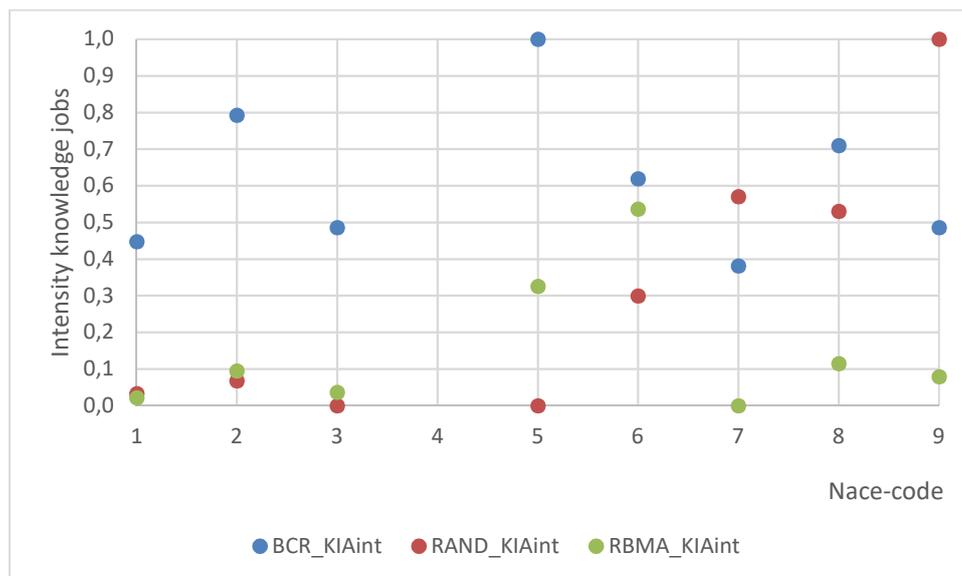
increment of 92,640 persons since 2008, or an annual growth of 1.18%. In terms of knowledge-intensive employment the periphery of Brussels is catching up, as the compound annual growth rate is 1.46% leading to an increment in knowledge-intensive employment of 43,550 employees. The weighted knowledge intensity of this 'region' is 39.4%. As the Brussels Metropolitan Area is the sum of the two regions above (see note Table 1.3), the share and growth rates and the weighted knowledge-intensiveness are their weighted average.

Table 1.3 further cites similar data for Belgium as a whole. As can be read from the table, in the period 2008-2020, the total employment growth of Belgium outperforms, with 0.90%, that of Brussels, and this both in terms of the Brussels Capital Region (0.54%), and to a lesser extent of the Brussels Metropolitan Area (0.84%).

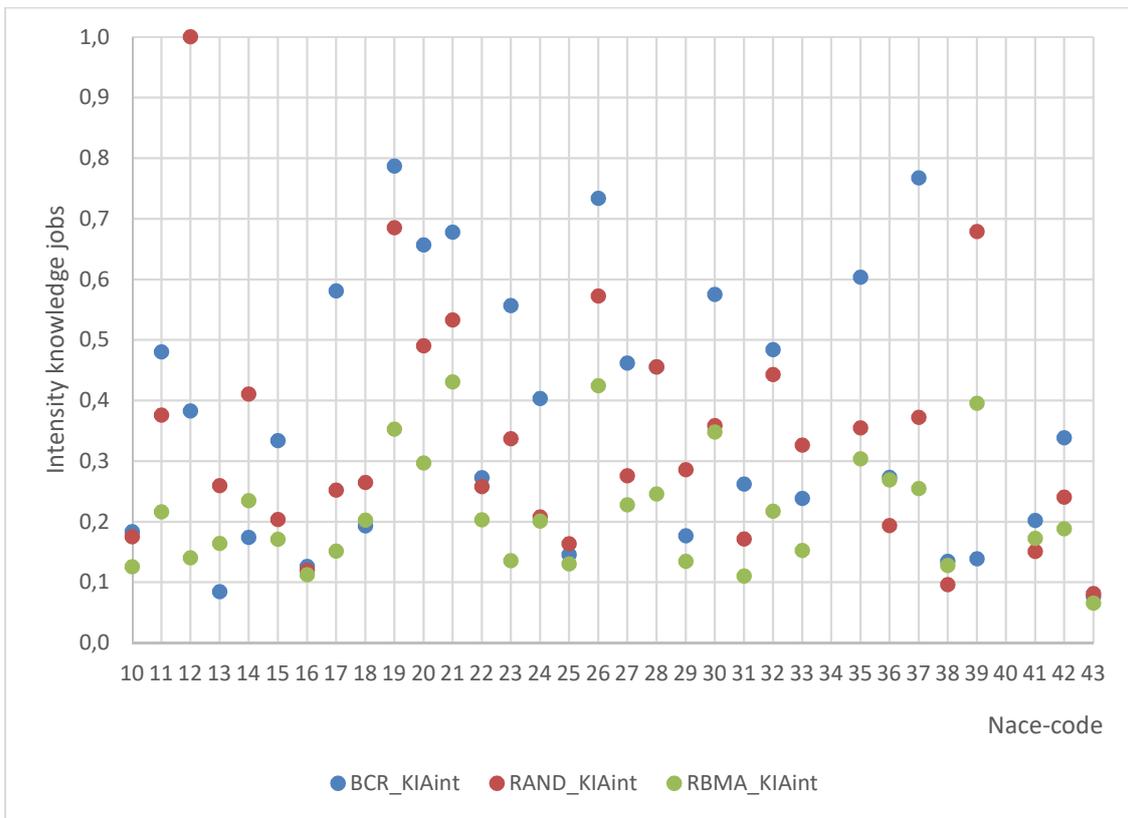
Figures 1.2 to 1.5 offer a more detailed view on the intensities of knowledge workers for the Brussels Capital Region, the periphery of Brussels, and Belgium (excluding the Brussels Metropolitan Area), indicated respectively by blue, orange and green bullets. The figures address the primary industry (1.2), the manufacturing industry (1.3), business services (1.4), and administrative and public services and education (1.5).

For example, in Figure 1.3, for the manufacturing of chemicals and chemical products (NACE 2 digit industry 20) and of basic pharmaceutical products and pharmaceutical preparations (NACE 21), we note a substantially higher intensity of knowledge jobs in the Brussels Capital Region, and a lower intensity outside the Brussels agglomeration. A similar situation can be seen in (Figure 1.4) computer programming, consultancy and related activities (NACE 62), information services activities (NACE 63), whereas for financial service activities (NACE 64) the intensity of knowledge jobs is largest in the Brussels periphery. In the large public administration industry (NACE 84) as well as in the creative industries (NACE 90) there's a gap in intensity of knowledge jobs in favor of the capital region (Figure 1.5).

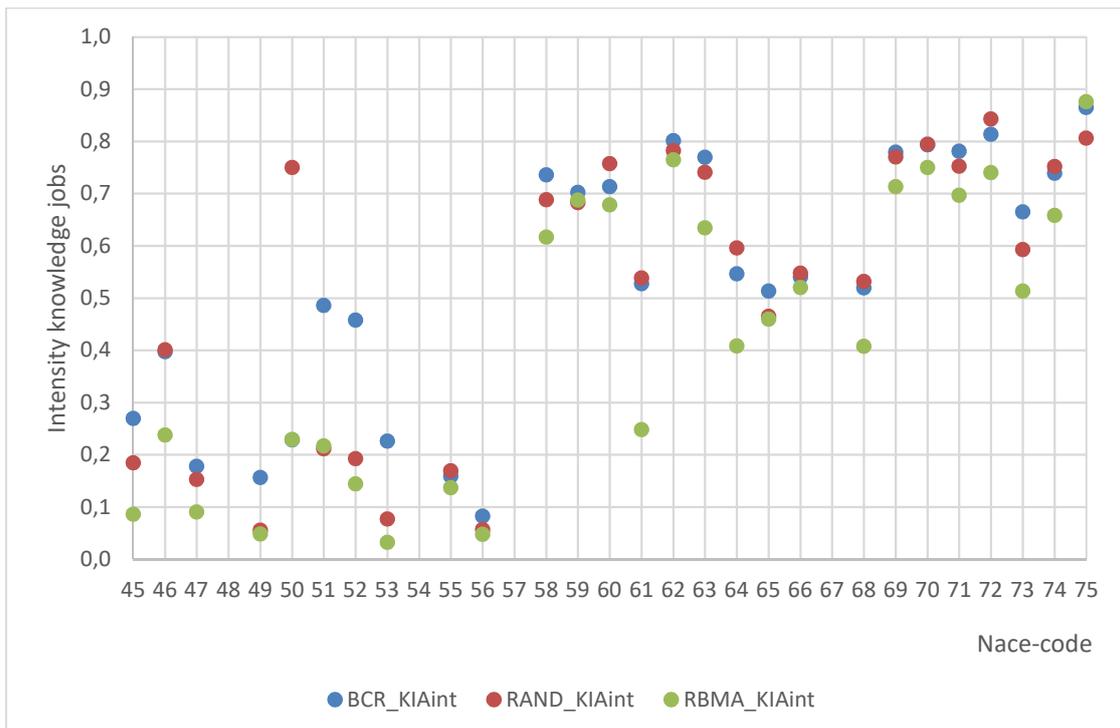
**Figure 1.2: Intensity of knowledge jobs (education and occupation) in the primary industry, average 2010-2020, by geographical territory**



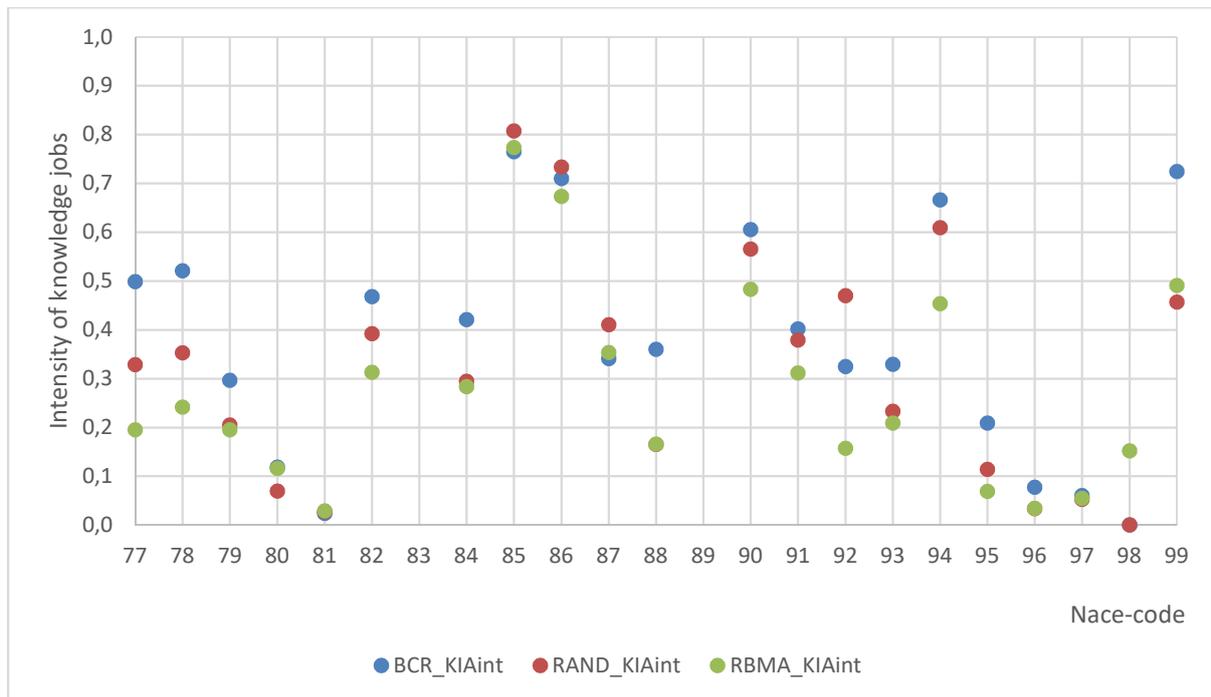
**Figure 1.3: Intensity of knowledge jobs (education and occupation) in the manufacturing industry, average 2010-2020, by geographical territory**



**Figure 1.4: Intensity of knowledge jobs (education and occupation) in the business services, average 2010-2020, by geographical territory**



**Figure 1.5: Intensity of knowledge jobs (education and occupation) in administrative and public services and education, average 2010-2020, by geographical territory**



## **Part 2: Mapping knowledge-intensive activities in and around Brussels**

### ***2.1. Assessing the concentration and specialisation of knowledge intensive sectors in Brussels***

Using the definition and industry intensities of knowledge jobs as presented in WP1, we produce an assessment of the geographical specialization and concentration of knowledge intensive jobs in Brussels.

To achieve this objective we have to make an assessment of employment data through ONSS-RSZ and INASTI (RSVZ), and we need to define “Brussels”.

#### **Assessment of employment data through ONSS-RSZ+ INASTI-RSVZ**

The ONSS-RSZ and INASTI-RSVZ data allow to achieve a full disaggregation at sector (up to NACE-5) and geographical level (municipality). Our employment data, as provided by ONSS-RSZ, and self-employment data, provided by INASTI-RSVZ, refer to 2018.

ONSS-RSZ data are complete by municipality and provided within the NACE classification. They also allow to distinguish between worker and employee in terms of legal status. INASTI-RSVZ data are much more difficult to deal with. The main issue is that self-employed are classified through a specific classification of professions<sup>7</sup> rather than industries. To provide total employment by industry, we need to convert the classification of self-employed into the NACE classification. The main steps for this complex process are as follows:

- we make a correspondence between the group of professions and large NACE sectors, using the lowest common denominator. For example, all medical professions, such as nurse, doctors, .. are grouped together into a large NACE health sector. In some cases, it is difficult to find a common large NACE sector, as it is the case for self-employed in trade, which cannot be easily distinguished between retail and wholesale trade, hence making necessary to group them into a large trade sector;
- we then break down the obtained number of self-employed in these aggregated NACE sectors into disaggregated sectors up to NACE-2 or even NACE-5 digit level. To do so, we use the VAT files<sup>8</sup>, excluding all enterprises with employees, and provide NACE-5 sector for all economic actors concerned.

#### **Defining Brussels**

Brussels cannot be reduced to its administrative limits of the Brussels Capital Region (BCR). In many ways, the Brussels economy goes far beyond these administrative limits. First, more than half of the jobs located in the BCR are occupied by workers living outside this administrative area (Vanderhaegen, 1991; Vandermotten, 2008). Second, interactions between firms, especially in high level services, are not limited by the Brussels regional border (Van Hamme et al., 2020) but are very intense among firms

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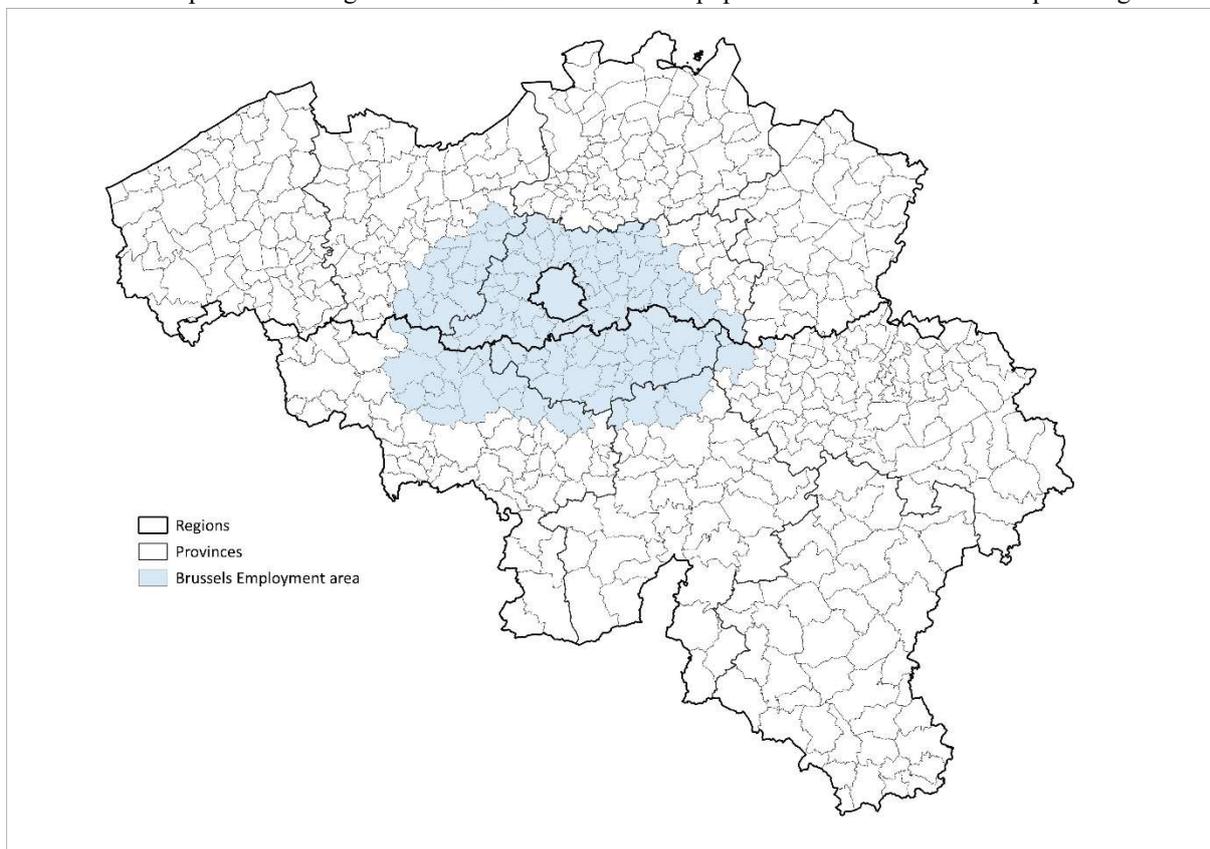
<sup>7</sup> The classification is indeed something in between professions and industries; you'll find the INASTI-RSVZ classification at the following link <https://www.inasti.be/fr/nomenclature-et-codes-des-professions>

<sup>8</sup> VAT file are related to tax issue: each Belgian economic actor is identified through this database.

located in the Brussels pool. Hence, the firm's location does not mainly depend on administrative issues, but rather on the necessity of centrality and proximity between firms (Waiengniez et al., 2020). In some industries, centrality remains essential, like in finance, while in others we observe concentration in suburban areas. In all cases, Brussels location is essential to the functioning of the firms: the Brussels firms in knowledge intensive services have strong interactions with other firms; they rely on the large highly qualified labour pool; they need strong European and global connections as allowed by the Brussels global central location.

The Brussels metropolitan area as defined by administrative borders in Part 1 can thus be refined to the Brussels functional urban area and includes all municipalities where more than 15 % of the occupied population works in the BCR (see Figure 2.1). This criterion is used by OECD or EUROSTAT for international comparisons.

**Figure 2.1 The Brussels metropolitan area based on functional employment area.** Defined as all municipalities sending more than 15 % of their active population into the Brussels Capital Region.



### Concentration and specialization in Brussels

Starting from the four definitions of knowledge intensive jobs, Table 2.1 uses two main indicators for both the BCR and in the Brussels metropolitan area. First, the share of national employment located in the BCR/Brussels metropolitan area (i.e., all jobs in BCR/all jobs in Belgium) has been assessed. A similar ratio focuses on knowledge intensive jobs only (and is, hence, scenario-dependent). Next, dividing the latter figure by the former yields a specialization index that allows for an intuitive interpretation: if the indicator's value exceeds 100, this means that the considered geographical entity

has a larger share of (Belgian) knowledge intensive employment than it has a share of Belgian (total) employment. In that sense, it can be considered as “more specialized” in knowledge intensive activities. Values below 100 have an equally intuitive (opposite) interpretation.

Considering total employment, the Brussels metropolitan (functional employment) area thus can be seen to concentrate 33 % of Belgian jobs, and about half of these jobs (14.6 %) are concentrated in the BCR. In terms of knowledge intensive jobs, the concentration in the Brussels metropolitan area ranges between 35 % and 39 % according to the definition of knowledge intensive jobs relied upon (cf; the four scenarios listed in Table 1.1). Note that this percentage is close to the 35.3% of knowledge intensive jobs in the Brussels metropolitan area, as based on administrative borders (Table 1.3). The higher percentage of knowledge jobs in Brussels means that there is a strong specialization of knowledge jobs in these sectors in Brussels; this specialization is mostly true for the BCR but also holds for the Brussels periphery (see fig. 2.2). Using the Eurostat definition of KIS for example, the BCR has a specialisation index of 130<sup>9</sup>, meaning that the BCR is 30% more specialized in such knowledge intensive sectors compared to the rest of Belgium.

Such figures confirm the concentration of highly qualified and remunerated jobs in the BCR’s service economy. The concentration in finance, in business services (consultancy, accountancy ...) combined with the importance of high level administration are indeed consistent with this feature of the Brussels economy. The data underlying table 2.1 can also be visualized to yield a more disaggregate geographical view, as is shown by the municipal breakdown of Figure 2.2. A specialization in knowledge intensive jobs is indeed observed within Brussels itself, but also in the suburban areas of Brussels, for example around Zaventem airport or in some parts of Walloon Brabant. These suburban areas are not anymore characterized by the dispersal of heavy activities (manufacturing, logistics ...) but also by the development of some high level services which do not require a location in the core city, such as in accountancy around Zaventem. However, compared to the core city (capital region), the peripheral areas appear to be less specialized in the knowledge jobs.

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<sup>9</sup> Specialization is defined by the ratio between the share of the defined activities in Brussels and the share of the same sector for the whole kingdom. All indexes above 100 identify activities where Brussels is more specialized than Belgium in average.

**Table 2.1 Concentration (1) and specialization (2) in 2018**

	Concentration (all jobs)	KIS OECD		KIA Eurostat		KI jobs-BEint		KI-jobs-BCRint	
		Concentration (KI jobs)	Specialization index						
Total	100	100	100	100	100	100	100	100	100
Brussels (BCR)	14.6	17.6	120	19.5	133	18.5	127	15.7	107
Metropolitan Area	18.5	19.5	105	19.7	107	20.7	112	19.3	104
BCR + periphery	33.2	37.1	112	39.3	118	39.2	118	35.0	106
Rest of Flemish region	45.9	42.0	91	40.1	87	40.2	88	44.2	96
Rest of Walloon region	20.9	20.9	100	20.6	99	20.5	98	20.8	99
Total Rest	66.8	62.9	94	60.7	91	60.8	91	65.0	97
Flemish Region	59.0	55.4	94	53.8	91	54.5	92	57.7	98
Walloon Region	26.3	26.9	102	26.7	102	27.0	103	26.5	101
Flemish Brabant	3.6	4.3	118	4.4	122	4.7	130	3.9	108
Walloon Brabant	10.1	10.4	103	10.6	104	11.1	110	10.5	104

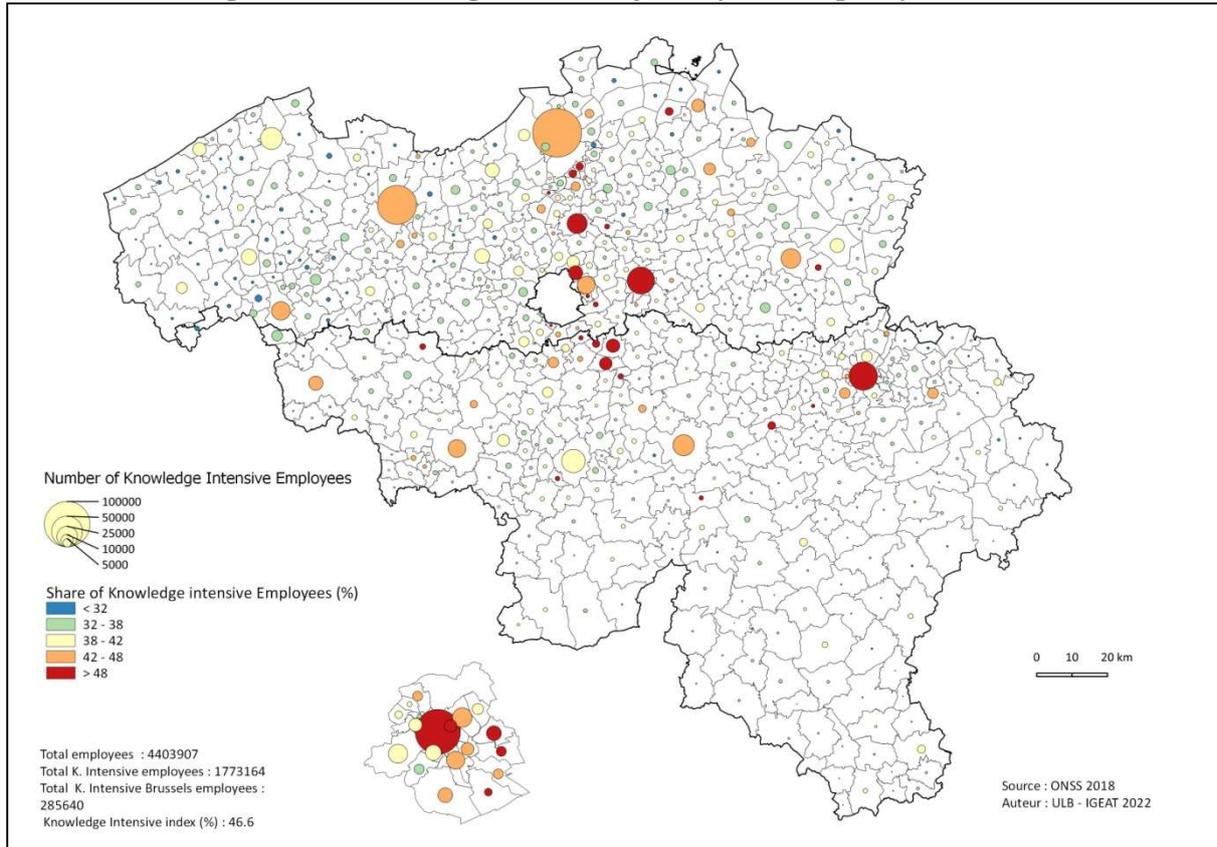
**Source:** ONSS-RSZ+ INASTI-RSVZ, Own calculations

**Remark:** Differences with Table 1.3 are related to:

- reference year (2018 in this table);
- the sources used allow for a rigorous definition of Brussels Metropolitan Area pool, based on municipalities.

- (1) Concentration is the share of a specific region in the total volume of jobs in Belgium for a given sector – it shows the spatial concentration of jobs in a specific activity
- (2) Specialization is the ratio of two concentration measures: the relative share of knowledge intensive jobs over the relative share of all jobs.

**Figure 2.2 Knowledge intensive jobs by municipality in 2018**



## ***2.2. Identification of major clusters in Knowledge intensive sectors***

We next complement the aggregate assessment of the geographical dispersion/concentration of knowledge intensive jobs (cf. figure 2.2), by looking at the maps of significant Brussels sector-specific clusters in knowledge intensive activities: pharmaceutical industries (Nace 21), telecommunications (Nace 61), computer programming, consultancy and related activities (Nace 62), financial services (Nace 64), legal and accounting activities (Nace 69), head offices and management consultancy activities (Nace 70), administration (Nace 84), Health activities (Nace 86), creative, arts and entertainment (Nace 90) (see fig 2.3-2.11).

Brussels is highly specialized in all these activities but, within the Brussels metropolitan area, the different knowledge intensive sectors show different locational patterns. Pharmaceutical industries are very concentrated in large structures located in peripheral areas of Antwerp and Brussels. In Brussels, most firms are located in Walloon Brabant where they find a green environment and the highly qualified labour required.

Some business services (computer activities, accounting activities or consultancy) are highly concentrated in Brussels and surroundings. Large international firms, such as major actors in accountancy, may settle in the immediate surroundings of Brussels, especially around the airport, benefiting from cheaper and larger spaces as well as a strong international and national accessibility.

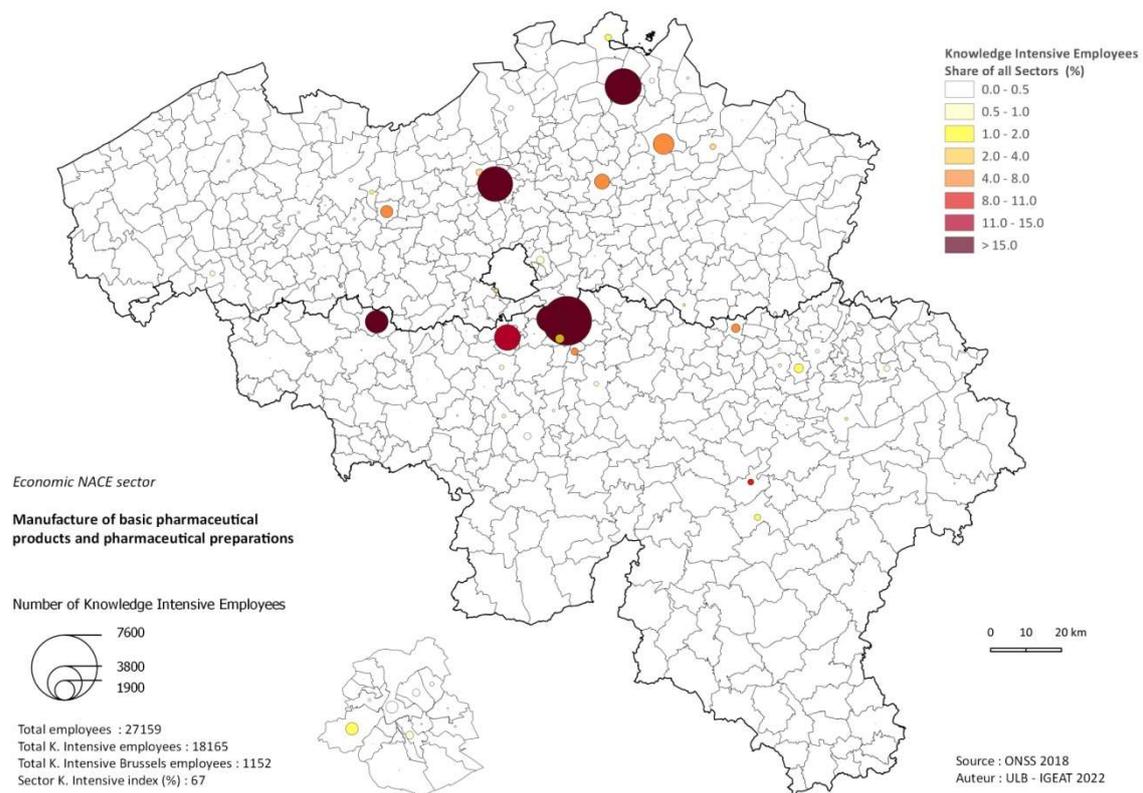
For example in computer activities they can easily access to any Belgian client from their suburban location near to the ring. However, some activities such as lobbying still favour core city location, because of the need of proximity with public authorities.

In contrast, some high level services still locate in the very core of the city, as observed for financial activities but the same is true for insurance for example. This central location is partly inherited for some big actors, such as BNP-Paribas-Fortis, whose seat is still located where the Société Générale had its headquarter in the nineteenth century. It is also the result of the strong interactions between financial actors within Brussels.

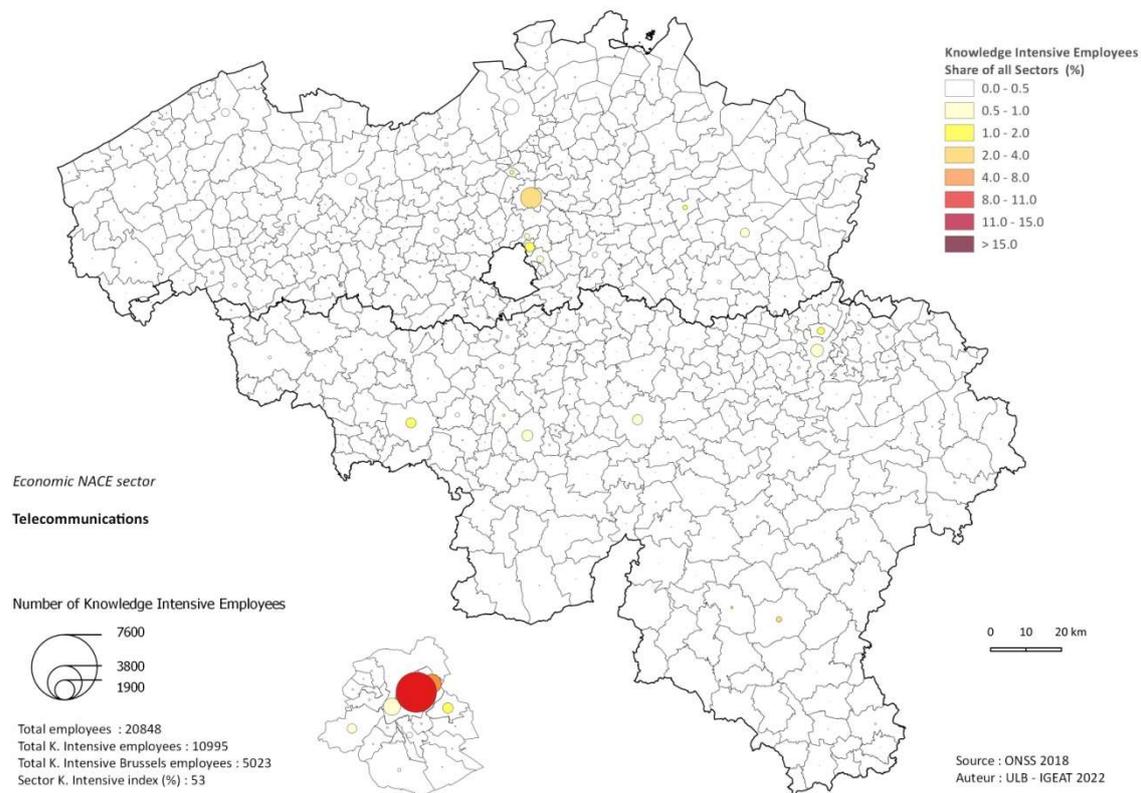
Finally, some knowledge intensive industries, related to art, cinema, ... are typically located in the core city of Brussels, where its labour tends to live and where interactions with major Belgian players, such as national radio and televisions networks can take place.

Annex 2.1 provides, for each of the sectors considered, more information on the exact municipalities in which the major actors (in terms of employment) are located.

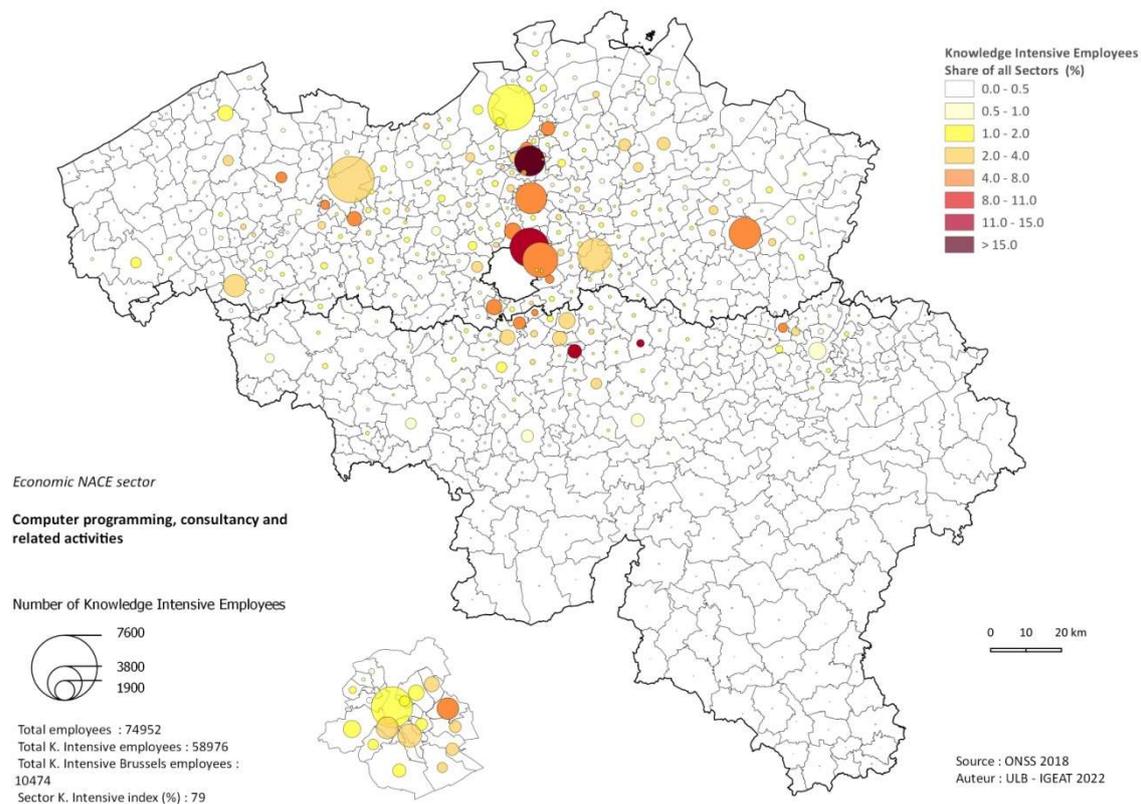
**Fig. 2.3. Manufacture of Pharmaceutical products**



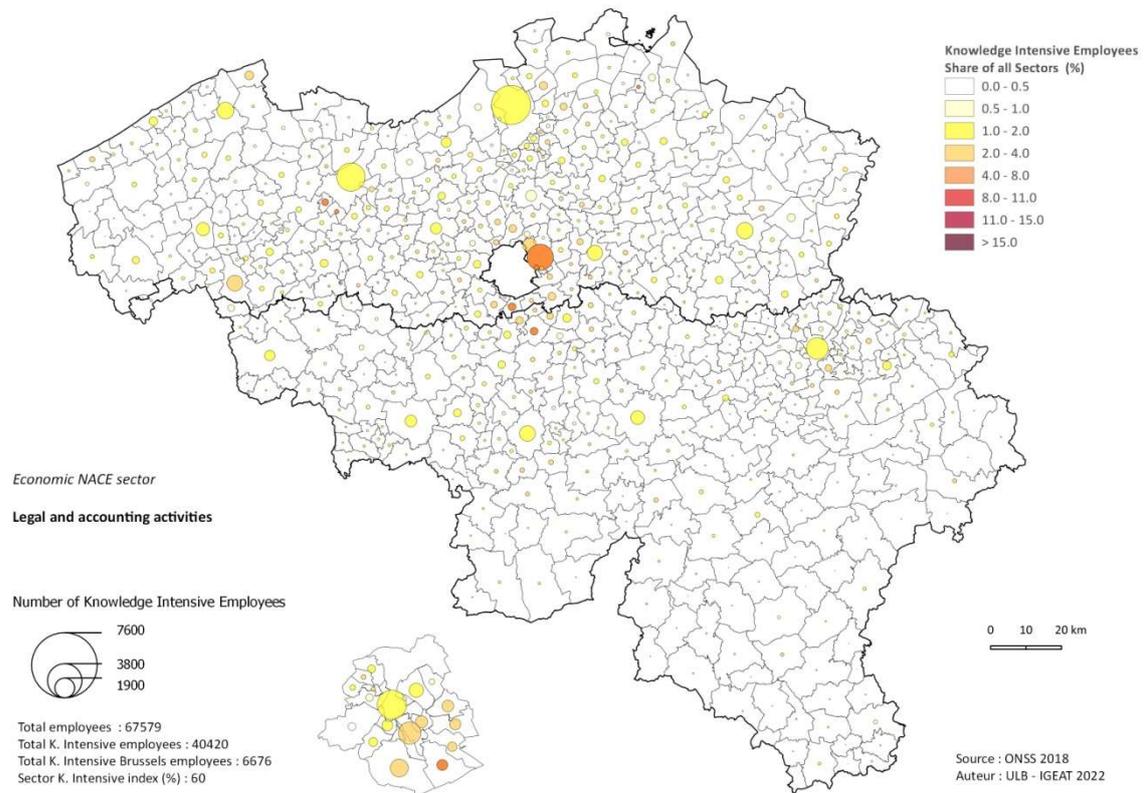
**Fig 2.4. Jobs in Telecommunications**



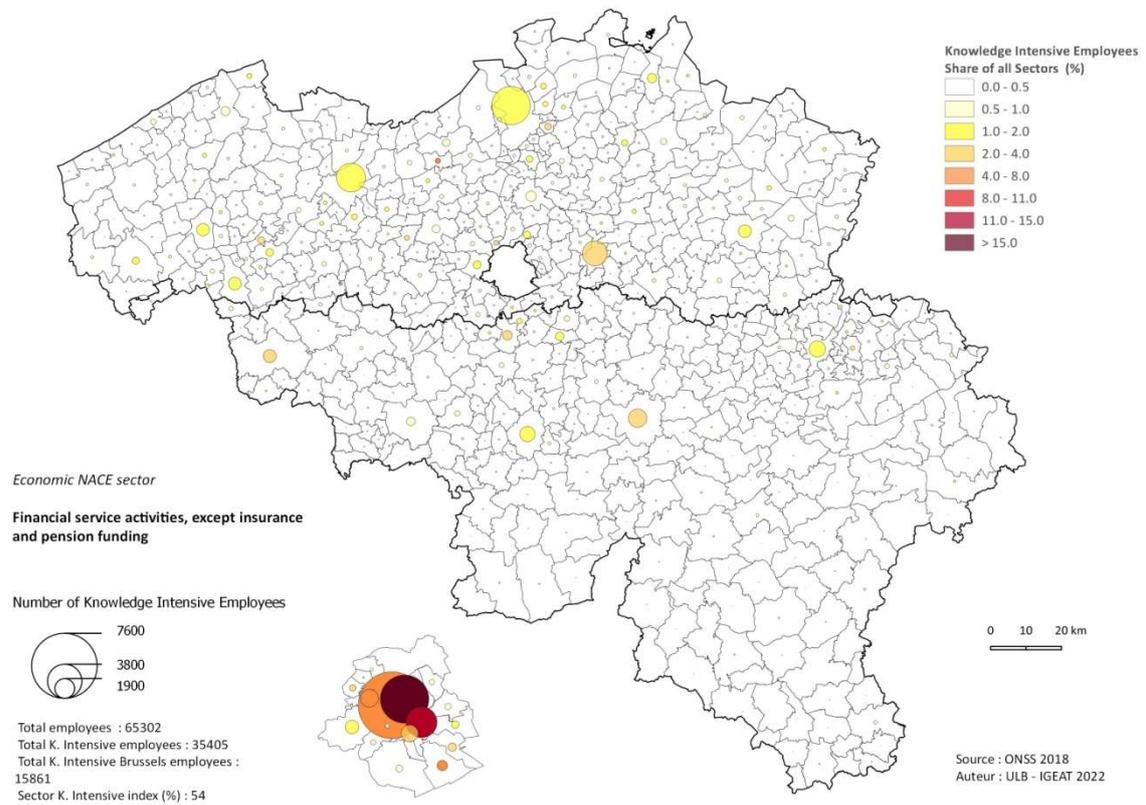
**Fig. 2.5 Jobs in Computer, consultancy and related activities**



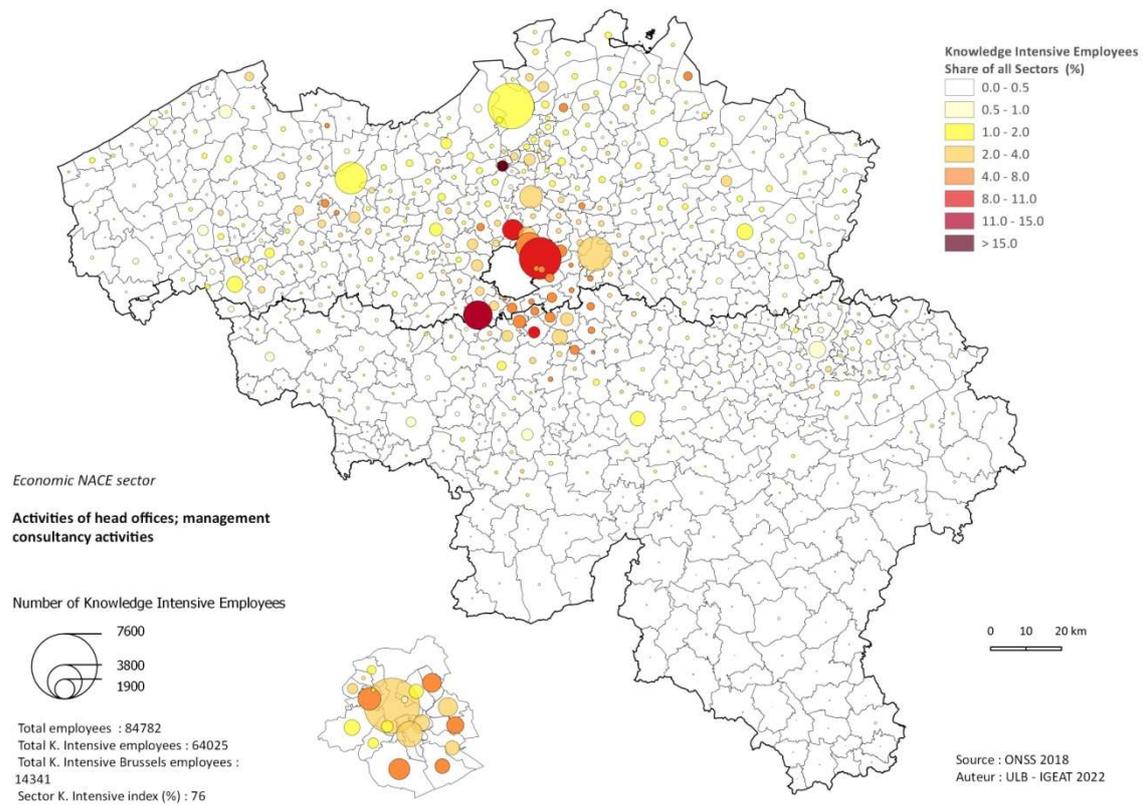
**Fig. 2.6. Jobs in Legal and accounting services**



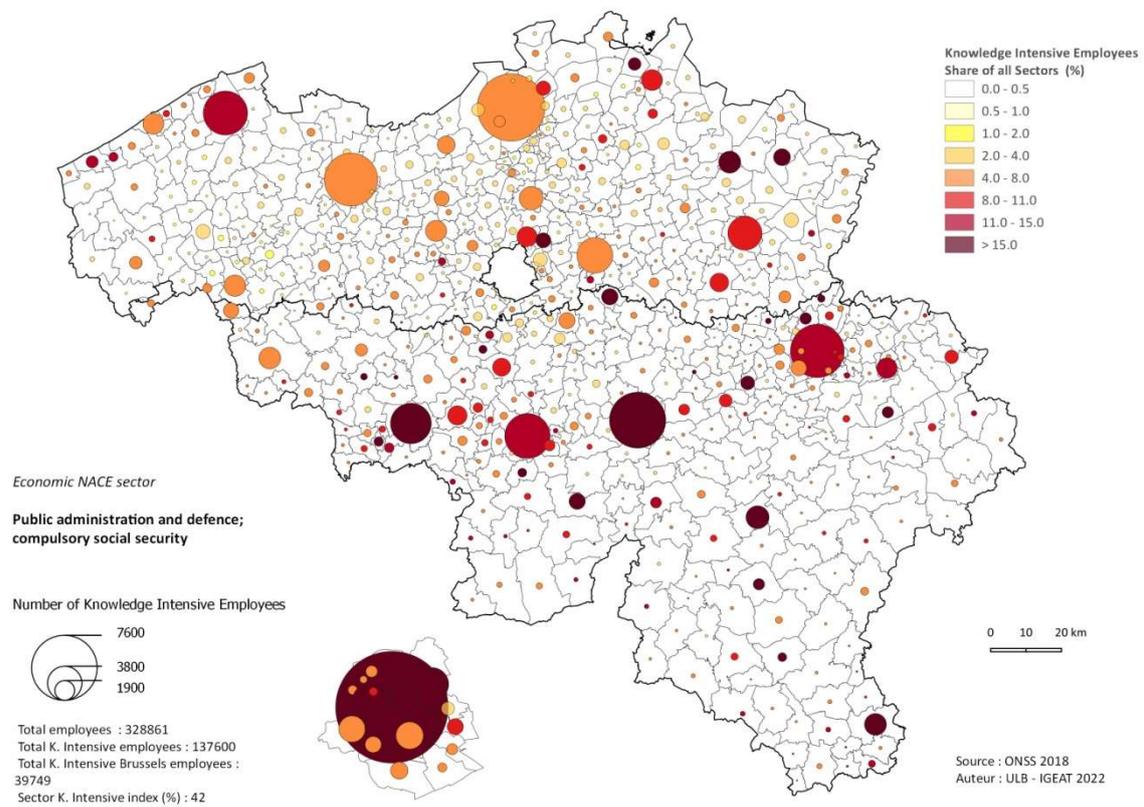
**Fig. 2.7 Jobs in financial services**



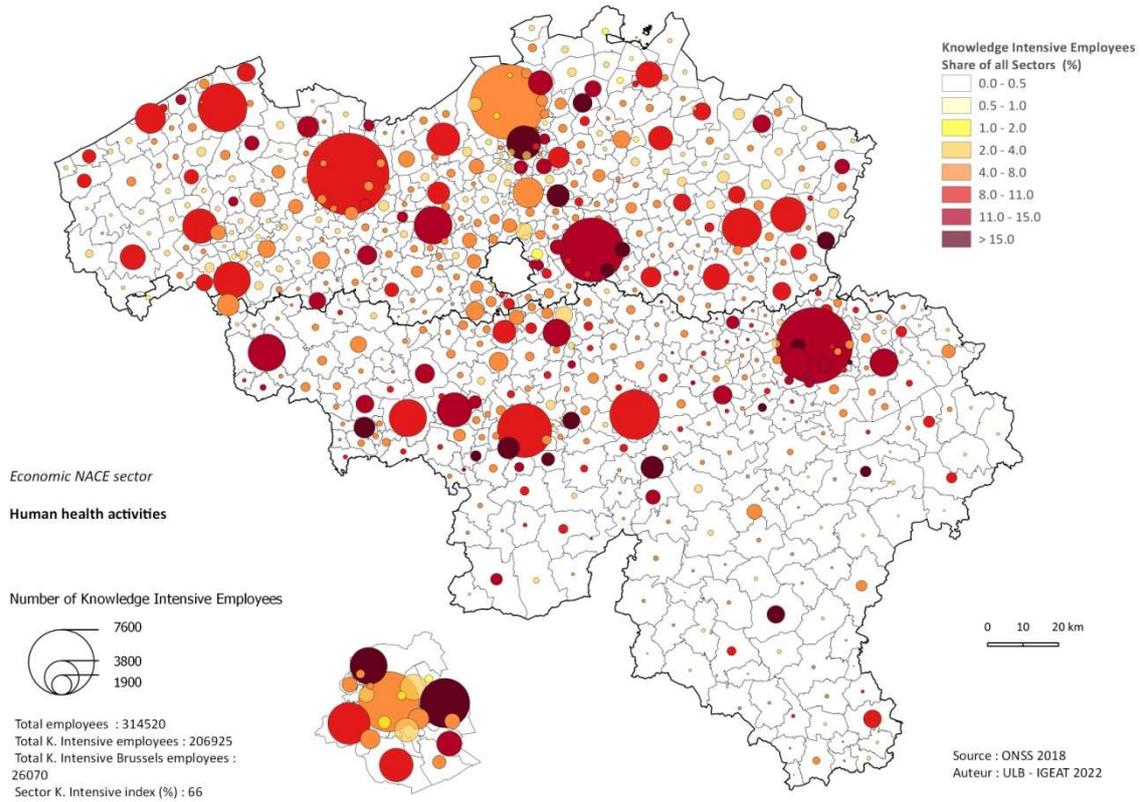
**Fig. 2.8. jobs in head offices and management activities**



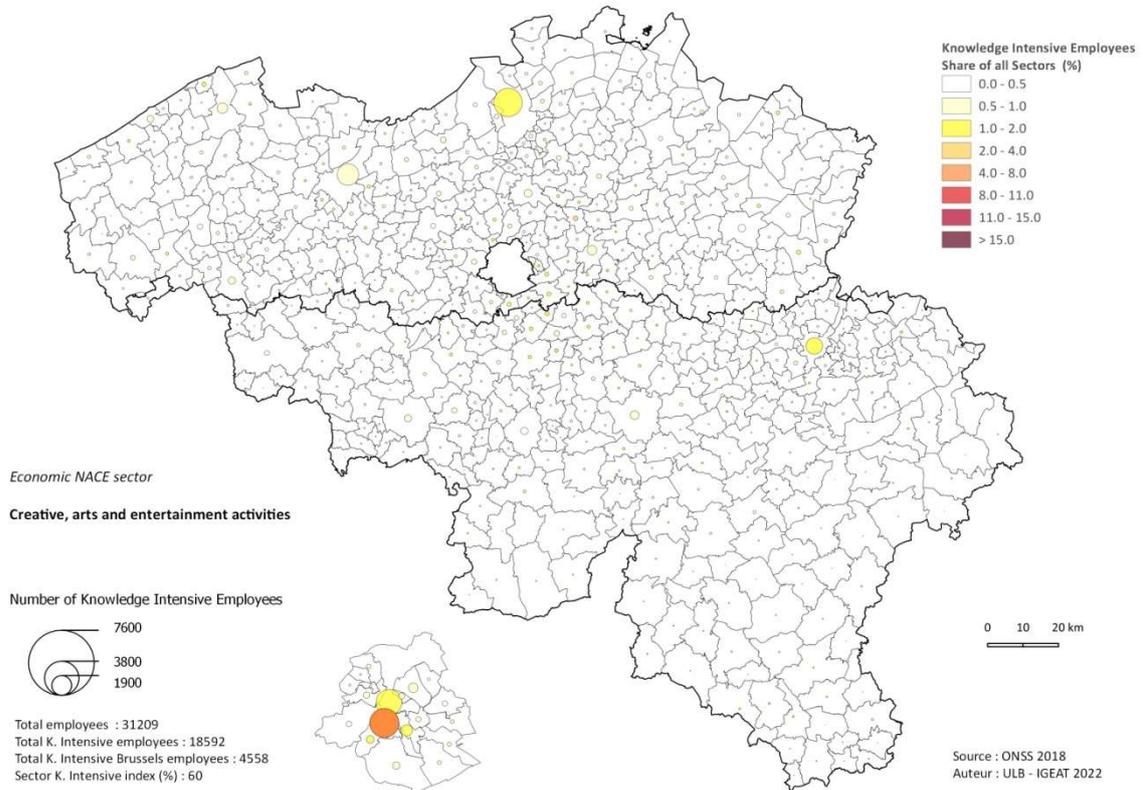
**Fig. 2.9. Jobs in administration**



**Fig 2.10. Jobs in human health**



**Fig. 2.11. Jobs in Creative activities**



## **Part 3: The Employment Effect of Knowledge-Intensive jobs in Brussels: Multipliers Based on Regression Analysis.**

### ***3.1. Introduction***

An often-used method to investigate the impact of an activity on the economy is by calculating a 'multiplier' that gives an estimate on the total effect of a change in one or more activities on all other activities within a territory. In many cases the activity under study can be treated as an exogenous shock to the regional economy. Examples related to Brussels are the impact of the R&D budget of Innoviris (Dotti et al., 2021) or the expenditure of the European institutions and their interest groups (Dotti et al., 2022). These activities, although significant, only make up a small portion of the Brussels economy as in the case of Innoviris or are largely financed from outside Brussels as in the case of the European institutions. Therefore, these activities can be considered as exogenous shocks to the Brussels economy.

The situation is, however, entirely different in the case of employment in the knowledge-intensive activities that make up a large share, 45.2%, of Brussels total employment (see Part 1 – Table 1.3) and hence are endogenous to the Brussels economic structure. This warrants a different approach which is followed in many economic studies. Two approaches are usually followed: (i) the use of input-output tables (see Part 4); (ii) the use of econometric multiplier analysis (this part). The input-output tables calculate the direct and indirect employment effects of a shock to the economic system. The econometric multiplier analyses also capture the induced effects, i.e. the effects due to household spending from the additional direct and indirect employment.

In this part, 'Brussels' takes on different forms. Obviously, the first is the administrative political-institutional level of Brussels, the Brussels Capital Region (BCR), to be compared with the rest of Belgium (RBCR). Second, the influence sphere of Brussels is much larger (see part 2 ) and comprises nearly the whole of the provinces of Flemish Brabant and Walloon Brabant. Because of data availability, we use these two provinces as constituting the periphery of Brussels Capital Region (BPER). Both the Brussels Capital Region and its periphery are formed into the Brussels Metropolitan Area (BMA), which is a functional urban area (OECD, 2020), and as is done by other international institutions (European Union, 2021). The results for the Brussels Metropolitan Area are confronted with the rest of Belgium (RBMA). It should be pointed out that the BMA-definition we employ here is, given data constraints, ultimately based on an administrative criterion, viz., by considering the two neighbouring provinces of Brussels. It thus differs from the definition used in section 2 (and visualized in figure 2.1).

The other two regions of Belgium – the Flemish Region (FLR) and the Walloon Region (WAR) will also be compared to the results for the much smaller Brussels Capital Region. To be complete, we also give results for Belgium (BEL) as a whole. Taken together, this implies that the multiplier analysis will be performed for eight different spatial scales. These spatial scales make use of the nomenclature of territorial units for statistics (NUTS) defined at level 2, which cover the 10 provinces in Belgium plus the Brussels Capital Region<sup>10</sup>.

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<sup>10</sup> The NUTS change regularly in the case of Belgium. In 2018, some Walloon municipalities changed to other administrative district and in 2019 several Flemish municipalities merged. As a result, the composition of the districts Hasselt, Maaseik, Ath, Charleroi, Mouscron, Soignies, Thuin and Tournai changed, and two new districts

### 3.2. Employment data

One aim of this report is to estimate the effects on less knowledge-intensive employment due to the existence of knowledge-intensive employment. Hence, employment data take a central place in this report. The employment data used in this section are composed from information on wage employment (RSZ/ONSS) and self-employment (INASTI/RSVZ). The annual data are gathered from these two administrative databases for 2008 to 2020 inclusive, i.e. 13 consecutive years.

#### 3.2.1. Employment types

This section briefly considers the employment data in a dynamic way: Table 3.1 considers the type of employment and provides a regional comparison of the Brussels Capital region with the other provinces in Belgium.<sup>11</sup>

**Table 3.1 – Positioning employment types in the Brussels Capital Region**

Provinces	Wage employment 2020	Self-employment 2020	Ratio wage/self in 2020	Evolution wage employment from 2008 (in %)	Evolution self-employment from 2008 (in %)
Brussels-Capital Region	633253	108198	5.85	1.9	31.0
Antwerpen	711622	173172	4.11	7.4	21.2
Limburg	292199	84892	3.44	7.7	19.5
Oost-Vlaanderen	524245	155349	3.37	14.7	18.2
Vlaams-Brabant	389587	123900	3.14	7.3	28.3
West-Vlaanderen	430033	141269	3.04	5.9	12.6
Brabant wallon	131873	49471	2.67	14.7	27.9
Hainaut	378892	95697	3.96	4.9	15.2
Liège	338308	86073	3.93	7.6	13.9
Luxembourg	80858	22780	3.55	10.3	0.9
Namur	142786	46505	3.07	9.8	21.4
BELGIUM	4053656	1087306	3.73	7.4	19.7

Source: RSZ/ONSS and INASTI/RSVZ; own calculations.

Note: These figures differ slightly from table 1.3 as the self-employed do not always report their sector of employment (see also the footnote below)

Table 3.1 offers some specificities of employment in the Brussels Capital Region. In Belgium, wage employment is much more prominent than self-employed persons: as there are 3.73 more wage employed than self-employed people. About one in five is self-employed (21.1%). However, as Table 3.1 reveals, this ratio is much higher in the Brussels Capital Region (5.85).

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were created: Tournai-Mouscron and La Louvière. However, the composition of the provinces and regions remains unaffected, and it is this spatial level that is used in this report.

<sup>11</sup> The sum of the wage employment figures and the self-employment figures in Table 3.1. -appearing as total employment figures in table 3.2- are lower than the total employment data reported for the same year in table 1.3. As we are ultimately concerned with sector-specific insights (about knowledge jobs), one has to face the issue that not all self-employed can be coupled with a specific NACE sector (and are put, for that reason, under a ‘NACE 0’-code in some databases. Such persons (less than 10.0000 in the case of Brussels for the year 2020) are surely working, but these observations need to be discarded in the analysis of this section.

Table 3.1 also highlights a potential problem in the Brussels Capital Region: the slow growth of wage employment by 1.9% between 2008 and 2020<sup>12</sup>; i.e. only 11,770 persons were additionally employed in 2020 when compared to 2008. This should be considered together with the fact that, over the same time period, Brussels had in fact the largest growth figure for self-employment growth. The table thus shows that the growth of self-employment was very outspoken (31%) over the same period.<sup>13</sup> When expressed in absolute terms, the difference between the increase in the number of self-employed (+ 25,597) is more than twice as large as the increase in wage employment (+11,770): the ratio of the extra wage employed over self-employed is 0.46. For Belgium, this ratio was 1.56<sup>14</sup>. This particularity must be kept in mind when analysing the employment in the Brussels-Capital Region.

### 3.2.2. Dynamics of total employment

This section on the multiplier does not consider the separate types of employment but focusses on total employment. Hence, Table 3.2 pictures the evolution of total employment between 2008 and 2020 for the provinces in Belgium. In general, table 3.1 shows that total employment in the Brussels Capital Region grew from 704,084 persons in 2008 to 741,451 in 2020: an increase by 37,367 persons (or by 5.4%).<sup>15</sup> In the case of the rest of Belgium, however, employment grew by 10.6% between 2008 and 2020, demonstrating the relative weak position of employment dynamics in the Brussels Capital Region.

**Table 3.2 – Evolution of total employment by province**

Provinces	Total employment in 2020	Share of employment in 2020	Compound annual growth rate 2008-2020 (in %)	Average annual growth 2008-2020
Brussels-Capital Region	741451	14.4	0.43	3114
Antwerpen	884794	17.2	0.79	6625
Limburg	377091	7.3	0.81	2890
Oost-Vlaanderen	679594	13.2	1.21	7584
Vlaams-Brabant	513487	10.0	0.93	4490
West-Vlaanderen	571302	11.1	0.60	3304
Brabant wallon	181344	3.5	1.39	2311
Hainaut	474589	9.2	0.55	2530
Liège	424381	8.3	0.71	2876
Luxembourg	103638	2.0	0.65	646
Namur	189291	3.7	0.98	1745
BELGIUM	5140962	100.0	0.78	38115

Source: RSZ/ONSS and INASTI/RSVZ; own calculations.

As for total employment, the employment in the Brussels Capital Region of 741,451 persons accounts for 14.4% of the Belgian total and is only outperformed by the province of Antwerpen (17.2%). The compound annual growth rate, which assumes a linear evolution between 2008 and 2020, is the lowest for the Brussels-Capital region. We saw previously that this evolution must be attributed to the evolution

<sup>12</sup> An overview of the different growth rates used in Part 3 are in Appendix 3.3.

<sup>13</sup> The considerably faster growth of the self-employed in Brussels amounts to a considerably faster growth in the denominator of the wage employment/self-employment ratio since 2008; whereas it amounts to 5.85 in 2020, it comes from 7.52 in 2008.

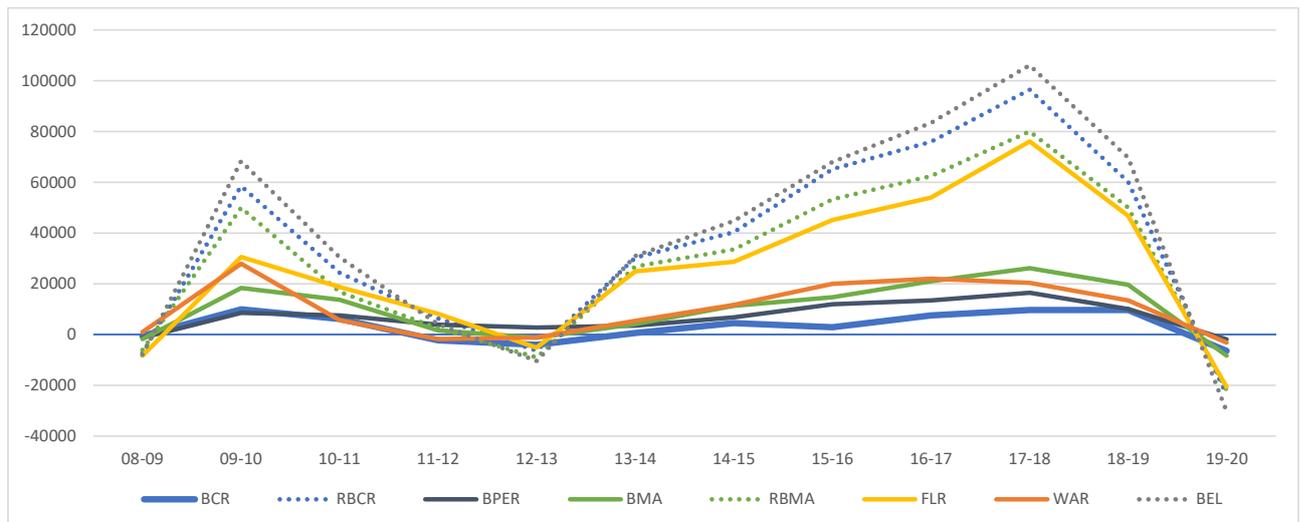
<sup>14</sup> Vlaams-Brabant is the only province where the growth in self-employment between 2008 and 2020 is only slightly larger than that of wage employment: the ratio of extra wage employed over self-employed is 0.97

<sup>15</sup> For completeness we recall the corresponding data in table 1.3: an employment level in 2020 of 751,369, and an absolute growth since 2008 by 46,642 persons (hence, a 6.6% growth).

of wage employment in the Brussels-Capital Region. The average annual growth shows that, between 2008 and 2020, total employment rose by 3,114 persons per year in the Brussels Capital Region, which is, given its weight in the Belgian economy, a relatively small growth, and is outperformed by four provinces: Oost-Vlaanderen, Antwerpen, Vlaams-Brabant and West-Vlaanderen.

Figure 3.1 looks at these employment data by spatial scale as discussed in the introduction to Part 3. It uses the same data of the provinces, but aggregates them by spatial scale to capture the Brussels Metropolitan Area (BMA)

**Figure 3.1 - Annual evolution of total employment between 2008 and 2020**



Source: RSZ/ONSS and INASTI/RSVZ; own calculations.

Figure 3.1 shows the variability of total employment on a year-to-year basis. Employment, at all spatial scales, declined firmly after the financial crisis (2011 to 2013), and the resilience of the Flemish Region (FLR) after this crisis is obvious (and affects all spatial scales which it included, such as RBCR, RBMA and BEL). However, it is interesting to see that employment growth already declines substantially in 2018-2019 in many regions, just before the outbreak of the COVID-19 pandemic which resulted in negative employment growth in 2019-2020.

The use of absolute employment changes in Figure 3.1 is instructive with an eye towards the interpretation of employment shocks in section 3.6. (where we will consider the impact on total demand following an increase of knowledge-intensive demand of 100 persons). At the same time, it is clear that the difference in scale between Brussels (and its immediate neighbours) on the one hand and other parts considered in Figure 3.1. on the other in itself explains why year-to-year changes for the latter group are always more outspoken. Correcting for these scale differences, viz. when calculating the coefficient of variation<sup>16</sup>, the fluctuations are the strongest for the Brussels Capital Region (1.82 against 1.07 for the rest of Belgium-RBCR), nuancing Figure 3.1 which obscures this fact.

<sup>16</sup> The coefficient of variation (CV) is the ratio of the standard deviation to the mean and shows the extent of variability in relation to the mean of the population. The higher the coefficient of variation, the greater the fluctuations around the mean.

### 3.2.3. Total sector employment

The data used in this part, especially the control variables in section 3.6.2, draws on various sources (Eurostat, Statbel, NBB). This implies that we need to resort to a somewhat different sector aggregation level than the one used in part 1. Note that this does *not* mean that sectors are left out of the analysis, but rather that some have been grouped into larger categories so as to be able to couple them with other data in subsequent analyses. Annex 3.1. shows the connection between the (groups of) NACE-2 codes and the sectors as they are displayed in table 3.3. The different aggregation also means that we have recalculated the knowledge-intensities for these 21 sectors (and for all spatial scales considered), to recalculate the knowledge-intensive employment for each province in Belgium (see section 3.3). Again, this information is provided in Appendix 3.1 for specific values). Hence, we have 231 unique datapoints - provinces-sector - in our database. As these are recorded for 13 years (annually from 2008 to 2020 included), we have 3,003 observations in the database.

Table 3.3 gives the employment data for the 21 aggregated sectors for the Brussels Capital region and the rest of Belgium. This allows for emphasising the particularities of Brussels in terms of sector weight of employment.

The Brussels Capital Region shows a specific economic structure when compared to the rest of Belgium. In 2020, six sectors provided 62.6% of total employment in the Brussels Capital Region: public administration (O: 14.23%), human health and social work activities (Q: 10.72%), education (P: 9.99%), wholesale and retail trade (G: 9.76%), administration and support services activities (N: 8.99%), and professional, scientific and technical activities (M: 8.88%).

Coloured cells show the evolution in terms of shares, the light shades lie between -1 and +1 percentage points and the dark shades are smaller than -1 and larger than +1 percentage points. Drivers of employment growth in the Brussels Capital Region are three sectors in particular: the administrative and support services (N) with an 22,408 extra employment since 2008, education (P) with 16,119 extra jobs, and the professional, scientific and technical activities (M) with 11,441 extra jobs. The financial sector (K) declined from 9.55% in 2008 to a share of 7.13% in 2020, or a job loss of 14,383 persons. The sector of wholesale, etc. (G) is equally affected by a job loss since 2008 of 14,151 jobs.

These findings are not completely mirrored by the sector evolution in the rest of Belgium. Marked employment increases are recorded in two sectors, the administrative and support services (N) with 142,385 extra jobs since 2008, and the professional, scientific and technical activities (M) with 88,210 extra jobs.

The specialisation index reveals the specialisation of employment in the Brussels Capital Region<sup>17</sup>. Not surprisingly, the activities of extraterritorial organisations and bodies (U) is typical for the Brussels Capital Region. Note that this employment of 2.739 persons is a serious underestimation of real

<sup>17</sup> The specialisation index, or the revealed comparative advantage (RCA), depicts the specialisation of sector

employment compared to a reference territory, and is calculated using equation 
$$RCA_{i,t}^j = \frac{\frac{EMP_{i,t}^j}{\sum_{i=1}^I EMP_{i,t}^j}}{\frac{\sum_{j=1}^{J-j} EMP_{i,j,t}}{\sum_{j=1}^{J-j} \sum_{i=1}^I EMP_{i,j,t}}}$$

If RCA is larger than unity, employment in the Brussels Capital Region is said to be ‘specialised’ in that activity. If it is less than unity, the employment is said to be ‘despecialised’ in that activity.

employment in this sector. Our data only register the employment as captured by the administrative databases of RSZ/ONSS and INASTI/RSVZ. According to Dotti et al. (2022) an extra of 53,335 employees of the international and European institutions and 15,160 employees of the interest groups must be included in these data<sup>18</sup>.

Employment in the Brussels-Capital Region is further particularly specialised in financial and insurance activities (K), public administration etc (O), and information and communication (J). It is not specialised in certain sectors with much employment such as manufacturing (C), wholesale and retail trade (G), and human health and social work activities (Q).<sup>19</sup>

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<sup>18</sup> As we do not possess these data for the rest of Belgium, which also host some international institutions (e.g. Shape in Mons or the JRC in Geel) we prefer to leave these out.

<sup>19</sup> A word of caution seems warranted here, especially with regard to the wholesale/retail sector. We earlier referred to the fact that administrative databases on the self-employed face cannot always clearly assign a specific NACE sector to the actual activities of a self-employed person. Insofar as a significant sub-group of these ('NACE 0') persons would have activities that *predominantly* are related to various retail activities, we might underestimate the real importance of the wholesale/retail sector.

**Table 3.3 – Sector shares of the employment in the Brussels Capital Region and the rest of Belgium**

Sector	Brussels Capital Region			Rest of Belgium			Specialisation °
	Employment in 2020	Share in 2020	Difference in share 2008	Employment in 2020	Share in 2020	Difference in share 2008	
Agriculture, forestry and fishing (A)	3261	0.44	0.33	112539	2.56	0.22	0.17
Mining and quarrying (B)	86	0.01	0.00	2303	0.05	-0.03	0.22
Manufacturing (C)	19187	2.59	-1.17	493322	11.21	-2.84	0.23
Electricity, gas, steam and air-conditioning supply (D)	4327	0.58	0.00	15021	0.34	-0.05	1.71
Water supply; sewerage, waste management and remediation activities (E)	3522	0.48	-0.11	29884	0.68	0.02	0.70
Construction (F)	35456	4.78	0.52	305285	6.94	-0.10	0.69
Wholesale and retail trade, repair of motor vehicles and motorcycles (G)	72398	9.76	-2.53	668930	15.20	-1.02	0.64
Transportation and storage (H)	36013	4.86	0.39	221963	5.05	-0.51	0.96
Accommodation and food service activities (I)	33118	4.47	-0.21	169158	3.84	-0.28	1.16
Information and communication (J)	33573	4.53	-0.56	87523	1.99	0.24	2.28
Financial and insurance activities (K)	52880	7.13	-2.42	76969	1.75	-0.36	4.08
Real estate activities (L)	7572	1.02	0.18	33392	0.76	0.04	1.35
Professional, scientific and technical activities (M)	65846	8.88	1.15	306879	6.98	1.48	1.27
Administrative and support service activities (N)	66693	8.99	2.71	373324	8.49	2.68	1.06
Public administration and defence; compulsory social security (O)	105480	14.23	-1.09	271692	6.18	-0.77	2.30
Education (P)	74095	9.99	1.76	390560	8.88	0.13	1.13
Human health and social work activities (Q)	79513	10.72	0.26	617721	14.04	0.56	0.76
Arts, entertainment and recreation (R)	14284	1.93	0.26	71324	1.62	0.20	1.19
Other service activities (S)	30839	4.16	0.46	147182	3.35	0.34	1.24
Activities of households as employers, etc. (T)	569	0.08	0.00	3976	0.09	0.02	0.85
Activities of extraterritorial organisations and bodies (U)	2739	0.37	0.07	564	0.01	0.00	28.82
<b>All sectors</b>	<b>741451</b>	<b>100</b>	<b>0.00</b>	<b>4399511</b>	<b>100</b>	<b>0.00</b>	<b>1</b>

Source: RSZ/ONSS and INASTI/RSVZ; own calculations.

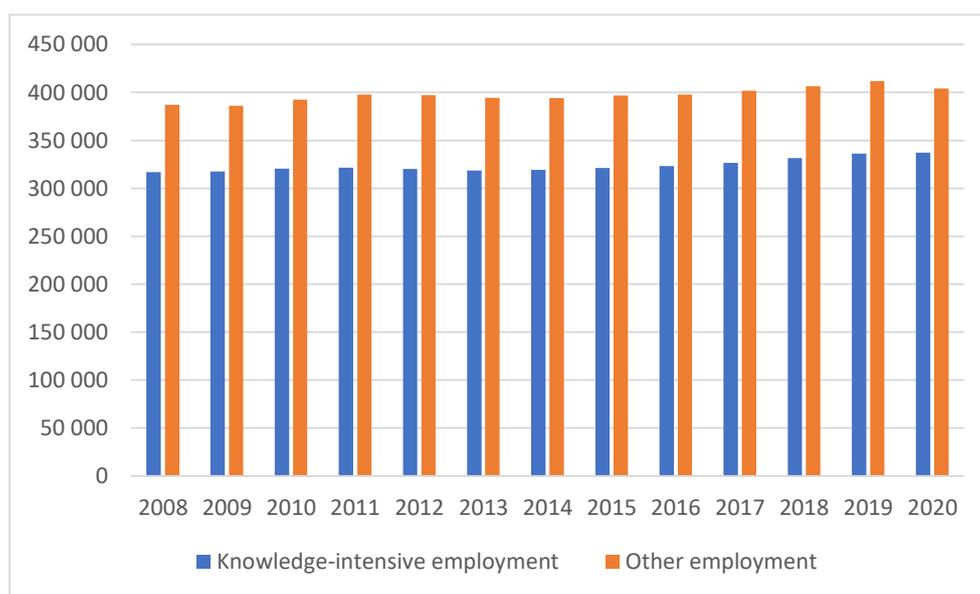
Note: ° The specialisation index is calculated by dividing the share in 2020 of Brussels by the share of the rest in Belgium. If the ratio is larger than 1, Brussels is specialised in the sector, if it is smaller than one, it is 'despecialised' in this activity.

### 3.3. Evolution of the knowledge-intensive employment

This section describes the evolution of knowledge-intensive employment, as calculated according to the method in Part 1, between 2008 and 2020 in the Brussels-Capital Region and benchmarks it against other spatial scales.

Breaking down total employment into knowledge-intensive employment and low knowledge-intensive employment (other employment) yields Figure 3.2, which depicts its evolution between 2008 and 2020, and sets it off against the other, less knowledge-intensive, employment.<sup>20</sup>

**Figure 3.2 – Evolution of knowledge-intensive employment and other employment, BCR**

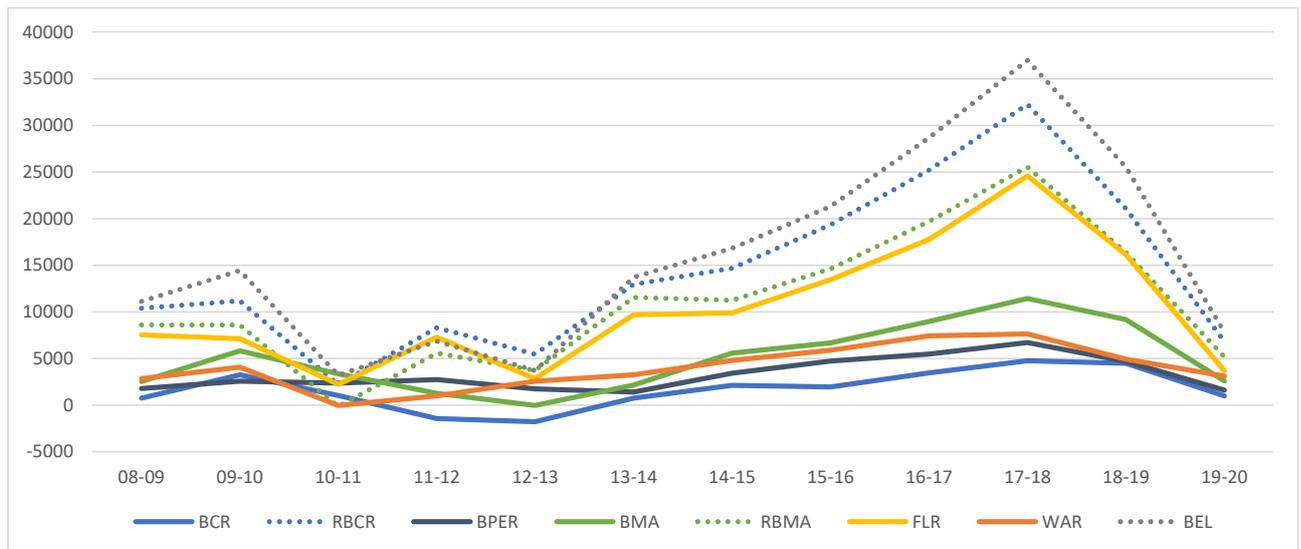


*Source: RSZ/ONSS and INASTI/RSVZ; own calculations.*

Figure 3.3 shows the evolution per year of knowledge-intensive employment between 2008 and 2020 by spatial scale. As in Figure 3.1, the financial crisis and its aftermath show up clearly. In the case of Brussels this is evident because of the presence of the financial sector (which shows a monotonous decline in employment since 2008). Only in 2014 the knowledge-intensive employment growth in the Brussels Capital Region became positive again, to decline again due to the outbreak of COVID-19 (from 4,489 in 2018-2019 to only 1,004 in 2019-2020).

<sup>20</sup> Again, and just as in the previous footnote, one should be cautious to draw strong conclusions about the *relative* position (and evolution) of both categories. Specifically, to the extent that the “Nace 0”-problem would be significantly more prevalent in one of these two categories, we would have a systematic bias in the- that ratio. It is indeed not impossible that those self-employed that cannot be unequivocally be assigned to a specific sector are overrepresented in the “other employment”-group.

**Figure 3.3 - Annual evolution of knowledge-intensive employment between 2008 and 2020**



Source: RSZ/ONSS and INASTI/RSVZ; own calculations.

As noted earlier, the decline in employment growth already started before the COVID-19 pandemic. The reason for this decline falls beyond the subject of this study.

According to the annual average growth rate (see Appendix 3.3 for its calculation) between 2008 and 2020, the average annual growth of the knowledge-intensive employment in the Brussels Capital Region amounts to about 1,700 persons (and to about 10,200 persons in the Flemish Region, and about 4,000 persons in the Walloon Region). This information is useful when interpreting the impact of the multiplier (see section 3.6).

### 3.4. Dynamics of total employment: shift-share analysis

Moretti (2010) and Van Dijk (2018) both make use of a shift-share analysis in their multiplier calculation. Hence, this report follows suit and performs a shift-share analysis to be included in the multiplier analysis.<sup>21</sup> Moreover, the shift-share results are interesting and relevant by themselves as they point to the particularities of the Brussels Capital Region, and thus will be discussed in this section.

Shift-share analyses are popular in regional research due to the simple data requirements. A shift share analysis considers the change over time of an economic variable, such as employment, within sectors (like those defined by NACE2) of a regional economy, and decomposes that change into various components. It investigates what shares of regional economic growth or contractions can be attributed to the overall national evolution, to the regional economic structure, or to region-specific factors. Shift-share analysis identifies those sectors where the regional economy has competitive advantages over the reference area. There are different versions of a shift-share analysis, but all identify national, industry, and regional factors that influence the changes of total employment.

<sup>21</sup> We build on a recent version of the shift-share analysis (Artige and van Neuss, 2014), and modify this by making it dynamic (Herath et al., 2013) and corrected the reference areas, i.e. use without the region under consideration. The reference area is, each time, the rest of Belgium and hence always excludes the focal region itself.

Specifically, our shift-share analyses looks at the employment growth rate differential between a specific region (the Brussels Capital Region, any of the Belgian Provinces) and a reference area, in each case constituted by “the rest of the Belgian economy”. To illustrate, the growth rate differential number of -0.41 in the first line of table 3.4 shows that total employment in the Brussels Capital region grew less than employment in the rest of Belgium.

These employment growth rate differentials are consequently decomposed by further zooming in at the sector level. The exact decomposition being done according to the formulas presented in Appendix 3.2., the intuition behind such decomposition is based on the basic insight that the total employment growth in a region is nothing but a sector-weighted average of sector-specific regional employment growth rates. Accordingly, both the relative importance of a sector within the regional economy and its own growth rate contribute to the overall change. The same reasoning obviously holds for the observed evolution in the reference area. As a result, the growth rate differential between the two regions can be explained by (1) differences between the two considered regions in terms of the weights of the different sectors, conventionally labelled an ‘industry effect’ and (2) inter-regional differences between the sector growth rates *per se* (usually labelled a ‘competitive’ effect) (Murray, 2010).

In sum, shift-share analysis compares the sector distributions of employment growth, checking if the regional economic structure brings more employment growth than the reference area and identifying to what extent this is driven by (i) the sectoral structure of a region and (ii) regional sector employment growth that outperforms the one of the reference area (Artige & van Neuss, 2014). Table 3.4 summarises the aggregate findings of this dynamic shift-share analysis for total employment in all provinces in Belgium<sup>22</sup>. In this and the following tables, green shaded cells provide the qualitative indication that the region considered does better than the reference area, and orange shaded cells indicate the opposite

**Table 3.4 - Shift-share analysis based on total employment data – 2008-2020**

Provinces	Growth rate differential	Industry-mix	Sector growth effect
Brussels-Capital Region	-0.41	-1.13	0.72
Antwerpen	0.01	-0.38	0.39
Limburg	0.03	-1.28	1.31
Oost-Vlaanderen	0.49	-0.58	1.07
Vlaams-Brabant	0.17	-0.96	1.12
West-Vlaanderen	-0.20	-0.27	0.07
Brabant wallon	0.64	0.93	-0.29
Hainaut	-0.25	-0.05	-0.20
Liège	-0.08	0.55	-0.62
Luxembourg	-0.13	0.79	-0.93
Namur	0.21	0.43	-0.22

Source: RSZ/ONSS and INASTI/RSVZ; own calculations.

As already stated, the table shows a negative growth rate differential for the Brussels Capital Region, indicating that it underperforms in total employment growth when compared to the rest of Belgium, i.e. Belgium minus the Brussels Capital Region. Specifically, employment growth in the Brussels Capital Region was 0.41 percentage points less than that of the rest of Belgium. Negative employment growth

<sup>22</sup> Table A3.1 in the Appendix does the same for the knowledge-intensive employment data. However, these results will not be used in section 3.6.2 on the multiplier and are just given as extra information.

differentials are also observed - be it to a lesser extent - for the provinces Hainaut, West-Vlaanderen, Luxembourg, and Liège. Brabant Wallon, Oost-Vlaanderen, Namur, Vlaams-Brabant present higher employment growth rates, whereas Limburg and Antwerpen are performing only slightly better than the rest of Belgium (which, to recall, for each province always amounts to a comparison with the rest of Belgium excluding the province itself).

As can be further noted from the table, the observation that the Brussels Capital Region experienced difficulties to keep up with employment growth in the rest of Belgium is the result of two opposing effects. Looking at the pure (unweighted) sector employment growth rates, Brussels is doing better on average (and, hence, in many specific sectors), than in the rest of Belgium. However, this effect is offset by the industry-mix effect (including, for example, cases in which a regional sector grows more than in the rest of the economy, but is of considerably less importance for the Brussels economy than it is in the rest of the economy, etc.).

A clear pattern emerges from Table 3.4: the Flemish provinces display a negative industry-mix effect and a positive competitive effect; and this is the reverse in the case of the Walloon provinces. The Brussels Capital Region follows the Flemish provinces, but ends up with a negative growth rate differential because of the magnitude of the negative industrial mix. This is also the case for the province of West-Vlaanderen.

Table 3.5 zooms in on the industry-mix of the ten provinces and compares them to the Brussels Capital Region. In particular, the table provides a breakdown of the overall industry-mix effect for the 21 sectorial groups considered.

**Table 3.5 – Industry-mix effects capturing the growth effect of economic structure**

Sector <sup>o</sup>	BCR	APEN	LIMB	OVL	VBR	WVL	BW	HAI	LIE	LUX	NAM
A	-0.59	-0.09	0.01	0.03	-0.02	0.06	-0.07	0.02	0.02	0.05	0.02
B	-0.66	-0.29	0.08	0.09	-0.32	-0.31	0.17	0.04	0.15	-0.01	-0.05
C	0.13	-0.04	-0.13	0.04	0.02	-0.05	0.19	-0.04	0.01	0.05	0.05
D	-0.03	0.00	-0.05	0.03	0.11	-0.01	0.13	-0.18	0.00	-0.01	0.11
E	0.09	-0.01	-0.10	-0.03	0.00	0.02	-0.05	0.02	-0.02	0.08	-0.05
F	-0.02	0.00	0.00	0.03	-0.01	0.01	-0.02	-0.02	-0.01	0.01	-0.01
G	-0.13	-0.03	0.05	0.04	0.04	0.06	-0.04	0.02	0.02	0.02	0.06
H	0.00	0.00	0.00	0.00	-0.02	0.00	-0.02	0.00	0.00	0.00	0.00
I	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	0.00	0.00	-0.01
J	0.06	-0.04	-0.12	-0.13	0.03	-0.04	-0.08	0.05	0.02	0.17	0.00
K	-0.09	0.00	-0.03	-0.01	-0.02	0.01	-0.03	0.03	0.01	0.03	0.00
L	-0.04	0.03	0.00	0.01	0.00	-0.04	-0.02	0.05	-0.01	-0.05	0.01
M	0.02	0.00	-0.04	0.01	0.15	-0.05	0.10	-0.06	-0.04	-0.07	-0.03
N	0.00	0.06	0.03	0.01	-0.01	-0.01	-0.03	-0.07	-0.03	-0.17	-0.09
O	-0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.01	-0.03	0.05	0.03
P	0.05	-0.01	-0.02	-0.01	0.00	-0.05	0.00	0.01	0.04	-0.02	0.01
Q	-0.07	0.01	0.03	0.06	-0.01	-0.02	-0.05	0.05	0.00	-0.03	0.04
R	0.01	0.03	0.00	-0.02	-0.07	-0.01	-0.04	-0.03	0.03	0.00	0.02
S	0.02	0.00	0.00	-0.01	-0.01	0.00	-0.03	0.01	0.00	0.02	0.02
T	0.15	-0.13	-0.23	-0.12	-0.01	0.06	0.17	0.14	0.11	0.36	0.21
U	-0.01	0.14	-0.76	-0.59	-0.81	0.10	0.62	-0.07	0.27	0.31	0.10
<b>Total</b>	<b>-1.13</b>	<b>-0.38</b>	<b>-1.28</b>	<b>-0.58</b>	<b>-0.96</b>	<b>-0.27</b>	<b>0.93</b>	<b>-0.05</b>	<b>0.55</b>	<b>0.79</b>	<b>0.43</b>

Source: RSZ/ONSS and INASTI/RSVZ; own calculations.

Notes: <sup>o</sup> The names of the sectors are in Table 3.3 and in Appendix 3.1.

Negative values indicate that the region's economic structure is generating less employment growth than the reference area. Limiting ourselves to large employment sectors, those that contribute to the negative score for the Brussels Capital Region are wholesale and retail (G), financial and insurance (K), human health and social work (Q), and construction (F). These losses in employment are not made up for by the employment increase in manufacturing (C), information and communication (J), and education (P). Table 3.4 also shows that the dynamic sectors of the Brussels Capital Region differ considerably from the other provinces in Belgium.

Table 3.6 considers a similar breakdown of the sector growth effect which captures the differences of the sectoral average annual growth rates of total employment between the province and the rest of Belgium.

**Table 3.6 – Sector growth effects capturing the growth effect of sectoral performance**

Sector <sup>o</sup>	BCR	APEN	LIMB	OVL	VBR	WVL	BW	HAI	LIE	LUX	NAM
A	0.58	0.14	-0.01	-0.04	0.02	-0.08	0.10	-0.03	-0.04	-0.12	-0.01
B	0.66	0.30	-0.08	-0.09	0.32	0.31	-0.18	-0.05	-0.16	0.00	0.05
C	-0.07	0.00	-0.04	0.04	-0.04	0.01	0.12	-0.03	0.01	0.03	-0.01
D	0.03	0.00	0.05	-0.04	-0.12	0.01	-0.14	0.19	0.00	0.01	-0.12
E	-0.10	0.01	0.12	0.04	-0.01	-0.02	0.05	-0.02	0.03	-0.09	0.07
F	0.03	0.00	-0.02	0.02	0.06	0.01	-0.04	-0.04	-0.03	-0.02	-0.03
G	-0.08	-0.01	0.02	0.02	0.01	0.03	-0.02	0.01	0.01	0.01	0.03
H	0.05	-0.01	0.05	0.05	-0.06	-0.05	0.04	-0.02	0.00	0.00	0.00
I	-0.01	-0.04	0.01	0.01	0.02	-0.05	0.06	0.05	0.03	0.03	0.05
J	-0.12	0.07	0.14	0.19	-0.04	0.03	0.17	-0.08	-0.04	-0.22	-0.02
K	-0.06	0.02	0.07	0.04	0.06	0.01	0.07	-0.02	0.01	-0.01	0.02
L	0.05	-0.04	0.00	-0.02	0.00	0.04	0.03	-0.06	0.01	0.05	-0.01
M	-0.06	0.00	0.01	0.04	0.04	0.04	0.03	-0.05	-0.02	-0.06	-0.01
N	-0.03	-0.02	0.02	0.05	-0.06	0.03	0.05	-0.04	0.04	0.19	0.06
O	0.00	0.02	0.00	0.00	-0.03	-0.02	0.02	0.02	-0.03	0.04	0.03
P	0.05	0.00	-0.02	-0.02	0.01	-0.04	-0.01	-0.01	0.02	-0.03	-0.01
Q	-0.02	0.02	0.01	0.02	0.01	-0.02	-0.01	0.00	-0.01	-0.02	0.01
R	-0.01	-0.04	-0.01	0.02	0.09	0.01	0.07	0.04	-0.05	-0.01	-0.03
S	-0.02	-0.03	0.01	0.01	0.01	0.00	0.08	0.01	-0.01	-0.03	0.04
T	-0.16	0.14	0.23	0.12	0.01	-0.06	-0.18	-0.14	-0.11	-0.36	-0.21
U	0.02	-0.14	0.76	0.59	0.81	-0.10	-0.62	0.07	-0.28	-0.31	-0.10
<b>Total</b>	<b>0.72</b>	<b>0.39</b>	<b>1.31</b>	<b>1.07</b>	<b>1.12</b>	<b>0.07</b>	<b>-0.29</b>	<b>-0.20</b>	<b>-0.62</b>	<b>-0.93</b>	<b>-0.22</b>

Source: RSZ/ONSS and INASTI/RSVZ; own calculations.

Notes: <sup>o</sup> The names of the sectors are in Table 3.3 and in Appendix 3.1.

Positive values in Table 3.6. indicate that the average annual growth rate of employment in that sector are higher in the region than that growth rate in the rest of Belgium. The main contributors for the Brussels value of 0.72 are unimportant sectors in terms of their share in total Brussels employment (agriculture (A), with a compound average growth rate of 13% between 2008 and 2020 and mining (B)). The only positive values for a large employment sector (see Table 3.3) are those of education (P), and transport and storage (H).

Taken together, Tables 3.3, 3.5 and 3.6 indicate that Brussels experienced a relative employment decline in various large sectors in which it is, at the moment, still specialized. This can be either because employment growth in such a sector is positive in Brussels, yet lower than that in the rest of Belgium – see, e.g., the Professional, scientific and technical activities (M), or the Human health sector (Q)–, or because employment has been declining, yet at a more outspoken rate in Brussels than in the rest of Belgium (see, e.g., Financial and Insurance activities (K), or Public Administration (P)). Importantly, these also largely coincide with important knowledge-intensive sectors as identified in part 1 and

analysed further in Part 2 of this study. The Education sector is a notable exception to this general observation.

### 3.5. Calculation of the multiplier effects: panel regression analysis

As stated in section 3.2.3, we recalculated the knowledge-intensities for 21 sectors which are analysed for 10 provinces in Belgium (next to the Brussels Capital Region). Hence, we have 231 unique - provinces-sector datapoints in our database. As these are recorded for 13 years (annually from 2008 to 2020 included), we have 3,003 observations in the database.

In its simplest formulation the employment multiplier results from an ordinary least squares (OLS) regression. Due to the particularities of our database, the regression technique used to estimate the multiplier is through a panel regression. Panel data are cross-sectional time-series data where the employment data of regions are observed across time. We use a fixed-effects model because the region is tracked throughout the period. A fixed-effects regression is an estimation technique employed in a panel data setting that allows one to control for time-invariant unobserved regional characteristics that can be correlated with the observed independent variables. In our case, each region has region-specific characteristics that impact our independent variable, which is in our case the evolution of knowledge-intensive employment.

Many papers calculate the employment multiplier through econometric models. By definition, a multiplier pictures the ratio between changes in a variable due to a change in another variable. In the context of this section, the employment multiplier depicts the change in total employment ( $\Delta TEMP$ ) in a region,  $j$ , divided by a change in knowledge-intensive employment ( $\Delta KEMP$ ) in that region.

The knowledge-intensive employment multiplier,  $\beta$ , is calculated using the following formula.

$$\beta = \frac{\Delta TEMP^j}{\Delta KEMP^j}$$

Or, which amounts to the same thing, it can be econometrically expressed as a simple regression:

$$\Delta TEMP^j = \alpha^j + \beta^j \Delta KEMP^j + \varepsilon^j$$

The equation for the fixed effects model, using year fixed-effects (YFE) if relevant, of region  $j$  becomes:

$$\Delta TEMP_{it}^j = \alpha_i^j + \beta_1^j \Delta KEMP_{it}^j + \beta_2^j YFE_{it}^j + u_{it}^j$$

Clearly, the magnitude of the multipliers calculated on the basis of this simple regression model provide valuable information in their own right. They should however be conceived as empirical models that address the basic question to what extent observed changes in knowledge-intensive employment go hand in hand with observed changes in total employment. At the same time, it is plainly wrong to regard the estimated value as capturing some kind of pure causal effect. The changes in knowledge-intensive employment as observed in our panel data can evidently not be taken as some kind of exogenous variable. Neither does it make sense to state that observed changes in total employment are exclusively driven by changes in knowledge-intensive employment.

To obtain insights on a *ceteris paribus* relation between knowledge-intensive and total employment, one hence needs a second model that controls for several variables. Each of the control variables must potentially affect total regional employment. We use control variables which are cited in the existing literature on multiplier calculations (e.g. Moretti, 2010; Van Dijk, 2018; Gutierrez-Posada, 2021) or

suggested elsewhere (Domenech et al., 2016). Many control variables are from existing databases. However, the sectoral aggregation of many data differs from the initial 88 sectors, necessitating the calculation of the knowledge-intensity for 21 aggregated sector groups for which comparable data are available (see Appendix 3.1).

In addition to the knowledge-intensive employment, the control variables that potentially impact total employment focus on the sector composition of the employment in the region; economic indicators; social indicators and knowledge-related indicators.

The sector composition of total employment can be captured including the industrial mix of the shift-share analysis (SSAIM) (see section 3.4 and Appendix 3.2). Next, three macroeconomic indicators are considered. First, gross domestic product per employed person (GDPTE) which measures a regions' economic output per person and is calculated by dividing the gross domestic product of a country by its labour force (i.e. the wage employment plus self-employment). This indicator is a measure to estimate the prosperity of a region based on its economic growth. Second, the gross value added per sector (GVASECT) captures the economic productivity that measures the contribution of a sector. Gross value added measures the output of a sector minus its intermediate consumption. Third, gross fixed capital formation per sector (GFCSECT) is relevant in terms of macro-economic policy, as gross fixed investment is the major component of domestic investment which is instrumental to accelerate economic growth.

Income per employed person (INCTE) measures the average income earned per employee in a given region in a specified year. It is calculated by dividing the region's total income by its total employment (i.e. wage employment plus self-employment). This indicator measures the wealth of employees and captures the standard of living and the demand conditions of a region.

Finally, patents (PATENT) are an indicator to measure the technological progress of a region, as they represent the actual creation and dissemination of knowledge in productive activities. Patents secure monetary benefits through marketing, sale or licensing of technology, and they also reflect a dynamic production of knowledge and technologies that positively impact societies. A mediocre performance in terms of patents suggests the need to improve patenting activities and innovation policies to increase the competitiveness of the region.

The extended model to be tested is, therefore, the following:

$$\Delta TEMP_{it}^j = \alpha_i^j + \beta_1^j \Delta KEMP_{it}^j + \beta_2^j SSAIM_{it}^j + \beta_3^j \Delta GDPTE_{it}^j + \beta_4^j \Delta GVASECT_{it}^j + \beta_5^j \Delta GFCSECT_{it}^j + \beta_6^j \Delta INCTE_{it}^j + \beta_7^j \Delta PATENT_{it}^j + \beta_7^j YFE_i^j + u_{it}^j$$

This second regression is a first-difference estimator that is used to address the problem of omitted variables in panel data. By using first differences, unobserved time-invariant variables are deleted from the regression.

### **3.6. The knowledge-intensive employment multiplier**

The advantage of performing an econometric multiplier analysis is that we do not need to rely on previous externally organised calculations as in the regional input-output tables (see Part 4). A drawback is that we cannot specify which economic sectors benefit or suffer most from additional knowledge-intensive employment which can be highlighted using regional input-output tables (see Part 4). The objective of the multiplier analysis is to estimate the effects of knowledge-intensive employment on total employment and additional knowledge-intensive and non-knowledge-intensive employment

As just stated, two multipliers will be estimated. The first one builds on simple regressions and thus adheres the closest to the definition of the employment multiplier as formally stated in the previous section. The second addresses the omitted variable issue that is intrinsic to the simple regression, and reconsiders a '*ceteris paribus*' multiplier by including other factors that may potentially influence the change in total employment additional to a change in knowledge-intensive employment..

#### **3.6.1. The employment multiplier without control variables**

The employment multiplier, as defined in section 3.5, is calculated for each of the spatial scales to benchmark the Brussels Capital region. Earlier empirical multiplier exercises showed that in the EU each high-tech job generates an additional five non-high-tech jobs (Goos et al., 2015), and five in the US (Moretti, 2013). In a study on creative industries in the UK, Gutierrez-Posada et al. (2021) found that each creative job generates around 1.9 additional employment because of employees local spending.

Table 3.7 shows the results and makes use of the knowledge-intensities of each spatial scale to derive the impact on additional knowledge-intensive employment and on low skilled jobs. It presents the results of the knowledge-intensive employment multiplier without controlling for additional variables that also might affect the evolution of the total employment. Obviously, this multiplier captures the maximum effect, and should be considered an overestimation as other explicative factors are left out of consideration (Sancho, 2013; Dotti et al., 2022). The reader must be warned that there is no lag in the analysis, which assumes that each additional employment is translated immediately into the effects.

The multiplier can be read from the first row in Table 3.7. For the Brussels Capital Region, this multiplier is 3.12 which means that 1 extra person in a knowledge-intensive employment gives rise to an extra total employment of 2.12 (2.116 in Table 3.7) jobs. We report the multiplier values for all considered spatial scales in the first row of the table.

The lower part of the table further looks at the nature of these extra jobs, by considering how much of these are extra knowledge-intensive jobs and how much or other jobs. This decomposition builds on the calculated knowledge-intensive intensities that are reported in Appendix 3.1. For convenience, we rescale the magnitude of the initial impact and consider the multiplier effects induced by an extra 100 knowledge-intensive jobs.<sup>23</sup>

Looking at the first column of Table 3.7, given a multiplier value of 2.12, an extra 100 knowledge-intensive jobs thus generates 212 other jobs. Of these, 100 persons are employed in a knowledge-intensive activity, and a further 112 persons are employed in other (less knowledge intensive) jobs. Put slightly otherwise, (i.e., in gross terms), for the Brussels Capital Region, the total employment increase

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<sup>23</sup> To put that number into perspective, recall from section 3.3. that, on average, there were about 1,700 extra knowledge-intensive jobs created annually in the Brussels Capital Region between 2008 and 2020.

amounts to the original 100 additional persons plus the generated 100 knowledge-intensive jobs and 112 lower skilled jobs, totalling 312 jobs (see Van Dijk, 2018).

Compared to the rest of Belgium (RBCR), the Brussels Capital Region is less efficient in translating additional knowledge-intensive employment in low skilled jobs. First, the employment multiplier is higher in the rest of Belgium and second, the major share of additional employment in the rest of Belgium is less knowledge-intensive. (As for the latter, note that the ratio of additional knowledge-intensive employment and low skilled employment is, with 1.12, the lowest in the Brussels Capital Region).

The last observation in fact mirrors the fact that the Brussels Capital Region is in fact the most knowledge-intensive region to start with. Thus, it is quite natural to expect that any (new) knowledge-intensive job would be associated with less other, i.e. non- knowledge-intensive (new) jobs, compared to the other spatial scales. But this does not mean that there is no impact at all, as we have seen by the creation of 112 low skilled jobs.

**Table 3.7 - Multiplier analysis without control variables: fixed-effects panel regression results 2008-2020**

Variables	BCR	RBCR	BPER	BMA	RBMA	FLR	WAR	BEL
$\Delta$ KEMP	2.116*** (0.079)	2.512*** (0.246)	1.879*** (0.313)	2.047*** (0.233)	2.681*** (0.292)	2.442*** (0.289)	2.687*** (0.349)	2.374*** (0.197)
Intercept	-22.90 (34.56)	-159.5*** (40.81)	15.53 (24.36)	-4.15 (18.36)	-174*** (45.89)	-254*** (72.32)	-64.24 (34.76)	-148*** (37.33)
Year effects	No	Included	No	No	Included	Included	Included	Included
Obs.	252	2520	504	756	2016	1260	1260	2772
Within R <sup>2</sup> (year effect)	0.757	0.542	0.621	0.716	0.551	0.506	0.614	0.575
F-test	46.42***	16.47***	36.11***	77.41***	14.92***	10.03***	10.42***	19.39***
<b>Implications</b>								
Knowledge-intensities (see Appendix 3.1)	0.472	0.321	0.394	0.436	0.308	0.322	0.319	0.344
Additional knowledge-intensive employment ( $\Delta$ KEMP=100)	100	81	74	89	79	79	86	82
Additional non KI employment ( $\Delta$ KEMP=100)	112	170	114	116	189	165	183	155

Source: Labour Force Survey, RSZ/ONSS and INASTI/RSVZ; own calculations.

Notes: Robust standard errors between brackets; \*, \*\*, \*\*\* significance at 5%, 1% and 0.1%.

In the periphery of the Brussels Capital Region – Vlaams-Brabant and Brabant Wallon – (BPER) the effect on low skilled jobs is slightly more outspoken. The periphery is characterised by a lower employment multiplier, thus generating less total employment, but employment in the periphery is less knowledge-intensive (by 0.078 percentage point).

Combined, the Brussels Metropolitan Area (BMA) is a weighted average of the Brussels Capital region and its periphery. From Table 3.7 it follows that the Brussels Metropolitan Area displays a gross multiplier effect of just over 2. However, the rest of Belgium (RBMA) shows a higher multiplier effect.

While the Walloon Region has a marginally higher employment multiplier, it should indeed be noted that the rest of Belgium (RBMA) generates about the same total employment effects *and*, having the lowest knowledge-intensity, is about the most efficient area to translate the additional employment in low skilled jobs. The Flemish Region displays a higher multiplier than the Brussels Capital Region. Therefore, in absolute terms, *i.e.* if we recognize that in view of their scale differences an increase in knowledge-intensive jobs is typically larger than in Brussels, the additional employment effects will be larger in the Flemish Region.

### ***3.6.2. The extended employment multiplier: accounting for other factors influencing total employment***

Because the knowledge-intensive employment is an endogenous variable it cannot be considered in isolation to generate other employment effects or types of employment (Van Dijk, 2018). Of course, it would be highly improbable should knowledge-intensive employment be the only determinant of total employment as in section 3.6.1. Hence, we need to control for all potential impactful factors or variables (Domenech et al., 2016). Thus, a set of control variables is needed to develop a more realistic estimation of the impact of knowledge-intensive employment. These control variables are discussed in section 3.5.

Table 3.8 presents the multipliers for eight spatial scales when controlled for other factors that are deemed to affect total employment growth.

**Table 3.8 – Impact on the evolution of total employment: results of the fixed-effects panel regression**

Variables	BCR	RBCR	BPER	BMA	RBMA	FLR	WAR	BEL
ΔKEMP	1.013*** (0.216)	1.137*** (0.173)	0.722*** (0.193)	1.119*** (0.159)	1.233*** (0.190)	0.955*** (0.181)	1.374*** (0.220)	1.183*** (0.126)
SSAIM	-0.278 (9.542)	8.921 (5.541)	5.120 (7.835)	8.653 (8.119)	13.084 (9.637)	10.337 (8.979)	19.601 (14.289)	11.183 (6.788)
ΔGDPTE	2.815*** (0.665)	1.347*** (0.324)	-0.359 (0.385)	2.180** (0.701)	1.655*** (0.395)	1.267** (0.419)	0.878*** (0.250)	1.796*** (0.368)
ΔGVASECT	-0.058 (0.152)	-0.090 (0.138)	0.025 (0.075)	-0.077 (0.113)	-0.171 (0.208)	-0.044 (0.185)	-0.008 (0.095)	-0.095 (0.109)
ΔGFCSECT	0.008 (0.114)	-0.024 (0.043)	0.010 (0.038)	0.025 (0.034)	-0.011 (0.053)	-0.013 (0.059)	0.041 (0.028)	0.005 (0.040)
ΔINCTE	8.888*** (1.860)	7.909*** (0.832)	11.626*** (1.587)	6.968*** (1.036)	9.431*** (0.996)	11.019*** (1.117)	9.216*** (1.339)	8.717*** (0.809)
ΔPATENT	21.631 (17.730)	-2.965 (3.603)	0.678 (2.398)	-7.164 (4.265)	0.428 (5.367)	12.990 (6.732)	-8.552*** (2.430)	-4.183 (3.730)
Intercept	-210.3*** (159.18)	-113.2*** (13.19)	-25.67 (20.66)	-105.7*** (31.79)	-67.30** (22.41)	-127.1*** (30.13)	-36.11 (18.50)	-69.03*** (19.66)
Year effects	Included	Included	Included	Included	Included	Included	Included	Included
Obs.	252	2520	504	756	2016	1260	1260	2772
Within R <sup>2</sup> (year effect)	0.845	0.762	0.784	0.811	0.770	0.752	0.776	0.775
F-test	833.83***	64.20***	34.70***	39.54***	62.98***	65.05***	41.91***	68.01***
<b>Implications</b>								
Knowledge-intensities (see Appendix 3.1)	0.472	0.321	0.394	0.436	0.308	0.322	0.319	0.344
Additional knowledge-intensive employment (ΔKEMP=100)	48	36	28	49	36	31	44	41
Additional non-KI (ΔKEMP=100)	53	77	44	63	87	65	94	78

Source: Labour Force Survey, Eurostat, NBB, Statbel, RSZ/ONSS and INASTI/RSVZ; own calculations.  
Notes: Robust standard errors between brackets; \*, \*\*, \*\*\* significance at 5%, 1% and 0.1%; the variance inflation factor (VIF) varies between 1.0 and 3.4 and is therefore largely below its critical value of 5.

Table 3.8 shows that the multiplier results reached earlier are affected negatively by the inclusion of our control variables, as they now vary between 1.72 in the Brussels' periphery (BPER) and 2.37 in the Walloon Region (WAR). Note also that, once we include such controls, the ordering of the magnitude of the multipliers over the difference spatial scales here and there changes (see specifically the 'position switch' between BCR and the Flemish Region). At the same time, even when accounting for sector composition, economic and knowledge-related indicators to explain total employment changes in a territory, the ('multiplier') coefficients associated with knowledge-intensive jobs remain statistically significant.

In the Brussels Capital Region (BCR), an extra job in a knowledge-intensive activity *ceteris paribus* generates an additional job in total employment, hence a gross knowledge-intensive employment multiplier of 2. Decomposition of additional job creation (given an increase of 100 knowledge-intensive jobs) shows a breakdown into 48 extra knowledge-intensive jobs and 53 non KI employment. Recalling that there are on average 1,700 knowledge-intensive jobs per year between 2008 and 2020, the extra

employment amounts to 816 persons in a knowledge-intensive activity and 901 persons in a lower skilled job.

As earlier, the rest of Belgium (RBCR) demonstrates a higher multiplier (2.14) but also shows a lower knowledge-intensity, which translates itself in the regional capability of generating more non KI jobs, but less knowledge-intensive employment. Because the multiplier of the Brussels periphery (BPER) is 1.72, its ability to generate extra employment is the lowest of all spatial scales. Moreover, due to a relatively high knowledge-intensity, its ability to generate lower skilled employment is also hampered. Combining BCR and BPER, the Brussels Metropolitan Area (BMA) shows a multiplier of 2.12, which is again lower than the rest of Belgium (RBMA). Again, because of the higher knowledge-intensity in the BMA, the creation of knowledge-intensive employment in is higher in the BMA than in the RBMA, and the reverse is true in the case of lower skilled employment.

The multipliers in Table 3.8 are substantially lower than in Table 3.7 due to the inclusion of control variables. It follows, from Table 3.8, that changes in total employment are statistically significant associated with the change in gross domestic product per employee and the change in income per employee for most spatial scales except the Brussels' periphery. The effect of changes in gross domestic product is the most outspoken in the Brussels Capital Region. GDP is in absolute levels also the highest in the Brussels Capital Region according to Eurostat.

## Part 4: Multiplier Effects as Identified through Interregional Input-Output Tables

### 4.1 Introduction: why use interregional Input-Output Tables?

In this part, we study the direct and indirect employment effects associated with (simulated) increases in knowledge-intensive activities in the Brussels Capital Region. For this purpose, we use the “Interregional Input-Output model 2015” and the employment multipliers associated with that model, as calculated and published by the Belgian Planning Bureau (Federaal Planbureau, 2018; Avonds, Hertveldt en Van den Cruyce, 2021)<sup>24</sup>.

In essence, an Input-Output model (IO model hereafter) provides a considerably detailed breakdown of an economy in terms of interindustry flows, expressed in monetary terms. Such flows elucidate how the total production within an industry uses various inputs stemming from different sectors (both domestically and abroad), or, from the opposite perspective, how part of the “output” produced in an industry is used as “inputs” in other industries. Of course, in many cases a (sometimes substantial) part of an industry’s output is not intended for such “intermediate” interindustry demand, and a full IO table thus also traces the link between each industry’s output and the various components of final macroeconomic demand (private and public consumption, investment, exports).

While already quite detailed, IO models are normally set up at the level of a country. However, given the purposes of the current study, we use an extended version that provides a breakdown of (intermediate and final) production at the level of the three Belgian regions.<sup>25</sup> Figure 4.1 shows, in abstract terms; how such an interregional IO table looks like.

**Figure 4.1: basic structure of the interregional IO table**

		intermediate deliveries																FINAL DEMAND												TOT					
		BRU					VLA					WAL					BRU			VLA			WAL			EXTRA									
		01A	02A	...	96A	97A	01A	02A	...	96A	97A	01A	02A	...	96A	97A	01A	02A	...	96A	97A	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP		
BRU	01A																	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP
	02A																																		
	...																																		
	96A																																		
VLA	01A																	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP
	02A																																		
	...																																		
	96A																																		
WAL	01A																	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP
	02A																																		
	...																																		
	96A																																		
EXTRA	01A																	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP
	02A																																		
	...																																		
	96A																																		
IMP	01A																	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP	C	I	EXP
	02A																																		
	...																																		
	96A																																		
TAX																																			
VA																																			
TOT																																			
emp																																			

<sup>24</sup>Tables constructed in the context of the "Agreement for the drawing up of monetary interregional input-output tables for Belgium for the year 2015' between on the one hand the FPB on the one hand and BISA, VSA/EWI and IWEPS on the other hand.

See: [https://www.plan.be/databases/data-69-nl-interregionale\\_input\\_outputtabel\\_multipliatoren\\_2015](https://www.plan.be/databases/data-69-nl-interregionale_input_outputtabel_multipliatoren_2015)

<sup>25</sup> The Belgian Interregional IO table as made of by the Federal Planning Bureau also considers a 4<sup>th</sup> “region”, viz. the “extraregional area”, comprising Belgian embassies and consulates, scientific bases abroad, etc. We do not consider this 4<sup>th</sup> “region” further.

With each line in this table representing *a particular industry in a particular region*, one can infer from the table how that industry's output finds its way throughout the entire economy, either as an intermediate input (in terms of the figure, as a non-negative entry in one or more of the 'orange' cells), as a final output to be used for (private or public) consumption (the green columns), investment (yellow), or as an export (the blue columns). The interregional breakdown of these various uses is also apparent in figure 4.1. Read column-wise, the left part of the table illustrates the cost structure of a particular industry in a particular region, showing how the total market value of its production decomposes in the cost of various intermediate inputs (from within the own region, the other regions, as well as other countries), product taxes/subsidies, and value added ("VA", serving as the basis for compensating the factors of production).

The core constituent element of the IO table, sometimes called the (domestic) intermediate use matrix, is shown here by the orange blocks, that symbolize the interindustry flows previously discussed. As suggested in the figure by the use of two different shades of orange, the interregional version of this intermediate use matrix can be decomposed quite neatly, as it allows to identify intermediate used within the region itself (the darker shaded blocks) as well as intermediate use stemming from or going to the other regions comprised in the table (the lighter shaded blocks). Furthermore, by construction, i.e. given that one uses an identical way of identifying the various industries or sectors in all regions (e.g. the same NACE coding, or the same number and type of products) throughout, all of the orange blocks have an identical dimension.

Clearly, an (interregional) Input-Output table provides a fairly comprehensive description of the various flows within a specific economy at a given point in time. More importantly though, it serves as the basis for input-output *analysis*. Such analyses revolve around the question which adjustments need to be made throughout the entire economy given an initial shock 'somewhere' in the system.

Consider, for example, an increase in private consumption of a specific product in, say, the Brussels Capital Region. In terms of Figure 4.1, this means that one of the cells in the (green) "C"-column for Brussels increases. In order to meet this increase in final demand, total output of the product considered obviously has to increase as well. The virtue of an IO-table is that it strongly alludes to additional effects that are triggered by this original shock: increasing a specific output requires a concomitant increase in intermediate inputs, thus also affecting other industries. (It should be noted that, given an interregional IO table, one can also identify where these other industries are located.) This is sometimes called the 'first-round' of the increased production. That very terms indicates that subsequent effects are far from unlikely. Indeed, second (and subsequent) round effects are associated with the fact that, with the first round resulting in an increase in intermediate inputs, this in turn instigates an increased demand for inputs by the involved industries, etc.<sup>26</sup>

This so-called "*impact analysis*" approach is commonly associated with the identification of so-called (IO) "*multipliers*", measuring, for example, the total effect on production (as measured in euros), or on employment, given an initial shock to the system. As will be detailed further, one can distinguish between various types of multipliers, especially in an interregional setting. In particular, they allow us

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<sup>26</sup> The IO-tables (and multipliers) as provided by the Federal Planning Bureau are associated with so-called "open models". In particular, they treat household consumption/income as exogenous, whereas in some 'closed models' households would be considered on an equal footing with industries (and, hence, further detailing how households earn (part of) their incomes as a compensation for their labor input in specific industries, and spend their income over these different industries as well). Put otherwise, open models do not identify the so-called "*induced effects*" of a shock, which are effects associated with (endogenous) income/spending increases.

to address questions regarding the *intraregional and interregional employment effects (both for knowledge-intensive jobs and other jobs) following a shock in one or several industries located in Brussels*.

Clearly, a substantial amount of data needs to be collected and judiciously combined to come up with adequate IO tables. As such, this task is not intrinsically different from what happens in similar macroeconomic accounting exercises, such as e.g. setting up detailed national accounts. Furthermore, the exact construction of the interregional IO tables is well-documented by the Federal Planning Bureau (see in particular Avonds, Hertveldt en Van den Cruyce, 2021).

However, it is good to state already here that moving from a purely descriptive use of the IO tables to their instrumental application in the context of impact analysis and the computation of various multipliers requires a set of ‘standard’, yet still very specific assumptions. Transforming the original data in an IO table into a true production model in fact can only be done by putting quite a few restrictions on the structure of the latter. Without going into technical details here<sup>27</sup>, the Leontief production function that serves as the analytical workhorse to achieve this transformation only allows for constant returns to scale and, moreover, rests on the quite restrictive assumption of “fixed technical coefficients”, which effectively implies that inputs are used in given fixed proportions in a specific production process. Importantly, this also entails that the model does not take into account any capacity constraints (a feature that is clearly empirically at odds with the current situation). We return to these and other caveats at the end of our own analyses.

#### **4.2. Method**

Our main analysis builds on the interregional employment multipliers as computed by the Federal Planning Bureau. For the Brussels Capital Region, such multipliers are publicly available for 111 industry sectors.<sup>28,29</sup> In their original form, all employment multipliers are presented as the number of jobs created following an increase in final demand of 1 million euro in a specific sector. The total effect of such an impulse can, moreover, be decomposed so as to take into account intra-regional and interregional employment effects. Furthermore, we decompose the intra-regional effect in an initial effect, measuring the employment increase within the sector that is subject to the demand increase, and first and subsequent round effects on the induced employment in other sectors.

A brief example may serve to illustrate this decomposition. The total employment multiplier for the “Computer programming, consultancy and related activities”-sector (NACE 62) in the Brussels Capital Region is 6,2. Thus, a 1 million euro increase in final demand for the output in this sector yields an extra 6,2 jobs in the Belgian economy. This job creation actually consists of an initial effect of 3,6 jobs in the computer programming-sector itself, and 2,6 jobs that are created upstream as a result of the fact that the increased production within the computer programming-sector requires extra inputs from other

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<sup>27</sup> See e.g. Chapter 2 in Miller and Blair (2022)

<sup>28</sup> See [https://www.plan.be/databases/data-69-nl-interregionale\\_input\\_outputtabel\\_multiplificatoren\\_2015](https://www.plan.be/databases/data-69-nl-interregionale_input_outputtabel_multiplificatoren_2015) . No multipliers are reported when the regional yearly turnover within a sector falls below 10 million euro.

<sup>29</sup> To be clear, we indeed use the multipliers as publicly provided by the Federal Planning Bureau. An interregional IO table was also obtained from the Federal Planning Bureau, and, as indicated in the main text, such a table could serve as a basis for calculating multipliers. However, for confidentiality reasons (i.e., in cases where only a small number of firms comprise a sector, the Federal Planning Bureau provides a table in which some sectors are aggregated. Thus, the official multipliers are actually available for more sectors.

sectors, which in turn leads these sectors to increase their labour input, etc. In our tables below, we will use the label ‘initial effect’ and “indirect effects” to designate each of these two sources of job creation.<sup>30</sup> The interregional perspective allows to decompose the extra 2,6 jobs further: 1,1 jobs are generated in Flanders, 0,5 jobs in Wallonia and, hence, the remaining 1 extra job is created in the Brussels Capital Region itself. Note that the total (initial plus indirect) effect *within* the Brussels Capital Region is thus  $3,6 + 1 = 4,6$  extra jobs.

As a minor note, we point out that in the remainder we will in general not work with the multiplier figures that are based on a 1 million euro increase in final demand. This, however, is not vital to our analysis. Given that the (‘Leontief’) production function that underlies IO impact analysis is linear, we can always rescale the effects proportionally and still act consistently with the assumptions of the model. In terms of the previous example: if we alternatively consider a 10 million euro increase, the total employment effect is 62 jobs, 36 of which are initially generated by that impulse in the Brussels’ computer industry itself, etc.

More important, however, is that we combine the multiplier information with our data on the knowledge-intensity of labour in a sector, as reported in part 1 of this study. Specifically, we will use the data that build on the “KI-jobs-BCRint” definition as used in part 1, so that we effectively have a share of knowledge-intensive labour (and, evidently, its complement) for each sector located in Brussels (recall the relevant column in Table 1.1). This information allows to decompose the initial employment effect itself in knowledge-intensive and less knowledge-intensive jobs using sector-specific data.<sup>31</sup>

Referring to our running example, and considering an impulse of 10 million euro in the Brussels computer programming sector, the 36 extra jobs initially created can thus be combined with the data in Table 1.1. (*in casu* indicating that 80,2% of the jobs in the Brussels computer programming sector is knowledge-intensive) to generate the additional insight that about 29 of these 36 jobs would be knowledge-intensive (or, equivalently, that about 7 extra jobs within this sector are less knowledge-intensive). For the indirect and interregional employment effects we can apply similar breakdowns, but in those cases we resort to the aggregate “average knowledge intensities” as reported in Table 1.3. for the Brussels Capital Region (47,2%), the Flemish Region (32,2%) and the Walloon region (31,9%).<sup>32</sup>

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<sup>30</sup> The IO literature is not always consistent when it comes to terminology. The term “initial effect”, referring to the first round employment effects within the sector(s) subject to a demand shock, is sometimes labelled a “direct effect” (e.g. by Miller and Blair, 2022). Conversely, one sometimes explicitly distinguishes between initial and direct (and indirect) effects: direct effects are then the ‘second-round’ effects, i.e. employment effects for those firms *directly* providing inputs to the sector subject to the original demand shock (whereas indirect effects then refer to third- and subsequent-round effects). In view of this confusion, we do not use the notion of direct effects in our tables.

<sup>31</sup> A similar approach, although in a somewhat different context, is discussed in Miller and Blair (2022, p. 25-26)

<sup>32</sup> In practice, coupling the Federal Planning Bureau’s sectorial multipliers with our sectorial data on knowledge-intensity requires to take into account that the former are defined using SUT-categories whereas the latter, building on Labour Force Survey data, use the NACE.2 format to identify different sectors. While SUT-NACE.2 conversion tables are readily available, this also implies that there are instances in which the SUT-approach generates a more fine-grained identification of sectors than the NACE.2 approach. Put otherwise: there are instances in which we have several sectorial multipliers (e.g., for “demolition works” (SUT 43A); “plumbing and electrical installations” (SUT 43B), “finishing building works” (SUT 43C);, and “other specialized building activities” (SUT 43D);), but we all couple these with one KI-jobs-BCRint number referring to NACE.2 43, “Specialized construction activities”.

<sup>33</sup> In principle, the regional IO tables (and, more specifically, the Leontief inverse matrices derived from such tables) would allow for a more fine-grained identification of how specific industries in the different regions respond to the increased production/employment in the sector that is initially subject to the demand shock. In

To summarize: our combined use of the Federal Planning Bureau’s interregional employment multipliers and data on the knowledge-intensity within different (Brussels) sectors yield results such as the one presented in Table 4.1. below, still taking the computer programming industry in Brussels as our example.

**Table 4.1. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels (NACE 62) Computer programming, consultancy and related activities-sector**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	34	12	46
- <i>Initial effect</i>	29	7	36
- <i>Indirect effects</i>	5	5	10
In Flemish Region	3,5	7,5	11
In Walloon Region	1,5	3,5	5
<b>TOTAL Belgian Economy</b>	<b>39</b>	<b>23</b>	<b>62</b>

Before proceeding, it is instructive to explicitly compare the method just sketched with the multiplier approach of section 3.

- First, and at the risk of stating the obvious, the previous section employs econometrics to calculate employment multipliers. The econometric analysis rested on (panel) data covering several years, and allows for various ways by which the Brussels Capital Region (or the Brussels Metropolitan Area) can be compared to other regional entities (“the periphery”, “the rest of Belgium”,...) In this section we use official figures stemming from underlying interregional IO tables. It means that we draw implicitly on detailed data for the Belgian economy for one year (2015), and that we can only use the regional decomposition as used in those tables.
- Conversely, and as stated in section 3, the creation of a panel data set and the selection of explanatory variables implied that model in that section needs to aggregate some NACE codes so that one ends up with 21 sector categories; Using the IO approach, a more fine-grained breakdown is available (111 sectors).
- The way in which the multiplier effect is expressed differs between the two sections. As just stated, we here study the effects on employment *following an increase in final demand* of one or several sectors. In section 3, the initial shock considered is *an increase in* (knowledge intensive) employment. In the technical jargon of impact analysis this amounts to the difference between “absolute employment multipliers” (this section) and “relative employment multipliers” (section 3). Information on relative employment multipliers is implicitly present in a table such as 4.1.<sup>34</sup>
- In terms of spatial coverage, the employment multipliers of the previous section look at effects within different areas, which allows for a comparison of their magnitude. In this section we

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turn, this could then be coupled with the appropriate figures on sectorial knowledge intensity. However, as we have already signaled in a previous footnote, due to confidentiality reasons there is an inconsistency between the dimensionality of the available regional IO tables and the available regional multipliers. We therefore opted for using regional knowledge-intensity *averages*.

<sup>34</sup> Specifically, neglecting further intra- and interregional decompositions, for that table it boils down to looking at the ratio of the total employment effect (+62) and the initial effect (+36 jobs), hence obtaining a relative multiplier of 1,74 for this sector.

only look at shocks within the Brussels Capital Region. On the other hand, the territory-specific multipliers reported in section 3 look at intra-regional effects only. Our IO framework also considers inter-regional employment spillovers.

- The econometric approach easily allows to add control variables to a regression model. In principle, such control variables allow to identify employment multipliers in a *ceteris paribus* fashion. From that perspective, the multipliers derived from an IO table are more comparable with the simple regression model -although as just stated the nature of the initial shocks is intrinsically different. In particular, there is a risk of mis-interpreting the simple regression findings as describing the effects of *exogenous* increases in (knowledge intensive) employment, whereas in this section the exogenous shock is always related to final demand.

### **4.3. Job creation by knowledge intensive industries located in the Brussels Capital Region**

We first proceed similarly as in the example of Table 4.1, with a few similar analyses for other relevant sectors (subsection 4.3.1.). This sector-by-sector approach is subsequently followed by an aggregate perspective, in which we consider the impact of shocks on all knowledge intensive sectors together (4.3.2).

It should be noted here already that, notably in the latter case, one has to think about how to specify the exact magnitude of the demand shock. Intuitively: a similar demand increase in absolute euro terms may mean quite different demand increases for the sectors involved, given that these sectors may well mutually differ in scale. We return to this point further below. For the case-by-case discussion in the next subsection we will keep the magnitude of the demand shock uniform over the different cases.

#### **4.3.1. Sector-specific examples**

The previous example served to illustrate our approach, while already focusing on one of the important knowledge intensive sectors examined in part 2 of this study. We complement that example with similarly constructed computations for 4 other sectors that were also shown to be rather significant knowledge intensive sectors in part 2, to wit, Financial service activities, except insurance and pension funding (NACE 64), Legal and accounting activities (NACE 69), Activities of head offices; management consultancy activities (NACE 70), and the Arts, entertainment and recreation sector (NACE 90). Results are given in Tables 4.2 to 4.5, and should be interpreted in the same way as Table 4.1.<sup>35</sup>

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<sup>35</sup> All numbers in these tables are rounded to 0,5 jobs.

**Table 4.2. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels (NACE 64) Financial service activities, except insurance and pension funding-sector**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	14,5	13,5	28
- <i>Initial effect</i>	10,5	8,5	19
- <i>Indirect effects</i>	4	5	9
In Flemish Region	2	4	6
In Walloon Region	1	2	3
<b>TOTAL Belgian Economy</b>	<b>17,5</b>	<b>19,5</b>	<b>37</b>

**Table 4.3. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels (NACE 69) Legal and accounting activities-sector**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	39	17	56
- <i>Initial effect</i>	31	9	40
- <i>Indirect effects</i>	8	8	16
In Flemish Region	4,5	9,5	14
In Walloon Region	1,5	3,5	5
<b>TOTAL Belgian Economy</b>	<b>45</b>	<b>30</b>	<b>75</b>

**Table 4.4. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels Activities of head offices; management consultancy activities (NACE 70)**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	48	15	63
- <i>Initial effect</i>	45	11	56
- <i>Indirect effects</i>	3	4	7
In Flemish Region	2,5	5,5	8
In Walloon Region	1	3	4
<b>TOTAL Belgian Economy</b>	<b>51,5</b>	<b>23,5</b>	<b>75</b>

**Table 4.5. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels Arts, entertainment and recreation sector (NACE 90)**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	67,5	47,5	115
- <i>Initial effect</i>	60,5	39,5	100
- <i>Indirect effects</i>	7	8	15
In Flemish Region	3	7	10
In Walloon Region	2	4	6
<b>TOTAL Belgian Economy</b>	<b>72,5</b>	<b>58,5</b>	<b>131</b>

Concluding our overview of results for *single* sectors, Table 4.6 shows the results for the R&D-sector (NACE 72).

**Table 4.6. Employment Impact (jobs generated) of a 10 million euro increase in final demand for output of the Brussels Scientific research and development-sector (NACE 72)**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	43	14	57
- <i>Initial effect</i>	39	9	48
- <i>Indirect effects</i>	4	5	9
In Flemish Region	2,5	5,5	8
In Walloon Region	1,5	3,5	5
<b>TOTAL Belgian Economy</b>	<b>47</b>	<b>23</b>	<b>70</b>

#### 4.3.2. Aggregate multiplier effects for all (knowledge-intensive) sectors

We next move to more aggregate views, in which we consider the effect of final demand shocks affecting more than one sector simultaneously. A first such exercise is still rather close to the previous tables: we consider the reported aggregate employment multipliers for the Brussels Capital Region as a whole, as reported by the Federal Planning Bureau, and apply a 10 million euro final demand increase. (Obviously, in this specific scenario the breakdown of initial effects into a knowledge-intensive share and its counterpart can only be done on the basis of the Brussels' average figure of 47.2%). This yields the results as reported in Table 4.7.

**Table 4.7. Aggregate employment impact (jobs generated) of a 10 million euro increase in final demand using global intra- and interregional multipliers**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	27	31	58
- <i>Initial effect</i>	23	26	49
- <i>Indirect effects</i>	4	5	9
In Flemish Region	3	7	10
In Walloon Region	1,5	3,5	5
<b>TOTAL Belgian Economy</b>	<b>31,5</b>	<b>41,5</b>	<b>73</b>

Evidently, when comparing/aggregating over different sectors, applying a similar *absolute* final demand shock of 10 million euro is highly likely to boil down to possibly rather diverging *relative* demand shocks for the industries concerned. For example, and using total final demand figures for this sector as found in the regional IO tables, the 10 million euro shock we considered for the Computer programming, consultancy and related activities-sector in Table 4.1 implies in fact a 0.68% increase in final demand. That figure should, e.g., be contrasted with the case of the Arts, entertainment and recreation sector (cf. Table 4.5), for which a 10 million euro shock in fact comes down to a relative final demand increase of about 4%. Put differently, if we'd alternatively had looked at the impact of an equal *one percent* increase in final demand, this would amount to a 14,7 million euro increase in the Computer programming, consultancy and related activities-sector, and the total employment effect

would amount to an extra 91 jobs (compare with Table 4.1). In the Arts, entertainment and recreation sector, a one percent increase would actually be equivalent to an absolute increase of 2,44 million euros in final demand, and such a shock would imply about 32 extra jobs.

Hence, when turning over to our set of results on the employment impact of aggregate shocks in the knowledge-intensive activities within the Brussels Capital Region, we will take into account such differences in the underlying relative importance (in final demand terms) of the concerned sectors by applying “growth equalized” multipliers as suggested by Miller and Blair (2022, p. 279-280). Specifically, we will subject all affected sectors by a one percent increase in their final demand (where final demand figures are obtained from the regional IO tables).

It remains to be clarified what we mean by “concerned knowledge-intensive activities sectors”. Here, we again revert to part 1 of this study. To recall, there we discussed a few scenarios on the basis of which a sector can be considered knowledge intensive or not. A first one is directly based on the OECD knowledge-intensive services classification (labelled KIS-OECD in Table 1.1), whereas a second follows the Eurostat classification (KIA-Eurostat in Table 1.1). The third scenario defined knowledge intensive industries based on at least 33% of the employees attaining education level short cycle tertiary education and more, based on Labour Force Survey data for Belgium (labeled KI Jobs-BEint in Table 1.1).

Consistent with the work done in part 1 of this study, we consider each of these three scenarios to identify knowledge intensive sectors, and then apply an equal (one percent) final demand increase to all sectors so identified. These aggregate shocks (which are evidently larger, in the aggregate, than the 10 million euro shocks considered in the previous tables), are subsequently decomposed in a similar way as was done previously. Specifically, we continue reporting the intraregional decompositions in initial and indirect effects as well as interregional effects. Also, we continue weighing each initial effect with the sector-specific value for the share of knowledge intensive workers and all other effects with regional averages to get a value for the further breakdown in generated knowledge intensive jobs (and their complements). The results for these three scenarios are reported in Tables 4.8 to 4.10 (with each cell rounded to the nearest integer).

**Table 4.8. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the OECD definition)**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	1618	1092	2710
- <i>Initial effect</i>	1406	860	2266
- <i>Indirect effects</i>	212	232	444
In Flemish Region	118	248	366
In Walloon Region	59	126	185
<b>TOTAL Belgian Economy</b>	<b>1795</b>	<b>1466</b>	<b>3262</b>

**Table 4.9. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the Eurostat definition)**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	1544	915	2459
- <i>Initial effects</i>	1334	685	2019
- <i>Indirect effects</i>	210	230	440
In Flemish Region	115	241	356
In Walloon Region	56	120	177
<b>TOTAL Belgian Economy</b>	<b>1715</b>	<b>1276</b>	<b>2992</b>

**Table 4.10. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the KI Jobs-BEint definition)**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	1379	740	2119
- <i>Initial effects</i>	1168	509	1677
- <i>Indirect effects</i>	211	231	442
In Flemish Region	116	244	360
In Walloon Region	58	124	182
<b>TOTAL Belgian Economy</b>	<b>1553</b>	<b>1108</b>	<b>2661</b>

Given the use of different definitions, it should not be surprising that the three tables provide differing results, although it is also clear that they are producing fairly similar results. A positive demand shock of one percent in knowledge intensive activities located in the Brussels Capital Region leads to about 3.000 extra jobs. These extra jobs are predominantly (i.e., about 8 out of 10) created in the Brussels Capital Region itself, and, even if these jobs are generated by knowledge intensive sectors, a substantial share of this extra employment within Brussels (viz., about 40%) is actually accruing to less knowledge intensive labour.<sup>36</sup>

One specific constitutive element of employment in Brussels is that the city hosts many public administrations associated with many different tiers of government. In this respect, it must be noted

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<sup>36</sup> As stated at the end of section 4.2, there are quite a few differences in terms of data coverage, underlying method etc. between the results reported in this section and the multiplier effects as identified by the econometric approach in section 3 (see in particular table 3.7). Keeping these important qualifications in mind, it still is possible to re-express the data of the tables 4.8, 4.9 and 4.10 in a relative fashion. For instance, using table 4.10, we can relate the total employment effect (+2661 jobs) to the ‘initial employment effect’ (+1677 jobs), so obtaining a relative employment multiplier value of 1,59. But even in that case, it should be clear that such a relative value still differs conceptually from the multipliers identified in section 3. Indeed, the latter constrain the “initial effect” to an increase in KI jobs, whereas in the example just given we instead consider the first round effects in terms of (KI *and* non-KI) employment in the sectors that are directly affected by the considered demand increase. Furthermore, alternative relative numbers could be created on the basis of table 4.10 (e.g. effectively confining the denominator to first round increases in KI jobs only, so yielding a relative multiplier value of 2,28, or, conversely, confining the ‘total’ effect to the intraregional effect only, implying a value of about 1.81, etc.). We refrain from doing this in the main text, as the cost of creating extra confusion about exact underlying definitions outweighs the benefits of being able to ‘readily compare’ the magnitude of the multipliers of this and the previous section.

that both the OECD and the Eurostat classification designate NACE sector 84 (“Public administration and defence; compulsory social security”) as being knowledge intensive, whereas our third definition does not (recall Table 1.3). To single out the impact of the public sector, we thus also present the counterpart of Table 4.8, but with NACE sector 84 excluded:

**Table 4.8bis. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the OECD definition BUT EXCLUDING NACE 84re – Public Sector)**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	1596	1063	2660
- <i>Initial effects</i>	1386	833	2220
- <i>Indirect effects</i>	210	230	440
In Flemish Region	117	247	364
In Walloon Region	59	125	184
<b>TOTAL Belgian Economy</b>	<b>1772</b>	<b>1435</b>	<b>3209</b>

Clearly, upon comparison with Table 4.8, the total employment impact is fairly limited: excluding the public sector from the aggregate analysis leads to a total drop of 53 jobs (or about 1.6% in relative terms), an impact that is largely confined to intraregional effects.<sup>37</sup> As should be expected, a similar minor effect can be discerned if one drops the public administration sector from the Eurostat-definition-based analysis of Table 4.9.<sup>38</sup>

Finally, for sake of completeness it should be recalled that section 1 in fact also looked at a fourth scenario to gauge the knowledge intensity of the different Brussels sectors. Contrary to the previous three, this scenario does not rest on a dichotomous (0/1) identification, but takes it that *all* sectors embed knowledge intensive jobs to a varying degree. Hence, an aggregate (equalized growth) shock in that case in fact boils down to analysing the aggregate employment multipliers for the Brussels economy as a whole. Put otherwise, this type of analysis largely boils down to a rescaled version of the information in Table 4.7. Of course, given that one then looks at the entire Brussels economy rather than a subset of sectors classified as knowledge intensive, the absolute effect of a “1% increase in the considered sectors’ final demand” is considerably larger than in the previous three cases.<sup>39</sup> The results as displayed in Table 4.11 should thus not readily be compared with the results in the previous three tables

<sup>37</sup> It may be good to point out that “intra-regional” job effects here (as elsewhere in section 4) refer to effects in terms of the workplace and *not* in terms of the place of residence of the involved employees. Thus, intraregional job creation might *de facto* be filled up by commuters from outside the region.

<sup>38</sup> In total employment terms, excluding NACE sector 84 from the analysis implies that about 2940 jobs are created (or about 1.7% less when compared with the 2992 figure in table 4.9)

<sup>39</sup> Depending on the way in which we delineate the knowledge intensive sectors, the 1% increase in final demand we consider in tables 4.8-4.10 implies a total final demand increase -i.e. for all affected sectors taken together, of 396 to 412 million euro. If we look at all Brussels sectors (i.e. the 111 sectors for which we have multiplier values at our disposal), this implies an absolute demand increase of about 628 million euro.

**Table 4.11. Aggregate employment impact (jobs generated) of a 1% increase in final demand of all Brussels sectors**

Extra jobs	Knowledge-intensive	Non-KI	Total
In BCR:	1695	1947	3642
- <i>Initial effects</i>	1444	1633	3077
- <i>Indirect effects</i>	251	314	565
In Flemish Region	188	440	628
In Walloon Region	94	220	314
<b>TOTAL Belgian Economy</b>	<b>1978</b>	<b>2606</b>	<b>4584</b>

#### 4.4 Limitations of the approach

We end this part of the study by signalling some limitations and important caveats regarding our method.

First, it should be clear that, throughout, we have been focusing on employment effects and their decomposition. Within the IO analyses framework, other perspectives are possible. In particular, the Federal Planning Bureau also publishes regional “Income multipliers”, indicating how an initial shock translates into the creation of *value added* in the concerned sector and the rest of that industry’s supply chain. However, and unlike our analysis in the previous section, the published multipliers do not allow to decompose the intraregional effect into an initial and subsequent round/indirect effects. Still, we can briefly illustrate the insights regarding the intra- and intraregional impact on value added of an aggregate final demand shock in Brussels’ knowledge intensive sectors. In Table 4.12 below, we display the specific scenario of a (one percent) growth equalized shock as applied to all sectors that can be considered as knowledge industries according to the OECD definition. The results can thus be considered as counterparts to the employment effects displayed in Table 4.8. The interpretation of this numbers is, of course, different (as well as less detailed), and refers to value added figures.

**Table 4.12. Intra- and interregional impact (value added generated) of a 1% increase in final demand of all knowledge-intensive sectors in Brussels (using the OECD definition)**

Value added (million euros)	Total
In BCR:	248
In Flemish Region	28
In Walloon Region	11
<b>TOTAL Belgian Economy</b>	<b>287</b>

Again, of course, the assessment of this type of impact is contingent on how one defines the group of “all-knowledge intensive sectors”. In the special case in which we take it that all sectors are knowledge intensive to a varying degree (cf. scenario 4), the impact of a 1% shock could actually readily be retrieved by a (conveniently rescaled) application of the income multipliers for Brussels as a whole, published by the Federal Planning Bureau. This yields the results in Table 4.13, which can be regarded

as the income multiplier counterpart of Table 4.11. (Again, the considerable increase in the effect relative to those in Table 4.12 is essentially caused by the much broader scope of the latter approach.)

**Table 4.13. Intra- and interregional impact (value added generated) of a 1% increase in final demand of all sectors in Brussels**

Value added (million euros)	Total
In BCR:	363
In Flemish Region	75
In Walloon Region	32
<b>TOTAL Belgian Economy</b>	<b>470</b>

Both employment multipliers and income multipliers ultimately are derived from the original IO tables. It is important to see that in moving from the former to the latter one necessarily needs to move from a ‘picture’ of an entire economy to a ‘model’, precisely because one seeks to address the impact of changes in some parts of the ‘picture’ on the rest of the economy. The underlying, so-called Leontief model is well-established but –as any model– has its limitations.

For one thing, we have earlier described it as a ‘linear model’. This feature is convenient from a mathematical point of view (as it essentially implies that multiplier values are not affected by the magnitude of the considered demand shock, so allowing for easy rescaling), but is in fact associated with an extremely stylized (“fixed input proportions”) production model. In particular, such a model does not take into account any capacity constraints, supply side pressures on the labour market, cost increase effects and concomitant input substitution, etc. Put differently, it abstracts from a lot of real phenomena that can and do play a role in our economies today. In particular, the fact that the labor market is very tight (for the time being perhaps) makes that the extra jobs calculated are to be considered theoretical. They might even lead to lower employment in other sectors (zero sum), an effect that is not taken into account in this analysis either. Certainly when considering large shocks such as the one displayed in Tables 4.11 or 4.13, these limitations should definitely be taken into account.

At a more profound level, all multipliers go back to the IO-‘picture’ that is taken on the basis of data that are averaged out over the span of a particular time period, thus neglecting that one is using information on averages to calculate marginal effect (which a final demand shock essentially is).

In point of fact, similar shortcomings relate to our decomposition of the employment effects in knowledge intensive jobs and their complements. These decompositions rest on the average (weighted sector) intensities we have calculated in section 1.1, and the linear, mechanical way of translating demand shocks to that level of detail thus also holds for that part of our analysis.

In a way, one could say that the figures reported in the various tables in this section are optimistic, i.e. are likely to provide a kind of maximum employment effect. Still, it should also be recalled that the interregional IO table (and the multipliers derived on its basis) is a so-called open model, leaving out any induced effects (i.e. effects that go back to the observation that production/employment increases eventually also imply that the (labour) incomes of households increase, thus positively affecting their consumption, which provides a separate impetus for yet more production). Relatedly, the multipliers as reported by the Federal Planning Bureau -and calculated fully in line with the traditional Leontief model- measure upstream supply chain effects only.

## Part 5: Summary

What is the extent of knowledge activities in Brussels? Is it atypical when compared to the rest of Belgium? These questions underlie the work done in part 1 of this report. Seemingly simple as those questions may look at first sight, as we have shown their answer in part depends on how one defines the very concept of knowledge activities. We have considered four scenario's, all of which have in common that we look both at education levels and occupation types within a sector to get an idea of that sector's knowledge intensity. This necessitates an empirical approach, combining Labour Force Survey data with Social Security statistics. Three of these scenario's, based on internationally accepted classifications, generate a 0/1 classification of sectors as being knowledge intensive or not. As Table 1.1 testifies, there is a considerable overlap between the three scenarios in terms of that classification.

Hence, depending on the way in which one defines sectors as being knowledge intensive or not, and considering the period 2008-2020, *total employment* in these knowledge intensive sectors in the Brussels Capital Region was on average somewhere between 343,000 and 420,000 in the period 2008-2020, and the number of knowledge intensive jobs within these sectors revolved around 240,000. Our fourth scenario was a bit different in that it records the (average) share of knowledge intensive jobs in all sectors, taking the perspective that every sector hosts knowledge intensive jobs (rather than a predefined list of sectors), and yields an average number of 323,677 knowledge intensive jobs in the period 2008-2020. In relative terms, the latter scenario implies that, in the year 2020, close to 1 out of 2 (45.2% to be exact) jobs in Brussels can be regarded as knowledge intensive. From a comparative perspective, this makes the Brussels Capital Region the most knowledge intensive region in Belgium. Similar sector-weighted intensities are observed when extending to the broader Brussels Metropolitan area, and are considerably larger than those for the Flemish (31.3%) and Walloon (30.9%) Regions.

However, over the period 2008-2020, compared to an average of 1.11% at national level, the compound annual growth rate of knowledge-intensive employment was lowest for the Brussels Capital Region (0.51%) and highest in the surrounding Brussels functional metropolitan area (which in part 1 is defined on an administrative basis and consists of Flemish and Walloon Brabant (1.46%). Since the overall employment growth rates were slightly higher (0.54%) for the Brussels Capital Region, and lower (1.18%) for the Brussels periphery, and for the entire country (0.90%) this gap is slightly reducing, in particular with the Brussels periphery.

The second part seeks to provide an idea about the spatial distribution patterns of knowledge intensive activities in Belgium, and in Brussels (and the larger Brussels metropolitan area) in particular. This part explicitly develops a different (municipality- rather than province-based) conception of what we mean by the "functional Brussels Metropolitan Area". This alternative does not alter the finding of the previous part that Brussels and its surrounding area are very important compared to other parts of the Belgian territory in terms of knowledge-intensive activities, as shown by specialization indices. Next, we further detail the spatial distribution patterns by focusing on a some specific sectors (to wit, pharmaceutical industries, telecommunications, computer programming, consultancy and related activities, financial services, legal and accounting activities, head offices and management consultancy activities, public administration, Health activities, and the creative, arts and entertainment sector).

The analysis confirms the strong concentration of several knowledge services in the Brussels metropolitan area. Such concentration is related to the characteristics of Brussels: its large and qualified labour pool, its attractiveness for international workers, its connectivity at European and global level, airport and high speed rail connections, or the diversity of firms on which other activities can rely.

However, the maps demonstrate that the geographical concentration of knowledge intensive activities on the Belgian territory is to some extent sector-specific. On the one hand, concentration in the metropolitan area ranges from around half of all Belgian jobs in finance to a third in most dispersed sectors, such as legal and accounting services. Indeed, legal and accounting services can mix very different activities: large parts of legal or accounting firms are performed by small firms serving local economic actors. In contrast, Brussels financial activities include mainly coordination at the national level, and international activities, that is the most strategic segments of financial activities. On the other hand, within the Brussels metropolitan area we observe very different locational patterns from one industry to another. In some industries, clusters of activities – such as finance - remain very central in the Brussels metropolitan areas, while others may favour peripheral location, as it is the case for the pharmaceutical industry with large plants settled in Walloon Brabant, or large accounting firms located around Zaventem. Indeed, the maps in section 2 also serve to underscore that, just as is the case with other economic activities, thinking of the knowledge base of “Brussels” quite naturally implies that one should also take (the relations with) its periphery into account. Note that, especially when we take the knowledge base perspective, one could even speak about a polycentric model of knowledge intensive activities in the larger Brussels area, as next to universities within Brussels there are also two large nearby universities (and their spin-offs) in the Brabant provinces.

The importance of Brussels’ knowledge intensive activities for the creation of high- and lower skilled jobs is subsequently approached from a somewhat different angle in parts 3 and 4.

Part 3 first looks at the dynamics of employment in the Brussels Capital Region and compares this with the Belgian provinces. Over the period 2008-2020, the compound annual total employment growth rate was the lowest for the Brussels-Capital region, which was notably due to the low growth of wage employment. A shift-share analysis further shows that the negative total employment growth rate differential between Brussels and the rest of Belgium is due to an industry-mix effect. By and large, while several important knowledge-intensive sectors such as Financial Services, Human health, or Professional, scientific and technical activities (which includes e.g. Legal and Accounting activities and activities of Head offices) are still overrepresented in Brussels relative to the rest of Belgium, it is exactly in those sectors that Brussels lost ground in terms of employment growth.

Part 3 also pays attention to the impact of knowledge intensive activities through the lens of econometric models that empirically examine the relation between the growth of knowledge intensive employment and total employment, i.e. a so-called (relative) employment multiplier. The underlying panel data set covers Brussels, its periphery, as well as the Flemish and Walloon regions. The estimated coefficient in a simple regression comes conceptually closest to the conventional definition of a multiplier. We find that each additional knowledge intensive job in Brussels can be associated with the creation of another 2.12 jobs. This is a relatively low figure when compared to other parts of Belgium (e.g., 2.44 jobs for the Flemish region). However, it is important here to recall the *relative* nature of the multipliers: a lower ratio of the growth of total employment growth and knowledge intensive employment growth might as well be the result of a lower value for the numerator as the result of a comparatively high value of the denominator (and vice versa). And in fact, Brussels fares comparatively well, precisely in terms of the denominator (cf. supra). As in reality the change in knowledge intensive jobs is not exogenous, and several variables have an impact on total employment change, the empirical model is next extended with several control variables. Even accounting for sector composition, economic and knowledge-related indicators, the coefficient associated with knowledge-intensive jobs remains statistically significant: in the Brussels Capital Region (BCR), an extra job in a knowledge-intensive activity *ceteris paribus* generates an additional job in total employment.

Employment multipliers are also the core focus of part 4, which builds on data directly stemming from the Federal Planning Bureau's interregional input-output tables. Consistent with the underlying economic (Leontief) model from which the Planning Bureau's multipliers are derived, we report the employment effects following a demand shock that affects a knowledge intensive sector, or a group of such sectors located in the Brussels Capital Region. A virtue of the adopted framework is that, next to decompositions in direct and subsequent round employment effects, we can explicitly look at intra- and interregional ('spillover') employment effects of such shocks. Moreover, we use the information on sectors' knowledge intensity to further decompose all these effects in the creation of knowledge intensive jobs and their complement.

In a first set of experiments, we investigate the job impact of an additional 10 mio euro demand for particular sectors. The ensuing employment effects for Belgium as a whole range from 131 extra jobs in the arts, entertainment and recreation sector (NACE 90) to 37 extra jobs in the financial services industry (NACE 64). The large majority of these extra jobs accrue to the BCR, 88% in NACE 90 and 75% in NACE 64 respectively. In a second experiment, we consider an equal (1%) demand shock that affects all knowledge intensive sectors. This leads to about 3.000 extra jobs (the exact number of course depending on which specific scenario from section 1 we use to identify the relevant sectors). These extra jobs are predominantly (i.e., about 8 out of 10) created in the Brussels Capital Region itself, but still leave room for noteworthy interregional spillovers in terms of job creation. Furthermore, even if our impact analysis is such that these jobs are generated by knowledge intensive sectors, a substantial share of the extra employment within Brussels (viz., about 40%) is actually accruing to less knowledge intensive labour.

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## Appendices

### Appendix 1.1: Knowledge intensive industries

For the activity or industry classification, we follow a sectoral approach<sup>40</sup>. The sectoral approach aggregates manufacturing industries according to technological intensity (R&D expenditure/value added) and is based on the Statistical classification of economic activities in the European Community (NACE) at 2-digit level. Services are classified into knowledge-intensive services and less knowledge-intensive services based on the share of tertiary educated persons at NACE 2-digit level. The classification of knowledge intensive services is more recent, and the current OECD definition of knowledge intensive industries includes high and medium tech manufacturing; high value added “knowledge intensive” market service industries such as finance and insurance and telecommunications; business services; education and health<sup>41</sup>. The basis for the sector approach is the Statistical classification of economic activities in the European Community (NACE) at 2-digit level. It includes both public and private actors (activities). For the knowledge jobs or knowledge workers classification, several approaches can be used to define knowledge workers, amongst which standard occupational classifications (managers, professionals, associate professionals) or classifications based on education<sup>42</sup>. Defining knowledge workers and knowledge industries remains challenging. As illustrated above, reference can be made to people who are working in knowledge-based industries or to workers who have particular skills or competences. Even a combination of both can be used.

Knowledge-intensity is defined at supranational level by OECD and Eurostat, which have the benefit of being internationally comparable. Sectors, however, differ in the use of knowledge. Some sectors make use of incremental knowledge gains and technical progress (e.g., 'food and beverage activities' or 'Services to buildings and landscape activities'), while other sectors make more use of complex technology or need highly qualified personnel (e.g., 'computer programming, consultancy and related activities' or 'manufacture of basic pharmaceutical products and pharmaceutical preparations'). What applies to Belgium differs according to region, stressing the importance of the spatial scale at which analyses are conducted.

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<sup>40</sup> [https://ec.europa.eu/eurostat/cache/metadata/EN/htec\\_esms.htm](https://ec.europa.eu/eurostat/cache/metadata/EN/htec_esms.htm). Alternatively, a product approach could be followed. The product approach complements the sectoral approach and is used for data on high-tech trade. The classification is based on a product list defined on the calculations of R&D intensity by groups of products (R&D expenditure/total sales). The groups classified as high-technology products are aggregated on the basis of the Standard International Trade Classification (SITC). As we do not have data in the European Labour Force Survey at product level (see further) we did not consider a product approach.

<sup>41</sup> For example, the Ideopolis report on knowledge city-regions extends this definition to capture a higher share of employment in the cultural and creative industries and defines knowledge activities in city-regions in different ways. file:///C:/Users/u0073713/Downloads/160\_Norwich\_KE.pdf

<sup>42</sup> As collected in the European Labour Force Survey (<https://ec.europa.eu/eurostat/statisticsexplained/index.php?oldid=488070>) DocuSign Envelope ID: E29B3CAA-B603-4158-ABAC-951EC5DE0B29 In Process

## **Appendix 1.2: Labour Force Survey**

To use occupation and education of the labour force, we rely on the European Labour Force Survey. This yearly survey is one of several European surveys on the active population, coordinated by Eurostat, the Statistical Office of the European Communities, in collaboration with national institutes for statistics and managed by the latter. It was first organized in 1983. The aim of the survey is to gather comparable information at European level, among other things: rates of employment and unemployment (the activity rate corresponds to the sum of these two rates) in line with the terminology of the International Labour Organization (ILO), as well as to gather and publish data that cannot be obtained elsewhere (worker mobility, motivation of part-time working, level of education of the population, etc.). As a starting point we take the results of the Labour Force Survey for the period 2010-2020. The employed comprise all people aged 15 and over who: (a) during the reference week performed some work for wage or salary, or for profit. This also includes family workers; (b) who had a job but were temporarily absent. From 2021 onwards there are some major changes in the methodological approach for the Survey. It must be noted that the Labour Force Survey is a survey and suffers from small sample sizes. For example, even when we look at Belgium for the full period 2010-2020, there are few observations for the agriculture and mining NACE groups 1-10, and even in some larger NACE sectors the number of observations is somewhat limited.

The Labour Force Survey follows a similar logic as proposed in the OECD Canberra Manual (OECD, 1995) that measures the human resources devoted to science and technology (HRST). The measurements consider education, occupation, and the intersection of both characteristics as core employment. These data are also reported by Eurostat.

## Appendix 1.3: Method note use of Labour Force Survey to calculate KIA for Belgium

### Main variables

#### 1. Sector variable (NACE 2 digits)

NAME	Observable	DEFINITION
nace_2	[2010-2020]	NACE-BEL-2008=NACE-Rev.2 (2 digits) ( <a href="https://statbel.fgov.be/fr/propos-de-statbel/methodologie/classifications/nace-bel-2008">https://statbel.fgov.be/fr/propos-de-statbel/methodologie/classifications/nace-bel-2008</a> )

#### 2. Occupation variable (ISCO 1 digit)

NAME	Observable	DEFINITION
isco_1	[2010] [2011] [2012-2020]	ISCO-08 4-digits → 435 codes ISCO-08 3-digits → 129 codes ISCO-08 4-digits → 435 codes ( <a href="https://statbel.fgov.be/nl/open-data/isco-code-2008-4-cijfers">https://statbel.fgov.be/nl/open-data/isco-code-2008-4-cijfers</a> )

Based on the above three variables which follow the same nomenclature (ISCO-08), we computed the harmonized ISCO-08 1-digit series (aggregating more detailed groups to the 1-digit major groups)

We have 8180 missing values for the ISCO variable. We removed the armed force occupation because we have very little observations for that group.

code	label (dutch)	label (English)
1	Managers	Managers
2	Intellectuele, wetenschappelijke en artistieke beroepen	Professionals
3	Technici en verwante beroepen	Technicians and associate professionals
4	Administratief personeel	Clerical support workers
5	Dienstverlenend personeel en verkopers	Service and sales workers
6	Geschoolde landbouwers, bosbouwers en vissers	Skilled agricultural, forestry and fishery workers
7	Ambachtlieden	Craft and related trades workers
8	Bedieners van machines en installaties, assembleurs	Plant and machine operators, and assemblers
9	Elementaire beroepen	Elementary occupations
0	Beroepen bij de strijdkrachten	Armed forces occupations

#### 3. Education variable

NAME	Observable	DEFINITION
ISCED2011 → isced_2011	2010-2020	Nomenclature ISCED 2011 (see <a href="https://ec.europa.eu/eurostat/statistics-explained/index.php/International_Standard_Classification_of_Education_(ISCED)#Background">https://ec.europa.eu/eurostat/statistics-explained/index.php/International_Standard_Classification_of_Education_(ISCED)#Background</a> )

Based on the above variable we created the dummy “highly educated” which takes the value one when ISCED is higher or equal to 500 and 0 otherwise

➔ The percentage in the tables gives the % of workers with a ISCED level above or equal to 500

ISCED code	Dummy for high educated	label (English)
0	0	Early childhood education

100	0	Primary
200	0	Lower secondary
300	0	Upper secondary
400	0	Post-secondary non tertiary
500	1	Short cycle tertiary
600	1	Bachelor or equivalent
700	1	Master or equivalent
800	1	Doctoral or equivalent

### Sub-sample variables

#### 1. Employment status variable

NAME	Observable	DEFINITION
Statuut → <b>profession</b>	[1983-2020]	Statut professionnel 1 Ouvrier 2 Employé 3 Fonctionnaire 4 Indépendant

Groups	Definition
1	Full sample, occupied population → Workers, Employees, civil servant & self-employed
2	Employed population → Workers, Employees, civil servant
3	Self-employed population → Self-employed

We have a more detailed variable which makes a distinction for self-employed between helpers and self-employed. We included both the helpers and the self-employed.

#### 2. Province

NAME	Observable	DEFINITION
Provnew → <b>province</b>	[2010-2020]	Province du lieu de résidence 1 Anvers 2 Bruxelles 3 Flandre occidentale 4 Flandre orientale 5 Hainaut 6 Liège 7 Limbourg 8 Luxembourg 9 Namur 10 Brabant flamand 11 Brabant wallon
provnew_tr → <b>provjob</b>	[2010-2020]	Province du lieu de travail 1 Anvers 2 Bruxelles

		3 Flandre occidentale 4 Flandre orientale 5 Hainaut 6 Liège 7 Limbourg 8 Luxembourg 9 Namur 10 Brabant flamand 11 Brabant wallon 12 Etranger
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We have three missing values for province of work. Remark: ISCO is not defined in Brussels in 2010.

### General information

There are **541,466 different observations** covering **11 years**:

Year	Number of observations
2010	44,185
2011	41,218
2012	41,032
2013	40,183
2014	42,583
2015	40,099
2016	40,800
2017	62,431
2018	62,187
2019	64,642
2020	62,106
<b>TOTAL=</b>	<b>541,466</b>

Using weights, there are **50,762,015 observations** covering **11 years**:

Year	Number of observations
2010	4,488,702
2011	4,509,274
2012	4,523,913
2013	4,530,299
2014	4,543,548
2015	4,551,619
2016	4,586,689
2017	4,637,786
2018	4,755,179
2019	4,832,024
2020	4,802,984
<b>TOTAL=</b>	<b>50,762,015</b>

The weights are defined as follows: for each quarter there's an extrapolation towards the entire population and a correction for non-response. The population and sample are subject to a post-stratification by province, gender, and age (five classes, with one class with people aged 75 years and more). For each of those categories a weight is calculated with as nominator the population in the middle of the quarter as available in the 'Rijksregister van natuurlijke personen' (and thus not influenced by sample errors) and as denominator the number of useful answers from the survey.

## **Appendix 2.1. The most important municipalities for knowledge activities.**

The tables in this annex are related to the maps in section 2. Each table identifies, for a specific knowledge intensive sector, the 20 most important Belgian municipalities where firms operating within that sector is located. “Importance” is defined here with reference to employment. Each table thus also shows the share of persons working within the municipality as a percentage of all Belgian persons working in the concerned sector.

**Table A2.1 a: Top 20 municipalities for manufacture of pharmaceutical products**

Waver	22,40
Beerse	13,07
Puurs	12,37
Rixensart	7,75
Eigenbrakel	7,25
Lessen	5,82
Geel	4,88
Heist-op-den-Berg	2,81
Anderlecht	2,03
Brussel	2,00
Wetteren	1,94
Seraing	1,21
Ottignies-Louvain-la-Neuve	1,13
Borgworm	1,05
Elsene	0,89
Zaventem	0,85
Schaarbeek	0,82
Mont-Saint-Guibert	0,76
Charleroi	0,74
Bornem	0,74

**Table A2.1 b: Top 20 municipalities for Telecommunications (NACE 61)**

Schaarbeek	25,88
Mechelen	8,23
Evere	6,92
Brussel	5,89
Antwerpen	4,80
Luik	3,46
Gent	2,95
Charleroi	2,72
Sint-Lambrechts-Woluwe	2,44
Namen	2,37
Bergen	2,26
Machelen	2,17
Anderlecht	2,09
Hasselt	1,95
Brugge	1,59
Herstal	1,29
Zaventem	1,18
Elsene	0,89
Libramont-Chevigny	0,81
Vilvoorde	0,74

**Table A2.1 c: Top 20 municipalities for Computer programming, consultancy and related activities (NACE 62)**

Gent	6,20
Antwerpen	6,15
Brussel	5,04
Machelen	4,56
Zaventem	3,81
Leuven	3,64
Hasselt	3,13
Mechelen	3,12
Kontich	2,87
Elsene	1,89
Kortrijk	1,77
Sint-Gillis	1,70
Sint-Lambrechts-Woluwe	1,64
Luik	1,12
Anderlecht	1,11
Grimbergen	1,02
Waver	0,99
Schaarbeek	0,94
Beersel	0,92
Brugge	0,92

**Table A2.1 d: Top 20 municipalities for Legal and accounting activities (NACE 69)**

Antwerpen	6,77
Brussel	4,06
Gent	3,83
Zaventem	3,34
Elsene	2,55
Luik	2,43
Ukkel	1,72
Brugge	1,53
Hasselt	1,47
Kortrijk	1,40
Charleroi	1,38
Leuven	1,29
Schaarbeek	1,15
Machelen	1,08
Namen	1,08
Roeselare	1,01
Etterbeek	0,88
Sint-Lambrechts-Woluwe	0,82
Bergen	0,81
Aalst	0,76

**Table A2.1 e: Top 20 municipalities for Activities of head offices; management consultancy activities (NACE 70)**

Brussel	7,89
Antwerpen	5,64
Zaventem	4,79
Leuven	3,41
Gent	3,01
Halle	2,50
Machelen	2,26
Elsene	2,06
Sint-Jans-Molenbeek	1,65
Mechelen	1,65
Ukkel	1,44
Grimbergen	1,39
Sint-Lambrechts-Woluwe	1,21
Evere	1,19
Vilvoorde	1,01
Sint-Pieters-Woluwe	1,01
Luik	0,97
Hasselt	0,91
Etterbeek	0,90
Kortrijk	0,88

**Table A2.1 f: Top 20 municipalities for financial services (NACE 64)**

Brussel	19,76
Sint-Joost-ten-Node	11,13
Antwerpen	7,44
Etterbeek	5,08
Gent	4,51
Leuven	3,53
Namen	2,05
Sint-Jans-Molenbeek	1,97
Elsene	1,79
Luik	1,66
Charleroi	1,49
Anderlecht	1,19
Doornik	1,14
Kortrijk	1,09
Hasselt	1,08
Roeselare	1,06
Mechelen	0,77
Watermaal-Bosvoorde	0,73
Eigenbrakel	0,67
Turnhout	0,64

**Table A2.1 g: Top 20 municipalities for public administration (NACE 84)**

Brussel	12,56
Antwerpen	5,17
Namen	3,72
Schaarbeek	3,59
Luik	3,43
Gent	3,39
Charleroi	2,55
Sint-Gillis	2,51
Brugge	2,45
Bergen	2,12
Leuven	1,68
Hasselt	1,55
Sint-Jans-Molenbeek	1,51
Evere	1,51
Etterbeek	1,46
Sint-Joost-ten-Node	1,11
Elsene	1,05
Anderlecht	0,98
Mechelen	0,81
Marche-en-Famenne	0,78

**Table A2.1 h: Top 20 municipalities for human health activities (NACE 86)**

Gent	4,82
Luik	4,26
Antwerpen	4,14
Leuven	3,13
Brussel	2,80
Charleroi	2,33
Namen	2,00
Sint-Lambrechts-Woluwe	1,98
Brugge	1,95
Anderlecht	1,50
Hasselt	1,33
Aalst	1,24
Bergen	1,22
Doornik	1,20
Jette	1,20
Kortrijk	1,19
Genk	1,10
Roeselare	1,07
La Louvière	1,06
Edegem	1,03

**Table A2.1 i: Top 20 municipalities for creative, arts and entertainment activities (NACE 90)**

Sint-Gillis	8,68
Antwerpen	8,30
Brussel	7,03
Gent	5,16
Luik	3,23
Elsene	1,69
Brugge	1,45
Schaarbeek	1,26
Leuven	1,24
Namen	1,04
Mechelen	0,91
Vorst	0,87
Hasselt	0,82
Charleroi	0,80
Ukkel	0,80
Kortrijk	0,79
Bergen	0,76
Oostende	0,67
Sint-Jans-Molenbeek	0,64
Sint-Joost-ten-Node	0,54

### **Appendix 3.1 - Average knowledge-intensities (LFS, 2010-2020) by spatial scale and aggregated sector (I21)**

Sector – NACE codes (from x to y inclusive)	Spatial scale							
	Brussels-Capital Region	Rest of Belgium (BCR)	Brussels periphery	Brussels metropolitan area	Rest of Belgium (BMA)	Flemish Region	Walloon Region	Belgium
Agriculture, forestry and fishing (A) – 01 to 03	0.479	0.026	0.034	0.067	0.025	0.023	0.030	0.030
Mining and quarrying (B) – 05 to 09	0.604	0.165	0.566	0.583	0.120	0.385	0.131	0.200
Manufacturing (C) – 10 to 33	0.402	0.217	0.365	0.375	0.195	0.213	0.230	0.225
Electricity, gas, steam and air-conditioning supply (D) – 35	0.604	0.310	0.354	0.536	0.304	0.341	0.268	0.381
Water supply; sewerage, waste management and remediation activities (E) – 36 to 39	0.215	0.176	0.184	0.202	0.175	0.177	0.175	0.181
Construction (F) – 41 to 43	0.146	0.108	0.112	0.128	0.107	0.111	0.100	0.111
Wholesale and retail trade, repair of motor vehicles and motorcycles (G) – 45 to 47	0.243	0.149	0.242	0.242	0.129	0.159	0.125	0.159
Transportation and storage (H) – 49 to 47	0.228	0.091	0.126	0.170	0.082	0.099	0.066	0.109
Accommodation and food service activities (I) – 55 to 56	0.100	0.063	0.070	0.088	0.062	0.060	0.070	0.069
Information and communication (J) – 58 to 63	0.696	0.668	0.738	0.714	0.638	0.694	0.579	0.676
Financial and insurance activities (K) – 64 to 66	0.538	0.495	0.561	0.543	0.479	0.515	0.443	0.513
Real estate activities (L) – 68	0.520	0.431	0.532	0.525	0.408	0.439	0.411	0.452
Professional, scientific and technical activities (M) – 69 to 75	0.770	0.718	0.766	0.768	0.704	0.728	0.691	0.729
Administrative and support service activities (N) – 77 to 82	0.207	0.157	0.187	0.198	0.150	0.172	0.126	0.167
Public administration and defence; compulsory social security (O) – 84	0.421	0.285	0.295	0.390	0.283	0.312	0.251	0.321
Education (P) – 85	0.765	0.779	0.807	0.786	0.774	0.800	0.741	0.777
Human health and social work activities (Q) – 86 to 88	0.560	0.455	0.496	0.527	0.449	0.437	0.493	0.467
Arts, entertainment and recreation (R) – 90 to 93	0.471	0.327	0.381	0.436	0.316	0.313	0.351	0.356
Other service activities (S) – 94 to 96	0.501	0.159	0.207	0.403	0.151	0.138	0.195	0.232
Activities of households as employers, etc. (T) – 97 to 98	0.060	0.055	0.053	0.057	0.055	0.009	0.134	0.056

Activities of extraterritorial organisations and bodies (U) – 99	0.724	0.485	0.457	0.722	0.490	0.592	0.440	0.714
<b>All sectors</b>	<b>0.472</b>	<b>0.321</b>	<b>0.394</b>	<b>0.436</b>	<b>0.308</b>	<b>0.322</b>	<b>0.319</b>	<b>0.344</b>

*Source: Labour Force Survey, 2010-2020, own calculations.*

### **Appendix 3.2 - Shift-share analysis**

This report uses the extension of Artige and Van Neuss (2014) of the shift-share analysis, that corrects for the often-cited drawbacks of previous formulations of the shift-share technique. However, it modifies this version even further with respect to the reference territory following the logic of Balassa (1965) in trade theory. And, finally, our use makes it a dynamic shift-share analysis following Herath et al. (2013).

The shift-share analysis draws on six ratios using the total employment (wage and self-employment) as key variable: three at regional level (j) and three at the level of the reference area (J-j). The first ratio covers the regional aggregate growth rate as given by equation (1).

$$RAG_{t+1}^j = \frac{\sum_{i=1}^I (EMP_{i,t+1}^j - EMP_{i,t}^j)}{\sum_{i=1}^I EMP_{i,t}^j} \quad (1)$$

This ratio is the employment growth rate of region j between times t and t+1. In our analysis the time span covers 12 years from 2008 to 2020 inclusive, and data are collected and calculated annually. In Belgium there are 11 NUTS2 regions (i.e. 10 provinces and the Brussels Capital region), so that j=1, 2, ..., 11 and J=11. We have identified 21 sectors (due to data availability) so that i=1, 2, ..., 21 and I=21. The second ratio in equation (2) is the share of total employment in a sector in region j.

$$RSS_{i,t}^j = \frac{EMP_{i,t}^j}{\sum_{i=1}^I EMP_{i,t}^j} \quad (2)$$

The third ratio in equation (3) represents the regional sector growth (RSG)

$$RSG_{i,t+1}^j = \frac{EMP_{i,t+1}^j - EMP_{i,t}^j}{EMP_{i,t}^j} \quad (3)$$

The relation between these three ratios is given by equation (4):

$$RAG_{t+1}^j = \sum_{i=1}^I \left( RSS_{i,t}^j - \frac{1}{I} \right) RSG_{i,t+1}^j + \sum_{i=1}^I \frac{1}{I} RSG_{i,t+1}^j \quad (4)$$

The first term on the right-hand side represents the regional economic structure and the second term captures the regional sector growth.

A similar set of ratios applies to the reference territory. As the Brussels Capital Region (j), like some other regions, is a substantial part of the Belgian total (J), the reference territory corrects for this by subtracting the region from the Belgian total (see Balassa, 1965).

Equation (5) yields the aggregate growth rate of the reference territory, i.e. the national minus the province under consideration.

$$NAG_{t+1}^{J-j} = \frac{\sum_{j=1}^{J-j} \sum_{i=1}^I (EMP_{i,j,t+1} - EMP_{i,j,t})}{\sum_{j=1}^{J-j} \sum_{i=1}^I EMP_{i,j,t}} \quad (5)$$

The share of total employment in a sector in the reference territory is given by equation (6).

$$NSS_{i,t}^{J-j} = \frac{\sum_{j=1}^{J-j} EMP_{i,j,t}}{\sum_{j=1}^{J-j} \sum_{i=1}^I EMP_{i,j,t}} \quad (6)$$

Regional sector growth rates in the reference territory are captured by equation (7).

$$NSG_{i,t+1}^{J-j} = \frac{\sum_{j=1}^{J-j} (EMP_{i,j,t+1} - EMP_{i,j,t})}{\sum_{j=1}^{J-j} EMP_{i,j,t}} \quad (7)$$

The relation between these three ratios at reference territory level is given by equation (8).

$$NAG_{t+1}^{J-j} = \sum_{i=1}^I \left( NSS_{i,t}^{J-j} - \frac{1}{I} \right) NSG_{i,t+1}^{J-j} + \sum_{i=1}^I \frac{1}{I} NSG_{i,t+1}^{J-j} \quad (8)$$

The difference between equation (4) and equation (8) yields equation (9) where the industry-mix is the first term of the right-hand side, and the competitive effect is the second term in the right-hand side.

$$RAG_{t+1}^j - NAG_{t+1}^{j-j} = \left[ \sum_{i=1}^I \left( RSS_{i,t}^j - \frac{1}{I} \right) RSG_{i,t+1}^j - \sum_{i=1}^I \left( NSS_{i,t}^{j-j} - \frac{1}{I} \right) NSG_{i,t+1}^{j-j} \right] + \sum_{i=1}^I \frac{1}{I} (RSG_{i,t+1}^j - NSG_{i,t+1}^{j-j}) \quad (9)$$

The difference between RAG and NAG in equation (9) is the growth rate differential between the region (i.e. the provincial growth rate) and the reference territory (i.e. the growth rate of the nation minus the province under consideration). As this is a dynamic shift-share, calculations are made with two successive periods, and the outcome rates are the averages over 2008-2020. The results for total employment are shown in Table 3.4.

The results for the knowledge-intensive employment are shown below:

*Table A3.1 - Shift-share analysis based on knowledge-intensive employment data*

Provinces	Growth rate differential	Industry-mix	Competitive effect
Brussels-Capital Region	-0.58	-1.35	0.77
Antwerpen	0.11	-0.21	0.32
Limburg	0.12	-0.22	0.34
Oost-Vlaanderen	0.57	-0.15	0.72
Vlaams-Brabant	0.27	-0.78	1.05
West-Vlaanderen	-0.19	0.11°	-0.30°
Brabant wallon	0.61	0.92	-0.32
Hainaut	-0.25	0.05	-0.30
Liège	-0.06	0.65	-0.71
Luxembourg	-0.29	-0.23°	-0.06
Namur	0.11	0.32	-0.21

*Source: RSZ/ONSS and INASTI/RSVZ; own calculations.*

There are only three differences (marked with °) in sign compared to total employment in Table 3.4.

### **Appendix 3.3 – Formulas to calculate growth rates**

Let E be the shorthand for employment, t be the shorthand for time and n the shorthand for the number of years, then we can express growth rates in three ways.

The first is the annual growth of employment between t and t+1.

$$AGR = \frac{E_{t+1} - E_t}{E_t}$$

The second calculates the compound annual growth rate (CAGR). This growth rate assumes that the years between the first year and the last evolve in a continuous linear way.

$$CAGR = \left( \frac{E_{t+n}}{E_t} \right)^{\frac{1}{n}} - 1$$

The third growth rate uses all information of the years between the start and final year, and sums these up to calculate the annual average growth rate (AAGR).

$$AAGR = \frac{\sum_{t=1}^{n-1} \frac{E_{t+1} - E_t}{E_t}}{n - 1}$$