Deliverable 4.4

Final report describing the survey results and methodology

Due date of deliverable: M34

Actual submission date: 2021/12/2

Globalinto Identifier:	WP4. Large scale pilot survey of intangible investments
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Work package/task:	WP4 / Task 4.8
Document status:	draft / **final**
Confidentiality:	confidential / restricted / **public**

DOCUMENT HISTORY

Version	*Date*	*Reason of change*
1		

This project has received funding from the *European Union's Horizon 2020 The mechanisms to promote smart, sustainable and inclusive growth* under grant agreement No 822259.

Summary

This report presents a descriptive approach on the main findings of the Globalinto large-scale pilot survey of intangible investments involving 1796 firms in seven European countries. It covers extensively all sections of the survey, question by question, allowing for a general overview of the main trends that were identified. This is a basic reference document that can fuel future analyses.

Specifically, the first section of the report outlines the survey's main findings and provides an overview of the survey methodology. The second section provides descriptive empirical results on general firm characteristics, while the third section offers an overview of the enterprise spending in intangibles and then focuses on each type of intangible assets investment, namely, R&D, employer funded training, organization/business process improvement, software and databases, design, and reputation and branding. The fourth section highlights the results on firm-specific factors that affect investments in intangible assets such as the enterprise strategy, human and technological resources and organizational capabilities including dynamic capabilities (sensing, seizing and knowledge acquisition capabilities), design capabilities, and digital capabilities. The fifth section provides empirical evidence on the innovation performance, and the impact of investments in intangible assets on the economic performance of enterprises. The sixth section focuses on policy incentives provided by national governments and whether they were beneficial to firms, while the next section provides some evidence on the impact of Covid-19 crisis on firms' economic performance as well as on their digital strategy and capabilities. The last section of the report presents some preliminary probit analysis results that highlight the determinants of intangible investments, i.e., it concentrates on firm-specific factors that in interaction with system-specific (external) factors can explain the firm's propensity to undertake this type of investments, as well as the role of intangible investments on the different types of innovation performance.

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1. The Globalinto survey: Main findings and methodology

1.1 The Globalinto pilot survey

Globalinto seeks to develop new measures of intangible assets in order to analyze the role of knowledge production and diffusion for innovation, productivity and growth. In general, the current treatment of Intangible Assets can be characterized as partial and uncoordinated with a particular lack in measurement at a micro (business-firm) level. New methodologies and statistics with micro foundations and harmonization approaches across countries are needed for micro level analysis to better understand individual firm behavior and performance, i.e., innovation and firm productivity.

In addition, survey-based approaches on micro level IAs remain rather limited. Literature review shows just three recent survey works attempting to measure intangible assets and relevant investments in different countries:

- ONS[1], Imperial College London and NESTA[2] (2009; 2011): Investment in Intangible Assets Survey (UK).
- Eurobarometer survey (2013): "Investing in Intangibles: Economic Assets and Innovation Drivers for Growth"
- INAPP[3] and ISTAT[4] (2013): "Rilevazione statistica sugli investimenti intangibili (in English: Statistical survey on intangible investment)" (Italy)

All three approaches focus on measuring firm's spending on diverse intangible types, differentiating between in-house spending and purchase of intangible assets. They also measure the expected duration of the benefits reaped from investing into each category of intangible capital explored. **Table 1.1** summarizes the basic characteristics of the abovementioned surveys.

The Globalinto large-scale survey aims to add to the existing studies by a) developing a more comprehensive view of business' spending on intangible assets contributing to the improvement of the micro level measurement approach, b) identifying the factors influencing these investments, c) assessing their impact on enterprise (economic and innovation) performance, and d) investigating the role of relevant policies and impact of Covid-19 pandemic on the level of these investments.

The survey constitutes **a unique asset** of Globalinto project as it offers a dataset which can be used for various types of statistical analysis and thus provide **evidence-based implications for coherent policies as well as business strategies with a holistic view**:

- **Policy Implications:** Informing policy formulation (system of policies & mix of measures diversified per sector, firm type etc.) at an EU (DG RTD, DG DIGIT, DG EMPL etc.) and national level regarding the

[1] Office for National Statistics
[2] National Endowment for Science Technology and the Arts
[3] National Institute for the Analysis of the Public Policies
[4] The National Statistical Institute

support of IAs development and effective use as well as other complementary measures for increasing European firms' and economies' innovation, competitiveness, and growth.

- **Managerial Implications:** Informing strategic decisions regarding the appropriate mix of investments in IAs and other issues such as the development of specific organizational capabilities so as to improve innovation and economic performance in the long-term.

These implications seem to be even more significant after the **outbreak of Covid-19 crisis,** i.e., the impact of the Covid-19 business disruption on the importance of ICT investments and their complementarity with investments in other types of IAs.

Therefore, the Globalinto pilot survey can be envisioned not as an ad hoc, one-off survey but oriented towards the possibility of regular data collection at National Statistical Institutes, or possible integration of some of its core elements into existing survey instruments (i.e., measurement of IAs in a sustainable manner).

Table 1.1: Micro Surveys on intangible assets spending and life lengths

Survey	Components of IAs	Measurement Approach	Other issues under Investigation	Sample
UK, launched by ONS in 2009 & 2011 (Awano et al. 2010; Goodridge et al, 2014)	• Training (employer funded) • Software • Reputation & Branding • R&D • Design • Organization / Business Process Improvement	• Expenditures ➢ In-house ➢ Purchased • Assets life-lengths / depreciation rates		• 838 UK firms with 10+ employees (Sample Source: UK CIS firms) • Sample stratified by industry & employment ➢ Over-sample to knowledge-intensive industries: Engineering; ICT; Financial Services ➢ Under-sample: Construction; Utilities; Distribution; Accommodation
Italy 2013 (INAPP, Public Policy Innovation)	• Training • Software/Databases • Reputation & Branding • R&D • Design • Organization and Management & Production Processes Improvement • Other (sector specific) IAs	• Expenditures ➢ In-house ➢ Purchased • Assets life-lengths / depreciation rates • Ratio of internal/external use for specific IAs (R&D, Software/Databases, Design)	• Effect of the economic crisis on Intangible Assets Investments	• 10.631 Italian firms with 10+ employees • Sectors: ➢ Manufacturing ➢ Services
EU - Innobarometer 2013 (Montresor and Vezzani, 2016)	• Training • Software • Reputation & Branding • R&D • Design • Organization / Business Process Improvement	• Expenditures but via qualitative scales ➢ In-house ➢ Purchased	• Investments in IAs ➢ Expected Benefits ➢ Motivation / Obstacles ➢ Impact ➢ Relation to innovation projects • Innovation	• 11,317 firms with 1+ employees in EU28 and other 8 non-EU countries • Sectors: ➢ Manufacturing ➢ Services ➢ Utilities

1.2 Main findings

The main findings of the survey conducted among 1796 firms across seven European countries are as follows:

General information about the enterprise

Most firms (76.8%) in the Globalinto survey sample are Small and Medium-sized Enterprises (SMEs) (20-249 full-time employees), whereas large firms (250+ full-time employees) account for 23.2% of the sample. In addition, almost two thirds of the firms (63.6%) have less than 100 full-time employees.

Manufacturing and service firms account for 60% and 40% of the survey sample respectively. Furthermore, 60% of the sample firms operate in high and medium-high tech manufacturing and knowledge-intensive services.

Finally, the majority of firms (56.4%) do not belong to a business group, either national or multinational. Being part of an enterprise group appears to be largely dependent on firm size. 7 out of 10 large enterprises belong to a business group, mostly to a multinational one. On the contrary, approximately 3 out of 4 small firms are not part of a business group.

Enterprise spending on intangible assets

The vast majority of firms report some training activity (9 out of 10). In addition, a large part of firms (over 61%) have R&D expenditures, while half of the sample firms report expenditures in software/databases and in organization/business process (OBP) improvement activities. Lower is the number of firms with reputation and branding expenditures (40%), and even lower the share of firms which conduct design activities (1 out of 3 firms). Only 65 firms (3.6%) report no intangible activity.

R&D exhibits by far the largest average expenditure level followed by design and software and databases, while average spending on organization and business process improvement, reputation & branding and training are relatively smaller. Furthermore, it appears that in-house investment is an important component in all asset categories, and especially for R&D, design, and OBP improvement. Only for software and databases, external investment outweighs in-house spending.

The distribution of firms regarding their total investment in intangible assets as % of turnover is highly skewed indicating a large share of firms with relatively low expenditures and a smaller share of firms with high expenditures intensity. 52.3% of firms spend less than or equal to 5% of their total turnover while only 1 out of 5 firms invest more than 15% of their turnover in intangible assets.

Size and sector matter, larger firms and firms operating in technology/knowledge intensive sectors exhibit higher intangible activity. In general, large countries appear to make higher expenditures than smaller countries. Among small countries, Denmark and Finland display the highest intangible investments.

The best part of firms reported that the Covid-19 crisis had no impact on the level of intangible spending in 2020 related to 2019 across asset types. However, investments in training are by far the most negatively affected by Covid-19 (4 out 10 firms expected, on average, a 50% decrease in training expenditures) followed by those in design, R&D and reputation and branding. On the other hand, software and databases is the less negatively affected activity (only 12.7% of firms reported that their investments would decrease) followed by organization/business process (OBP) improvement. Moreover, for the latter two activities, the share of firms that reported "increase" of expenditures was higher than those that reported "decrease", especially for software and databases.

Types of enterprise spending

R&D activity and acquisition of external knowledge

Approximately 4 out of 10 (38.4%) firms exhibit no R&D activity. Most firms (55.3%) have in-house R&D activity, while much less firms (24.7%) invest in R&D carried out by external providers or in the acquisition of external knowledge e.g., patents, process blueprints (18.2%).

Firm size matters for R&D spending. In particular, the share of medium-sized (61.9%) and large firms (61.5%) that conduct in-house R&D is higher than that of small firms (46.9%).

Sector also matters for R&D spending. More firms in manufacturing (63%) are conducting in-house R&D activity than firms in services (43.7%), while the same applies for outsourced R&D as well (28% in manufacturing vs. 19.7% in services). Moreover, the technology/knowledge intensity of sectors matter: 3 out of 4 firms in high- and medium-high tech (H&MHT) manufacturing conduct in-house R&D. Firms operating in both knowledge-intensive services and H&MHT manufacturing, on average, spend more on in-house R&D compared to less knowledge intensive sectors

Training activity and spending

The vast majority of sample firms exhibit training activity across size and sector categories. However, some differences exist. Specifically, 96.2% of large firms conduct training activity as compared to medium-sized (91.9%) and small firms (83.4%). Furthermore, the highest share of firms with training activity is in knowledge-intensive services (92.9%) whereas the lowest in low-tech manufacturing (84.4%). Also, firms in services spend more on training activities (both in house and undertaken by external providers) than firms in manufacturing.

Organization / Business Process (OBP) improvement: activity and spending

More than half of the total sample firms (50.7%) do not conduct Organization / Business Process improvement activity, while average overall spending (both in-house and purchased) as % of turnover is 2.69.

Firm size matters as only 4 out of 10 small firms spend on OBP improvement activities, whereas the relevant shares of medium-sized and large firms are higher (54% and 61.2% respectively). However, no differentiation exists between manufacturing and services regarding the share of firms conducting OBP improvement activity. The most popular types of OBP in both manufacturing and services are quality improvement programs, business process reengineering, and business process digitization.

Software and Databases (S&D): activity and spending

Almost half of sample firms (48.6%) have no expenditures in Software & Databases, whereas the average overall spending (in-house and purchased) as % of turnover is 3.27.

Firm size matters, a higher share of large firms (63.5%) spend on S&D compared to 53.7% medium-sized (53.7%) and small firms (43.2%). Sector also matters as more firms in services invest in software/databases (57.7%) than firms in manufacturing (47.2%). In addition, sectors with higher technology/knowledge intensity demonstrate a larger share of firms with S&D activity than less knowledge intensive sectors and, moreover, KIS exhibit by far the highest share (60.4%) and average expenditures as % of total turnover (mean: 5.58, median: 2).

The most popular type of S&D activity is "special purpose applications" (e.g., accounting management software, control of production flows, business intelligence tools). Furthermore, a higher share of firms in services (57.1%) invest in "databases and other computerized information" (including big data) than in manufacturing (43.3%).

Design activity and spending

Only 1 out of 3 firms invest in design activities. Average overall spending as % of turnover is 4.69 while spending on in-house design activities prevail.

There is a higher share of firms with design activity in H&MHT and LT manufacturing firms (38% and 36.5% respectively), while average spending is much higher for KIS firms as far as in-house design activity is concerned.

3 out of 4 firms with expenditures in design, invest on technical design in the creation of products and services, almost 2 out of 3 firms invest on design for promotion purposes (for specific products and services and/or for their corporate identity), whereas 47% of firms make investments on design of user/customer experience.

Furthermore, the most popular type of design activity in manufacturing is 'technical design' and in services is 'design for corporate identity'. Finally, a much higher share of firms in services invest on design of user/customer experience (57%) than manufacturing (41.2%).

Reputation & Branding activity and spending

Only 4 out of 10 firms conduct reputation and branding activity and average overall spending (in-house and contracted-out) as % of turnover is 2.48.

Firm size matters as 44% of medium-sized and 45.7% of large firms conduct such activity whereas the share of small firms is smaller (34%).

Sector also matters as a higher share of service firms (44.2%) invest on R&B than manufacturing firms (37.2%). Low-tech manufacturing firms (44,8%) exhibit higher activity than H&MHT (38,3%) and MLT (25,5%) manufacturing firms. Furthermore, firms in knowledge intensive services exhibit the higher average spending on reputation and branding activities.

Factors influencing investments in intangible assets

Strategy

In general, there is no significant change in firms' strategic priorities before (2017- 2019) and during Covid-19 crisis. The larger part of firms reports that increasing labor productivity is important for both periods (57.3% and 53% respectively), while for almost half of the sample firms the decrease of production costs and the development of tailored, customized solution are significant strategic priorities as well. Somewhat lower is the percentage of firms targeting primarily the rapid development of new products and services (39.4% and 36.3%). On the other hand, only 1 out of 4 firms focus on price leadership strategies.

There is a large heterogeneity in firms' export activity. Over 1 out of 4 firms (26.8%) are oriented exclusively towards their national market and approximately 3 out of 10 firms have exports accounting for up to 25% of their turnover. However, 17.4% of firms report a very high export intensity exceeding 75% of their turnover.

50% of the firms report an intense competition in their market (i.e., many business competitors offering very similar products) while 44.7% of firms state that they face a moderate competition (only a few business competitors).

Only 12.8% of firms made Foreign Direct Investments (FDI) during the period 2017-2019.

Human and technological resources

On average, the share of full-time employees with a university and postgraduate degree is 25% and 8.6% respectively. In more detail, for the majority of firms (62.8%), the share of full-time employees with a university degree is less than or equal to 25%, while for only 15.6% of them this share exceeds 50%. Approximately 4 out of 10 firms does not employee people with a post graduate degree, while for only a small portion of the sample firms (3.4%) the share of full-time employees with a post graduate degree overcomes 50%.

Furthermore, on average, the share of full-time employees involved in R&D activities is 9.7%. 31.1% of the sample firms do not have R&D personnel while for an additional 27.3% of firms the share of full-time employees engaged in R&D is up to 5%.

Only a small part of the sample firms reported investing in Industry 4.0 to a high extent (i.e., they have responded 4 or 5 on a five-point Likert type scale) in the 2017-2019 period. Specifically, 15.7% of firms invested in innovative hardware technologies (e.g., robots, 3D technologies, sensor technologies), 12.6% in innovative digital technologies (e.g., artificial intelligence, data analytics, IoT, machine learning) and only 1.7% in bioinformatics-related technologies.

Organizational capabilities

The main part of sample firms seems to acquire new knowledge by encouraging cooperation with external actors across the value chain (62.6%) and systematic screening of their field (e.g., through patent searches, attending trade fares, reading trade or scientific journals, or web searches) (51.8%). In addition, many firms (68.7%) seem to support the internal exchange of knowledge and ideas. However, a much lower percentage of firms (39.5%) enhance the joint development of innovation strategies across functional areas. Moreover, networking capabilities such as strategic cooperations/alliances with other organizations and collaborative research agreements with universities and research institutes are far less popular knowledge acquisition practices among firms.

Almost 1 out of 3 firms responded that they do not work systematically with design and another 15.1% that design is used as last finish (e.g., when developing new products). However, the best part of firms use design more systematically as they reported that design is integrated into the product development process (32.5%) or even that design is a key strategic element of their business model (19.8%).

In terms of specific digital capabilities development level, approximately 2 out of 3 firms have a well-developed capability for the effective management of privacy and cybersecurity risks. Less than half of the firms seem to have developed a digital integration capability within and across different business functions (39.1%) and a capability of accessing networks and using appropriate solutions and architectures (45.1%). Furthermore, much lower is the share of firms which have developed high-level capabilities relating to data analytics access and use (29%) or have adopted appropriate business models for digital environments (26%).

The use of digital platforms is rather limited. Sample firms use digital platforms primarily for providing customer services. In addition, 1 out of 3 firms use digital platforms for providing seamless connection among partners, and 1 out of 4 firms for carrying out pre-sale interactions with existing or potential customers.

Firms in services have higher digital capabilities than firms in manufacturing. This is aligned with the higher investments of service firms in software and databases as well as in innovative digital technologies (artificial intelligence, machine learning etc.) compared to manufacturing.

Preliminary probit analysis results on the drivers of investments in intangible assets indicate that the propensity of firms to invest in intangibles depends largely on endogenous factors such as their strategic priorities, human and technological resources, dynamic and other organizational capabilities as well as on exogenous factors such as policy measures and the technological and business environment of their economic sector.

Firm performance

Innovation performance during 2017-2019. More than 6 out of 10 firms of the survey sample have introduced a product innovation, 53% of them have introduced a process innovation and half of the firms have launched a service innovation. Organizational innovation follows with 44.7%, whereas marketing innovation exhibits the lowest percentage (39.4%). Furthermore, 11.5% of the survey firms introduced all these five innovation types whereas 12.4% of the firms did not introduce any innovation in the period examined.

Preliminary probit analysis results show that *investments in diverse intangible assets*, especially in in-house R&D, reputation & branding, design, and organization/business process improvement appear to have an important impact on the firms' propensity to innovate. In addition, intangible assets' spending can fuel all innovation types i.e., product, service, process, marketing, and organizational innovation. Furthermore, investing in intangibles internally (in-house R&D and internal training) increases the probability to innovate. This finding is related to the strategic choice of 'making' rather than 'buying' intangibles. External development of IAs could pose problems of knowledge fragmentation and issues of coordination and control which could negatively affect innovation performance.

Impact of investments in intangible assets (made in 2017-2019) on economic performance: In their majority firms seem to benefit to a relatively low or moderate extent from investments in IAs, Higher benefits are perceived regarding the skills and qualifications of employees and the overall value of the firm, and much lower regarding economic indicators such as turnover, profit margin or market share.

Covid-19 crisis had an impact on firms' economic performance in 2020 as compared to 2019. For the larger part of firms (53.9%), turnover was the indicator more negatively affected by the covid-19 crisis, while profit margin follows. With regard to employment and overall investment, almost half of firms report "no impact" whereas 1 out of 3 firms refer that they decreased their employees and/or overall investment.

Policy measures for supporting investments in intangible assets before the Covid-19 crisis

The vast majority of firms did not benefit from government measures (tax incentives and direct subsidies) for supporting investments in R&D, internal training or software and databases activities. 32% of the sample firms were provided with tax incentives or direct subsidies for conducting R&D, and only 19% of firms utilized at least one of these measures for internal training programmes. The relevant share of firms that benefited from policy measures for supporting software and databases activities is even lower.

More than half of the UK firms were provided with R&D tax incentives (52.1%), followed by firms in France (39.2%). For Slovenia and Greece, the share of firms that utilized R&D tax incentives is lower (i.e., 24.4% and 19% respectively) but much higher than the corresponding percentages of Germany, Denmark and Finland that are below 5%. In terms of R&D direct subsidies, Finland, France, Greece, and Slovenia present similar shares (19.5% - 21.1%) and Germany follows with 14.6%. UK, in contrast to its performance in receiving tax incentives, exhibits a rather low share of firms provided with direct subsidies (8%), and even lower is the relevant share of Denmark (6.3%).

Covid-19 and digital transformation

4 out of 10 firms seem to be late adopters of digital technologies whereas only 1 out of 3 firms appear to be early adopters. A lower share of firms perceive themselves as laggards (i.e., they report a very slow or limited adoption of digital technologies) (15.7%) and innovators (11.5%).

Most firms did not proceed to an extensive increase of ICT investments or renewal of business processes and practices as a reaction to the Covid-19 pandemic disruptive changes. Only 23.5% of firms reported a large increase of spending on ICT infrastructure. Somewhat higher but still relatively low is the percentage of firms that renewed extensively their processes and practices during the Covid-19 crisis (27.3%).

Regarding the use of specific digital work practices and tools that may allow firms to respond the Covid-19 disruptions, it appears that firms have primarily adopted practices for teleworking and remote collaboration (40-45% of sample firms reported an extensive use of these tools), whereas the use of tools to access better data, to automate business processes, to address shifting customer needs and even more to ship product, is rather limited.

A high share of firms (2 out of 3) report that they will sustain changes in business processes and practices in the long term. In addition, almost 4 out of 10 firms see Covid-19 as a digital transformation accelerator while a much lower share (1 out of 4 firms) view Covid-19 crisis as a survival threat.

Firms exhibiting higher levels of digital transformation performance, i.e., innovators and early adopters (of digital technologies), have increased their spending on ICT infrastructure and business processes/practices renewal at a higher degree compared to lower performers (i.e., late adopters and laggards). Furthermore, higher digital performers see the Covid-19 crisis primarily as a digital transformation accelerator.

In general, firms in services seem to adopt and implement digital transformation practices as a response to the pandemic challenges at a higher level than firms in manufacturing. This finding can be related to the higher investments of service firms in software and databases, their increased level of digital capabilities and the lower impact of Covid-19 on software and databases investments.

1.3 The survey methodology: Questionnaire development[5]

The development of Globalinto Intangible Assets (IAs) Survey questionnaire is based on previous theoretical and empirical evidence. A first step to the questionnaire development was undertaking a literature review of existing empirical studies on intangible assets**.** Our review reveals that in general the current treatment of IAs is partial and uncoordinated with a particular lack in micro level measurement of intangible assets. In recent years an increasing effort has been devoted to finding more suitable measures of intangible assets. It appears that three approaches prevail:

1. The first one is based on aggregate estimates derived from **firm expenditures** on intangibles such as R&D, training and innovation (e.g., Corrado et al., 2005).
2. The second one uses measures based on the **labour input** of workers in high skilled R&D, ICT, and Organisational Capital related occupations (Piekkola et al., 2011 - Innodrive Project)
3. The third one uses direct measures based on stocks originally reported as assets on **companies' balance sheets** (e.g., Marrocu et al., 2012).

However, it seems that new methodologies and statistics with micro foundations and harmonization approaches across countries are needed for micro level analysis to better understand individual firm behavior and performance, i.e., innovation and productivity. **Table 1.2** summarizes the results of this literature review focusing on the basic components used to capture intangible assets as well as the measurement approaches that have been followed.

[5] All details on the questionnaire development can be found in *Deliverable 4.1 v1 (revised version): Set up of pilot questionnaire and datasets.*

Table 1.2: Literature review on IAs empirical studies at the micro level

Basic Components of IAs	Measurement Approach
• Tehnological and Non-technological R&D / Design • ICT intangibles (software, databases) • Marketing/Reputation/Customer Capital • Human Capital (firm-specific) • Organizational Capital ➢ Management / New Management Systems ➢ Organizational Structure / Restructuring ➢ Strategic Planning – New Business Strategies ➢ Business Process Improvement ➢ Marketing ➢ Human Capital – Training	• Expenditures-based [Purchased (external) and In-house/Own-account (internal)] ➢ Using firm's expenditures on intangibles (applying a depreciation rate) (e.g., Di Ubaldo and Siedschlag, 2017; Hulten and Hao, 2008) • Labor-based ➢ Using the labor input of workers in particular occupations (e.g., Piekkola et al. 2011, Riley and Robinson, 2011) • Stocks-based ➢ Using firms' balance sheets (e.g., Maroccu et al. 2012; Arrighetti et al. 2014; Battisti et al. 2015) • Qualitative and/or other quantitative measures through surveys (e.g., EU - Innobarometer, 2013; INAPP and ISTAT, 2013; ONS Survey, 2009 & 2011) • Mixed methods ➢ Expenditures-based and stocks-based (e.g., Bontempi and Marraise, 2015; Goldar and Parida 2017) ➢ Expenditures-based, stocks-based and qualitative and/or other quantitative measures (Crass and Peters, 2014) ➢ Expenditures-based and qualitative and/or other quantitative measures (e.g., Higon et al. 2017; Hall et al. 2013; Chappell and Jaffe, 2018)

The development of the Globalinto IAs questionnaire is grounded on the questionnaires of the three surveys mentioned above, the research team's experience from large-scale firm surveys on innovation and knowledge-intensive entrepreneurship either in the context of EU FP-funded projects (e.g. AEGIS, cre8tv.eu) or national projects (e.g., surveys on the top 2000^{+} Greek firms), and other available sources such as additional empirical studies on IAs and their impact on productivity and firm performance, the latest version of OSLO manual, Community Innovation Survey questionnaires etc.

The questionnaire includes six different sections. Please see the framework for the questionnaire's development on page 19 (**Figure 1.1**). **Section A** focuses on **general information about the firm** including firm's primary and secondary activities, whether the firm belongs to a national or multinational enterprise group and firm size. **Section B** concentrates on **firm's intangible investments** drawing on previous surveys on intangibles, mainly the one commissioned to NESTA by the UK Office for National Statistics (see Awano et al. 2010) and the Innobarometer 2013. Following the classification developed by NESTA, the questionnaire aims at investigating investment decisions on six intangible assets: (i) research and development (R&D) and acquisition of external knowledge, (ii) training, (iii) organization or business process improvements, (iv) software and databases, (v) design of products and services (excluding research and development), and (vi) company reputation and branding. Measuring investments in intangibles involves two steps. First, we need to find out how much firms spend on each intangible category. Furthermore, we need to ask firms how much they spend on purchasing intangible assets and what they spend on "in house" or own account investment assets. For example, many firms write their own software, do their own R&D or organize their own training activities. Specifically, the questionnaire targets at capturing spending in intangible assets in terms of expenditures as a % of the firm's turnover and the firm's choice to allocate resources to "making" internally rather than "buying" externally those intangibles. Finally, section B attempts to capture the impact of the Covid-19 crisis on the enterprise spending on each IA type.

Section C puts emphasis **on the determinants of a firm's investment in intangible assets**. In line with the capability view of the firm (e.g., Dosi et al, 2001; Teece et al, 1997, Teece, 2007; Helfat et al., 2007 etc.) it is argued that a firm's propensity to invest in intangible assets can be understood mainly as a bundle of resources and capabilities that the firm has evolved over time and only marginally as a result of exogenous technological contingencies (e.g., Arrighetti et al., 2014; Montresor and Vezzani, 2016). The adoption of such a perspective in the study of intangible assets investments calls for a focus on firm-specific factors that in interaction with system-specific (external) factors can explain the firm's propensity to undertake this type of investments. On this basis, we choose to focus on variables such as strategic priorities (e.g., price vs. differentiation strategy), organizational complexity (e.g., degree of internationalization, FDIs), human and technological resources as well as specific organizational capabilities (e.g., dynamic capabilities, and design and digital capabilities) which may have a significant impact on the firm's intangible investment decisions.

Section D aims at capturing **innovation performance and the impact of investments in intangible assets on economic performance**. Please note that additional performance measures related to productivity such as sales per employee, profits per employee etc. can be deducted for the sample firms from the financial data available from Orbis.

In section E several questions related to the **impact of public policies on the intangible investments** of a firm are included.

Finally, section F, which includes **questions on the COVID-19 crisis,** attempts to capture the impact of the pandemic on firms' economic performance as well as on their digital strategy and capabilities.

The questionnaire was originally developed in English and was significantly improved through several rounds of consultation with partners and the advisory board (for more details on the important stages of questionnaire development please see Deliverable 4.1 v1).

The questionnaire was translated into six national languages (German, French, Danish, Finish, Slovenian and Greek) based on the Guidelines for Best Practice in Cross-Cultural Surveys by the respective country research teams. The translation framework and the translation process were prepared and coordinated by UL (for more details on the questionnaire translation process please see Deliverable 4.2[6]). Translation is key to collecting comparable data in multinational, multicultural, or multiregional surveys ("3MC" surveys). Each language has specifics that influence the intended meaning, especially as the survey questionnaire addresses new topics for which vocabulary might not have developed fully.

An accompanying manual of the Globalinto IAs questionnaire was also developed to provide brief definitions and interpretation of specific questions as a guidance to the interviewer. This was considered as a necessary element of the questionnaire design because it would enable interviewers to provide explanations or clarifications during the interview, improving thus the reliability of the obtained responses. The last version of the questionnaire (in English) and the accompanying manual (both as updated following the pilot questionnaire testing at the end of October 2020) can be found in the Appendices 1A and 1B respectively.

[6] Deliverable 4.2: Set-up of subcontracted survey - monitoring and assessment for quality control

Figure 1.1: Framework for the survey and questionnaire development

1.4 The survey methodology: Preparatory phase

The need for a centralized approach in survey implementation

The research team decided to adopt a centralized approach in survey implementation and use a unified database with harmonized data at the European level to draw the population from. In this respect, a subcontracting scheme (one subcontractor would implement the survey across countries) was preferred over a decentralized solution (e.g., undertaken by individual project partners in each country) that would create methodological but also practical problems.

A centralized approach has several merits over a decentralized one including fewer transaction costs i.e., more effective, and efficient management and coordination of data collection, monitoring of the survey implementation progress, homogenization of data, etc., and in essence a better quality of collected data across countries on time. The survey population for the large-scale pilot survey was mainly drawn from Orbis. Orbis is a commercially available database which includes information on more than 310 million companies across the globe and collects data from more than 160 separate providers as well as other own sources[7]. An important advantage for using a unified database such as Orbis is harmonized financial data for the firms participating in the survey. This element was considered important to

- avoid asking questions related to firm financial data, which are both sensitive and extent the length of the questionnaire,
- analyze the financial status and the evolution of firms participating in the survey,
- compare growth rates of firms across countries, sectors, etc.,
- allow some financial comparisons with non-participants
- compare with countries that are not participating in the survey, and
- be able to undertake any other comparative work that may seem necessary

These possible lines of analysis clearly indicate that the use of a unified European database would help the project beyond the specific purpose of drawing samples and conducting the survey. In this respect, it allows analysis of the non-respondents, a general mapping of the available population based on growth or other criteria, or any other comparative work (across countries, across sectors, across firm sizes etc.) that may be necessary for ongoing or future analysis.

Selection criteria for target population

Selection criterion 1: Sector

The Globalinto pilot survey aims at covering economic activities with intensive investments in intangible assets. These can be found in both manufacturing industries and knowledge-intensive services. The selected subsectors in two-digit level (NACE Rev.2 statistical classification of economic activities) are listed in **Table 1.3**.

[7] https://www.bvdinfo.com/en-gb/our-products/data/international/orbis

Table 1.3. The selected sectors for the Globalinto survey

Nace_Rev 2	Sector / Subsector
	Manufacturing
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c.
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other Manufacturing
33	Repair and installation of machinery and equipment
35	Electricity, gas, steam and air conditioning supply
	Services
46	Wholesale trade, except of motor vehicles and motorcycles
47	Retail trade, except of motor vehicles and motorcycles
58.2	Software publishing
59	Motion picture, video and television programme production, sound recording and music publishing activities
61	Telecommunications
62	Computer programming, consultancy and related activities
63	Information service activities

64.1	Monetary intermediation
69	Legal and accounting activities
70	Activities of head offices; management consultancy activities
71	Architectural and engineering activities; technical testing and analysis
72	Scientific research and development
73	Advertising and market research
74	Other professional, scientific and technical activities
90	Creative, arts and entertainment activities

Selection criterion 2: Firm size

The survey focuses on enterprises employing at least 20 people at the end of 2019. The study aims to compare larger and smaller enterprises, but the smallest enterprises are not expected to invest much in intangible assets; even if the smallest enterprises invested in intangible assets, their contribution would be small. The study thus uses the threshold of at least 20 full time employees, which also ensures a sufficiently large target population to achieve the required sample size in large and small countries alike.

Selection criterion 3: Country

The survey was run in seven countries (all consortium partners' countries except for one): Germany, UK, France, Finland, Denmark, Slovenia, and Greece.

The population of firms was mainly drawn from Orbis by the UVA research team since UVA had access to Orbis. Furthermore, we only considered those firms with contact information available in Orbis i.e., telephone number and/or website. Most firms with missing telephone number were also not having a website address.

Selection of the survey implementation method

Choosing the most suitable method for the implementation of a survey is a critical parameter for a survey's success. It affects response rates, the reliability of the survey and when well-designed, it defines the real added value of a survey project.

Among the three main methodologies used for research and surveys [telephone (CATI), web (CAWI) and face-to-face (CAPI)[8]], CATI was selected for the Globalinto Survey (as described in the

[8] CAPI (Computer Assisted Personal Interviewing) is face to face collection where an interviewer administers the questionnaire to the respondent and marks down answers on a smartphone, tablet, or PC. This method provides more accurate answers and is considered the most reliable data collection method compared to the other two. However, it is not considered as an alternative for this survey as it is time consuming and costly.

Globalinto project’s proposal, the Grant Agreement, and the two Call for Tenders for the survey subcontracting) as the most suitable methodology for a business survey. CATI offers a lot of advantages compared with other methodologies as it combines high quality, acceptable reliability, and reasonable cost (best value for money).

1. The main advantage of CATI (Computer-Assisted Telephone Interviewing) method is the presence of a real person (the well-trained interviewer) that acts like a mediator between the questionnaire and the respondent. As a result, CATI has several significant benefits:
    a. The respondent can understand questions better,
    b. A lot of don't know/don't answer can be avoided, and most importantly
    c. The dropout rate is much lower.

Therefore, CATI ensures higher quality of collected data, more accuracy and considerably lower number of partially completed questionnaires and missing values. Thus, CATI is more appropriate method for longer and complex questionnaires for large-scale surveys addressed to business enterprises.

2. A general CAWI (Computer-Assisted Web Interviewing) survey can be cheaper, but it is mainly addressed to individuals and/or consumers and is not used in large-scale business enterprise surveys. In addition, CAWI compared to CATI has several significant limitations:
    a. It is not suitable for long and complex surveys such as the Globalinto survey.
    b. Answers may not be accurate as respondents can more easily answer with a random option or give hurried answers.
    c. Dropout rate can be significantly higher.
    d. There is no feedback on questionnaire design errors.
    e. The response rate is generally lower.

Overall, the above points indicate that the CAWI method is not appropriate for long and challenging surveys, and this is verified by the empirical fact that the usual method for conducting this kind of surveys is CATI.

The CATI choice however would require sub-contracting the telephone interview part of the survey. In fact, the need to employ a specialized company emerged from the lack of technical know-how and the necessary resources (e.g., well-trained interviewers to conduct the survey across the seven countries in national languages) to perform such a large-scale survey by the partners of the consortium.

Following two official calls for tender as foreseen by the European Commission's rules (see Deliverable 4.2 for more details) the Global Data Collection Company (www.gdcc.com) was appointed to implement the survey using the CATI method.

1.5 The survey methodology: Implementation phase

Final sample and quotas

Based on the initial proposal for the final sample of complete questionnaires (as described in the Globalinto project's proposal and the Grant Agreement) and the available financial resources it was decided to come up with a sample of **1790 questionnaires** across countries that would allow a sound and solid statistical analysis at the cross-country, national but also at the sectoral (manufacturing vs. services) and firm size (large vs. SMEs) level. To achieve this final sample target it was decided to collect approximately 215 questionnaires from firms in each small country (Finland, Denmark, Greece, and Slovenia) and 310 questionnaires from firms based in each large-sized country (UK, France, and Germany).

Furthermore, the sample structure by country was refined by imposing two quotas: a sector quota, and a firm size quota (**Table 1.4**).

Sector quota: 60 % (manufacturing) - 40 % (services). This quota was decided because a) the survey aims at capturing six different types of investment in intangible assets and manufacturing enterprises typically have more types of intangibles than service enterprises, b) there is a structural shift in manufacturing production with intangibles becoming increasingly important in manufacturing production, b) manufacturing gets a renewed attention from an industrial policy perspective as a dynamic manufacturing sector is again considered as an important prerequisite for an innovative and fast-growing economy.

Size quota: 60 % (SMEs) – 40 % (large enterprises). The quota for a somewhat larger share of SMEs (20-249 employees in 2019) vs. large enterprises (at least 250 employees in 2019) was decided because the actual population sizes in targeted economic activities are in favour of SMEs, with few large enterprises, especially in smaller countries (Denmark, Finland, Greece, Slovenia). Furthermore, SMEs are considered a source of innovation and productivity.

Table 1.4 Sample structure by country, sectoral group and firm size

Countries	Planned Sample				
	Manufacturing SMEs	Manufacturing Large	Services SMEs	Services Large	Total
Denmark	77	52	52	34	**215**
Finland	77	52	52	34	**215**
France	112	74	74	50	**310**
Germany	112	74	74	50	**310**
Greece	77	52	52	34	**215**
Slovenia	77	52	52	34	**215**
UK	112	74	74	50	**310**
TOTAL	**644**	**430**	**430**	**286**	**1790**

To come up with a population of firms that would allow us to reach the final target sample of 1790 complete questionnaires we had to take into consideration: a) the selection criteria for target population (please see section 1.4 above) and the predetermined sample structure and b) the rule of thumb 1:15 that was specified by GDCC between targets and sample availability. This rule implies that we would need to have an original sample at least 15 times larger than the actual number of responses. We needed, thus, to provide to GDCC a large pool of firms for the telephone surveys, so we could deal with refusals / non-responses etc.

During the survey implementation we had to enrich our initial Orbis population sample with additional sample from Orbis and other sources to be able to comply with the predetermined sample structure within countries due to the unforeseen disruption in enterprises daily operation caused by the COVID-19 pandemic (**Table 1.5**). The additional sources used to draw population from were Dan & Bradstreet[9] (the additional sample was provided by GDCC) and national registries for Slovenia (APJES database) and Greece (ICAP database) (see **Table 1.6**).

[9] Dun & Bradstreet is a leading global provider of mission-critical enterprise data (http://www.dnb.com)

Table 1.5 Population of firms (breakdown by country, sectoral group and firm size)

	Manufacturing SMEs (20-249 employees)	**Manufacturing Large** (250+ employees)	**Services SMEs** (20-249 employees)	**Services Large** (250+ employees)	**Total**
Denmark	1754	244	2511	381	**4890**
Finland	1717	239	1870	258	**4084**
France	5206	1316	4886	1274	**12682**
Germany	16651	3974	19010	3786	**43421**
Greece	1738	171	1772	179	**3860**
Slovenia	962	124	638	47	**1771**
UK	5029	1527	10005	2265	**18826**
TOTAL	**33057**	**7595**	**40692**	**8190**	**89534**

Table 1.6 Population of firms (breakdown by country and data source)

Country	**Orbis**	**DnB**	**National Registries**	**Total**
Denmark	4862	28	0	**4890**
Finland	3698	386	0	**4084**
France	11941	741	0	**12682**
Germany	42690	731	0	**43421**
Greece	3656	148	56 (ICAP)	**3860**
Slovenia	1538	63	170 (AJPES)	**1771**
UK	17960	866	0	**18826**
TOTAL	86345	2963	226	**89534**

The questionnaire set up and training of interviewers

The final questionnaire version was programmed and tested in the data collection application of GDCC (CATI platform) to allow a CATI version over the phone. The ready to be programmed English version of the questionnaire (word format) was provided to GDCC in early September 2020 and the programming of the "Master" questionnaire (English version) was finalized on 17/9/2020. A test link was provided to assess/test the questionnaire. After reviewing and approving the English questionnaire version, the six translated questionnaire versions[10] were also programmed and

[10] The finalization of the translation process for programming and testing the CATI versions of the questionnaires into national languages was coordinated by UL with the cooperation of project partners.

tested using the standard GDCC language overlay template to ensure that all questions appear correctly in national languages.

Before the initiation of the pilot phase there was a) an initial briefing (video conferencing meeting) of the GDCC team members by NTUA and UL on the Globalinto survey, and b) a training video conferencing meeting (zoom) that was also organized by NTUA and UL for the interviewers assigned to the pilot survey so that they become fully familiar with the content of the survey (27/10/2021).

The interviewers were closely monitored by the GDCC team leaders and quality control managers during the field work process. Of the interviews held, 8 interviews were flagged by quality control for removal from the data file since these did not meet the GDCC's quality standard. In total 73 interviewers have been working on the project. The following table (**Table 1.7**) shows the number of interviewers in the project by country

Table 1.7 Interviewers by country

Country	Number of interviewers
Denmark	8
Finland	4
France	15
Germany	16
Greece	7
Slovenia	3
UK	20
TOTAL	73

The pilot fieldwork

The **pilot testing** of the questionnaire was conducted in late October 2020 (27-29/10). 27 interviews in total were conducted as follows: 5 in Finland and France, 4 in Denmark and Greece, 3 in Germany, Slovenia and the UK. The purpose of the pilot phase was testing the questionnaire in a live environment to:

- check if the questionnaire is understandable for the respondents in all countries
- check the questionnaire sequence, routing of filter questions and overall survey "flow"
- test the function of CATI scripts and data collection infrastructure

- check for translation effects on the respondents' interpretation of the translated questionnaire versions
- test the interviewer instructions and support
- test the length of the questionnaire
- anticipate any unforeseen issues in an early stage of the fieldwork process

The pilot fieldwork provided useful feedback on further improving the questionnaire and the accompanying manual (e.g., some translation errors were addressed, the manual was complemented and enriched with additional information that would be helpful to the interviewers) while several clarification issues regarding the interview procedure were addressed. For example, many respondents requested for an information email to be sent prior to conducting the survey. In this respect, the option to send out information emails was set up in order to send the eligible respondent an information letter stating the entities involved in the study, the purpose of the study and a sentence about confidentiality of the information collected.

Furthermore, based on pilot feedback information[11] and the particularities of the survey questionnaire it was decided that the person best able to provide the requested information could be one of the following top-level managers: CEO (Chief Executive Officer), CFO (Chief Financial Officer), Head of R&D and Innovation, CTO (Chief Technology Officer), CIO (Chief Information Officer, a manager dealing with ICT strategy and policy of the enterprise) or the Owner.

The survey fieldwork

The **official fieldwork** period started on 2/11/2020. The fieldwork progress was significantly affected by the Covid-19 pandemic. The major challenges as reported by the interviewers were:

- **Unavailability of businesses (businesses out of reach)** [e.g., many enterprises with answering machines informing that the company was closed temporarily due to the Covid-19]
- **Difficulty to reach the appropriate respondent** due to teleworking [e.g., numerous respondents worked from home, and were only contactable by email]
- **Lower availability of time** for questionnaire completion [e.g., many businesses reduced staff and opening hours, thus had less time for their usual, day-to-day business responsibilities]

Due to the abovementioned difficulties, the following decisions were made by early December 2020 to reach our sample targets:

- Expand the sample population by additional economic activities (2-digit NACE codes)
- Modify the size quota targets: It should be stressed that the initial quota target [60 % (SMEs) – 40 % (large enterprises)] for the enterprise size was amended to **77% SMEs & 23% Large firms** during the implementation phase of the survey. The change was deemed essential to

[11] NTUA and UL teams had the possibility to hear some of the pilot recordings as well.

enlarge our target population due to several difficulties in reaching out firms during the pandemic, and especially large firms in small countries. The 23% threshold would ensure that a minimum of 20 complete questionnaires for large firms would be achieved per country.

Table 1.8 Planned and Achieved Sample

Countries	Planned Sample					Achieved Sample				
	Mnf SMEs	Mnf Large	Srv SMEs	Srv Large	Total	Mnf SMEs	Mnf Large	Srv SMEs	Srv Large	Total
Denmark	77	52	52	34	**215**	99	30	66	20	**215**
Finland	77	52	52	34	**215**	99	29	66	21	**215**
France	112	74	74	50	**310**	145	43	96	30	**314**
Germany	112	74	74	50	**310**	143	43	95	29	**310**
Greece	77	52	52	34	**215**	98	30	67	20	**215**
Slovenia	77	52	52	34	**215**	99	33	66	17	**215**
UK	112	74	74	50	**310**	144	43	96	29	**312**
TOTAL	**644**	**430**	**430**	**286**	**1790**	**827**	**251**	**552**	**166**	**1796**

Furthermore, there was additional effort by the UL research team that contributed to the fieldwork completion in Slovenia. As foreseen in the Call for Tenders, UL provided a list of contacts for Slovenian enterprises to GDCC. Furthermore, UL became occasionally involved in the survey response process, although this was not initially planned. As the data collection agency was not able to ensure the targeted quotas for large units, UL helped by contacting these units through their own network and providing established contacts to the agency. A few telephone interviews were also completely conducted by UL. Despite the difficulties imposed by the worldwide Corona crisis, the main fieldwork was successfully completed in 9/3/2021.

Table 1.9 Burn and incidence rates by country

Country	Completed Interviews	Refusals	Screen Outs	Burn rate	Incidence rate
Denmark	215	703	30	5.5	84%
Finland	215	571	25	4.6	88%
France	314	1177	39	6.2	86%
Germany	310	3627	145	15.5	65%
Greece	215	223	26	2.3	85%
Slovenia	215	550	14	5.2	94%
UK	312	6047	62	14.5	82%
TOTAL	**1796**	**12898**	**341**	**8.4**	**82%**

As seen in **Table 1.9** the countries where enterprises were more difficult to reach were Germany and the UK. This can be verified by the fact that these two countries have the highest burn rates and the highest refusal rates. The burn rate shows how many records are disposed[12] (i.e., records that were called and got a final status such as completed interview, refusal, screen out, etc.) per completed interview. For Germany the main reason for exhibiting a high burn rate is the high refusal rate and the high % of screen outs (i.e., enterprises that were deemed not eligible to complete the questionnaire because of their responses to the screener questions of the questionnaire) and in consequence the lower incidence rate[13] (65%). For the UK the main reason for high burn rates is the high refusal rate.

The data cleaning process

Upon the fieldwork completion, a laborious **quality control and dataset cleaning process** was implemented to eliminate potential errors, especially regarding data on intangible investments, and, in general, to ensure the highest possible quality of the database. Specifically, as soon as the subcontractor delivered the Globalinto survey database, there was extensive quality control of the dataset to identify potential measurement errors. Many checks were made following a systematic procedure per questionnaire section. This procedure was based on the previous experience of NTUA in survey data cleaning and specific qualitative information acquired by UL during the Globalinto survey data collection period in Slovenia.

The quality control aimed to assess the validity, accuracy, completeness, consistency, and uniformity of data and identify potential sources of measurement errors. The quality control process highlighted several potential measurement errors. The NTUA and UL research teams decided to do some desk research and, most importantly, follow-up calls in both countries to understand the source and extent of measurement errors. This process helped them monitor specific problems and take corrective action when and as needed for the two countries.

Following the dataset quality control process and the initial feedback from Greece and Slovenia, GDCC, the survey subcontractor, was informed about the database cleaning process, the potential measurement problems, and the experience from the follow-up work in the two countries. GDCC was asked to provide feedback and assistance for follow-up work that would be needed to identify

[12] If for example 100 records were disposed, and from those 100 records 8 interviews were completed, then the burn rate is 12.5 (100/8).
Burn rate: Finished_Total+Max Tries Blocked/Completes
Finished_Total: all records that cannot be called anymore (i.e., refusals, completed interviews, screen outs)
Max tries blocked means a number has reached the max # of call attempts with no result. It then gets blocked as it has reached the maximum amount of tries.
[13] Incidence rate shows the percentage of respondents that qualify for the study. It is calculated as: Incidence: Completes/Completes+ DMC +Quote Complete)
DMC: Doesn't meet criteria, all cases that screen out at a certain question
A quote complete means that a company qualifies in a quota (size class in this study) where the target has already been reached. They then terminate the interview and screen out due to the quota being completed already.

and correct possible errors in the remaining five countries. In this respect, the GDCC Quality Control (QC) department started cross-checking the records against the recordings of the respective cases to identify deviations between the data collected and what was reported by the respondents. Reviewing the recordings was quite a time-consuming process. However, this process offered some helpful feedback on specific issues identified during the cleaning process that required further clarification. In addition, since the callbacks conducted by the NTUA and UL teams were successful in finding that much of the problems with quantitative questions in section B of the questionnaire were down to misunderstandings of the script, GDCC pursued a course of action with follow-up calls in the other countries.

The data cleaning process was completed in early June 2021 and the dataset was amended accordingly. A unified dataset in both MS Excel and SPSS accompanied by an 'instruction guide', which includes a description of the database variables and shows how each variable was measured and coded were delivered by the end of June 2021 (for a detailed information on the quality control and cleaning process, please see Deliverable 4.3[14]).

[14] Deliverable 4.3: A unified dataset in SPSS format with "instruction guide"

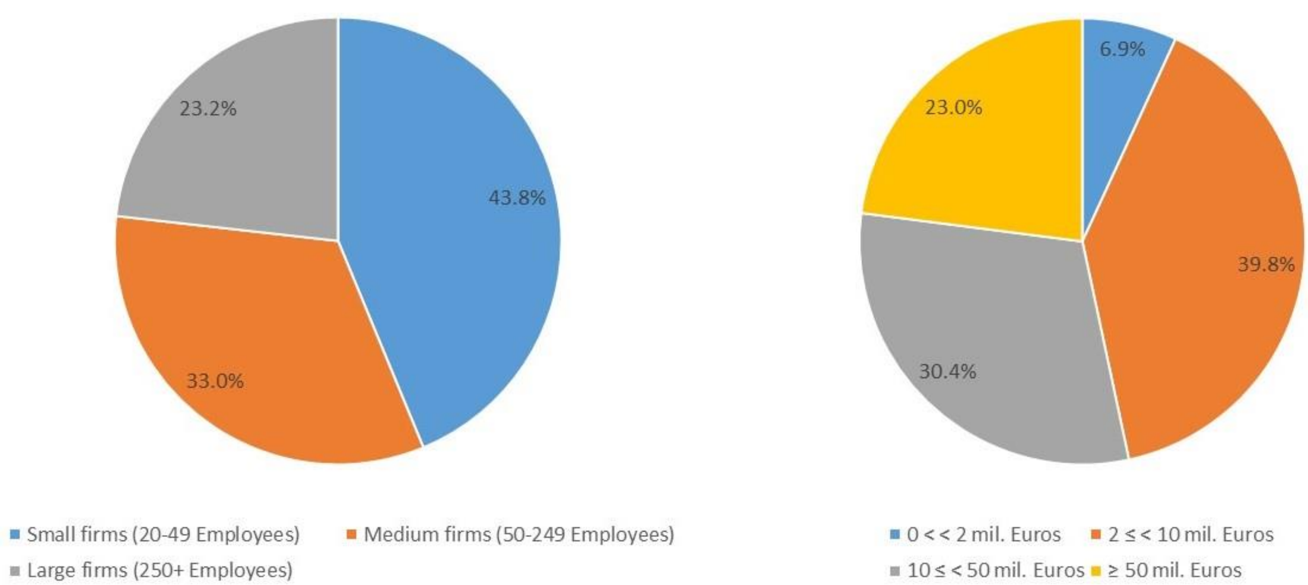
2. The sample characteristics (Section A of the Questionnaire)

This section provides descriptive empirical results on general firm characteristics such as firm size in terms of both full-time employees and turnover, sector, and whether the enterprise is part of an enterprise group at a national or international level.

2.1 Number of full-time employees and turnover (2019)

Most firms (76.8%) in the Globalinto survey sample are Small and Medium-sized Enterprises (SMEs)[15]. In particular, 43.8% and 33% of the sample are small (20-49 full-time employees) and medium-sized (50-249 full-time employees) firms respectively, whereas large firms (250+ full-time employees) correspond to 23.2% of the sample (**Figure 2.1**). In addition, almost two thirds of the firms (63.6%) have less than 100 full-time employees. Small firms have on average 31.7 employees (median:30). The average number of employees in medium-sized firms is 102.1, somewhat higher than the median (85), while the average number of employees in large firms (837.6) (median: 420), indicates the presence of some very large enterprises in the sample[16] (**Table 2A.1** in **Appendix 2A**).

Figure 2.1 Sample distribution by firm size (number of employees & annual turnover) [N = 1796]



In addition, **Figure 2.1** depicts the sample distribution following an alternative size categorization that is based on annual turnover. The turnover limits used for its category are based on *EC's recommendation as of 6 May 2003 concerning the definition of micro, small and medium-sized*

[15] The specific distribution was one of the survey sample targets.
[16] In the sample there are 45 firms with over 1000 full-time employees (15.9% of large firms).

enterprises that combines two criteria i.e., the number of employees and the annual turnover[17]. For this analysis, we use the proposed annual turnover limits to provide a complementary picture for the sample distribution in terms of firm size.

It is important to note that the sample distribution follows the same pattern for both firm size categorizations, i.e., the former that is based on the number of employees and the latter that is based on the annual turnover (share of small firms: 43.8% and 46.7% respectively, share of medium firms 33% and 30.4% respectively, and share of large firms: 23.2% and 23% respectively). In addition, in all enterprise categories the mean value is close to the median, except for the firms with annual turnover higher than 50 mil. Euros. In this category, the mean is much higher than the median illustrating again that our sample includes some very large enterprises (**Table 2A.2** in **Appendix 2A**).

2.2 Sectoral distribution

Manufacturing firms make up 60% of the survey sample while the remaining 40% consists of firms in services [18]. In terms of sectors' technology and knowledge intensity, firms that belong to High & Medium-high technology (H&MHT) manufacturing sectors account for 30% of the total sample. Most of them (5 out of 6) are medium-high-tech firms, whereas the remaining are high-tech firms[19]. Another 30% of the sample are knowledge-intensive services (KIS) firms. Therefore, according to the sectoral classification, 60% of the sample are firms with relatively high technology/knowledge intensity. Medium-low-tech (MLT) and low-tech (LT) manufacturing firms account for 13.5% and 16.1% of the sample respectively. Moreover, 1 out of 10 firms belong to less knowledge-intensive services (less KIS) and, more specifically, to wholesale and retail trade (vehicles and motorcycles not included) [**Figure 2.2**]. **Table 2A.3** in **Appendix 2A** presents the distribution of firms by 2-digit NACE 2 category.

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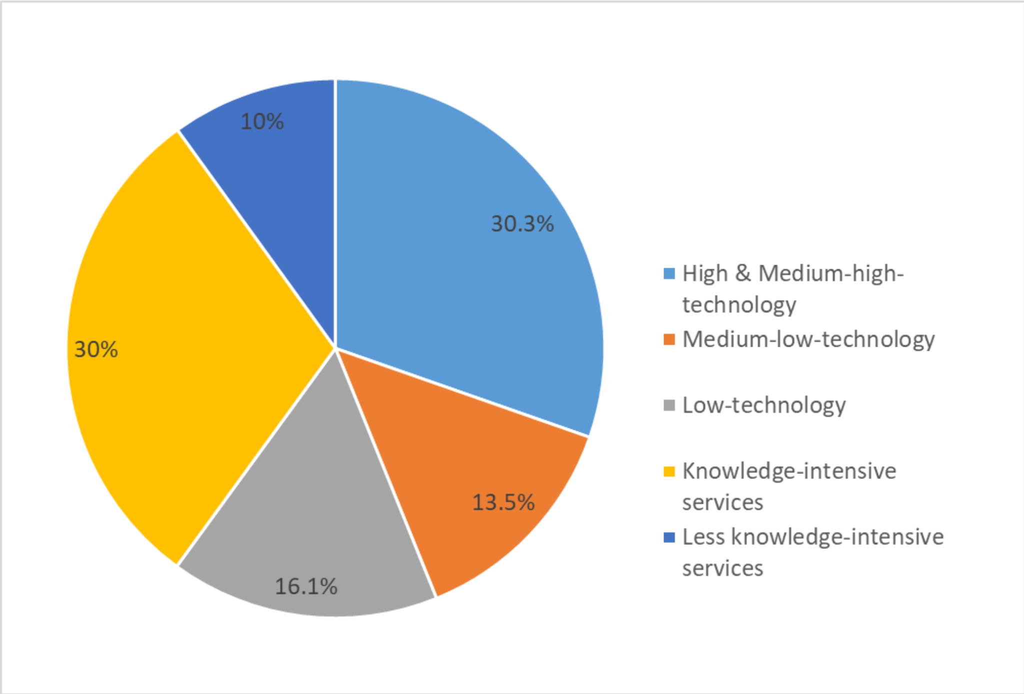
[17] ANNEX, TITLE 1, Article 2: **Staff headcount and financial ceilings determining enterprise categories:** 1) The category of micro, small and medium-sized enterprises (**SMEs**) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million Euros, and/or an annual balance sheet total not exceeding 43 million Euros. 2) Within the SME category, **a small enterprise** is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed 10 million Euros. 3) Within the SME category, a **microenterprise** is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed 2 million Euros. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003H0361&from=EN

[18] The specific distribution was one of the survey sample targets.

[19] Namely, they belong to the following two NACE 2 economic sectors: 21 Manufacture of basic pharmaceutical products and pharmaceutical preparations & 26 Manufacture of computer, electronic and optical products.

Figure 2.2 Sample distribution by sectoral group (technology/knowledge intensity) [N = 1796]

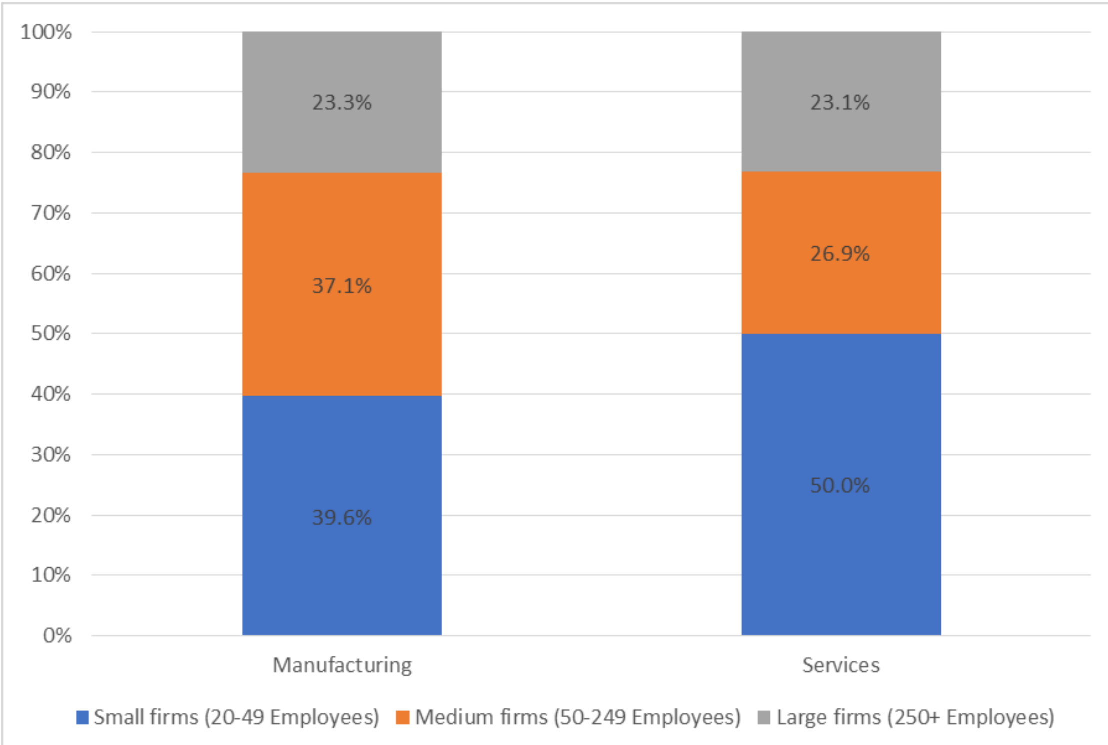


The distribution of firms by sector and size category indicates that half of service firms are small but the share of small firms in manufacturing is lower (40%) and this differentiation is statistically significant (Pearson Chi-square, sig. < 0.001). On the other hand, the share of medium-sized firms is higher in manufacturing (37.1%) than in services (26.9%), while large firms represent similar percentage in both sectors (23.3% and 23.1%) [**Figure 2.3**]. The corresponding figure for Turnover is included in **Appendix 2A** and shows the same pattern, i.e., firms in manufacturing are somewhat larger than firms in services (**Figure 2A.1**, Pearson Chi-square, sig. < 0.001).

Regarding the technology/knowledge intensity of sectors, **Figure 2A.2 in Appendix 2A** illustrates that the distribution of all sector categories in manufacturing follows (more or less) the same pattern[20]. On the other hand, KIS are characterized by quite higher percentage of small firms (54%) and less KIS by quite higher percentage of large firms (38%) compared to the other categories[21].

[20] Pearson Chi-square coeff. (sig. > 0.05) for each pair of these three categories.
[21] Pearson Chi-square coeff. (sig. < 0.05) regarding the comparison between knowledge-intensive services and the other categories as well as the comparison between less knowledge-intensive services and the other categories.

Figure 2.3 Sample distribution by firm size (number of employees) and sectoral group (manufacturing vs. services) [N = 1796]



As regards sectors' technology/knowledge intensity by country, the share of H&MHT manufacturing firms is quite lower in Slovenia (24.7%) and even lower in Greece (18.1%) whereas Denmark exhibits the highest percentage (35.8%). In addition, Slovenia and Finland have a higher share of MLT manufacturing firms compared to the sample average. Furthermore, the share of LT manufacturing firms in Greece (30.7%) is up to two times higher compared to the remaining sample countries reflecting the structure of the Greek economy in terms of sectors. In services, the vast majority of firms in Denmark, Finland, Germany and the UK belong to KIS, whereas in France, Greece and Slovenia the distribution is more balanced between knowledge-intensive and less knowledge-intensive services (**Table 2.1**).

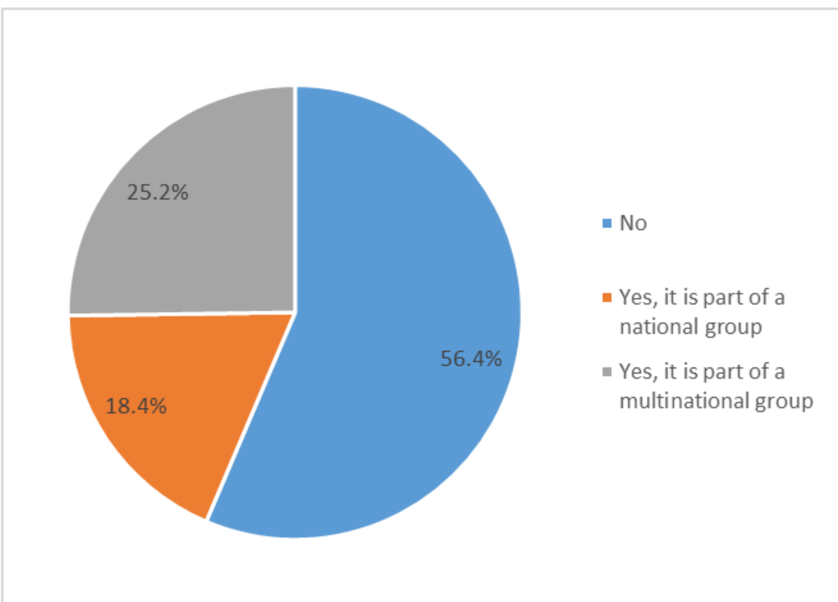
Table 2.1 Sample distribution by country and sectoral group (technology/knowledge intensity) [N = 1796]

	High & Medium-high-technology	Medium-low-technology	Low-technology	Knowledge-intensive services	Less knowledge-intensive services	TOTAL
Denmark	35.8%	12.6%	11.6%	37.7%	2.3%	100%
Finland	30.7%	18.6%	10.2%	34.4%	6.0%	100%
France	31.2%	11.8%	16.9%	19.1%	21.0%	100%
Germany	33.9%	13.2%	12.9%	36.5%	3.5%	100%
Greece	18.1%	10.7%	30.7%	18.6%	21.9%	100%
Slovenia	24.7%	20.9%	15.8%	24.7%	14.0%	100%
UK	34.3%	9.6%	16.0%	37.8%	2.2%	100%

2.3 Part of an enterprise group

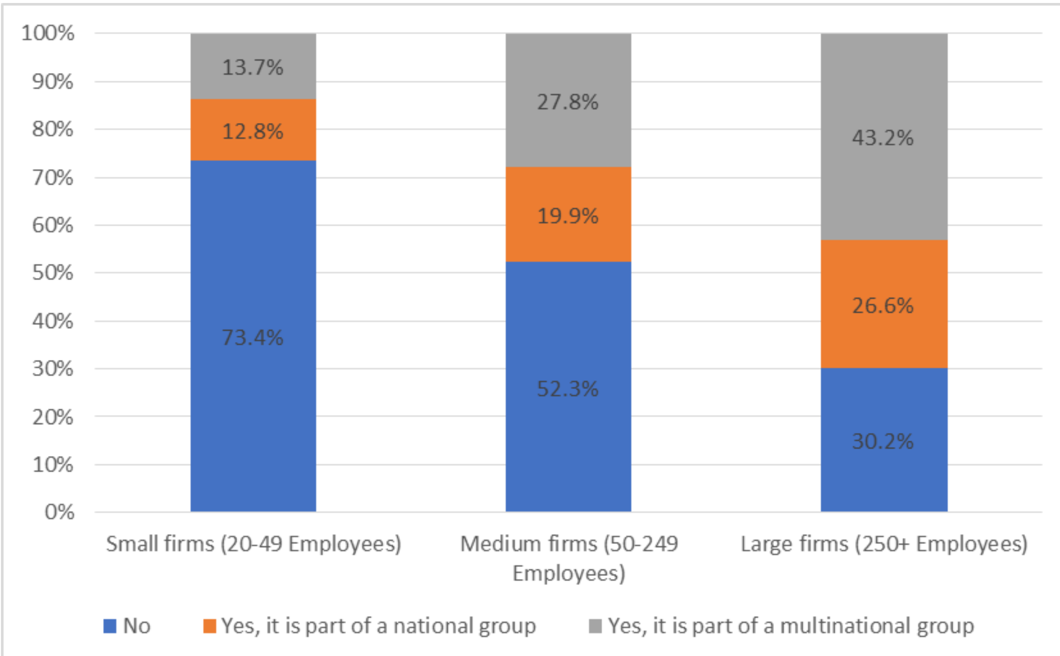
Figure 2.4 indicates that more than half of the sample firms (56.4%) do not belong to a business group. Only 1 out of 4 firms belong to a multinational group and approximately 1 out of 5 firms are part of a national group.

Figure 2.4 Sample distribution by enterprise group [N = 1796]



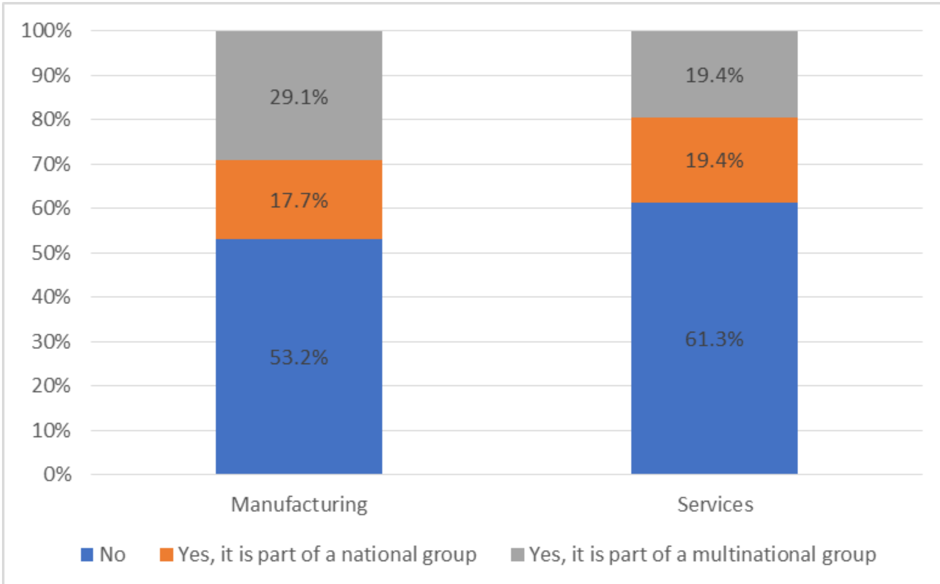
Being part of an enterprise group appears to be largely dependent on firm size (Pearson Chi-square, sig. < 0.001[22]). In particular, among large firms, 7 out of 10 enterprises belong to a business group and most of them to a multinational group. In addition, almost half of medium-sized firms are part of a group (47.7%), the majority of which are multinational groups as well. On the contrary, almost 3 out of 4 small firms are not part of a business group (**Figure 2.5**).

Figure 2.5 Sample distribution by enterprise group and firm size [N = 1796]



[22] Both for the chi-square test across firm size categories and for the chi-square tests for each pair of these three categories.

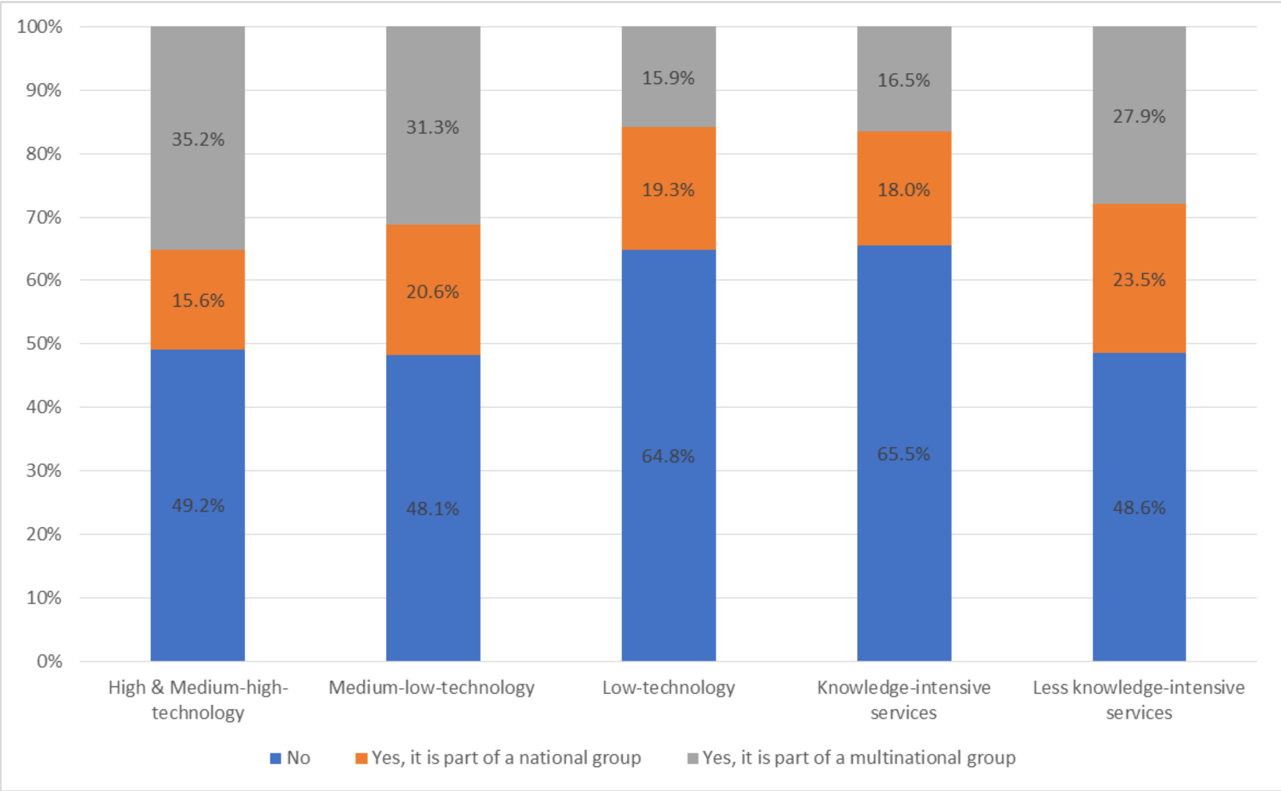
Figure 2.6 Sample distribution by enterprise group and sector (manufacturing vs. services) [N = 1796]



In addition, **Figure 2.6** indicates that manufacturing firms tend to belong more in business groups compared to service firms (Pearson Chi-square, sig. < 0.001). Furthermore, within manufacturing and service sectors we observe differentiations between sectors with different technology/knowledge intensity (Pearson Chi-square, sig. < 0.001). Regarding manufacturing, over 50% of firms in H&MHT and MLT sectors (50.8% and 51.9% respectively) are part of a business group, whereas the relevant share in LT firms is much lower (35.2%)[23] [**Figure 2.7**]. This could be attributed to the fact that low-tech sectors include more traditional economic activities where the percentage of family firms may be higher. In services there is an opposite trend between knowledge-intensive and less knowledge-intensive sectors (Pearson Chi-square, sig. < 0.001) [**Figure 2.7**]. An explanation could be that KIS have a higher share of small and young firms, while at the same time the less KIS firms, which primarily operate in wholesale and retail sectors, are larger in size, and, thus, may exhibit a higher tendency to become part of a business group.

[23] The chi-square test relating to the comparison of LT firms with H&MHT and MLT firms respectively is statistically significant (sig. < 0.001).

Figure 2.7 Sample distribution by enterprise group and sector (technology/knowledge intensity) [N = 1796]



3. Enterprise spending on different types of intangible assets (Section B of the Questionnaire)

Section 3 provides descriptive empirical results relating to the second part of the questionnaire which deals with investments in six different types of intangible assets. Section 3.1 offers an overview of the enterprise spending on intangibles while the following sections focus on each type of enterprise spending separately.

3.1 An overview of intangibles assets spending

Figure 3.1 shows the percentage of firms that make expenditures in each category of intangible assets, whereas **Table 3.1** depict the intensity of this spending as percentage of turnover (i.e., the mean and median values of spending in the relevant category) both for in-house and purchased activities.

Figure 3.1 % of firms conducting intangible activity by asset type [N = 1792]

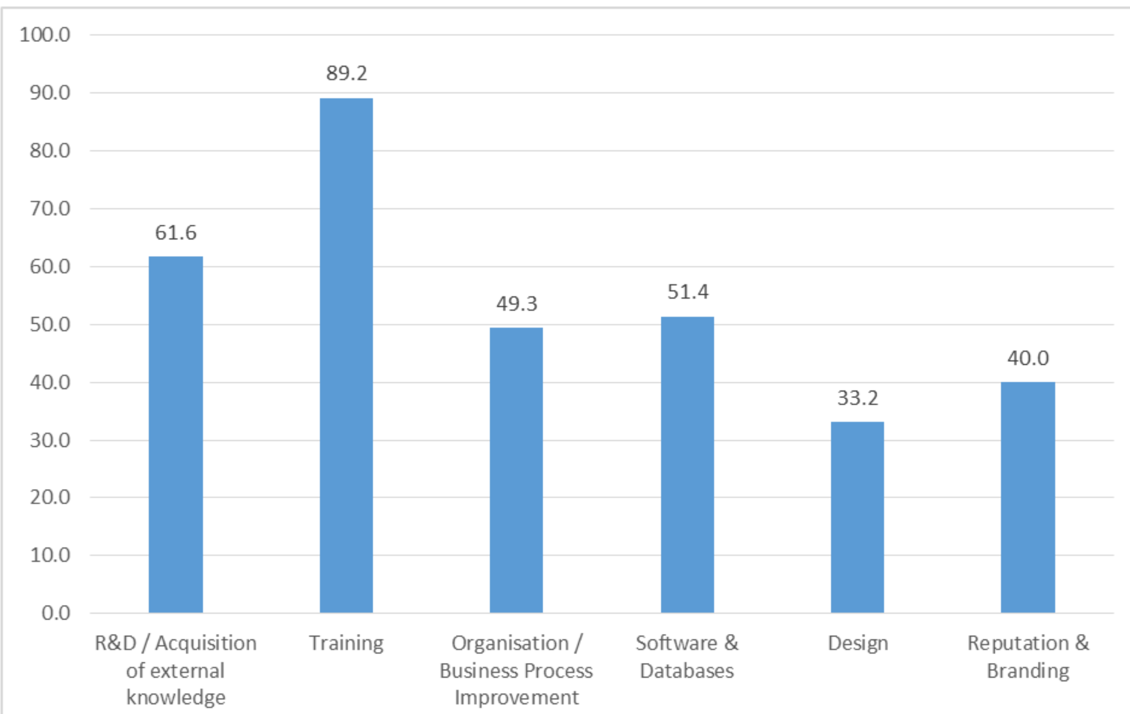


Figure 3.1 shows that the vast majority of firms report some training activity (9 out of 10). In addition, a large part of firms (over 61%) have R&D expenditures (and/or acquire external knowledge such as patents, process blueprints or non-patented inventions) as well. About half of the firms report expenditures in software/databases and in organization/business process (OBP) improvement activities. Lower is the percentage of firms with reputation and branding expenditures (40%), whereas design exhibits the lowest incidence (1 out of 3 firms). Only 65 firms (3.6%) have no intangible activity.

Table 3.1 illustrates the average spending (in-house and purchased) by asset category as a percentage of turnover conditional on reporting some spending. R&D exhibits by far the largest average expenditure level (both in terms of mean and median) followed by design and software and databases, while average spending on organization and business process improvement, reputation & branding and training are relatively smaller. Furthermore, it appears that in-house investment is an important component in all asset categories, and especially for R&D, design, and OBP improvement. Only for software and databases, external investment outweighs in-house spending.

Table 3.1 Average spending (in-house and purchased) by asset type

Type of Intangible Asset	In-house			Purchased		
	Number of Firms	Mean	Median	Number of Firms	Mean	Median
R&D[24]	894	6.61	3	386	1.92	1
Training	996	1.21	0.5	1255	1.06	0.5
Organisation / Business Process Improvement	706	1.53	0.5	749	1.15	0.4
Software & Databases	777	1.59	0.18	804	1.69	0.9
Design	499	3.22	0.5	518	1.42	0.3
Reputation & Branding	612	1.28	0.5	641	1.21	0.5

Taking all six types of spending together, **Figure 3.2** depicts the distribution of firms regarding their total investment as % of turnover[25]. The right-skewed distribution indicates a large share of firms with relatively low expenditures in intangible activities and the existence of a smaller share of firms with high expenditures intensity[26].

52.3% of firms spend less than or equal to 5% of their turnover in intangible assets with 21.8% of them spending just up to 1% of their turnover. 1 out of 4 firms (27.3%) spend between 5% and 15% of their turnover while only 20.4% of firms invest more than 15% of their turnover in intangible assets (**Table 3.2**).

[24] The mean and median values regarding the expenditures in acquisition of external knowledge as % of turnover are 1.84% and 0.5% respectively (N=288).
[25] We omitted from this calculation the firms that could not estimate their expenditures as % of turnover in at least one of the intangible asset categories, i.e., 445 firms. Therefore, the distribution refers to 1351 sample firms.
[26] The median is 4.6 whereas the mean is 10.73.

Figure 3.2 Total spending on intangible activities as % of turnover (N = 1351)

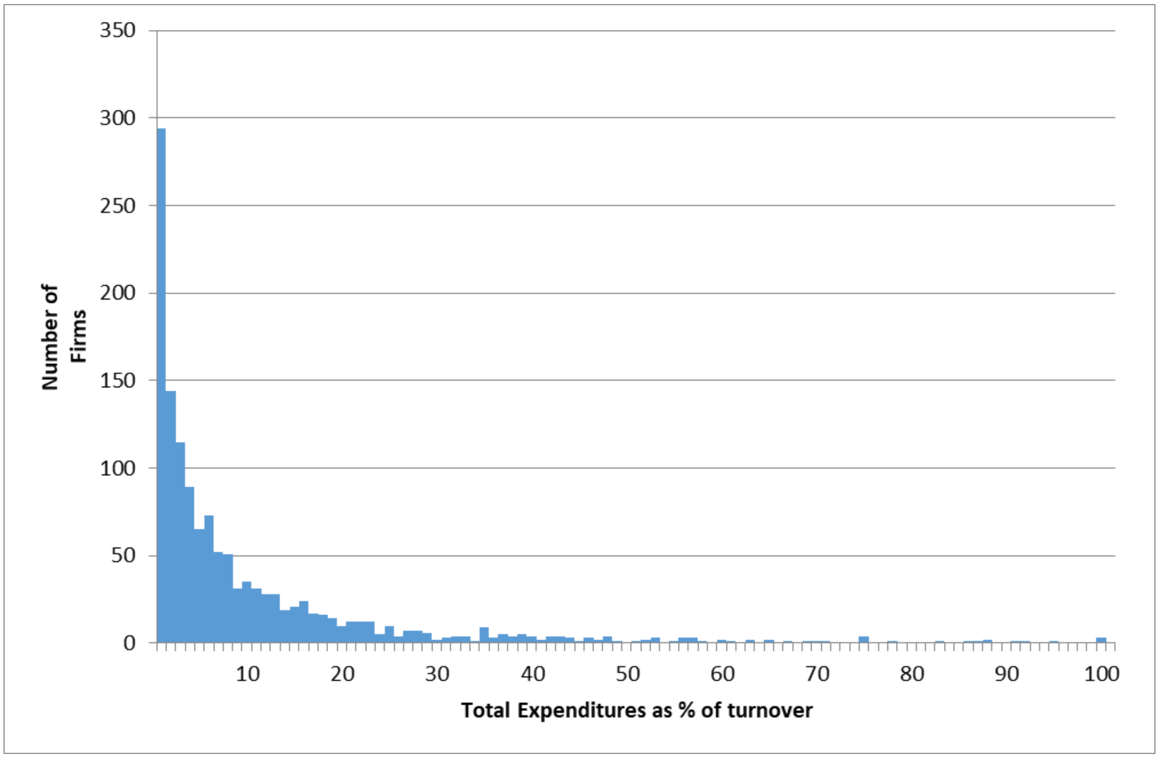
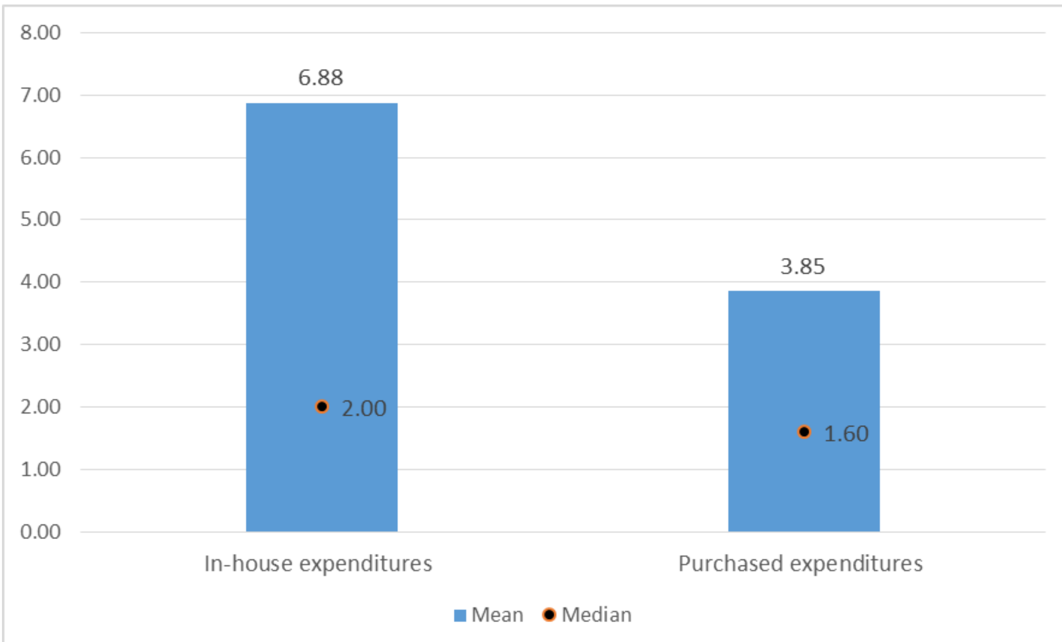


Table 3.2 Total spending on intangible activities as % of turnover (N = 1351)

Spending (as % of turnover)	% of Firms
0 < ≤ 1%	21.8
1 < ≤ 5%	30.5
5 < ≤ 15%	27.3
15 < ≤ 25%	9.8
25 < ≤ 50%	6.8
> 50%	3.8

Regarding the distribution of total expenditures between in-house and outsourced activities, **Figure 3.3** indicate that the former outweighs the latter[27].

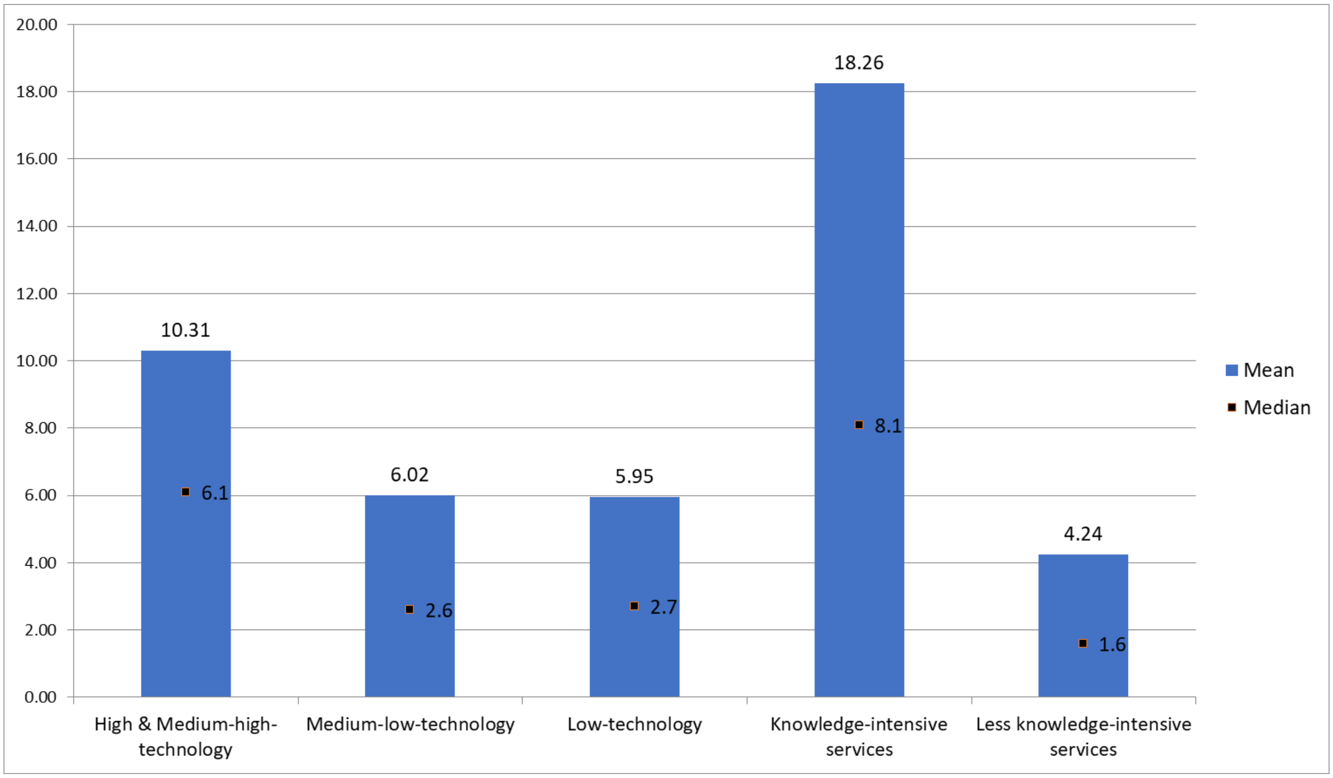
Figure 3.3 In-house and purchased expenditures as percentage of turnover (N = 1351)



In terms of sectors' technology/knowledge intensity, KIS exhibit by far the highest expenditures followed by H&MHT manufacturing. Firms in MLT and LT manufacturing demonstrate quite lower expenditures (these two sectors have similar mean and median values) whereas less KIS make the lowest investment in intangible assets. Therefore, sectors with high technology/knowledge intensity invest more in intangible activities (**Figure 3.4**)[28].

[27] The figure refers again to the 1351 sample firms which could estimate their expenditures in all types of intangible assets.
[28] ANOVA test (sig. < 0.001) and Eta squared = 0.093. The post-hoc analysis results are presented in Table 3A.1 in Appendix 3A.

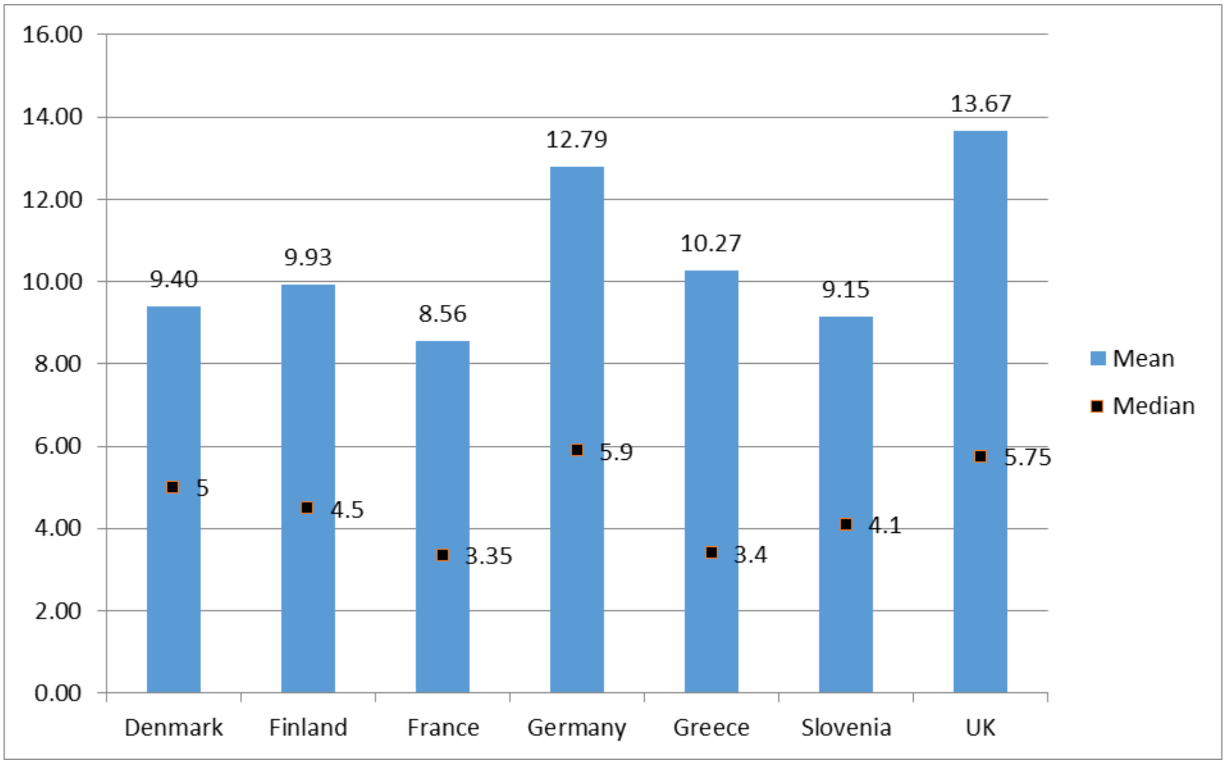
Figure 3.4 Total spending on intangible activities as % of turnover by sectoral group (technology/knowledge intensity) [N = 1351]



As regards total investment in intangibles per country, **Figure 3.5** illustrates that large countries except for France seem to make higher expenditures. The low mean and median values for France can be partly attributed to the characteristics of the sample of French firms and specifically the relatively high representation of less KIS (**Table 2.1**). Among small countries, Denmark and Finland display the highest investments as indicated by the relative mean values[29].

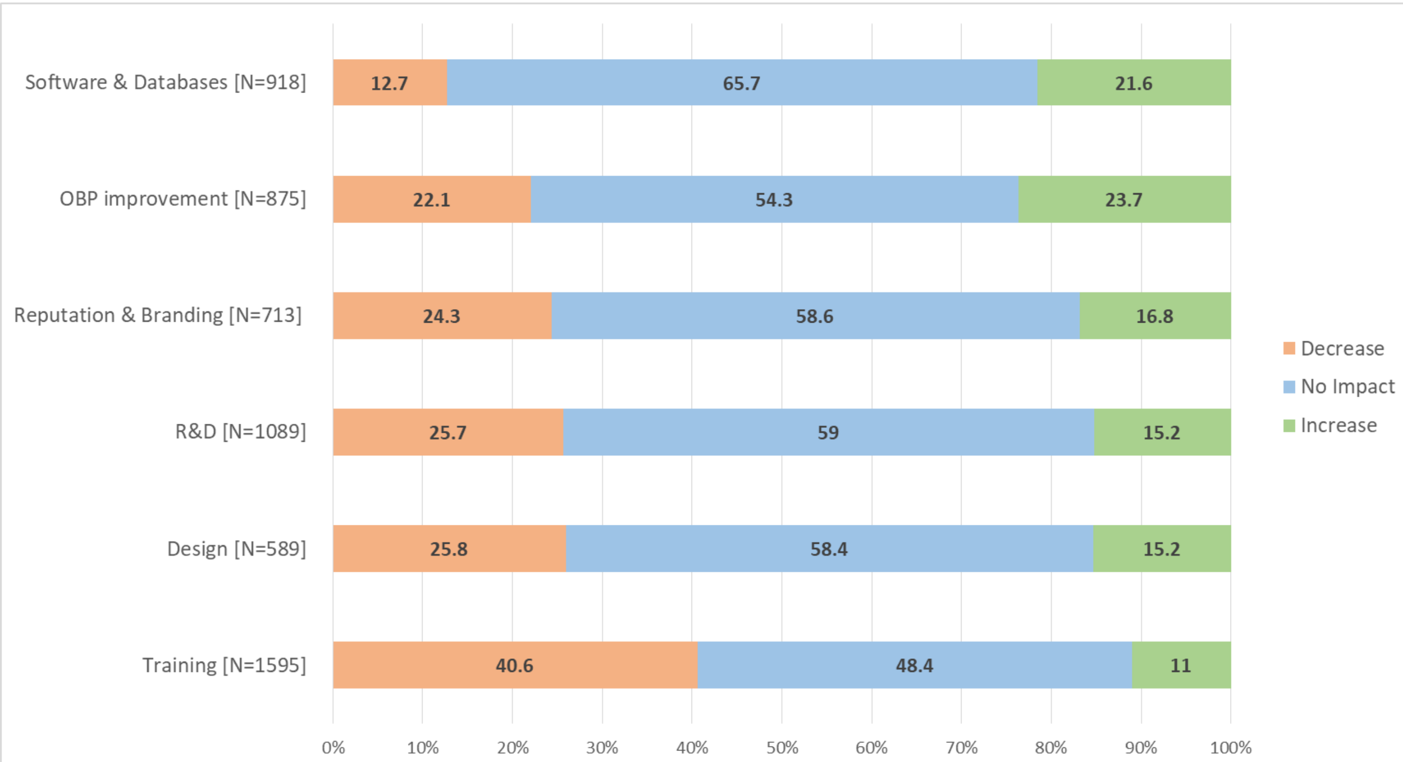
[29] ANOVA test (sig. < 0.05) and Eta squared = 0.012. The post-hoc analysis results are presented in Table 3A.2 in Appendix 3A.

Figure 3.5 Total spending on intangible activities as % of turnover by country (N = 1351)



The firms that make investments (even very limited) in each type of intangible assets (IAs) were asked whether and to what extent Covid-19 crisis had impact on the level of these investments. **Figure 3.6** illustrates that most firms reported "no impact" on their intangible assets spending in 2020 related to 2019 across different IAs. However, training is by far the most negatively affected category by Covid-19 (40.6% of firms answered that their spending would decrease in 2020) followed by design and R&D. On the other hand, software and databases is the less negatively affected activity (12.7% of firms answered that their spending would decrease) followed by organization/business process (OBP) improvement. Moreover, for these two IAs types, the share of firms that reported "increase" of expenditures was higher than those that reported "decrease", and this positive difference is much higher for software and databases.

Figure 3.6 Covid-19 impact on intangible assets spending by asset type (2020)



In addition, for each category of IAs, the firms that reported a positive or negative impact were asked to assess the precise degree of this impact. A clear conclusion resulting from the provided data is that the level of spending decrease is quite higher than the level of increase for all IAs (**Table 3.3**).

Table 3.3 Degree of Covid-19 impact on intangible assets spending (2020)

	Covid-19 impact on spending (2020)	Number of Firms	% of Firms	Number of Firms	Percentage Change (Mean)	Percentage Change (Median)
R&D	Decrease	280	25.7	263	-34.8%	-30%
	No Impact	643	59			
	Increase	166	15.2	161	35.8%	15%
Training	Decrease	648	40.6	609	-46.7%	-50%
	No Impact	772	48.4			
	Increase	175	11	162	29.8%	10%
Organization / Business Process Improvement	Decrease	193	22.1	177	-43.4%	-50%
	No Impact	475	54.3			
	Increase	207	23.7	188	39.5%	15%
Software & Databases	Decrease	117	12.7	114	-46.5%	-50%
	No Impact	603	65.7			
	Increase	198	21.6	185	29.6%	10%
Design	Decrease	153	26	143	-42.3%	-40%
	No Impact	346	58.7			
	Increase	90	15.3	85	36.5%	20%
Reputation & Branding	Decrease	174	24.4	165	-40.7%	-40%
	No Impact	419	58.8			
	Increase	120	16.8	108	26%	10%

3.2 Enterprise spending on R&D and acquisition of external knowledge

Figure 3.7 shows that most firms (55.3%) have in-house R&D activity, while much lower is the share of firms that invest in R&D carried out by external providers (24.7%) or in the acquisition of external knowledge e.g., patents, process blueprints (18.2%). In addition, 21.7% of enterprises spend both on in-house R&D and R&D outsourced to external partners and 8.1% of firms report expenditures in all three categories (i.e., internal and external R&D, and external knowledge acquisition). On the other hand, almost 4 out of 10 firms (38.4%) have no R&D activity.

Firm size matters for R&D spending. In particular, the percentage of medium-sized and large firms that conduct in-house R&D is much higher than small firms (Pearson Chi-square, sig. < 0.001). In addition, the incidence of expenditures in the other two types of intangibles depends also on firm size. For external R&D, the larger the firm the higher is the possibility that has some spending, and the differentiation is statistically significant between all three categories (Pearson Chi-square, sig. < 0.01). The same applies to external knowledge acquisition although the difference between small and medium-sized firms is not statistically significant (Pearson Chi-square, sig. > 0.05) [**Figure 3.8**].

Figure 3.7 % of firms conducting R&D activity (N = 1788)

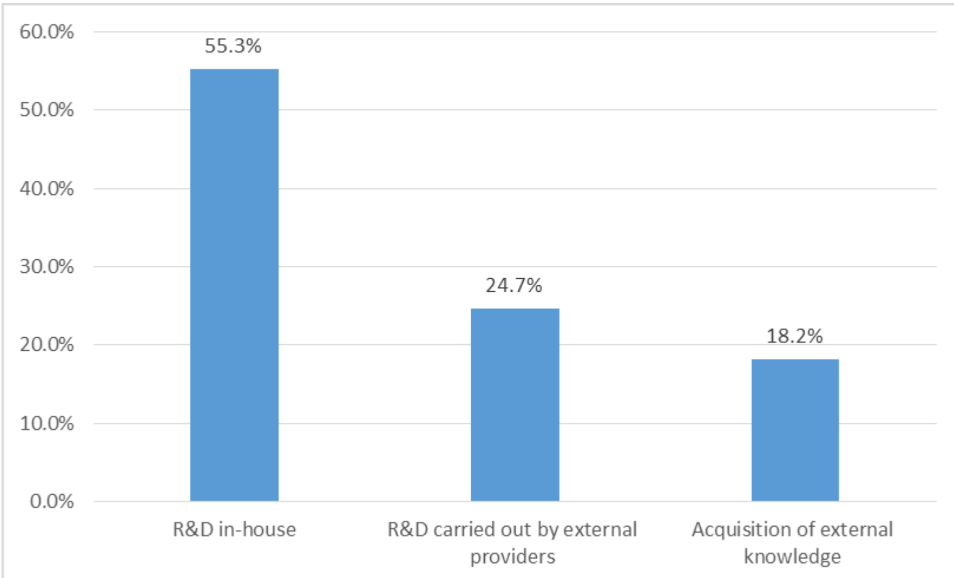
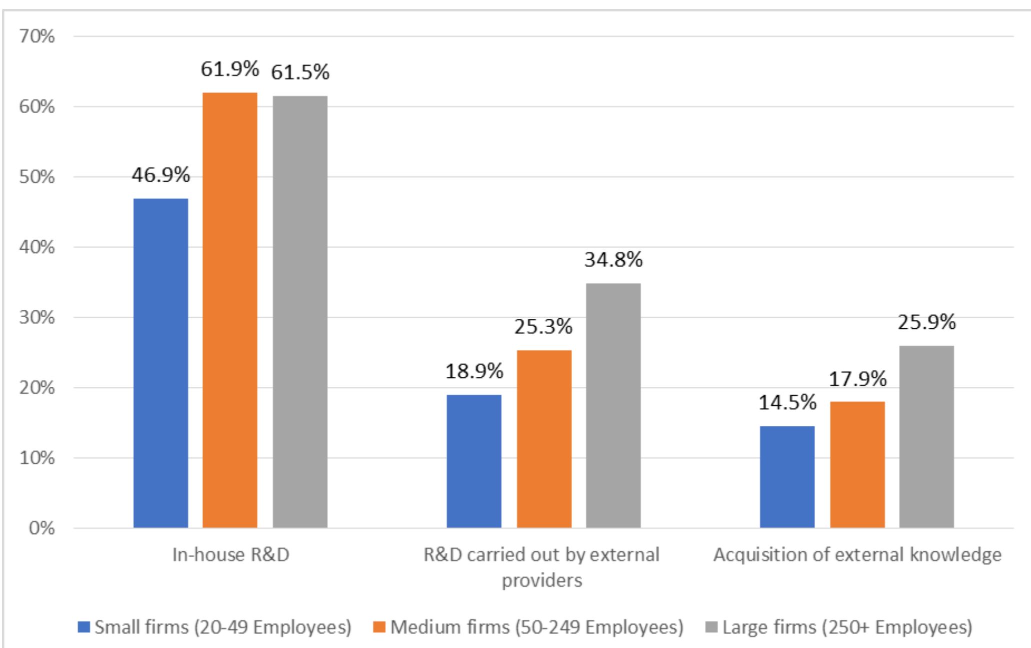
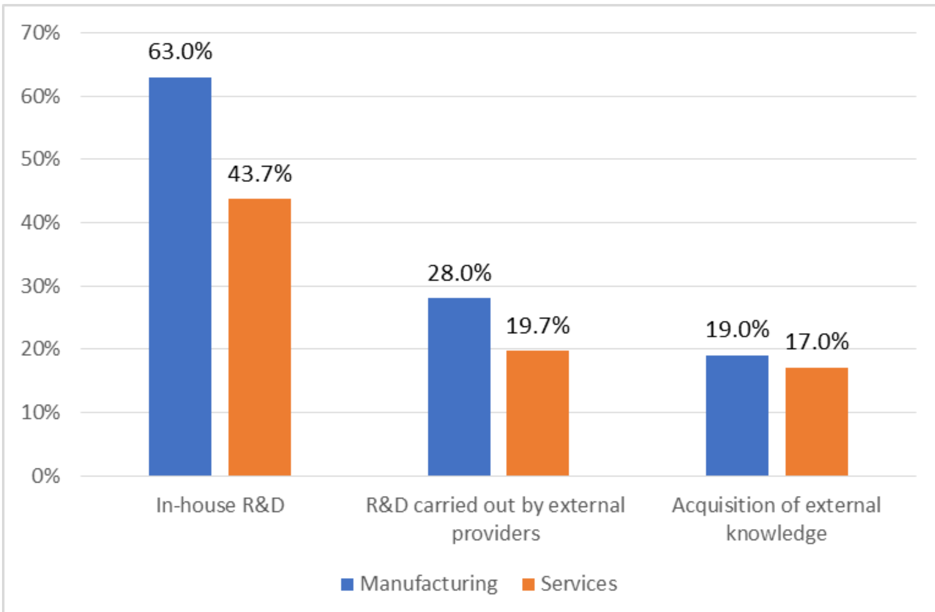


Figure 3.8 % of firms conducting R&D activity by size (N = 1788)



As regards sectors, much more firms in manufacturing are involved in R&D activity than firms in services for both in-house and outsourced R&D (Pearson Chi-square, sig. < 0.001). On the other hand, there is no statistically significant difference between manufacturing and service firms regarding the acquisition of external knowledge (Pearson Chi-square, sig. > 0.05) [**Figure 3.9**].

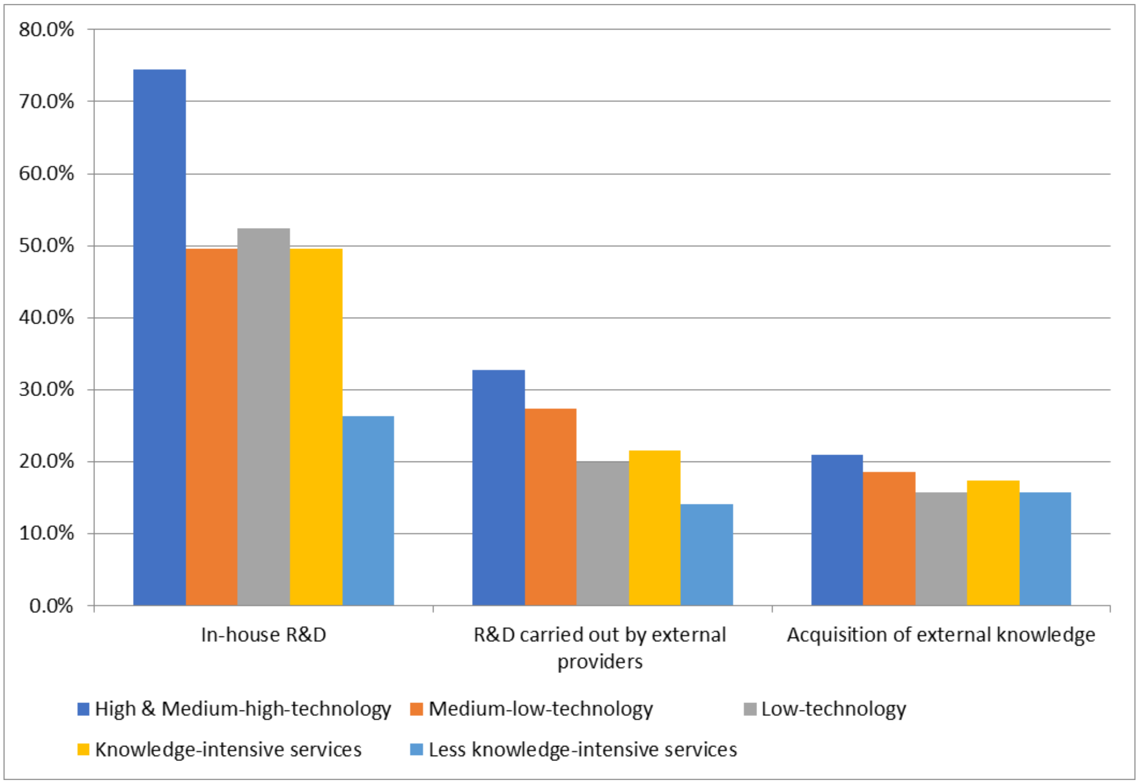
Figure 3.9 % of firms conducting R&D activity by sectoral group (manufacturing vs. services) [N = 1788]



In terms of sectors' technology/knowledge intensity, **Figure 3.10** shows that about half of MLT and LT manufacturing firms as well as firms from KIS conduct in-house R&D. Much higher is the corresponding share of H&MHT firms (3 out of 4 firms) whereas much lower is the share of firms from less KIS (1 out of 4 firms) [Pearson Chi-square, sig. < 0.001]. Regarding R&D carried out by external providers, the picture is similar regarding the ranking of sector categories[30]. However, the percentages of H&MHT and MLT firms are closer (Pearson Chi-square, sig. > 0.05)[31] and furthermore less KIS differ at a lower degree from LT manufacturing and KIS compared to the corresponding differentiation regarding in-house R&D[32]. On the contrary, there is no statistically significant difference between sectoral groups as regards the acquisition of external knowledge (Pearson Chi-square, sig. > 0.05)[33].

[30] Pearson Chi-square coeff. (sig. < 0.001).
[31] Refers to the chi-square test that compares these two categories.
[32] In particular, the differentiation between less KIS and KIS is statistically significant (Pearson Chi-square, sig. < 0.05), whereas the differentiation between less KIS and low-tech manufacturing is not (Pearson Chi-square, sig. > 0.05).
[33] Both for the chi-square test across categories and for chi-square tests for each pair of these five categories.

Figure 3.10 % of firms conducting R&D activity by sectoral group (technology/knowledge intensity) [N = 1788]



Pertaining to expenditures intensity as % of turnover, we observe that in general they are inversely proportional to firm size. More specifically, small firms exhibit a much higher median value in internal R&D and a higher mean value in all three categories (the higher difference is observed in external knowledge acquisition). On the other hand, large firms present the lowest mean in all types of expenditures although in external knowledge acquisition the relevant value is almost equal to the mean of medium-sized firms (**Table 3.4**).

Table 3.4 R&D spending (in-house and purchased) as % of turnover by firm size

	Size Category	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
In-House R&D	Small firms (20-49 Employees)	332	7.81	5.00	0.015	0.009
	Medium firms (50-249 Employees)	335	6.66	2.00		
	Large firms (250+ Employees)	227	4.76	2.00		
R&D carried out by external providers	Small firms (20-49 Employees)	127	2.47	1.00	0.034	0.018
	Medium firms (50-249 Employees)	134	2.15	1.00		
	Large firms (250+ Employees)	125	1.12	0.50		
Acquisition of external knowledge	Small firms (20-49 Employees)	101	3.14	1.00	0.003	0.039
	Medium firms (50-249 Employees)	96	1.15	0.50		
	Large firms (250+ Employees)	91	1.13	0.40		

Table 3.5 R&D spending (in-house and purchased) as % of turnover by sectoral group (manufacturing vs. services)

	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	T-test Sig.	Eta squared
In-House R&D	Manufacturing	614	4.45	2.00	0.000	0.038
	Services	280	11.33	5.00		
R&D carried out by external providers	Manufacturing	264	1.51	1.00	0.040	0.011
	Services	122	2.83	1.00		
Acquisition of external knowledge	Manufacturing	181	1.20	0.50	0.014	0.021
	Services	107	2.94	1.00		

Furthermore, there is a statistically significant difference between manufacturing and services in all three types of spending, especially for in-house R&D and the acquisition of external knowledge **Table 3.5**). This can be attributed to the fact that some sectors that belong to knowledge-intensive services (e.g., 62. Computer programming, consultancy and related activities, 72. Scientific research and development) demonstrate quite high values. This is also illustrated in **Table 3.6** where we observe that knowledge-intensive service firms exhibit significantly higher mean values than all the other sector categories. However, the differentiation of KIS is smaller in terms of median values. In general, **Table 3.6** shows that sectors with high technology/knowledge intensity both in manufacturing and services make higher investments in R&D.

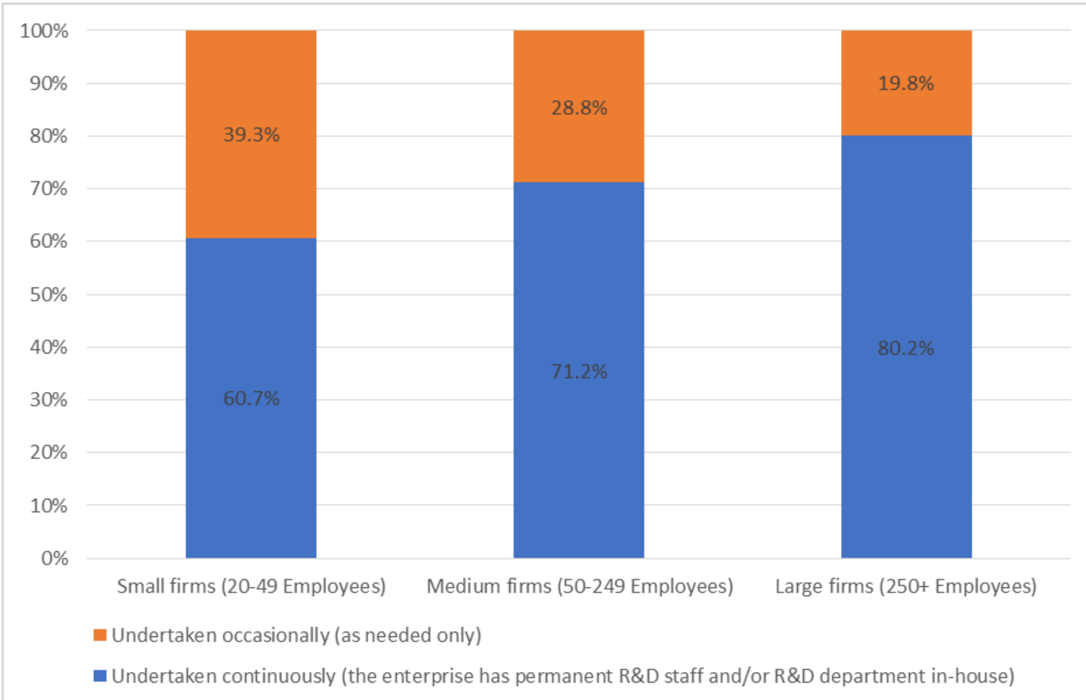
Table 3.6 R&D spending (in-house and purchased) as % of turnover by sectoral group (technology/knowledge intensity)

	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
In-House R&D	High & Medium-high-technology	363	5.87	4.00	0.000	0.116
	Medium-low-technology	114	2.38	1.00		
	Low-technology	137	2.41	1.00		
	Knowledge-intensive services	235	13.14	5.00		
	Less knowledge-intensive services	45	1.91	0.50		
R&D carried out by external providers	High & Medium-high-technology	152	1.68	1.00	0.002	0.044
	Medium-low-technology	62	1.10	0.50		
	Low-technology	50	1.50	0.50		
	Knowledge-intensive services	97	3.40	1.00		
	Less knowledge-intensive services	25	0.61	0.30		
Acquisition external knowledge	High & Medium-high-technology	100	1.23	0.50	0.002	0.058
	Medium-low-technology	39	1.23	1.00		
	Low-technology	42	1.08	0.40		
	Knowledge-intensive services	80	3.69	1.00		
	Less knowledge-intensive services	27	0.70	0.30		

Those firms that have in-house R&D activity were asked whether they perform in-house R&D continuously (i.e., they have permanent R&D staff and/or R&D department) or occasionally (as needed only). 7 out of 10 firms responded that perform this activity continuously. The responses depend on firm size, namely, larger firms exhibit higher incidence of continuous and systematic R&D activity. In particular, approximately 8 out of 10 large firms, 7 out of 10 medium-sized firms and 6 out of 10 small firms conduct internal R&D on a systematic basis (**Figure 3.11**)[34].

[34] Pearson Chi-square coeff. (sig. < 0.001) for the chi-square test across categories and for small and large firms. Pearson Chi-square coeff. (sig. < 0.05) for the comparison between medium firms and the other two categories.

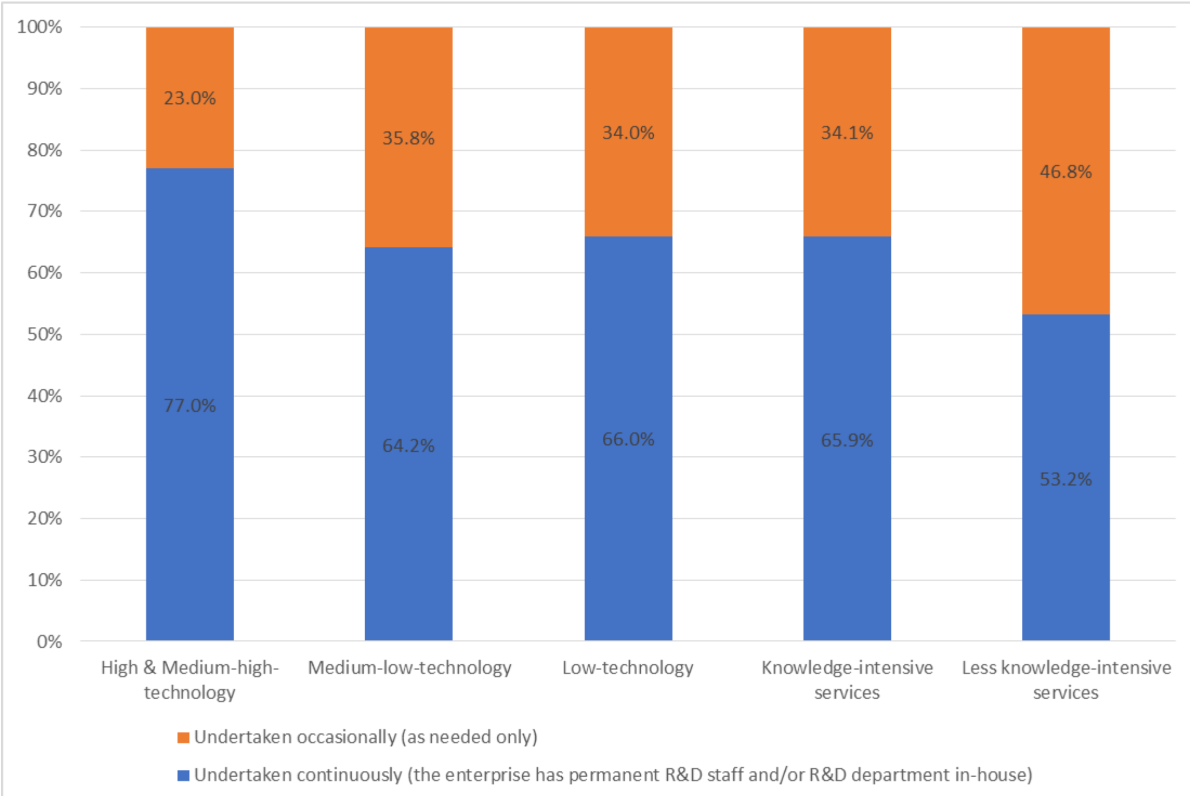
Figure 3.11 In-house R&D activity by firm size (N = 981)



In addition, a higher share of manufacturing firms conducts continuous R&D activity than service firms (72.2% and 64% respectively). This difference is statistically significant (Pearson Chi-square, sig. < 0.05) and is further elaborated in **Figure 3.12** that shows the relevant distribution of firms per sector category in terms of technology/knowledge intensity level. We observe that about 2 out of 3 firms in MLT and LT manufacturing, and knowledge-intensive services perform in-house R&D continuously. The relevant share of H&MHT firms is higher (77%) whereas the share of less KIS firms is lower (53.2%)[35].

[35] Pearson Chi-square coeff. (sig. < 0.001) for the chi-square test across categories. Pearson Chi-square coeff. (sig. < 0.05) for the comparison between H&MHT sectors and the other sector categories.

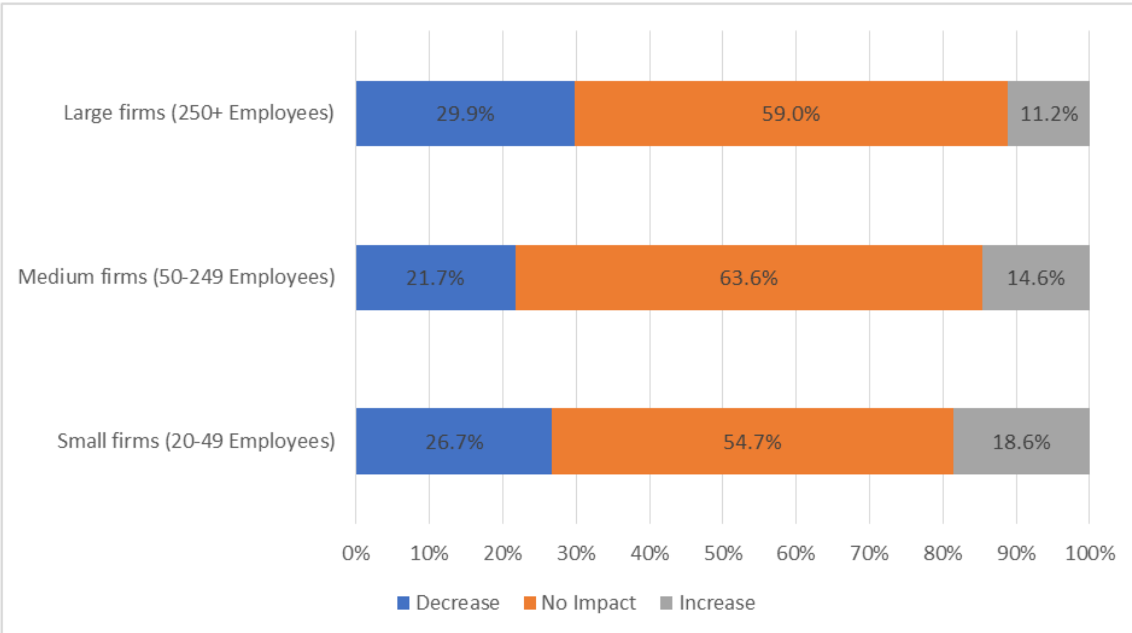
Figure 3.12 In-house R&D activity by sectoral group (technology/knowledge intensity) [N = 981]



Regarding the impact of Covid-19 crisis on R&D expenditures, the majority of firms in all size and sector categories reported "no impact". However, there is some statistically significant differentiation between small, medium-sized, and large firms (Pearson Chi-square, sig. < 0.05)[36]. Large firms seem to experience a larger impact of Covid-19 (i.e., a higher share of firms report "decrease" and a smaller share report "increase") on R&D spending compared to the other two size classes (**Figure 3.13**).

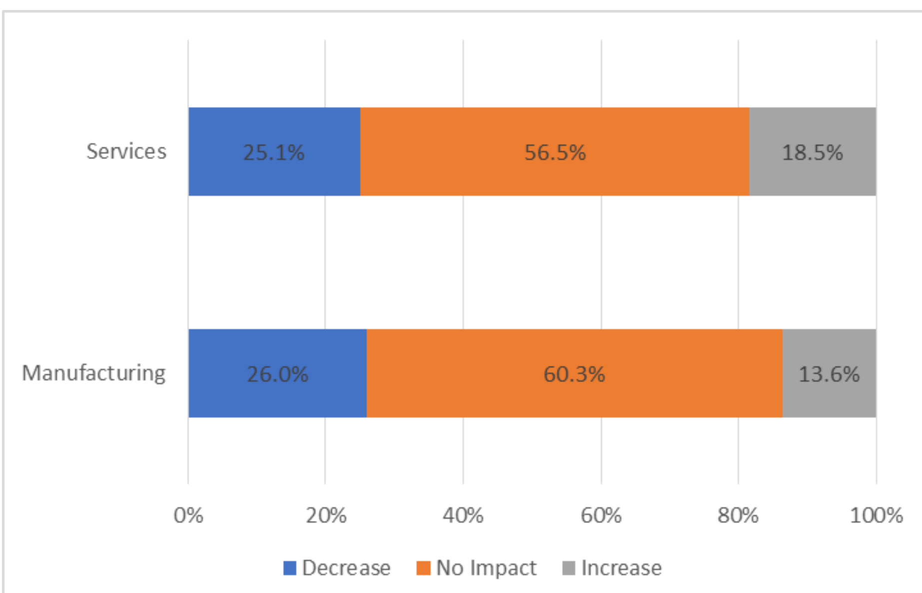
[36] Both for the chi-square test across categories and the chi-square tests for each pair of these three categories.

Figure 3.13 Impact of Covid-19 crisis on R&D spending by firm size (N = 1089)



In addition, a relatively higher share of service firms report expenditures increase compared to manufacturing firms (**Figure 3.14**). However, this difference is not statistically significant (Pearson Chi-square, sig. > 0.05).

Figure 3.14 Impact of Covid-19 crisis on R&D spending by sectoral group (manufacturing vs. services) [N = 1089]

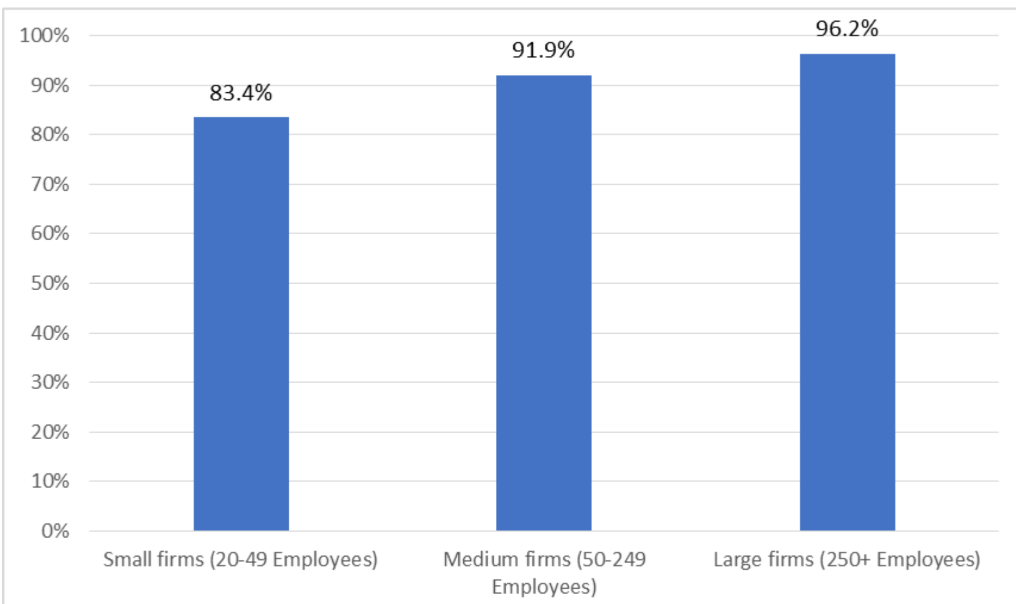


Finally, the picture is mixed regarding the dimension of sector technology/knowledge intensity and the total chi-square test does not show a statistically significant differentiation between sector categories (Pearson Chi-square, sig. > 0.05) [**Figure 3A.1** in **Appendix 3A**].

3.3 Enterprise spending on training

Figures 3.15 and **3.16** show that the vast majority of firms have training activity across size and sector categories. However, some differentiation exists, especially as regards firm size. 96.2% of large firms conduct training activity while the corresponding percentages for medium-sized and small firms are 91.9% and 83.4% respectively (Pearson Chi-square, sig. < 0.01)[37]. A smaller differentiation exists between sectors as 87.3% firms in manufacturing and 91.9% firms in services fund training activities (Pearson Chi-square, sig. < 0.01). Regarding sectors' technology/knowledge intensity, the highest share of firms with training activity is in knowledge-intensive services (92.9%) whereas the lowest in low-tech manufacturing (84.4%)[38].

Figure 3.15 % of firms conducting training activity by firm size (N = 1792)



[37] Both for the chi-square test across size categories and for the chi-square test for each pair of these three categories.
[38] Pearson Chi-square coeff. (sig. < 0.01)

Figure 3.16 % of firms conducting training activity by sectoral group (technology/knowledge intensity) [N = 1792]

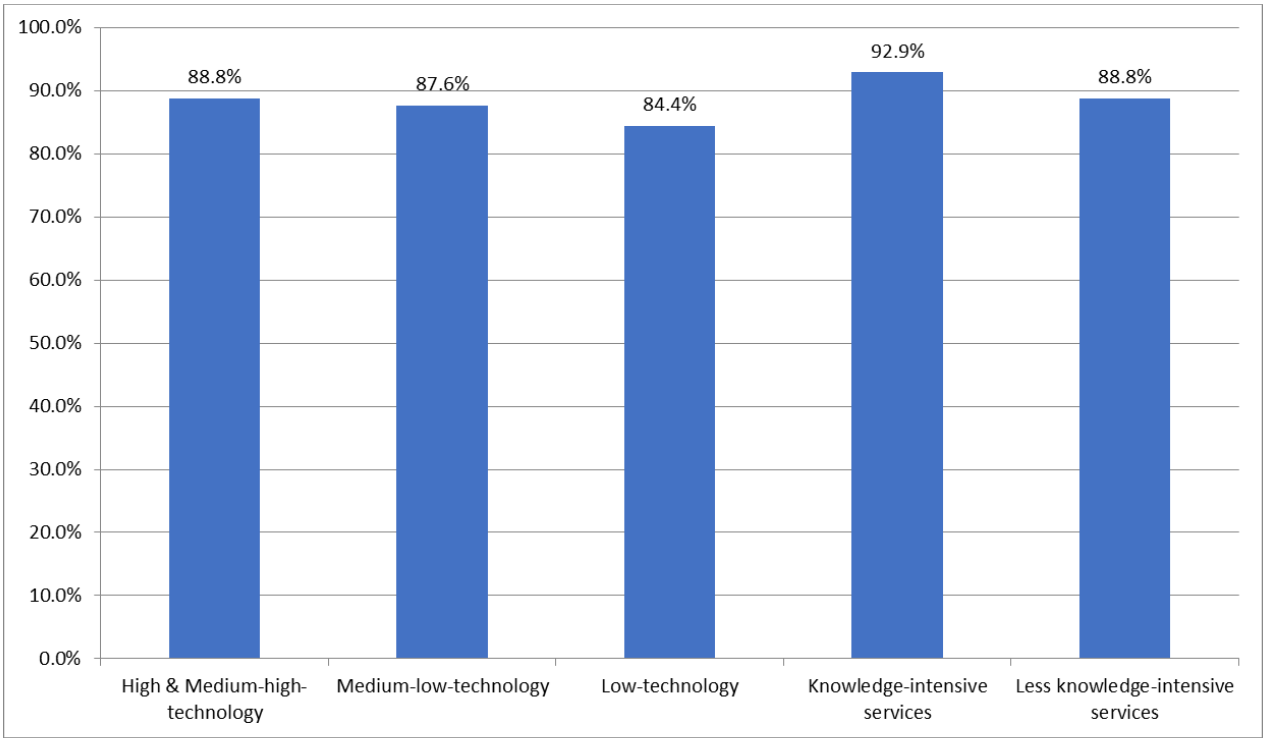


Table 3.7 Spending (in-house and purchased) on training activities by firm size

	Size Category	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
Training organized by external providers	Small firms (20-49 Employees)	501	1.25	0.50	0.037	0.005
	Medium firms (50-249 Employees)	444	1.06	0.50		
	Large firms (250+ Employees)	310	0.77	0.30		
Training using internal resources	Small firms (20-49 Employees)	386	1.83	1.00	0.000	0.035
	Medium firms (50-249 Employees)	339	0.99	0.50		
	Large firms (250+ Employees)	271	0.60	0.20		

Regarding expenditures intensity as % of turnover, the trend is similar as in R&D regarding the differentiation between size categories, i.e., smaller firms are characterized by higher percentages, and this difference is higher for training activities conducted using internal resources (**Table 3.7**). In addition, firms in services make higher expenditures than firms in manufacturing, both for training using internal resources and for training provided by external providers (**Table 3.8**). This difference between manufacturing and services appears because KIS exhibit by far the highest spending values. On the other hand, less KIS exhibit the lowest spending across sector categories (**Table 3.9**).

Table 3.8 Spending (in-house and purchased) on training activities by sectoral group (manufacturing vs. services)

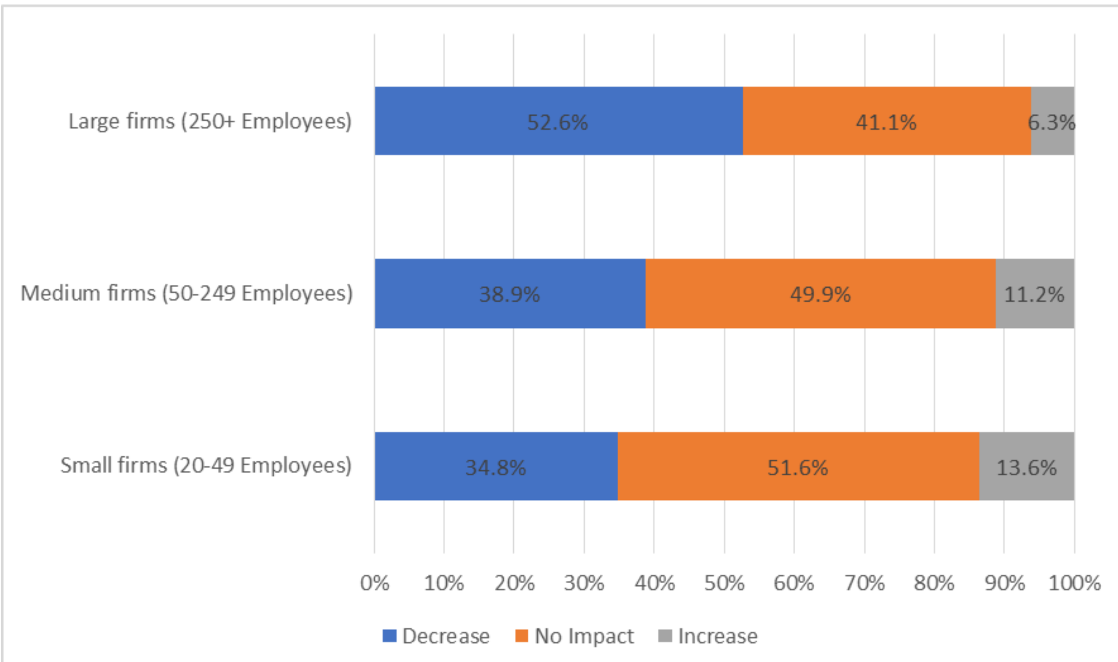
	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	T-test Sig.	Eta squared
Training organized by external providers	Manufacturing	736	0.88	0.50	0.006	0.006
	Services	519	1.32	0.50		
Training using internal resources	Manufacturing	572	0.92	0.40	0.000	0.013
	Services	424	1.60	0.50		

Table 3.9 Spending (in-house and purchased) on training activities by sectoral group (technology/knowledge intensity)

	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
Training organized by external providers	High & Medium-high-technology	384	0.94	0.50	0.000	0.018
	Medium-low-technology	177	0.82	0.50		
	Low-technology	175	0.82	0.20		
	Knowledge-intensive services	381	1.57	0.80		
	Less knowledge-intensive services	138	0.62	0.20		
Training using internal resources	High & Medium-high-technology	301	0.95	0.50	0.000	0.035
	Medium-low-technology	123	0.93	0.30		
	Low-technology	148	0.86	0.28		
	Knowledge-intensive services	324	1.93	0.95		
	Less knowledge-intensive services	100	0.52	0.20		

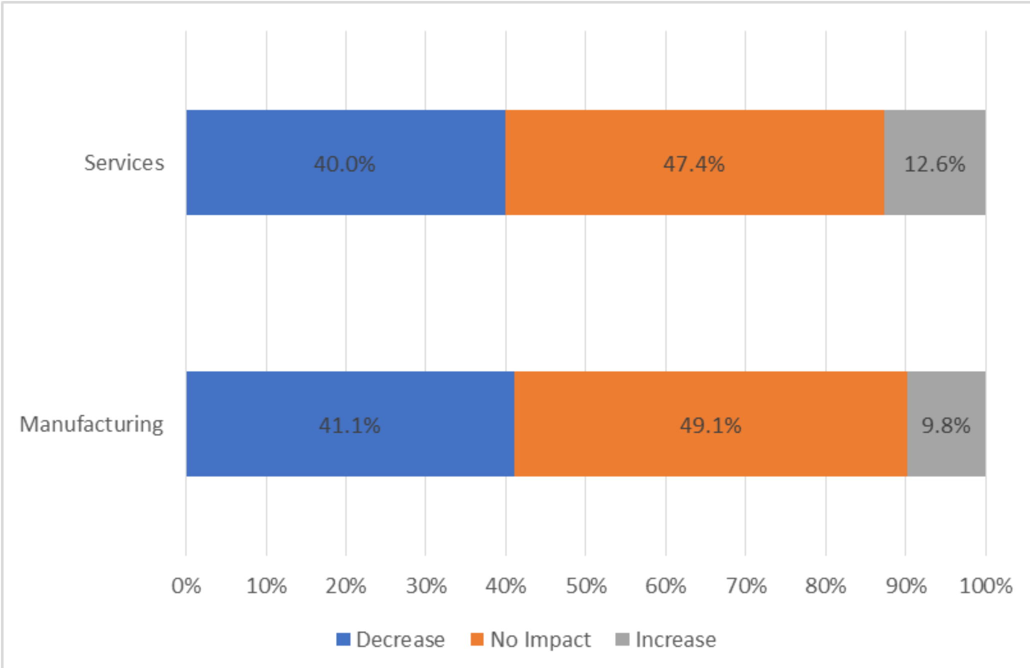
Pertaining to the impact of Covid-19 crisis, firms' size matters negatively as over half of large firms (52.6%) reported spending decrease and only 6.3% of firms reported spending increase. The corresponding percentages for the medium-sized firms are 38.9% and 11.2% whereas for the small firms are 34.8% and 13.6% respectively (**Figure 3.17**)[39]. On the contrary, there is no statistically significant differentiation between manufacturing and service firms (Pearson Chi-square, sig. > 0.05) [**Figure 3.18**]. Furthermore, less KIS include the highest share of firms reporting expenditures decrease (45.9%) whereas LT manufacturing firms the lowest (35.8%) [**Figure 3A.2** in **Appendix 3A**]. However, the differentiation between sector categories is not statistically significant (Pearson Chi-square, sig. > 0.05)[40].

Figure 3.17 Impact of Covid-19 crisis on training expenditure by firm size (N = 1595)



[39] Pearson Chi-square sig. coeff. (sig. < 0.001) for the chi-square test across categories and regarding the comparison between large firms and the other size categories. Pearson Chi-square coeff. (sig. > 0.05) for the comparison between small and medium firms.
[40] Both for the chi-square test across sector categories and the chi-square test for each pair of these five categories.

Figure 3.18 Impact of Covid-19 crisis on training expenditure by sectoral group (manufacturing vs. services) [N = 1595]



3.4 Enterprise spending on Organization / Business Process (OBP) improvement

Over half of the total sample firms (50.7%) do not have spending on Organization / Business Process (OBP) improvement activity. Size matters as only 4 out of 10 small firms spend on OBP improvement activities whereas the relevant percentages of medium-sized and large firms are 54% and 61.2% respectively (**Figure 3.19**)[41]. In addition, no differentiation exists between manufacturing and services as 48.9% of firms in manufacturing and 50% of firms in services fund OBP improvement activities (Pearson Chi-square, sig. > 0.05). No statistically significant differentiation exists in terms of sectors' technology/knowledge intensity as well (Pearson Chi-square, sig. > 0.05)[42]. However, the highest percentage is observed for KIS (51.3%) and the lowest percentage is observed for less KIS (46.1%) [**Figure 3.20**].

[41] Pearson Chi-square coeff. (sig. < 0.001), both for the chi-square test across categories and the comparison between small firms and the other size categories. Pearson Chi-square coeff. (sig. < 0.05) for the comparison between medium-sized and large firms.

[42] Both for the chi-square test across sector categories and the chi-square test for each pair of these five categories.

Figure 3.19 % of firms conducting organization/business process improvement activities by firm size (N = 1780)

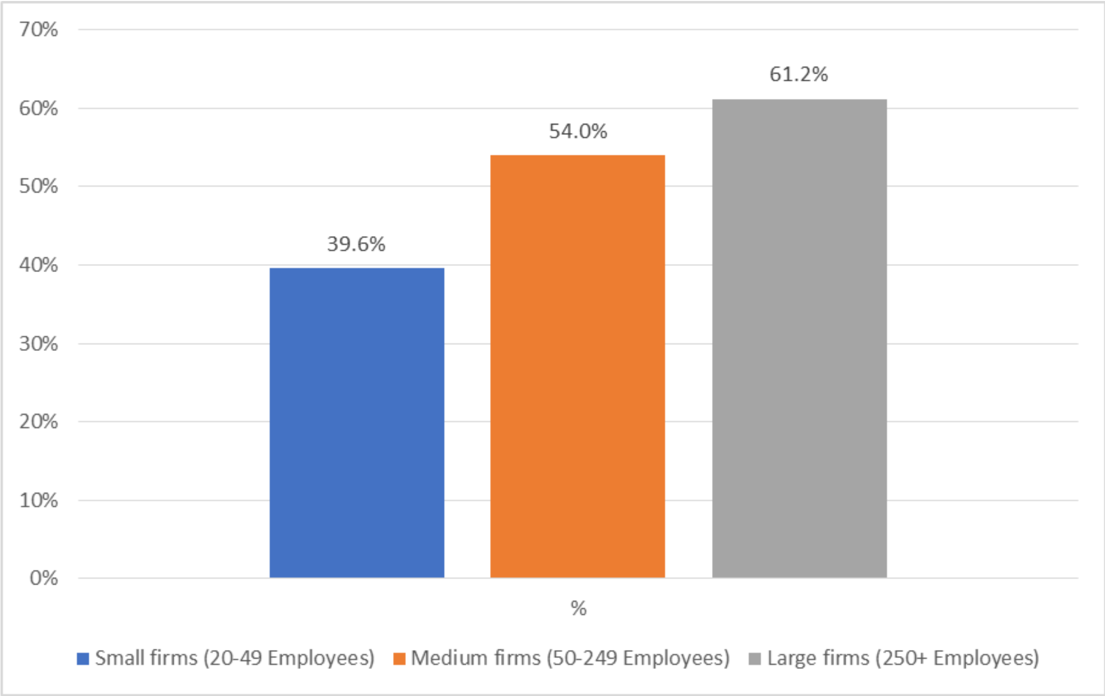
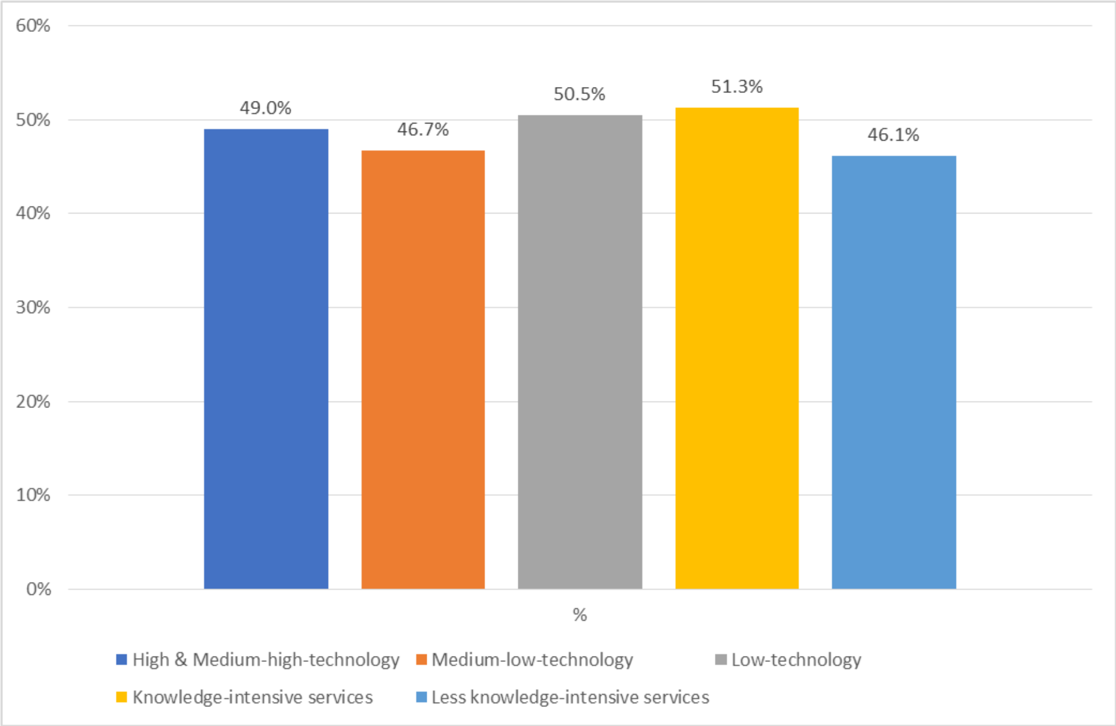


Figure 3.20 % of firms conducting organization/business process improvement activities by sectoral group (technology/knowledge intensity) [N = 1780]



Pertaining to expenditures intensity, for OBP improvement using internal resources, we observe the same trend of differentiation between size categories as in the R&D and training activities, i.e., the smaller the firm the higher the investment as % of turnover. On the contrary, there is no differentiation with regard to OBP improvement carried out by external providers (**Table 3.10**). Regarding sector categories, manufacturing firms spend more on the latter activities than service firms, whereas no differentiation is identified as regards OBP improvement using internal resources (**Table 3.11**).

Table 3.10 Spending (in-house and purchased) on organization/business process improvement activities by firm size

	Size Category	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
OBP improvement carried out by external providers	Small firms (20-49 Employees)	280	1.20	0.40	0.736	0.001
	Medium firms (50-249 Employees)	272	1.06	0.50		
	Large firms (250+ Employees)	197	1.21	0.40		
OBP improvement using internal resources	Small firms (20-49 Employees)	263	1.92	1.00	0.000	0.022
	Medium firms (50-249 Employees)	256	1.58	0.50		
	Large firms (250+ Employees)	187	0.92	0.30		

Table 3.11 Spending (in-house and purchased) on organization/business process improvement activities by sectoral group (manufacturing vs. services)

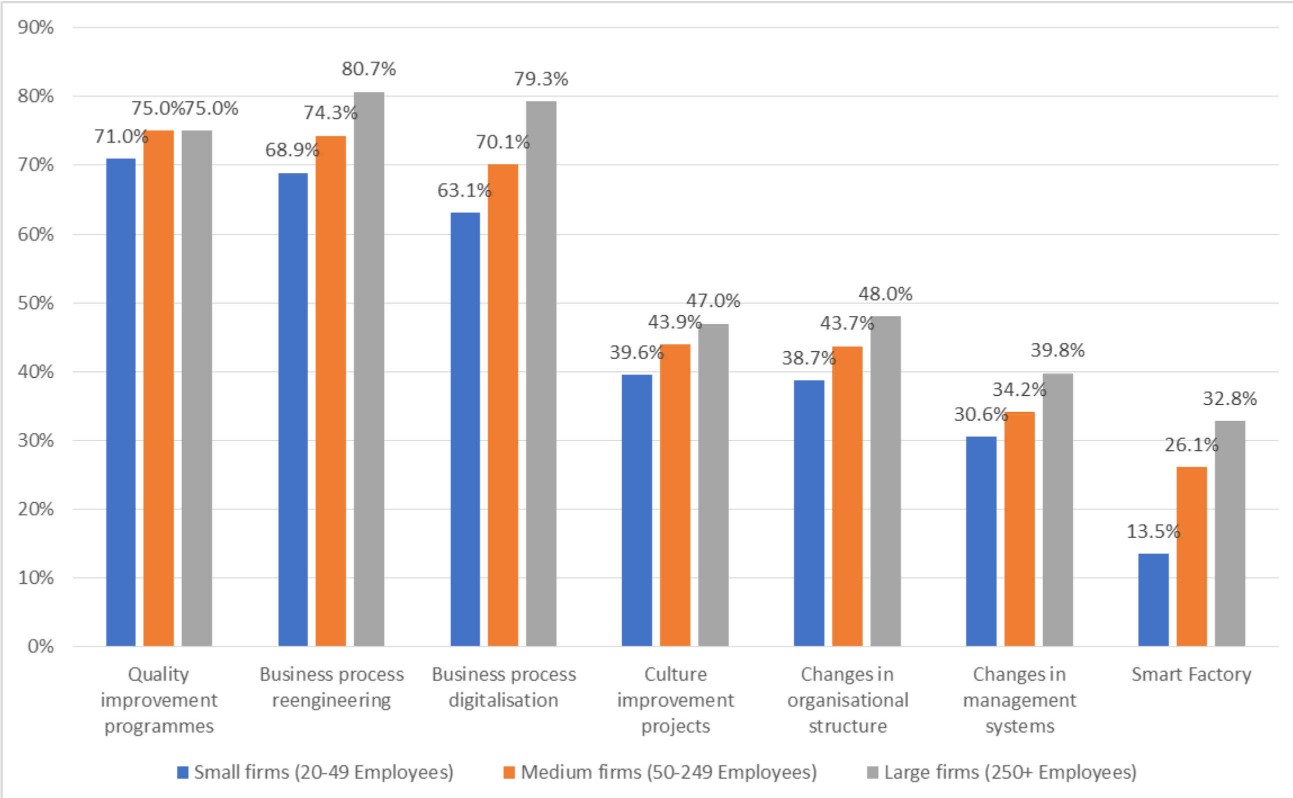
	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	T-test Sig.	Eta squared
OBP improvement carried out by external providers	Manufacturing	442	1.31	0.50	0.017	0.008
	Services	307	0.92	0.30		
OBP improvement using internal resources	Manufacturing	413	1.54	0.50	0.931	0.000
	Services	293	1.52	0.50		

Table 3.12 illustrates that all subsectors of manufacturing regardless of technology/knowledge intensity exhibit higher investment than services subsectors (i.e., KIS and less KIS) in OBP improvement activities carried out by external providers. On the other hand, when using internal resources, the technology/knowledge intensity of sectors matters as H&MHT manufacturing and KIS have the highest percentages in terms of median and mean respectively. Less KIS exhibit by far the lowest expenditures.

Table 3.12 Spending (in-house and purchased) on organization/business process improvement activities by sectoral group (technology/knowledge intensity)

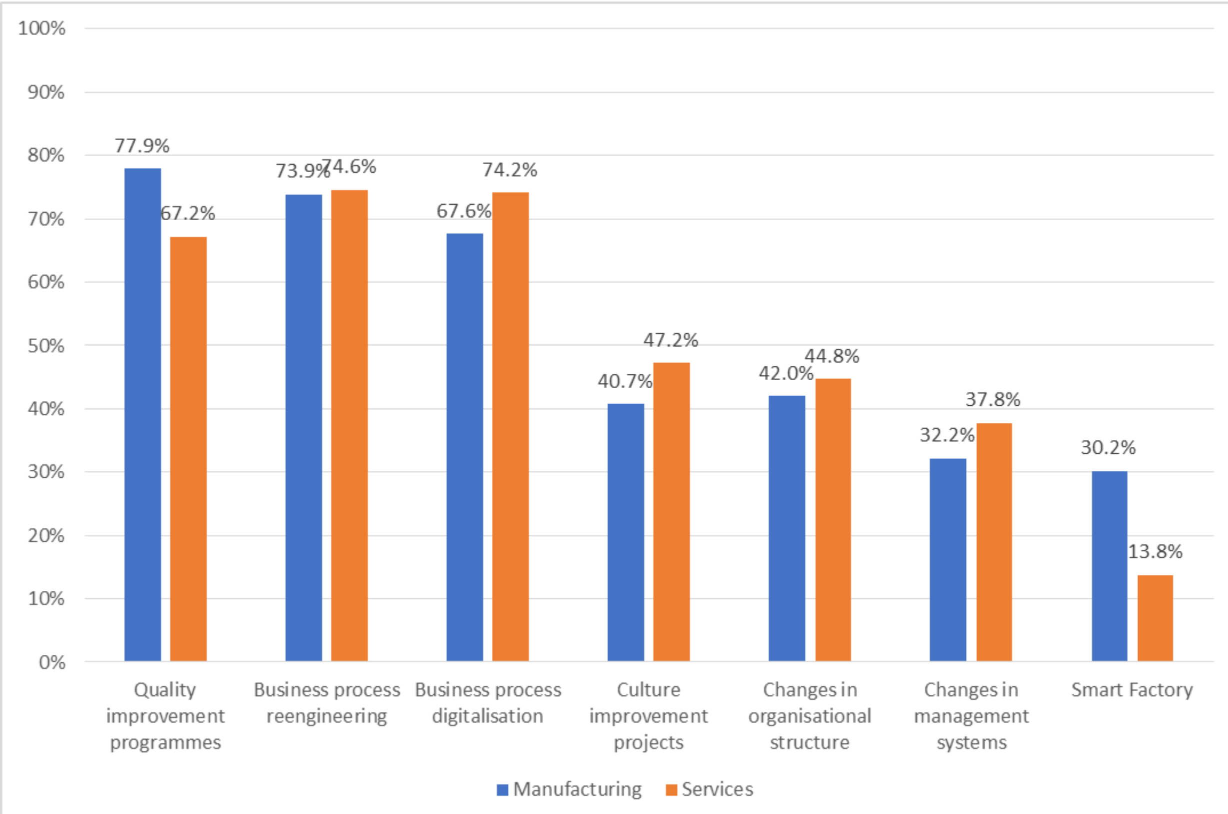
	Sectoral Group	**Number of Firms**	**Spending as % of turnover (Mean)**	**Spending as % of turnover (Median)**	**ANOVA Sig.**	**Eta squared**
OBP improvement carried out by external providers	High & Medium-high-technology	219	1.22	0.50	0.158	0.009
	Medium-low-technology	101	1.32	0.50		
	Low-technology	122	1.46	0.50		
	Knowledge-intensive services	238	0.99	0.30		
	Less knowledge-intensive services	69	0.70	0.20		
OBP improvement using internal resources	High & Medium-high-technology	206	1.65	1.00	0.014	0.018
	Medium-low-technology	96	1.58	0.50		
	Low-technology	111	1.30	0.40		
	Knowledge-intensive services	226	1.80	0.80		
	Less knowledge-intensive services	67	0.56	0.10		

Figure 3.21 % of firms involved in activities for OBP improvement by activity type and firm size (N = 878)



The most "popular" types of OBP improvement (for firms that conduct this type of activity) across size and sector categories are Quality improvement programmes, Business process reengineering (BPR) and Business process digitalization illustrating the significance of these activities in business operation (**Figures 3.21** and **3.22**). The share of firms that conduct the specific activities accounts for 73.6%, 74.2% and 70.3% respectively of the sample of firms with OBP improvement expenditures. Regarding size categories, there is a statistically significant differentiation for BPR, Business process digitalization and, more importantly, for Smart Factory where larger firms are characterized by higher percentages (Pearson Chi-square, sig. < 0.01) [**Figure 3.21**]. In terms of sector, a higher share of manufacturing firms (with expenditures in OBP improvement) invest in Smart Factory and Quality improvement programmes (Pearson Chi-square, sig. < 0.01), whereas a higher share of service firms invests in Business process digitalization (Pearson Chi-square, sig. < 0.05). For the remaining types of OBP improvement, the differentiations are not statistically significant (**Figure 3.22**).

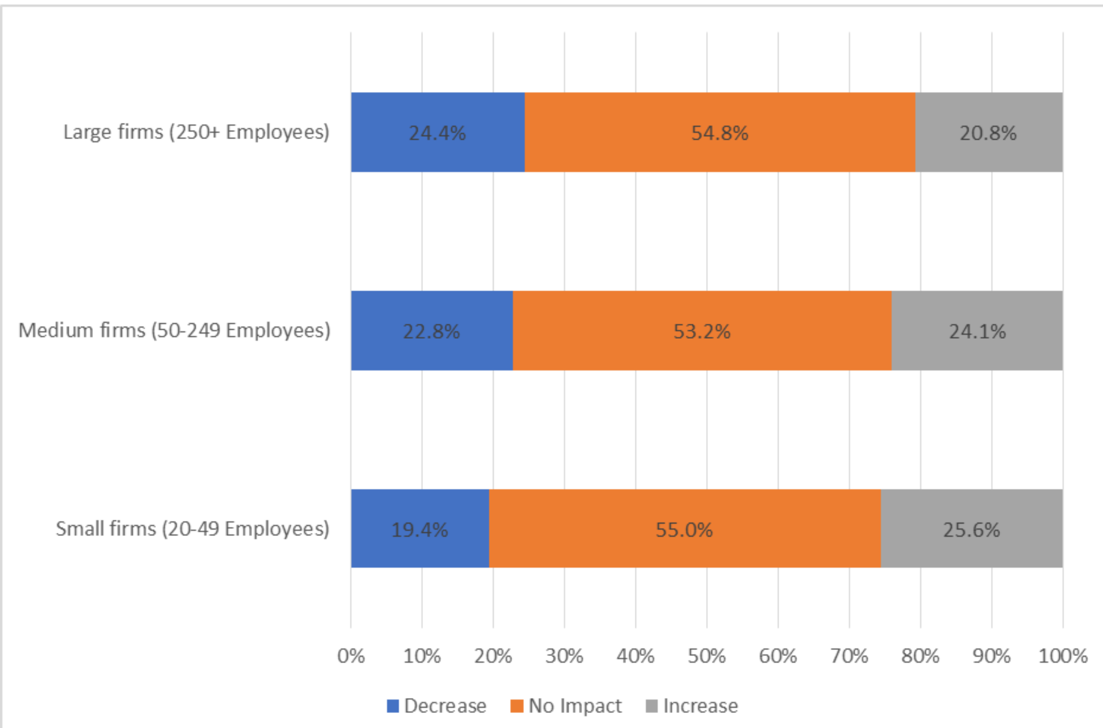
Figure 3.22 % of firms involved in activities for OBP improvement by activity type and sectoral group (manufacturing vs. services) [N = 878]



Furthermore, **Figure 3A.3** in **Appendix 3A** depicts the percentages of firms (with expenditures in OBP improvement) involved in different types of OBP improvement per sector technology/knowledge intensity. It is worth noting that firms in less KIS exhibit by far the highest percentage in business process digitalization (86.6%) illustrating the high need for this type of investment in wholesale and retail trade activities. Less KIS also display the highest percentage of firms that invest in culture improvement projects and organizational structure changes and a relatively high percentage in BPR. A general conclusion resulting from **Figure 3A.3** (**Appendix 3A**) is that, regardless of their knowledge intensity level, all sectors face the need of improving their organization and business processes.

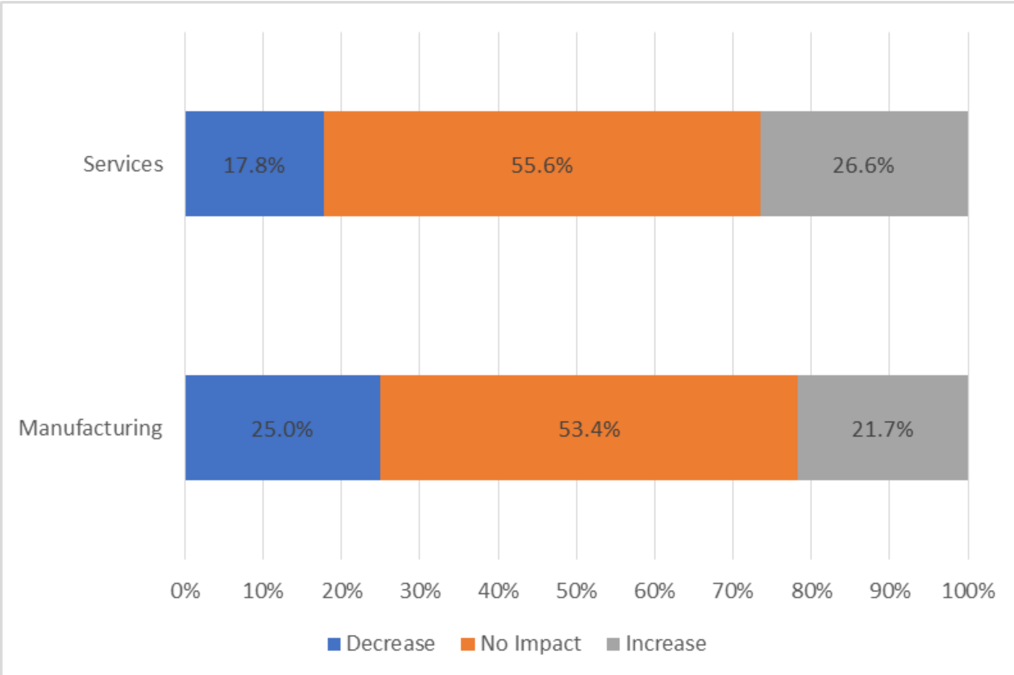
Relating to the impact of Covid-19 crisis on expenditures for OBP improvement, firms' size again matters negatively but not to a statistically significant degree (Pearson Chi-square, sig. > 0.05) [**Figure 3.23**]. On the other hand, the differentiation between manufacturing and service firms is statistically significant (Pearson Chi-square, sig. < 0.05). In services the share of firms with increase of expenditures in 2020 compared to 2019 is higher than those with expenditures decrease. The opposite applies to manufacturing (**Figure 3.24**). Regarding sectors' technology/knowledge intensity, LT manufacturing has the highest percentage of firms that report expenditures decrease (26.4%) whereas KIS the lowest (16.5%) [**Figure 3A.4** in **Appendix 3A**]. However, in general, the differentiations between sector categories are not statistically significant (Pearson Chi-square, sig. > 0.05)[43].

Figure 3.23 Impact of Covid-19 crisis on OBP improvement expenditure by firm size (N = 875)



[43] For both the chi-square test and across categories and the chi-square test for each pair of these five categories. An exception is the comparison between KIS and H&MHT manufacturing.

Figure 3.24 Impact of Covid-19 crisis on OBP improvement expenditure by sectoral group (manufacturing vs. services) [N = 875]



3.5 Enterprise spending on Software & Databases

Almost half of the total sample firms (48.6%) have no expenditures in Software & Databases. Size matters to a high degree as 63.5% of large firms spend on Software & Databases, whereas the corresponding percentages of medium-sized and small firms are 53.7% and 43.2% respectively (Pearson Chi-square, sig. < 0.01)[44] [**Figure 3.25**]. Sector also matters as more firms in services invest in software/databases (57.7%) than firms in manufacturing (47.2%) (Pearson Chi-square, sig. < 0.001). In addition, sectors with higher technology/knowledge intensity demonstrate a higher percentage of firms with Software & Databases activity than less knowledge intensive sectors and moreover KIS exhibit by far the highest share (60.4%) [**Figure 3.26**][45].

[44] Both for the chi-square test across categories and the chi-square test for each pair of these three categories.

[45] Pearson Chi-square coeff. (sig. < 0.001) for the chi-square test across categories. Pearson Chi-square coeff. (sig. < 0.05) regarding the comparison between KIS and the other categories.

Figure 3.25 % of firms with expenditures in Software & Databases by firm size (N = 1787)

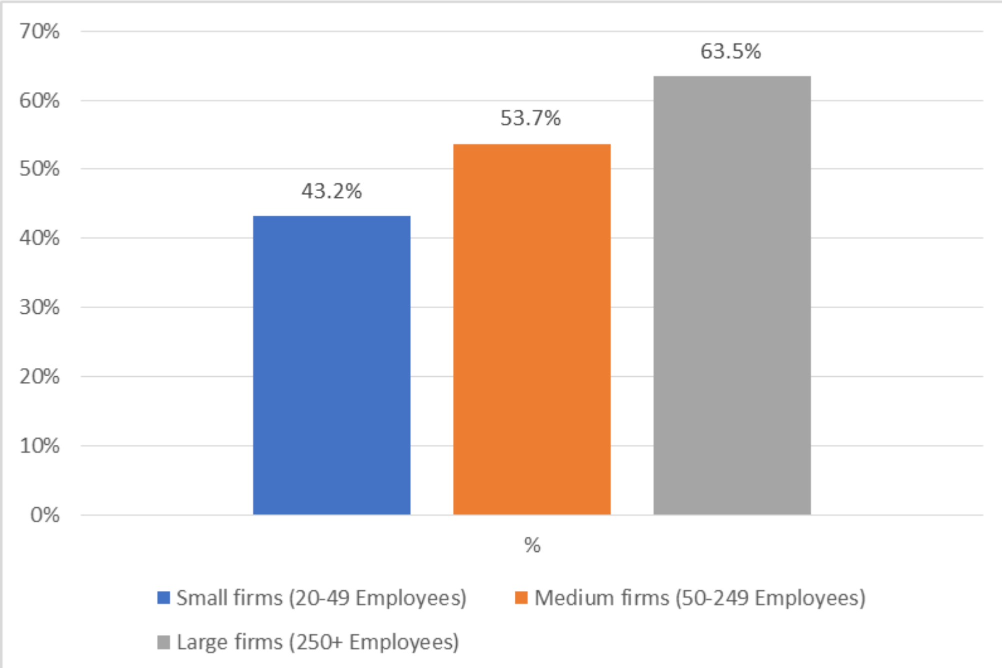
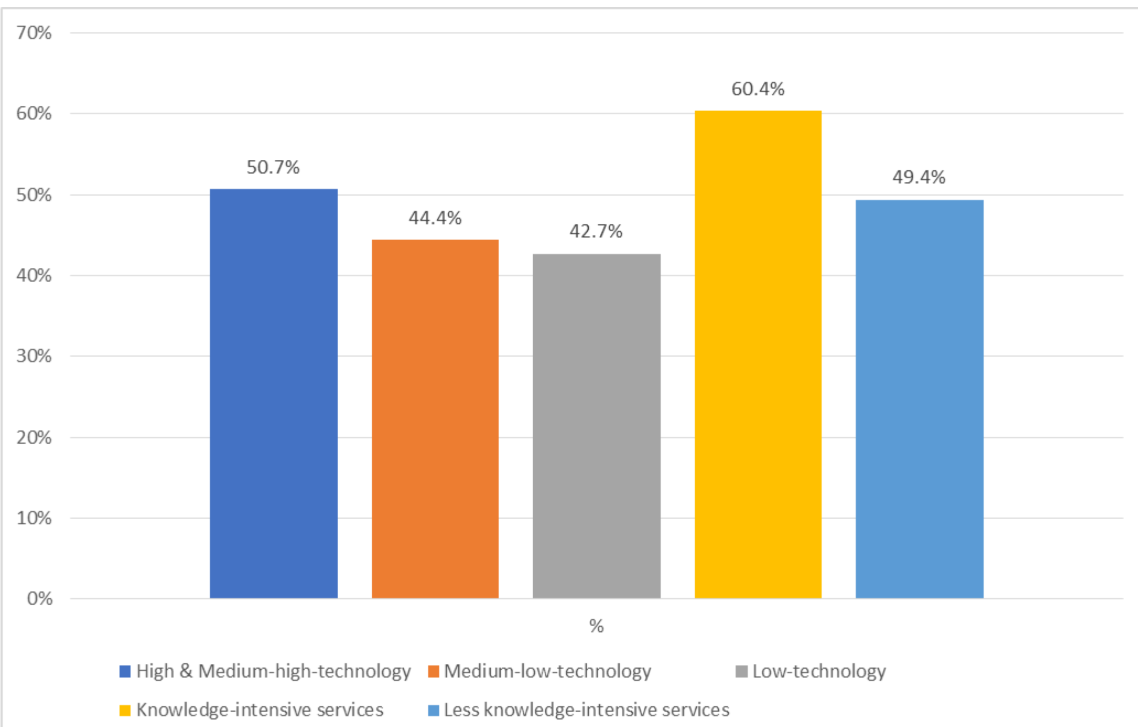


Figure 3.26 % of firms with expenditures in Software & Databases by sectoral group (technology/knowledge intensity) [N = 1787]



Smaller firms demonstrate higher expenditures as percentage of turnover both for Software & Databases purchased from external providers and for Software & Databases developed or customized in-house (**Table 3.13**). In addition, service firms with Software & Databases activity make roughly double investment than manufacturing firms in both categories (**Table 3.14**). This is due to the much higher spending intensity of KIS compared to the other sector categories. Within manufacturing, LT firms exhibit much lower percentages than H&MHT and MLT firms especially as regards Software & Databases developed/customized in-house (**Table 3.15**).

Table 3.13 Spending (in-house and purchased) on Software and Databases by firm size

	Size Category	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
Software & Databases purchased from external providers	Small firms (20-49 Employees)	302	2.14	1.00	0.001	0.016
	Medium firms (50-249 Employees)	286	1.60	0.95		
	Large firms (250+ Employees)	216	1.18	0.50		
Software & Databases developed or customized in-house	Small firms (20-49 Employees)	293	2.22	0.40	0.028	0.009
	Medium firms (50-249 Employees)	278	1.48	0.10		
	Large firms (250+ Employees)	206	0.83	0.10		

Table 3.14 Spending (in-house and purchased) on Software and Databases by sectoral group (manufacturing vs. services)

	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	T-test Sig.	Eta squared
Software & Databases purchased from external providers	Manufacturing	445	1.24	0.50	0.000	0.024
	Services	359	2.25	1.00		
Software & Databases developed or customized in-house	Manufacturing	434	1.02	0.10	0.004	0.010
	Services	343	2.31	0.30		

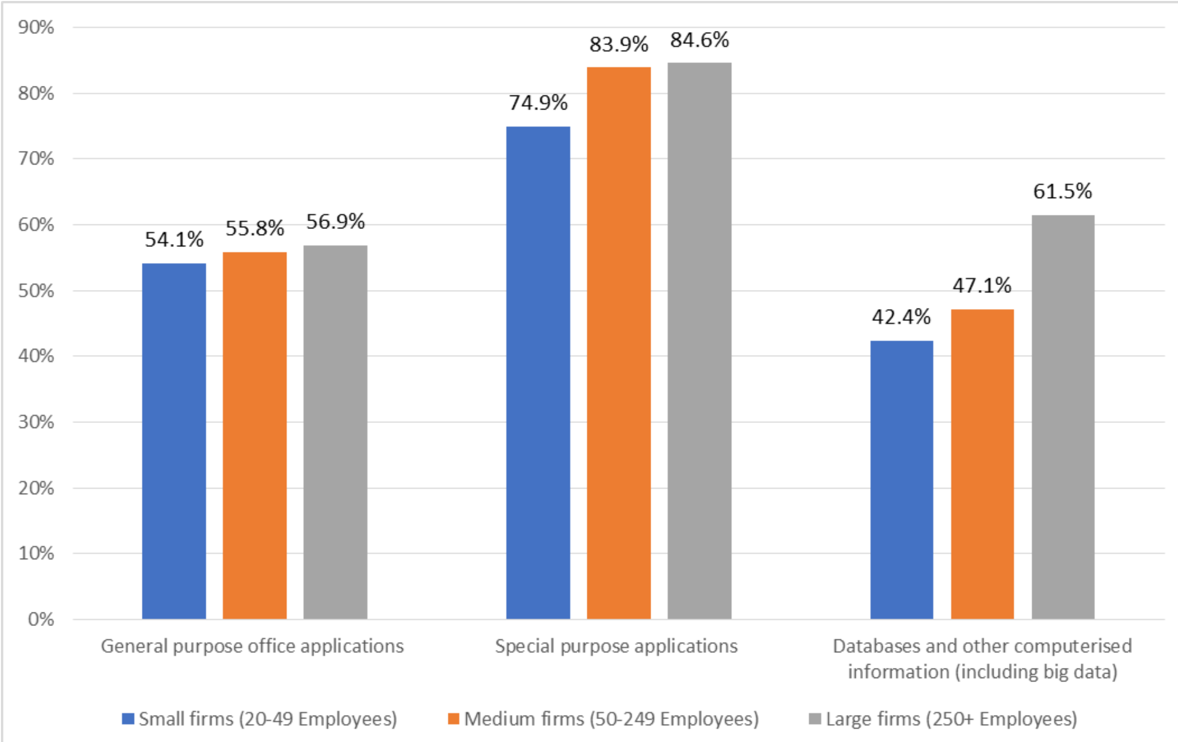
Table 3.15 Spending (in-house and purchased) on Software and Databases by sectoral group (technology/knowledge intensity)

	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
Software & Databases purchased from external providers	High & Medium-high-technology	238	1.24	0.70	0.000	0.051
	Medium-low-technology	99	1.56	1.00		
	Low-technology	108	0.97	0.50		
	Knowledge-intensive services	275	2.60	1.00		
	Less knowledge-intensive services	84	1.07	0.34		
Software & Databases developed or customized in-house	High & Medium-high-technology	232	1.32	0.20	0.000	0.027
	Medium-low-technology	94	1.09	0.00		
	Low-technology	108	0.32	0.00		
	Knowledge-intensive services	263	2.84	0.50		
	Less knowledge-intensive services	80	0.55	0.00		

Over 4 out of 5 firms (80.8%) which conduct Software & Databases activity invest in special purpose applications. This fact illustrates the significance of specialized software usage for businesses' primary functions. The share of firms with spending on general purpose office applications and databases is lower, i.e., 55.5% and 49.5% respectively. Furthermore, the portion of small firms investing in special purpose applications is lower than that of medium and large firms (Pearson Chi-square, sig. < 0.01)[46]. In addition, a much higher percentage of large firms (61.5%) invest in databases and other computerized information compared to small and medium-sized firms (Pearson Chi-square, sig. < 0.01)[47]. On the other hand, no significant differentiation between size categories exists regarding general purpose office applications (Pearson Chi-square, sig. > 0.05)[48] [**Figure 3.27**].

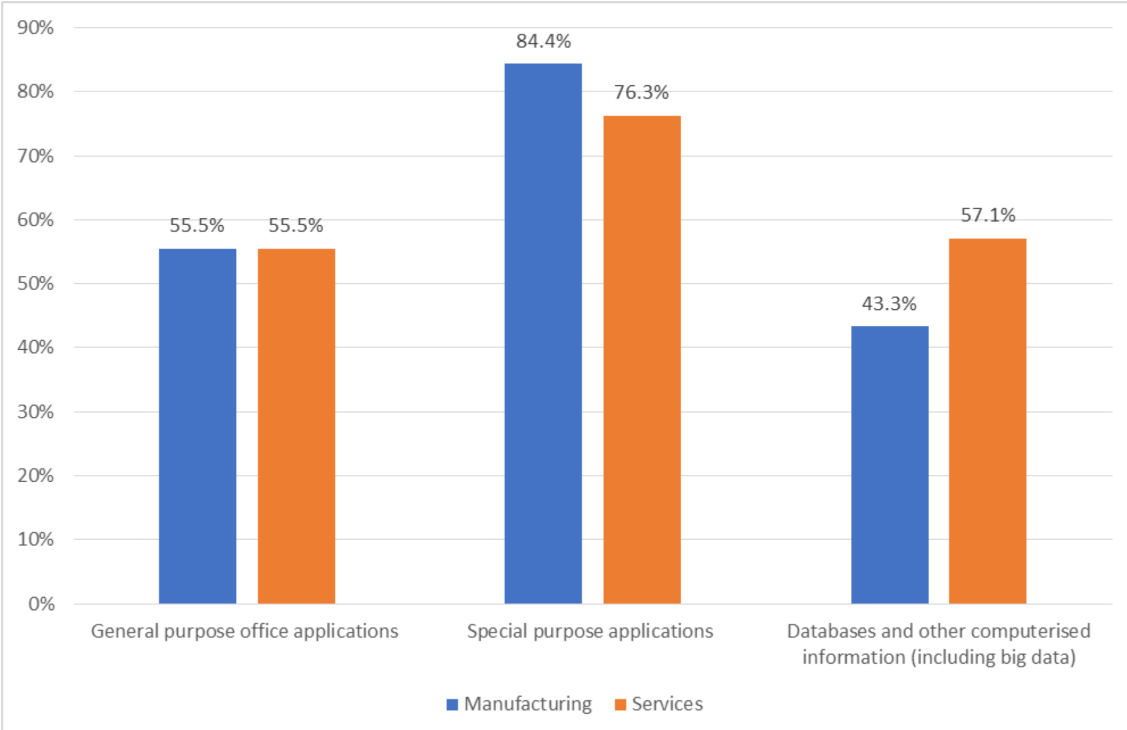
[46] Both for the chi-square test across size categories and the comparison between small firms and the other categories.
[47] Both for the total chi-square test across size categories and the comparison between large firms and the other categories.
[48] Both for the total chi-square test across categories and the chi-square tests for each pair of these three categories.

Figure 3.27 % of firms with software and database expenditures by activity type and firm size (N = 917)



In addition, **Figure 3.28** shows that the share of firms (with expenditures in Software & Databases) that make investment in general purpose office applications is exactly the same for services and manufacturing (55.5%). In addition, more firms in manufacturing investment in special purpose applications than firms in services (84.4% and 76.3% respectively) [Pearson Chi-square, sig. < 0.01]. On the other hand, a significantly higher percentage of service firms (57.1%) make expenditures in databases and other computerized information than manufacturing firms (43.3%) [Pearson Chi-square, sig. < 0.01]. This indicates the increasing importance of databases / big data access and use for many service sectors. Most importantly, less KIS display the highest share of firms with spending in this type of activity, i.e., over 64%, whereas in KIS the corresponding percentage is 55.2%. Pertaining to special purpose applications, over 3 out of 4 KIS and less KIS firms (with expenditures in Software & Databases) make such investments, whereas the relevant share of manufacturing firms is even higher [**Figure 3A.5** in **Appendix 3A**].

Figure 3.28 % of firms with software and database expenditures by activity type and sectoral group (manufacturing vs. services) [N = 917]



Regarding the impact of Covid-19 crisis on Software & Databases expenditures, all size categories follow the same trend i.e., the majority of firms report "no impact" and the share of firms with expenditures increase is larger than the share of firms with expenditures decrease (**Figure 3.29**)[49]. In terms of sectors, the percentage of firms in services with expenditures increase (26.5%) is much higher than the percentage of firms with expenditures decrease (10%). In manufacturing, the corresponding percentages are almost equal (Pearson Chi-square, sig. < 0.01) [**Figure 3.30**]. This highlights that digital transformation acceleration due to Covid-19 is more intense and necessary in services than in manufacturing. Finally, **Figure 3A.6** in **Appendix 3A** presents the relevant distribution as regards sector technology/knowledge intensity and shows that KIS are characterized by the highest share of firms with spending increase and the lowest share of firms with spending decrease. The opposite applies to MLT manufacturing.

[49] Pearson Chi-square coeff. (sig. > 0.05) both for the chi-square test across categories and the chi-square tests for each pair of these three categories.

Figure 3.29 Impact of Covid-19 crisis on Software & Databases expenditure by firm size (N = 918)

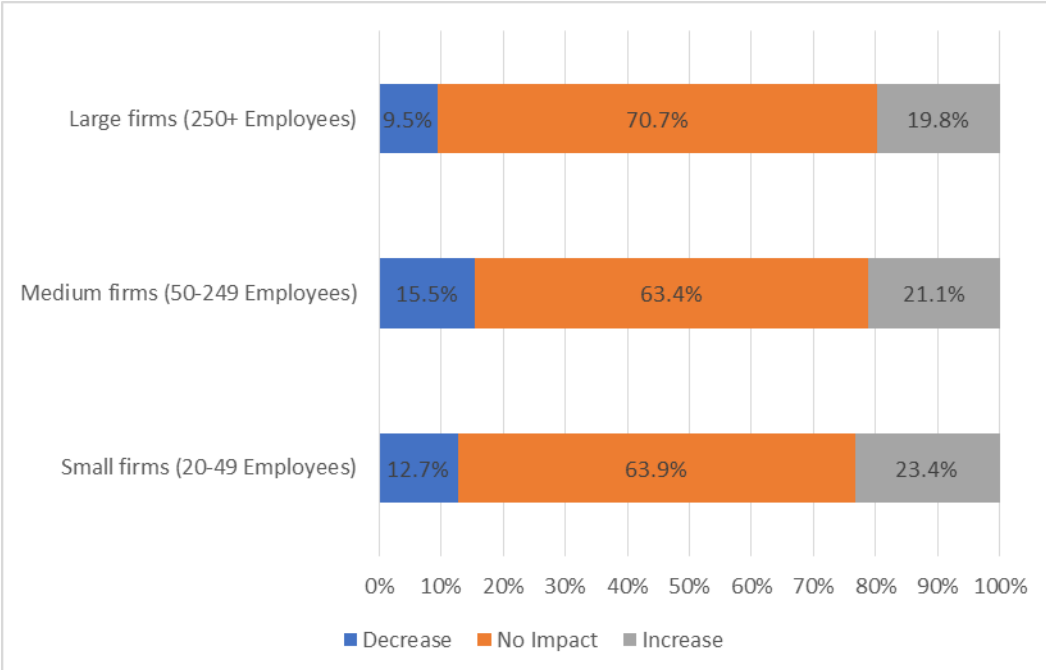
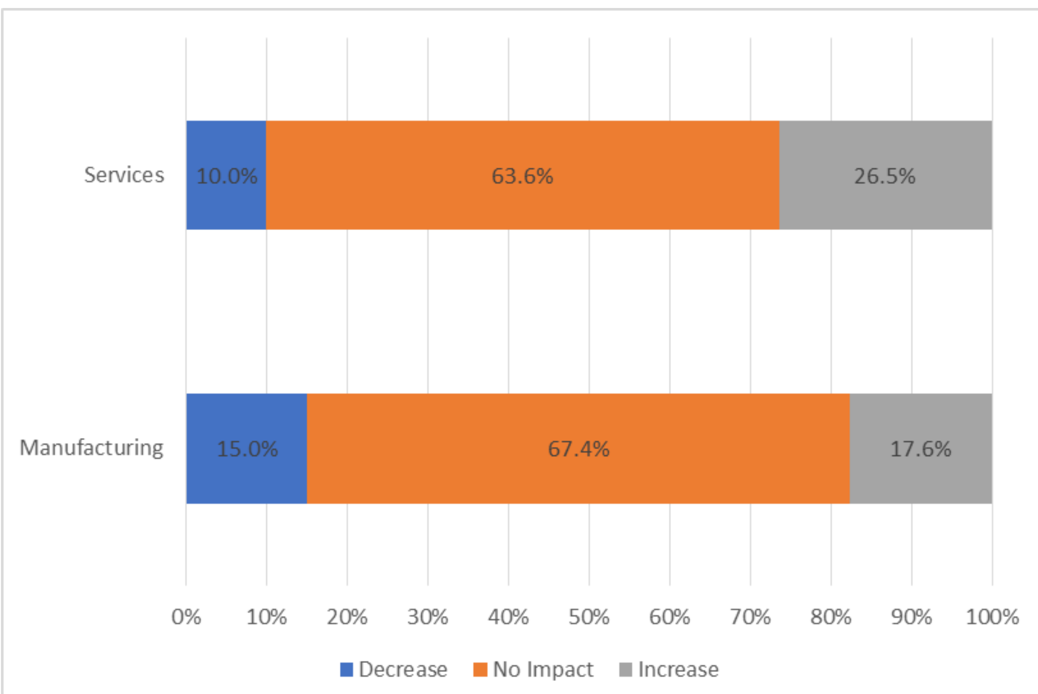


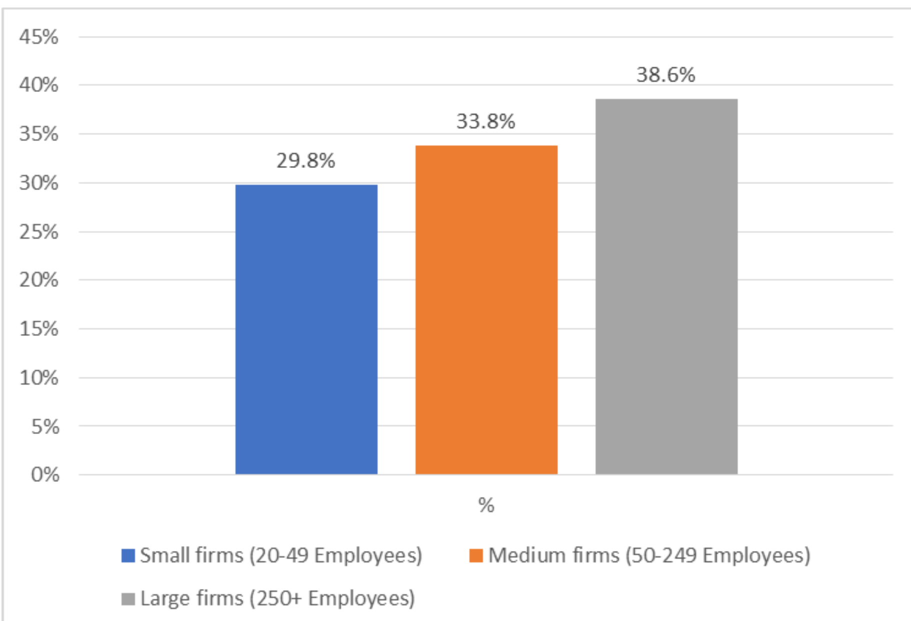
Figure 3.30 Impact of Covid-19 crisis on Software & Databases expenditure by sectoral group (manufacturing vs. services) [N = 918]



3.6 Enterprise spending on design

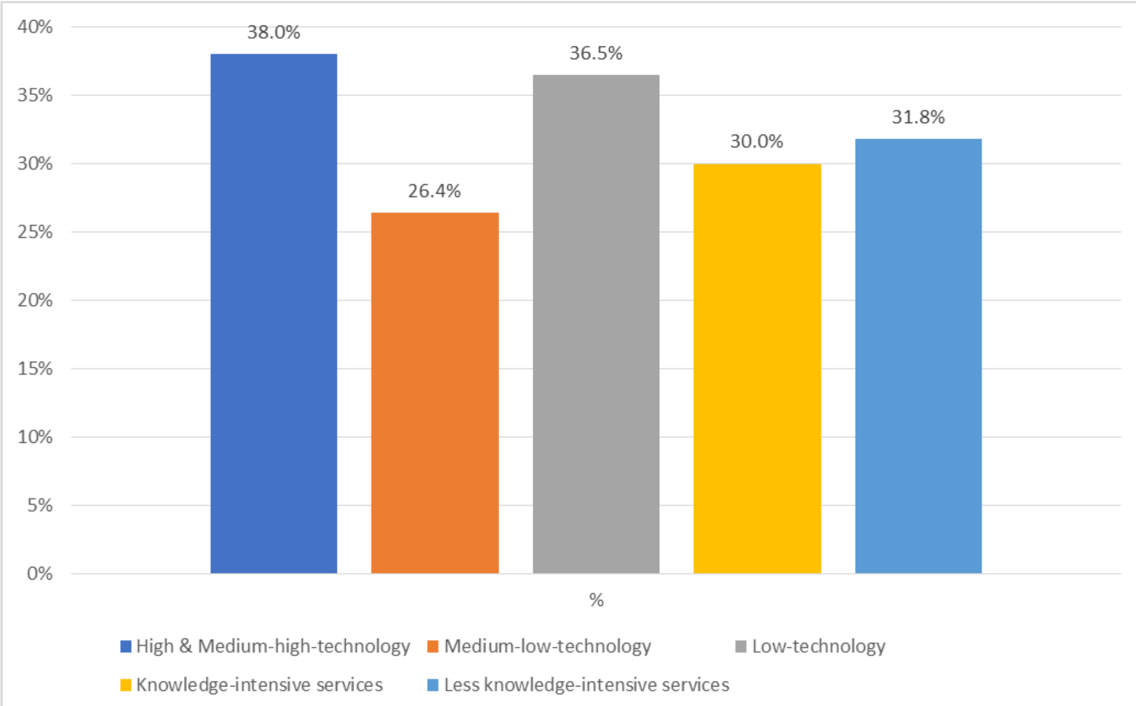
As it has already been mentioned, only 1 out of 3 firms invest in design activities. In terms of size and sector, there is some differentiation but not particularly high. Specifically, 38.6% of large firms have design activity whereas the corresponding percentages for medium-sized and small firms are lower, i.e., 33.8% and 29.8% respectively (**Figure 3.31**)[50]. Furthermore, manufacturing displays a higher percentage of firms with expenditures in design (35%) than services (30.5%). However, this differentiation is not statistically significant (Pearson Chi-square, sig. > 0.05). Higher differentiations are identified as regards sectors' technology/knowledge intensity. H&MHT manufacturing exhibits the highest percentage (38%) and low-tech manufacturing follows (36.5%). In addition, 3 out of 10 KIS firms have design activity and the relevant share of less KIS firms is similar. MLT manufacturing is characterized by the lowest percentage (26.4%) [**Figure 3.32**][51]. A possible interpretation of these results is that MLT sectors that include "heavy" industries (e.g., manufacture of basic metals) may have lower requirements for conducting design activities than sectors such as food products (i.e., low-tech manufacturing) which may encompass more sophisticated activities such as food engineering etc.

Figure 3.31 % of firms conducting design activity by firm size (N = 1785)



[50] Pearson Chi-square coeff. (sig. < 0.01), both for the chi-square test across categories and the comparison between small and large firms. Pearson Chi-square coeff. (sig. > 0.05) regarding the comparison of medium-sized firms and the other size categories.
[51] Pearson Chi-square coeff. (sig. < 0.01) for the chi-square test across categories and the comparison between H&MHT manufacturing and other two categories i.e., MLT manufacturing and KIS. Pearson Chi-square coeff. (sig. < 0.05) regarding the comparison between MLT and LT manufacturing firms.

Figure 3.32 % of firms conducting design activity by sectoral group (technology/knowledge intensity) [N = 1785]



Pertaining to the subsample of firms that have design activity, the same trend is observed here regarding size categories (as in other types of intangible assets) since smaller firms make higher investments as % of their turnover. This differentiation is much higher with regard to design activities using internal resources (**Table 3.16**). In addition, while the corresponding median values are similar for manufacturing and services, the mean values are much higher for services, especially relating to internal activities (**Table 3.17**). This can be attributed to the much higher expenditures in KIS compared to the other sectors as they include creative industries in which design is a significant activity (e.g., Architectural and engineering activities, Creative arts and entertainment activities, Advertising, Other professional, scientific and technical activities incl. design, photography, translation etc.) [**Table 3.18**].

Table 3.16 Spending (in-house and purchased) on design by firm size

	Size Category	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
Design activities carried out by external providers	Small firms (20-49 Employees)	211	1.91	0.50	0.146	0.007
	Medium firms (50-249 Employees)	183	1.31	0.30		
	Large firms (250+ Employees)	124	0.74	0.20		
Design activities using internal resources	Small firms (20-49 Employees)	204	5.39	1.00	0.000	0.032
	Medium firms (50-249 Employees)	174	2.19	0.50		
	Large firms (250+ Employees)	121	1.04	0.20		

Table 3.17 Spending (in-house and purchased) on design by sectoral group (manufacturing vs. services)

	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	T-test Sig.	Eta squared
Design activities carried out by external providers	Manufacturing	328	1.10	0.30	0.155	0.004
	Services	190	1.96	0.20		
Design activities using internal resources	Manufacturing	317	1.81	0.50	0.002	0.020
	Services	182	5.67	0.50		

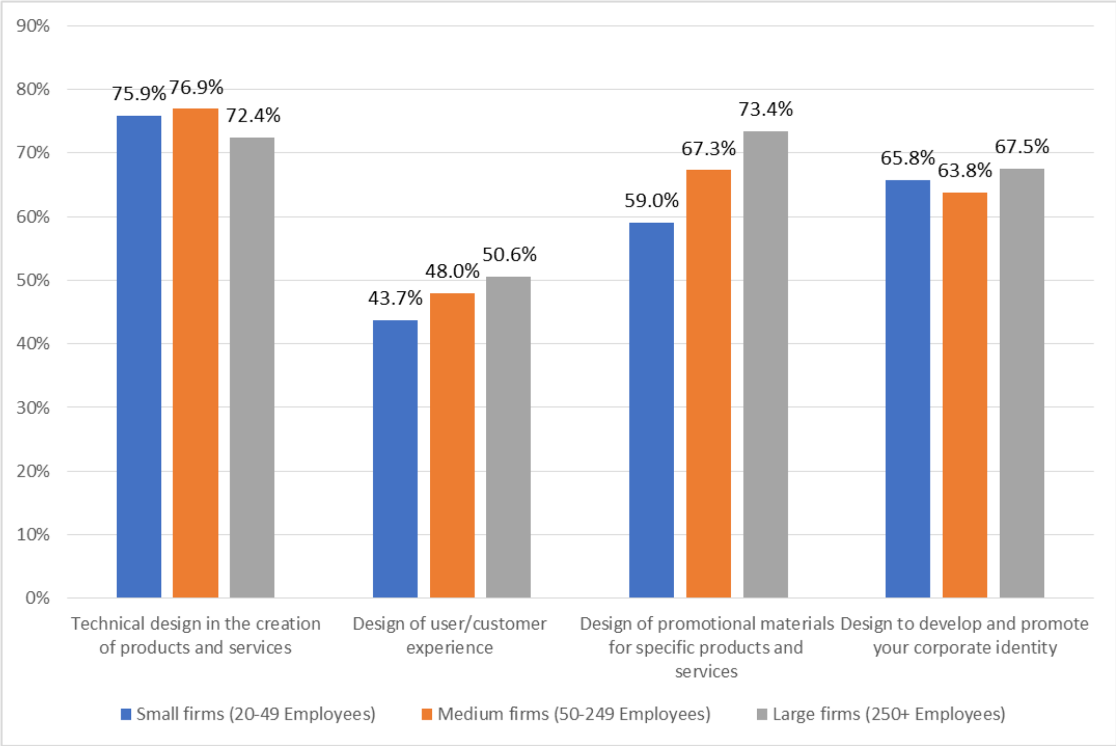
Table 3.18 Spending (in-house and purchased) on design by sectoral group (technology/knowledge intensity)

	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
Design activities carried out by external providers	High & Medium-high-technology	177	1.01	0.30	0.330	0.009
	Medium-low-technology	57	1.35	0.20		
	Low-technology	94	1.12	0.40		
	Knowledge-intensive services	139	2.24	0.30		
	Less knowledge-intensive services	51	1.22	0.20		
Design activities using internal resources	High & Medium-high-technology	168	2.64	0.90	0.000	0.063
	Medium-low-technology	57	0.96	0.40		
	Low-technology	92	0.83	0.10		
	Knowledge-intensive services	133	7.36	1.00		
	Less knowledge-intensive services	49	1.08	0.10		

Regarding the types of design activities, 3 out of 4 firms (75.3%) with expenditures in design, invest on technical design in the creation of products and services, almost 2 out of 3 firms invest on design for promotion purposes (for specific products and services and/or for their corporate identity) whereas 47% of firms make investments on design of user/customer experience. In terms of size, the differentiation is statistically significant only for the design of promotional materials for specific products and services as large firms probably have available more financial resources to spend for promotion activities (**Figure 3.33**)[52].

[52] Pearson Chi-square coeff. (sig. < 0.05) for the chi-square test across categories. Pearson Chi-square coeff. (sig. < 0.01) for the comparison between small and large firms.

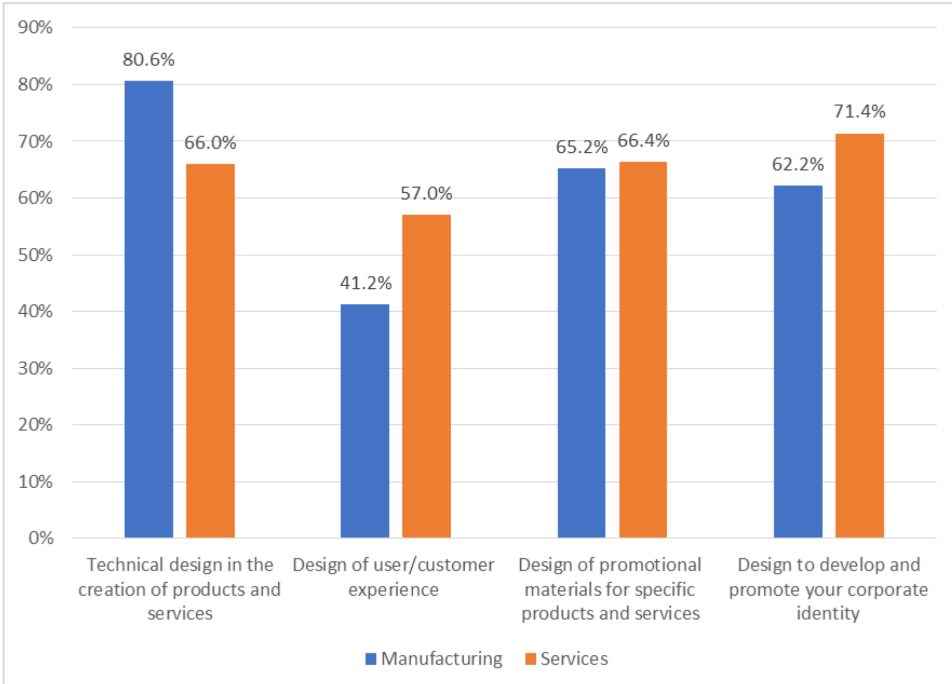
Figure 3.33 % of firms with design expenditures by activity type and firm size (N = 591)



With regard to sectors, there are more interesting observations. **Figure 3.34** indicates that the most "popular" type of design activity in manufacturing is technical design (Pearson Chi-square, sig. < 0.001) and in services the design for corporate identity (Pearson Chi-square, sig. < 0.05). In addition, a significantly higher share of firms in services invest in user/customer experience design (57%) than manufacturing (41.2%) [Pearson Chi-square, sig. < 0.001].

Some interesting results relating to the sector technology/knowledge intensity is that H&MHT manufacturing has by far the highest percentage of firms with investment on technical design (88.8%), and less KIS has the highest share of firms that use design for promotion activities, both for specific products/services (84.2%) and for the development and promotion of the corporate identity (77.2%). For the former type, low-tech manufacturing exhibits also a much higher percentage than the other three sector categories (79%) [**Figure 3A.7** in **Appendix 3A**]. These findings indicate the high need of spending in promotion activities in less KIS and low-tech manufacturing firms.

Figure 3.34 % of firms with design expenditures by activity type and sectoral group (manufacturing vs. services) [N = 591]



As regards the impact of Covid-19 crisis on design expenditures, the majority of firms across size classes report "no impact", and the share of firms with expenditures decrease is larger than the share of firms with expenditures increase (**Figure 3.35**). However, large firms have the highest percentage of firms with no impact and small firms the lowest[53]. In terms of sectors, there is no statistically significant difference between manufacturing and service firms (**Figure 3.36**) [Pearson Chi-square, sig. > 0.05]. Finally, the picture is mixed regarding sectors' technology/knowledge intensity and no statistically significant differentiation between sector categories has been identified (Pearson Chi-square, sig. > 0.05)[54] [**Figure 3A.8** in **Appendix 3A**].

[53] Pearson Chi-square coeff. (sig. > 0.05) for the chi-square test across categories and the comparison between medium-sized firms and the other two size categories. Pearson Chi-square coeff. (sig. < 0.05) for the comparison between large and small firms.
[54] For the chi-square test across categories and the chi-square test for each pair of the five sector categories, except for pair LT and MLT manufacturing firms.

Figure 3.35 Impact of Covid-19 crisis on design expenditure by firm size (N = 589)

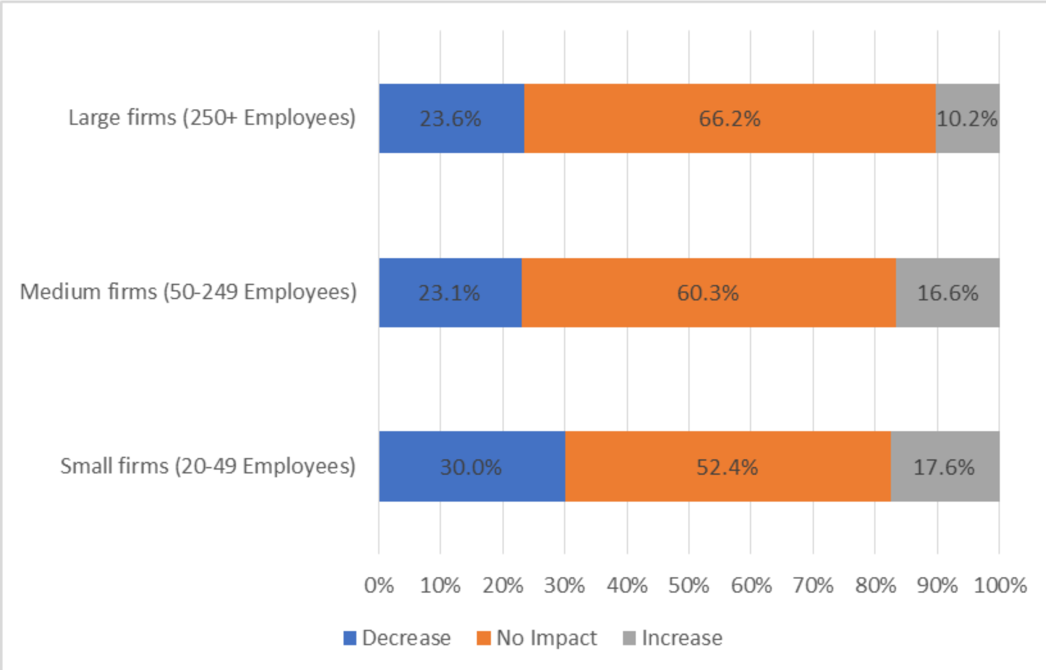
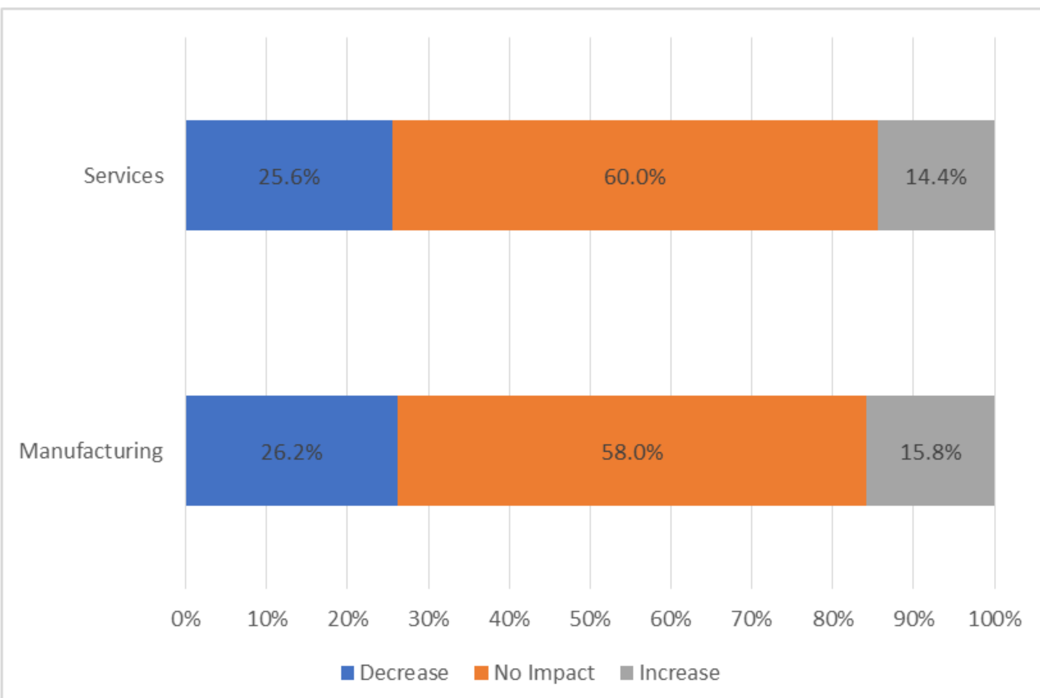


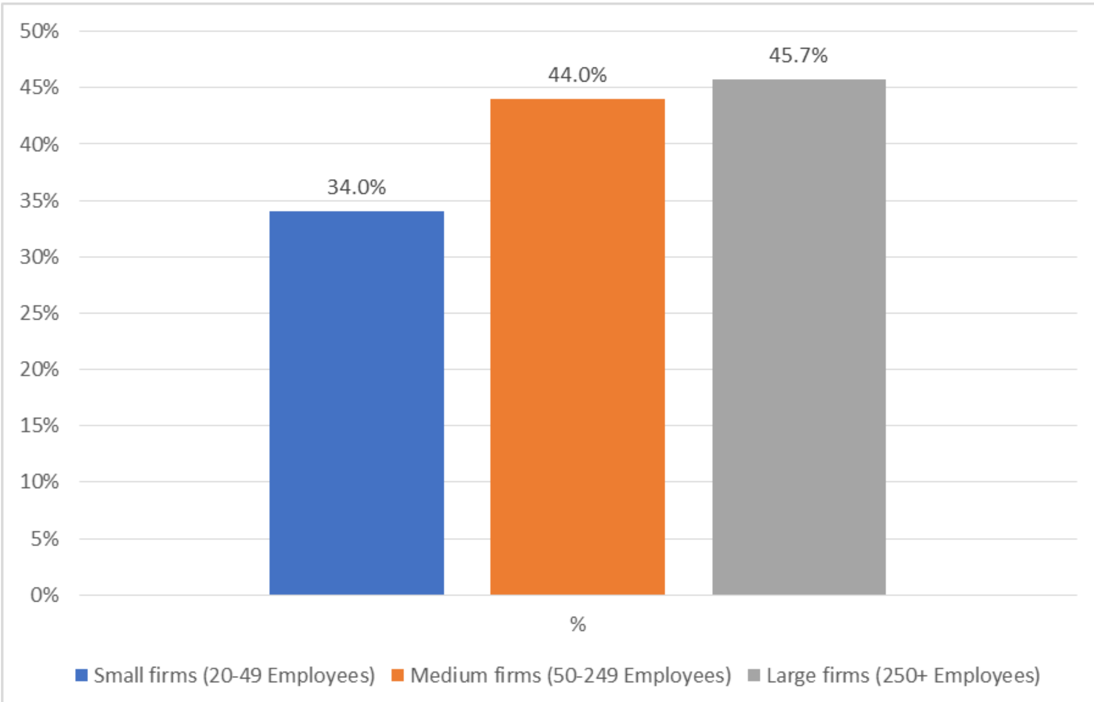
Figure 3.36 Impact of Covid-19 crisis on design expenditure by sectoral group (manufacturing vs. services) [N = 589]



3.7 Enterprise spending on reputation & branding

6 out of 10 firms have no Reputation & Branding (R&B) activity. In addition, size matters as 44% of medium-sized and 45.7% of large firms conduct such activity whereas the percentage of small firms is smaller (34%) [**Figure 3.37**][55].

Figure 3.37 % of firms conducting Reputation & Branding activity by firm size (N = 1788)



Sector also matters as a higher share of service firms (44.2%) invest in R&B than manufacturing firms (37.2%)[56]. Moreover, focusing on sector technology/knowledge intensity, it is observed that KIS and less KIS exhibit similar shares, whereas there is a large differentiation within manufacturing. In particular, low-tech manufacturing has a relatively high share of firms with R&B activity that is equal to the percentage of KIS (44.8%), and in MLT manufacturing only 1 out of 4 firms conducts R&B activity (**Figure 3.38**)[57]. Probably, sectors such as manufacture of food products have higher need of investment in R&B activities than sectors such as manufacture of basic metals or non-metallic mineral products.

[55] Pearson Chi-square coeff. (sig. < 0.001) for the chi-square test across categories and the comparison between small firms and the other two size categories.
[56] Pearson Chi-square coeff. (sig. < 0.01).
[57] Pearson Chi-square coeff. (sig. < 0.001) for the chi-square test across categories and between MLT manufacturing firms and the other sector categories.

Figure 3.38 % of firms conducting Reputation & Branding activity by sectoral group (technology/knowledge intensity) [N = 1788]

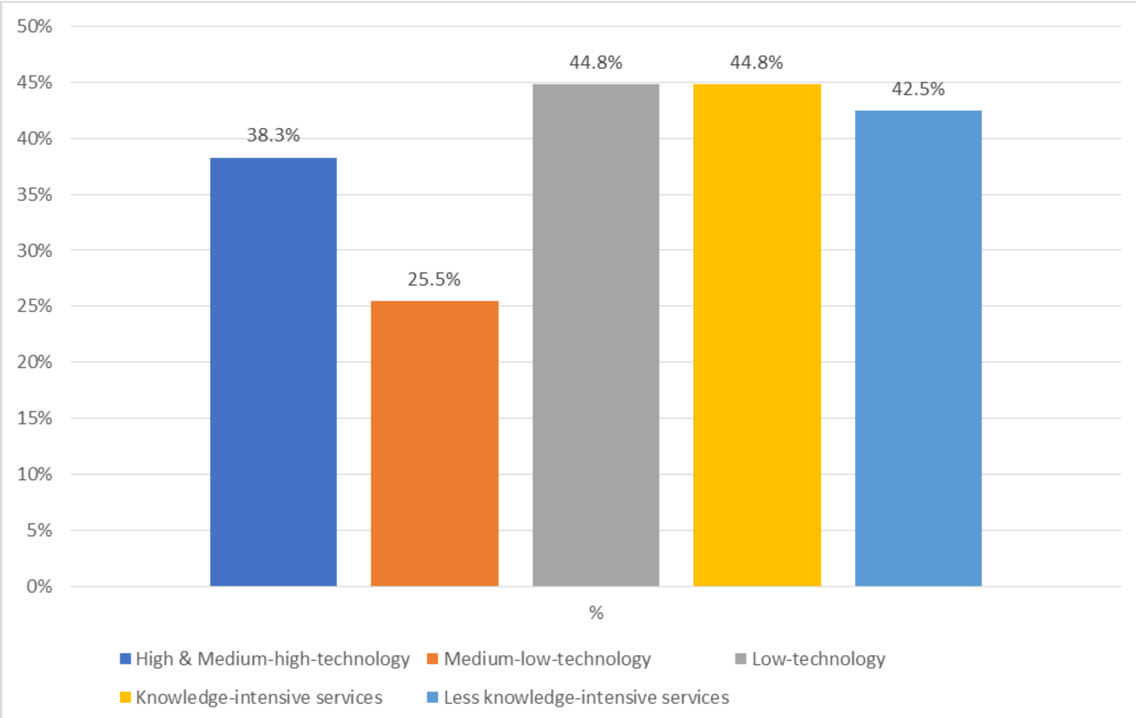


Table 3.19 Spending (in-house and purchased) on Reputation & Branding by firm size

	Size Category	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
Reputation & Branding activities undertaken by external providers	Small firms (20-49 Employees)	239	1.60	1.00	0.001	0.022
	Medium firms (50-249 Employees)	245	0.89	0.50		
	Large firms (250+ Employees)	157	1.12	0.30		
Reputation & Branding activities using internal resources	Small firms (20-49 Employees)	230	1.94	0.95	0.000	0.040
	Medium firms (50-249 Employees)	231	0.96	0.30		
	Large firms (250+ Employees)	151	0.75	0.20		

Regarding expenditures intensity, small firms are generally characterized by higher expenditures in R&B as % of turnover than the other size categories and this differentiation is higher pertaining to R&B activities using internal resources (**Table 3.19**). In terms of sector, there is no differentiation between manufacturing and services for R&B activities undertaken by external providers. On the other hand, firms in services roughly make double expenditures in R&B activities using internal resources than firms in manufacturing (**Table 3.20**). This differentiation is mainly attributed to the fact that firms in KIS make by far the highest expenditures. In addition, technology/knowledge intensity matters within manufacturing as well (**Table 3.21**).

Table 3.20 Spending (in-house and purchased) on Reputation & Branding by sectoral group (manufacturing vs. services)

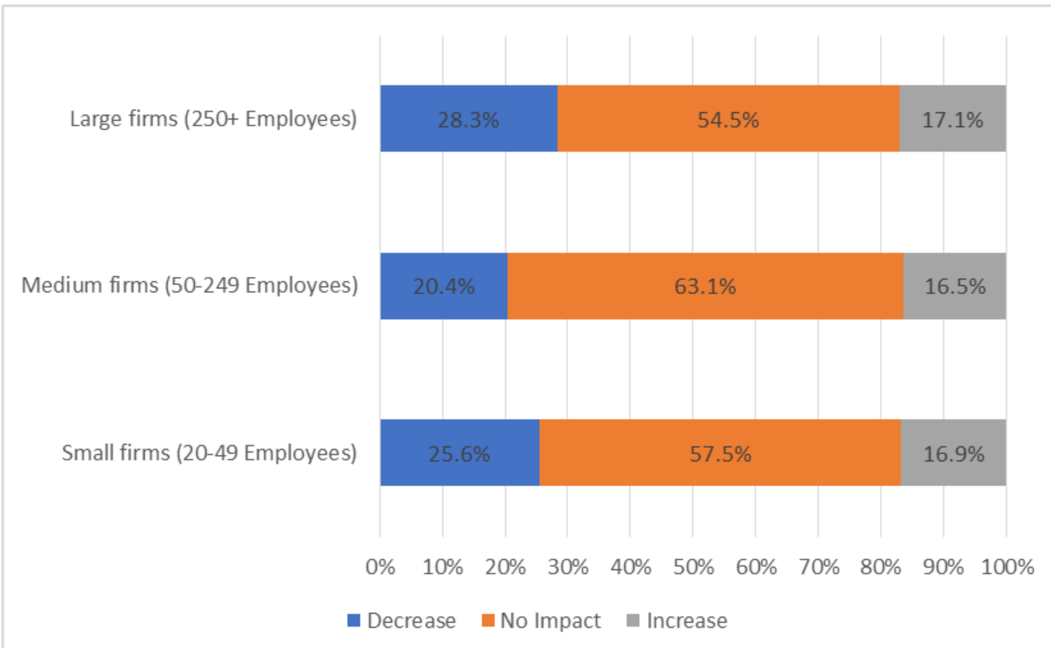
	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	T-test Sig.	Eta squared
Reputation & Branding activities undertaken by external providers	Manufacturing	356	1.19	0.50	0.782	0.000
	Services	285	1.24	0.50		
Reputation & Branding activities using internal resources	Manufacturing	340	0.92	0.30	0.000	0.021
	Services	272	1.72	0.50		

Table 3.21 Spending (in-house and purchased) on Reputation & Branding by sectoral group (technology/knowledge intensity)

	Sectoral Group	Number of Firms	Spending as % of turnover (Mean)	Spending as % of turnover (Median)	ANOVA Sig.	Eta squared
Reputation & Branding activities undertaken by external providers	High & Medium-high-technology	181	1.35	0.50	0.129	0.011
	Medium-low-technology	57	0.72	0.30		
	Low-technology	118	1.18	0.50		
	Knowledge-intensive services	216	1.37	0.70		
	Less knowledge-intensive services	69	0.84	0.30		
Reputation & Branding activities using internal resources	High & Medium-high-technology	178	1.20	0.50	0.000	0.046
	Medium-low-technology	54	0.62	0.30		
	Low-technology	108	0.60	0.10		
	Knowledge-intensive services	206	2.00	1.00		
	Less knowledge-intensive services	66	0.86	0.10		

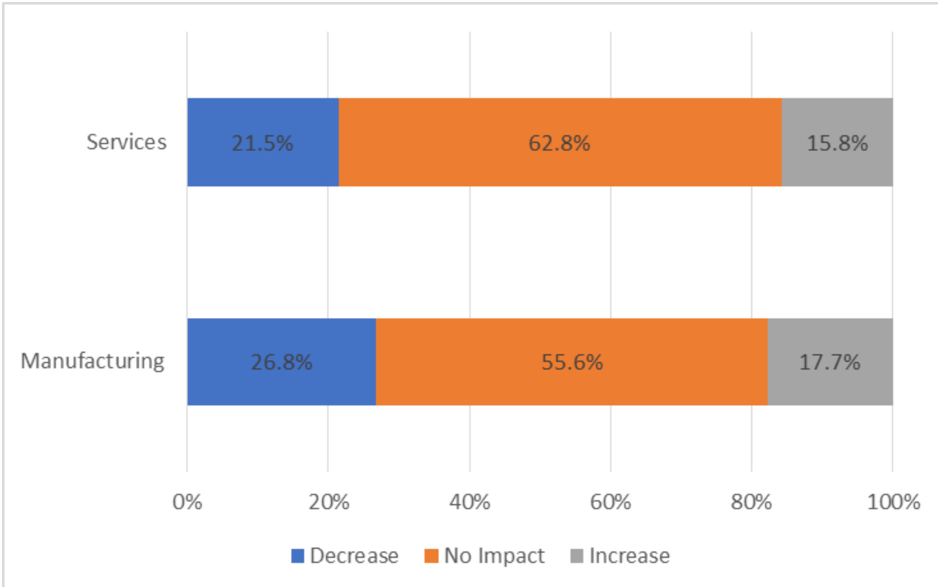
Finally, Covid-19 crisis has generally a similar impact on R&B expenditures for all size categories. In particular, in all categories the majority of firms report "no impact" and the share of firms with expenditures decrease is larger than the share of firms with expenditures increase (**Figure 3.39**)[58]. The same applies to the sector dimension (**Figure 3.40**) [Pearson Chi-square, sig. > 0.05]**.** In terms of sector technology/knowledge intensity, the picture is mixed, and the chi-square test does not show a statistically significant differentiation between sector categories (Pearson Chi-square, sig. > 0.05)[59]. However, an interesting observation is that within manufacturing the highest share of firms that report expenditures decrease is identified in H&MHT sectors and the lowest in LT sectors [**Figure 3A.9** in **Appendix 3A**].

Figure 3.39 Impact of Covid-19 crisis on Reputation & Branding expenditure by firm size (N = 713)



[58] Pearson Chi-square coeff. (sig. > 0.05) for the chi-square test across categories and the chi-square test for each pair of these three categories.
[59] Except for the comparison between KIS and H&MHT manufacturing firms.

Figure 3.40 Impact of Covid-19 crisis on Reputation & Branding expenditure by sectoral group (manufacturing vs. services) [N = 713]



4. Factors influencing investments in intangible assets (Section C of the Questionnaire)

The third part of the Globalinto survey questionnaire focused on capturing factors that would affect investments in intangible assets (IAs) such as the enterprise strategy, human and technological resources and organizational capabilities including dynamic capabilities (sensing, seizing and knowledge acquisition capabilities), design capabilities, and digital capabilities. The following subsections will highlight the main relevant findings.

4.1 Strategy

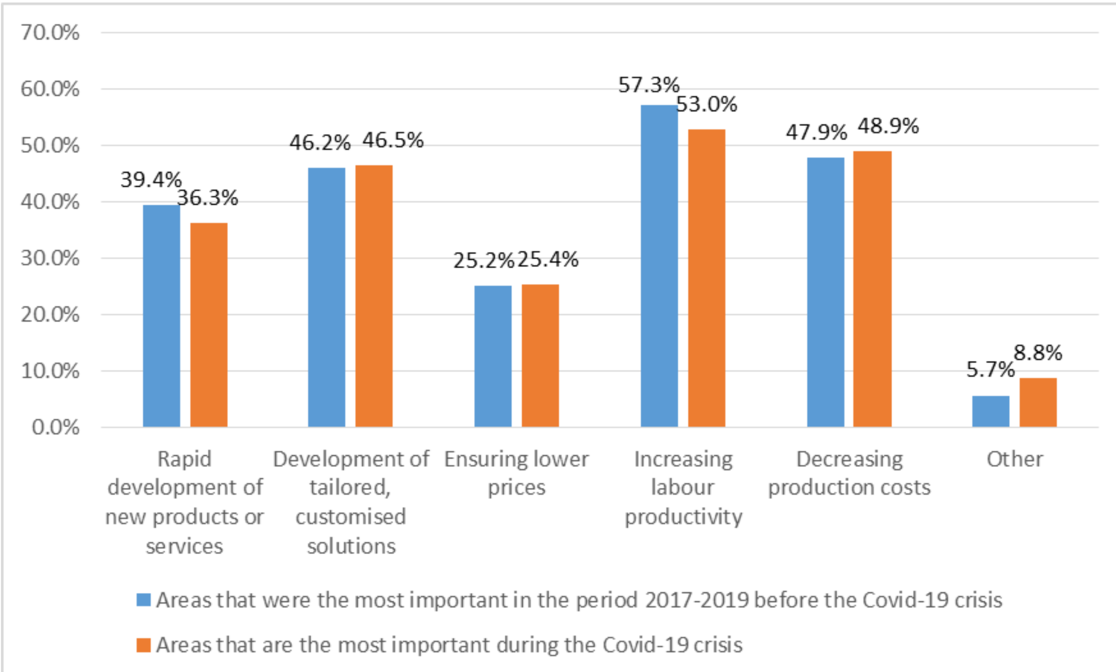
This subsection presents survey results that refer to business strategy issues such as the strategic priorities of firms, their export activity, the implementation of Foreign Direct Investments as well as the intensity of competition that they face in their main market.

A firm's strategic priorities can have an important impact on the decisions to invest in intangible assets. Strategic priorities are captured using the measurement scale employed in the Eurobarometer 2013 survey on IAs (Montresor and Vezzani, 2016), i.e., they are gauged either as price or premium objectives (ensuring lower prices or developing tailored, customized solutions), and also as objectives relating to innovation strategy such as the rapid development of new products of services, increasing labor productivity or decreasing production costs.

In general, **Figure 4.1** illustrates that there is no significant change in firms' strategic priorities before (in the period 2017- 2019) and during Covid-19 crisis. The majority of firms state that increasing labor productivity is important for both periods (57.3% and 53% respectively). In addition, almost half of the sample firms report "decreasing production costs" as an important area. Therefore, business efficiency and productivity seem to be a significant strategic priority for firms. Furthermore, the development of tailored, customized solutions is a priority for also a significant share of firms (46%-47%), while the rapid development of new products and services is key priority for a somewhat lower share of firms (39.4% and 36.3%). On the other hand, only 1 out of 4 firms focus on price leadership strategies[60].

[60] We conducted a nonparametric test, i.e., the Wilcoxon signed-rank test, for assessing the level of statistical significance regarding the change in firms' strategic priorities.

Figure 4.1 Strategic priorities before and during Covid-19 crisis[61] (N = 1796)



Figures 4.2 and 4.3 depict the differentiation between manufacturing and services regarding firms' strategic priorities in the two periods, i.e., before and during Covid-19 crisis respectively. For both periods the highest differentiation by far is observed for "Decreasing production costs", where manufacturing firms exhibit the highest percentage obviously due to the nature of their activities (Pearson Chi-square, sig. < 0.001). Manufacturing firms are also characterized by higher percentages in the areas "ensuring lower prices" and "increasing labour productivity" but these differences are statistically insignificant for both periods (Pearson Chi-square, sig. > 0.05). On the other hand, more firms in services view the development of new and/or customized products/services and solutions as an important priority and these differentiations are more intense and statistically significant after the Covid-19 outbreak[62].

[61] In the relevant question, the respondents could select up to 3 answers for each period.

[62] Pearson Chi-square coeff. (sig. < 0.01) for "Rapid development of new products and services" and Pearson Chi-square coeff. (sig. < 0.001) for "Development of tailored, customized solutions".

Figure 4.2 Strategic priorities before Covid-19 crisis by sectoral group (manufacturing vs. services) [N = 1796]

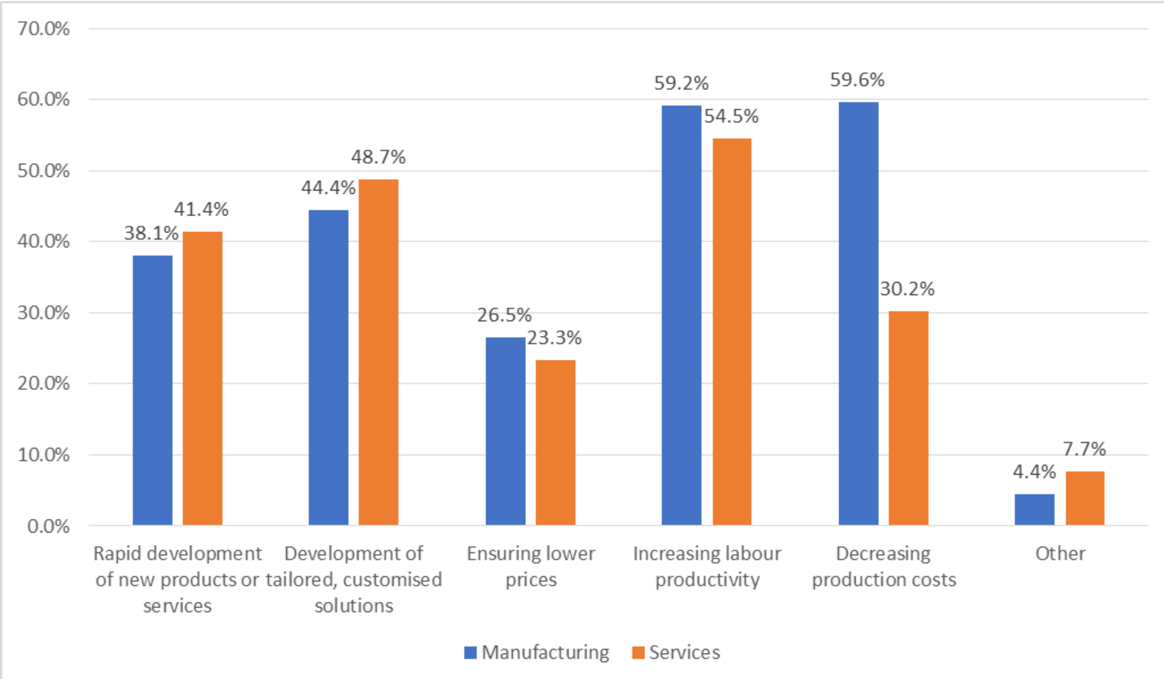
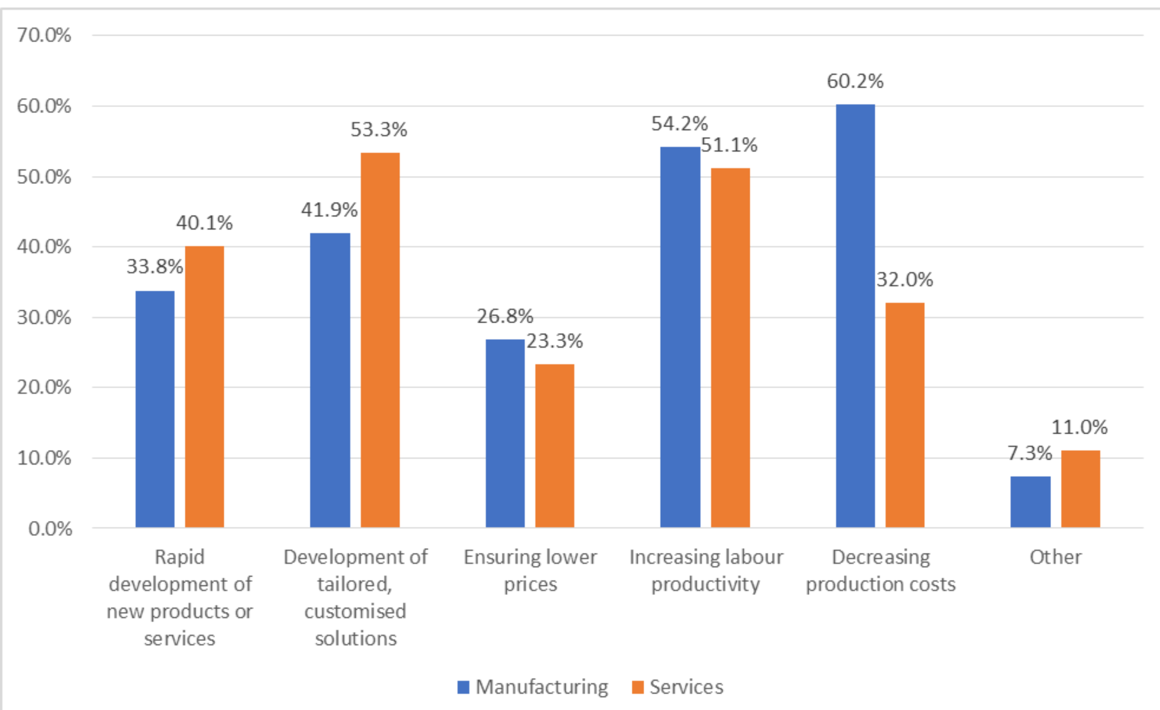


Figure 4.3 Strategic priorities during Covid-19 crisis by sectoral group (manufacturing vs. services) [N = 1796]



There is a large heterogeneity in firms' export activity. Over 1 out of 4 firms (26.8%) are oriented exclusively towards their national market, and approximately 3 out of 10 firms have exports accounting for up to 25% of their turnover. Furthermore, about 15% and 10% of firms have export activity between 25-50% and 50-75% of their turnover respectively whereas a significant share of firms (17.4%) report a very high export intensity exceeding 75% of their turnover (**Table 4.1**).

Table 4.1 Exports as % of the enterprise turnover (N = 1708)

	Number of Firms	% of Firms
0%	458	26.8
0 < ≤ 25%	523	30.6
25 < ≤ 50%	248	14.6
50 < ≤ 75%	182	10.6
75 < ≤ 100%	297	17.4

In addition, **Table 4.2** shows the mean and median values of business turnover in the national, European, and international market. This table as well indicates that the majority of firms tend to sell their products/services to the national market. However, firms with high export intensity raise the mean value for both European and international markets.

Table 4.2 Enterprise turnover distribution by market

	Number of Firms	Mean	Median
National market	1708	68.6%	85.0%
European market (excluding their national market)	1708	20.3%	10.0%
International market (outside Europe)	1708	11.1%	0%

Regarding enterprise size classes, there is a statistically significant differentiation between small firms and the other two categories, therefore, as expected small firm exhibit a lower export intensity (**Table 4.3**).

Table 4.3 Exports as % of turnover by firm size

Size category	Number of Firms	Mean	Median	ANOVA Sig.	Eta squared
Small firms (20-49 Employees)	737	27.4%	10%	0.000	0.011
Medium firms (50-249 Employees)	569	34.6%	20%		
Large firms (250+ Employees)	402	34.5%	20%		

Moreover, sector appears to be the main source of heterogeneity in enterprises' export orientation. Firms in manufacturing display a much higher export activity than firms in services (**Table 4.4**). In addition, the sectors' technology/knowledge intensity matters a lot as the median value of H&MHT is 50%, whereas the median values of MLT and LT are 30% and 10% respectively. Moreover, within less technology/knowledge intensive sectors the variation in export intensity is higher as in H&MHT the mean and median values are almost equal while in LT the mean value is almost two times higher. Finally, within KIS and less KIS the difference between mean and median values is much higher indicating an even higher heterogeneity of firms within these sectors (**Table 4.5**).

Table 4.4 Exports as % turnover by sectoral group (manufacturing vs. services)

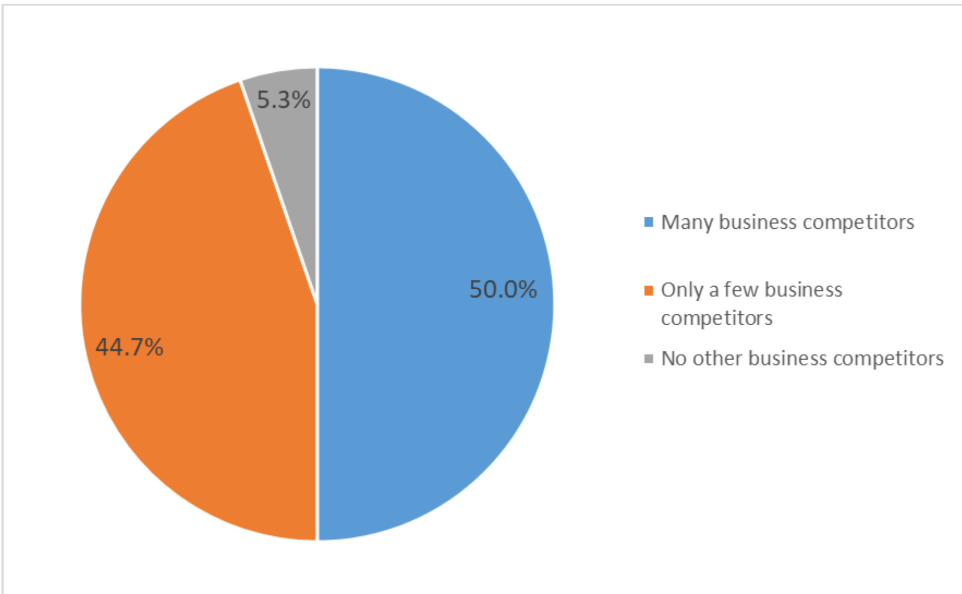
Sectoral group	Number of Firms	Mean	Median	T-test Sig.	Eta squared
Manufacturing	1028	41.5%	35%	0.000	0.141
Services	680	16.3%	2%		

Table 4.5 Exports as % of turnover by sectoral group (technology/knowledge intensity)

Sectoral group	Number of Firms	Mean	Median	ANOVA Sig.	Eta squared
High & Medium-high-technology	515	50.3%	50%	0.000	0.175
Medium-low-technology	235	37.3%	30%		
Low-technology	278	28.6%	10%		
Knowledge-intensive services	504	17.8%	2%		
Less knowledge-intensive services	176	11.9%	1.9%		

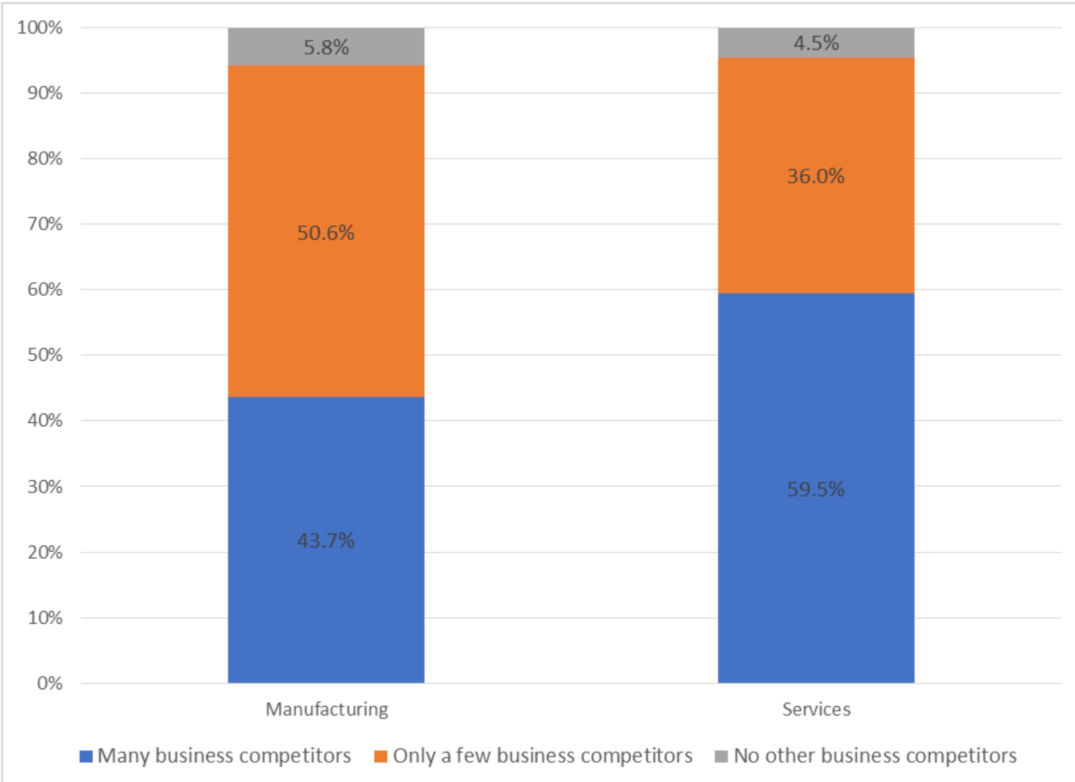
Regarding competition, half of the sample firms state that there are many enterprises offering very similar products and/or services to their potential customers in their main market (i.e., many business competitors) whereas 44.7% of firms that there are only a few business competitors, and only 5.3% of firms report that there is no other competitor (**Figure 4.4**). In general, larger firms appear to have more competitors than smaller firms as 55.5% of large firms, 49.2% of medium-sized firms and 47.6% of small firms report that they have many business competitors in their main market (see **Figure 4A.1** in the **Appendix 4A**)[63].

Figure 4.4 Competition intensity in the main market (N = 1783)



[63] Pearson Chi-square coeff. (sig. < 0.01) for the chi-square test across categories and the comparison between small firms and the other two categories.

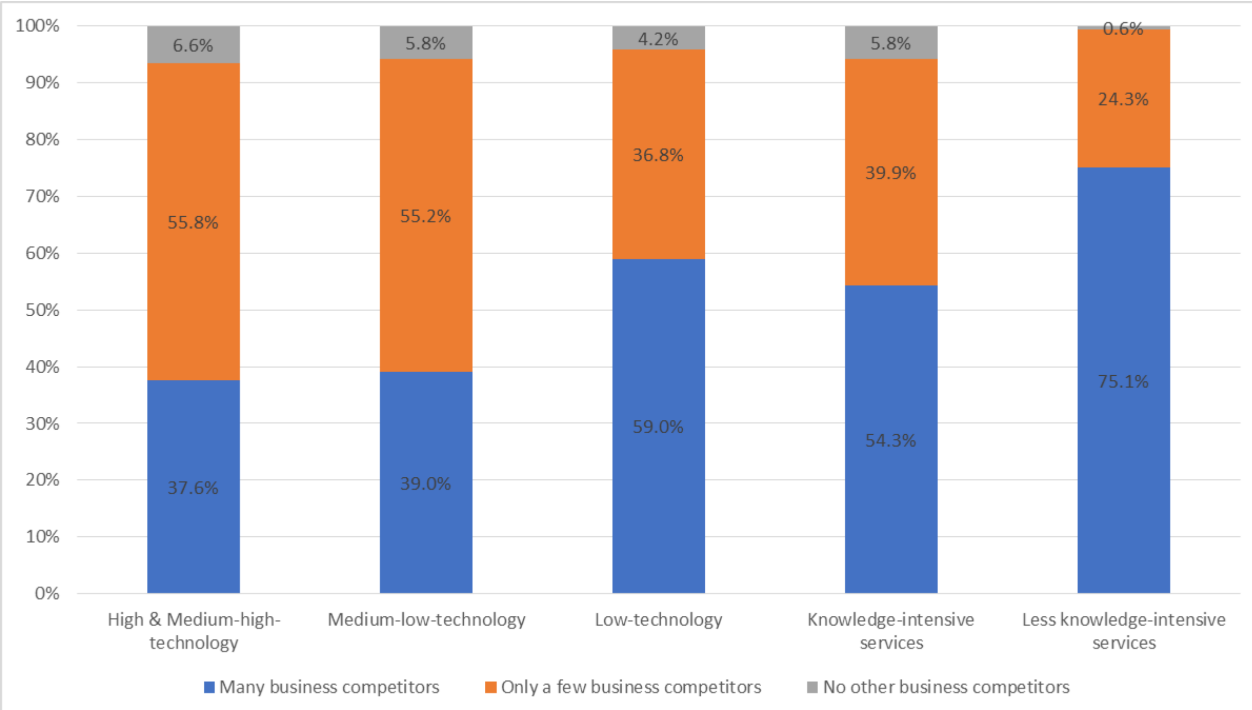
Figure 4.5 Competition intensity in the main market by sectoral group (manufacturing vs. services) [N = 1783]



Focusing on the sectoral dimension, in general, firms in services face more intense competition than firms in manufacturing. Almost 6 out of 10 service firms have many business competitors in their main market while the relevant share of manufacturing firms is 43.7% (**Figure 4.5**) [Pearson Chi-square, sig. < 0.001]. In terms of sector technology/knowledge intensity, **Figure 4.6** indicates that enterprises in less KIS demonstrate the highest competition intensity by far since 3 out of 4 firms state that they have many competitors and only 0.6% of them report "no competitor". The larger part of firms in LT (59%) and KIS (54.3%) report also "many business competitors" and, on the other hand, most firms in H&MHT and MLT (over 55%) have few competitors. Hence, the competition in sectors with lowest technology/knowledge intensity is higher, probably because firms in these sectors do not target niche markets that much[64].

[64] Pearson Chi-square coeff. (sig. < 0.001) for the chi-square test across categories and the chi-square test for each pair of these five categories (except for the comparison between H&MHT and MLT and the comparison between LT and KIS).

Figure 4.6 Competition intensity in the main market by sectoral group (technology/knowledge intensity) (N = 1783)



Furthermore, 12.8% of firms made Foreign Direct Investments (FDI) during the period 2017-2019. As expected, size matters. Among large firms the share of enterprises with FDI is 21.5%, while in the remaining size classes 15.2% of medium-sized firms and only 6.4% of small firms exhibit FDI activity (**Figure 4.7**)[65]. In terms of sector, more firms in manufacturing (14.4%) than firms in services (10.5%) make FDI investments [Pearson Chi-square, sig. < 0.05]. In addition, more technology/knowledge intensity sectors exhibit higher percentages, and the relevant differentiation is statistically significant especially within manufacturing (**Figure 4.8**)[66].

[65] Pearson Chi-square coeff. (sig. < 0.001) for the chi-square test across categories and between small firms and the other two categories. Pearson Chi-square coeff. (sig. < 0.05) for the comparison between medium-sized and large firms.

[66] Pearson Chi-square coeff. (sig. < 0.01) for the chi-square test across categories and the comparison of H&MHT with three categories (LT, KIS and less KIS).

Figure 4.7 % of firms with Foreign Direct Investments during the period 2017-2019 by size (N = 1788)

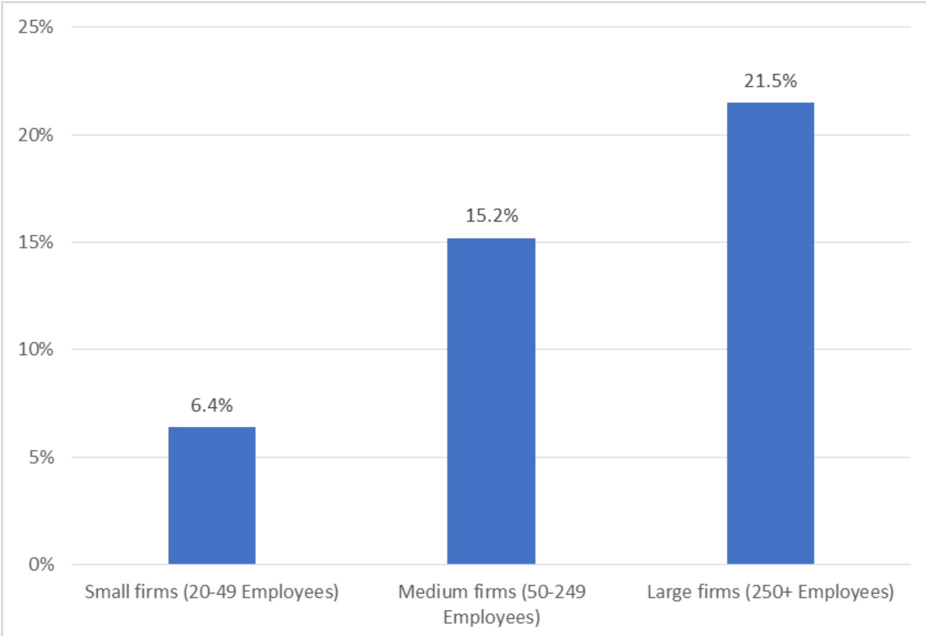
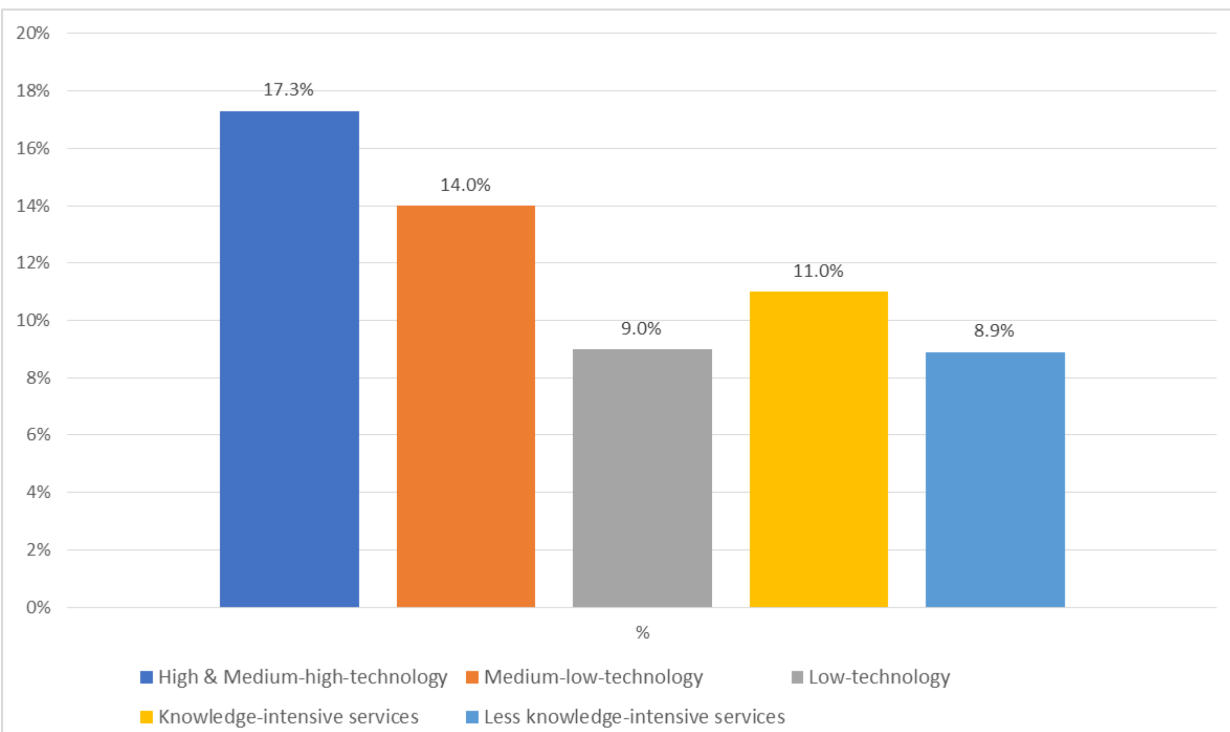


Figure 4.8 % of firms with Foreign Direct Investments during the period 2017-2019 by sectoral group (technology/knowledge intensity) [N = 1788]



4.2 Human and technological resources

Relating to firms' human resources, the survey examined the education level of employees as well as the number of employees involved in R&D activities. On average, the share of full-time employees with a university and postgraduate degree is 25% and 8.6% respectively (**Table 4.6**). In more detail, for the majority of firms (62.8%), the share of full-time employees with a university degree is less than or equal to 25%, while for only 15.6% of them this share exceeds 50%. Furthermore, approximately 4 out of 10 firms does not employee people with a post graduate degree, while for only a small portion of the sample firms (3.4%) the share of full-time employees with a post graduate degree overcomes 50% (**Table 4.7**).

Furthermore, on average, the share of full-time employees involved in R&D activities is 9.7% (**Table 4.6**). 31.1% of firms do not have R&D personnel. For an additional 27.3% of firms, the share of full-time employees engaged in R&D is up to 5%. For 23.7% of firms, the relevant share ranges between 5% and 15% and for the remaining firms (17.9%) exceeds 15% (**Table 4.8**).

Table 4.6 Education level of employees and engagement in R&D activities

% of full-time employees	Number of Firms	Mean	Median
with University Degree	1646	25.0%	16.0%
with Postgraduate Degree	1604	8.6%	2.0%
engaged in R&D activities	1764	9.7%	4.0%

Table 4.7 Employees with University or Postgraduate Degree as % of full-time employees

	Employees with University Degree		Employees with Postgraduate Degree	
	Number of Firms	% of Firms	Number of Firms	% of Firms
0%	74	4.5	619	38.6
0 < ≤ 25%	1033	62.8	831	51.8
25 < ≤ 50%	282	17.1	98	6.1
50 < ≤ 75%	149	9	28	1.7
75 < ≤ 100%	108	6.6	28	1.7

Table 4.8 Employees engaged in R&D activities as % of full-time employees

	Number of Firms	% of Firms
0%	549	31.1
0 < ≤ 5%	482	27.3
5 < ≤ 15%	418	23.7
15 < ≤ 25%	152	8.7
25 < ≤ 50%	96	5.4
50 < ≤ 100%	67	3.8

Table 4.9 presents the corresponding mean and median values in manufacturing and services. As expected, services have a much higher share of highly-educated staff as in manufacturing there is higher percentage of non-specialized workers. Moreover, within each sector category the difference between the mean and median values regarding employees with postgraduate degree is quite high. This reflects a large variation of enterprises as regards the employment of highly-specialized personnel. In addition, **Table 4A.1 in Appendix 4A** illustrates that sectors' technology/knowledge intensity is also important in that matter. As expected, firms operating in more technology/knowledge intensive sectors employ a higher share of well-educated staff.

Our results on R&D employees appear to be aligned with the findings presented in Section 3.2 on R&D investments. Manufacturing firms exhibit a twofold median value (in R&D employment) compared to service firms (4% and 2% respectively) whereas services have a fairly higher mean value (12.8%) than manufacturing (7.7%) [**Table 4.9**]. These figures can be interpreted by the fact that the share of manufacturing firms conducting R&D activities [in-house (63%) and externally (28%)] is much higher than the relevant share of service firms (43.7% and 19.7% respectively). On the other hand, relating to the specific subsample of firms that conduct investment in R&D, the expenditures intensity in services and specifically in KIS is much higher. The results included in **Table 4A.1 in Appendix 4A** complement the picture. Besides, **Table 4A.2 in Appendix 4A** presents the average share of full-time employees with university or postgraduate degree and the average share of employees involved in R&D activities by size class.

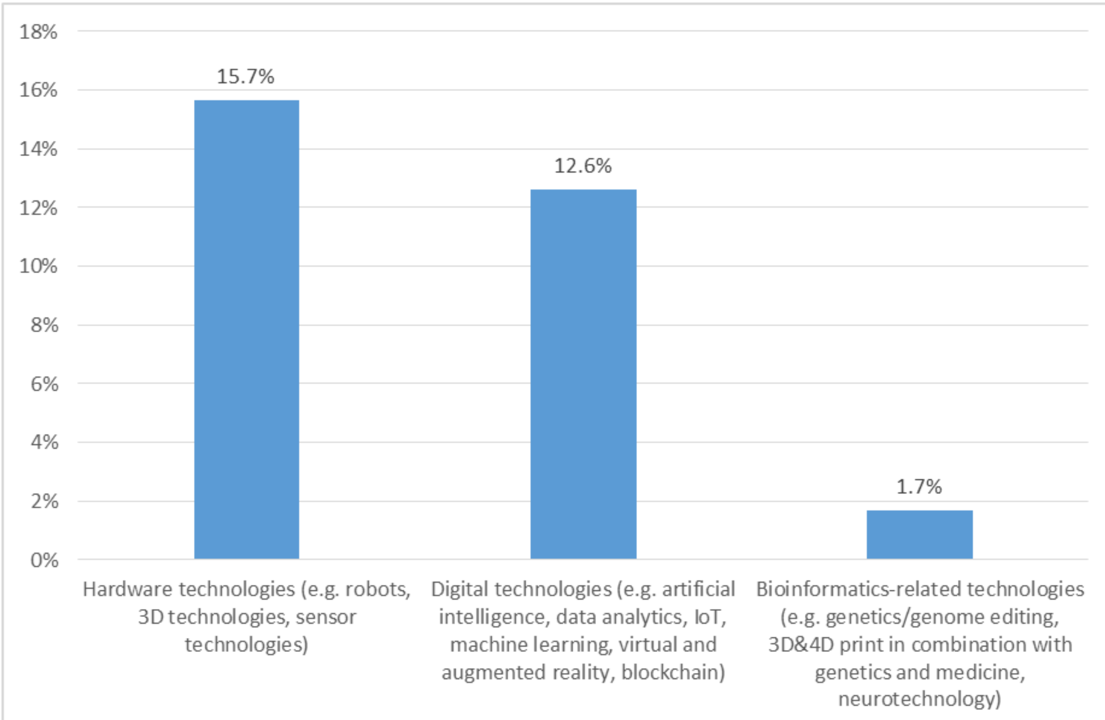
Table 4.9 Education level of employees and engagement in R&D activities by sectoral group (manufacturing vs. services)

% of full-time employees	Sectoral Group	Number of Firms	Mean	Median	T-test Sig.	Eta squared
with University Degree	Manufacturing	983	15.8%	11.0%	0.000	0.177
	Services	663	38.7%	33.0%		
with Postgraduate Degree	Manufacturing	978	4.8%	1.0%	0.000	0.064
	Services	626	14.5%	5.0%		
engaged in R&D activities	Manufacturing	1060	7.7%	4.0%	0.000	0.017
	Services	704	12.8%	2.0%		

Trying to extent the questionnaire's focus on advanced technological resources, a question that captures specific investment types in industry 4.0 technologies was included in the survey instrument. Taking into consideration that such investments are crucial in supporting and further fueling performance improvement and innovation, firms were asked to indicate the extent to which they made investments in three types of innovative Industry 4.0 technologies during the period 2017-2019. Only a small share of them reported investing in such technologies to a high extent (i.e., they have responded 4 or 5 on a five-point Likert type scale). Specifically, 15.7% of firms invested in innovative hardware technologies (e.g., robots, 3D technologies, sensor technologies), 12.6% in innovative digital technologies (e.g., artificial intelligence, data analytics, IoT, machine learning) and only 1.7% in bioinformatics-related technologies[67] (**Figure 4.9**).

[67] Surely, the last type of technologies is related to specific sectors.

Figure 4.9 Investments in Industry 4.0 technologies[68]



Comparing size categories, as expected, larger firms make higher investments (see **Table 4A.3 in Appendix 4A**). In terms of sector, firms in manufacturing spend quite more in innovative hardware technologies than firms in services. The opposite occurs for innovative digital technologies (**Table 4.10**). These findings seem reasonable based on the nature of each sectoral group's activities and specifically for digital technologies are in the same vein with the survey results on investments in software and databases. Furthermore, firms operating in more technology/knowledge intensity sectors make such investments to a much higher degree (see **Table 4A.4 in Appendix 4A**).

[68] Responses of 4 or 5 on a 5-point Likert-type scale, i.e., made investments to a large or great extent

Table 4.10 Investments in Industry 4.0 technologies by sectoral group (manufacturing vs. services)

	Sectoral Group	Number of Firms	High Extent[69] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
Hardware technologies (e.g., robots, 3D technologies, sensor technologies)	Manufacturing	1052	18.8%	2.20	0.000	0.040
	Services	685	10.8%	1.68		
Digital technologies (e.g. artificial intelligence, data analytics, IoT, machine learning, virtual and augmented reality, blockchain)	Manufacturing	1050	9%	1.77	0.000	0.023
	Services	703	18.1%	2.15		
Bioinformatics-related technologies (e.g. genetics/genome editing, 3D&4D print in combination with genetics and medicine, neurotechnology)	Manufacturing	965	0.9%	1.10	0.028	0.003
	Services	658	2.7%	1.16		

4.3 Organizational capabilities

This section includes the survey results regarding firms' dynamic, design and digital capabilities that were mainly measured through questions using a 5-point Likert-type scale.

4.3.1 Dynamic capabilities

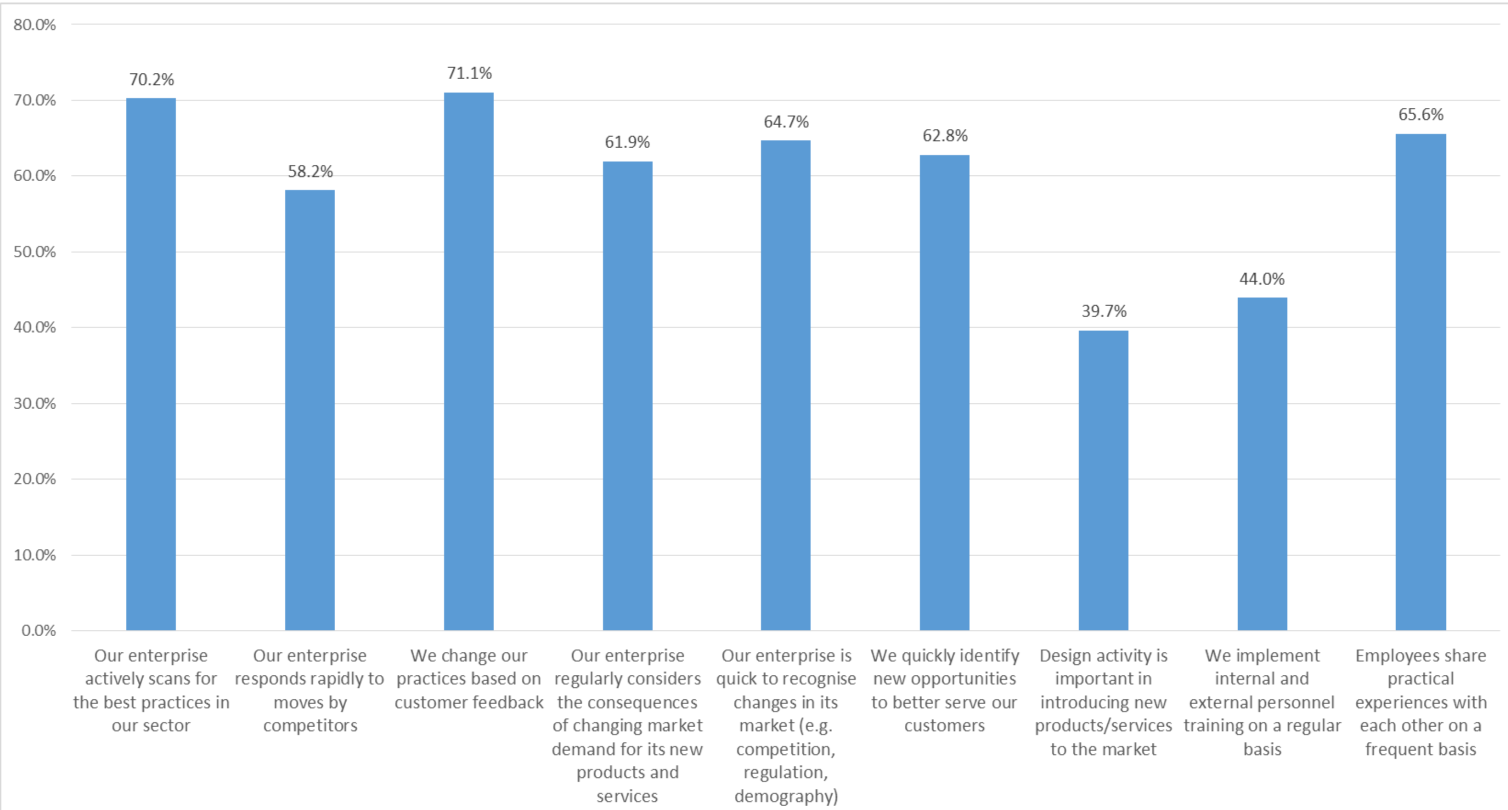
The first question attempts to gauge the enterprise's dynamic capabilities to sense and seize opportunities. Dynamic capabilities are used to explaining how organizations may continuously adapt and align their resources and capabilities to achieve long-term competitive advantage (Teece et al., 1997). Thus, we assume that such capabilities may affect investment decisions in IAs. Sensing dynamic capabilities includes all processes that help an organization collect and analyze market information and learn about customers and competitors. Seizing refers to addressing sensed opportunities "through new products, processes, or services" (Teece et al., 2007).

Figure 4.10 shows the share of firms that agree or strongly agree to the 9 items used to measure the specific question[70]. Specifically, approximately 60%-70% of firms agree with the statements that relate to the capability of sensing opportunities and changes in the market. Regarding learning and training capabilities, almost 2 out of 3 firms agree that "Employees share practical experiences with each other on a frequent basis" whereas a much lower percentage of firms implement internal and external personnel training on a regular basis (44%). In addition, a very high percentage of firms (71.1%) change their practices based on customer feedback. On the other

[69] Responses of 4 or 5 on a 5-point Likert-type scale.
[70] Namely, they responded 4 or 5 on the relevant 5-point Likert-type scale.

hand, a much lower share of firms (4 out of 10) report that "Design activity is important in introducing new products/services to the market".

Figure 4.10 Capabilities of sensing and seizing opportunities[71]



When comparing manufacturing and services, it appears that service firms conduct training and learning activities to a higher degree than manufacturing firms. They also scan the environment more actively for the best practices in their sectors and are quicker to recognize changes in their market and identify new opportunities to better serve their customers. On the other hand, more manufacturing firms consider design activity as important in introducing new products/services to the market (**Table 4.11**).

[71] Responses of 4 or 5 on a five-point Likert-type scale, i.e., agree or fully agree.

Table 4.11 Capabilities of sensing and seizing opportunities by sectoral group (manufacturing vs. services)

	Sectoral group	Number of Firms	Agreement[72] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
Our enterprise actively scans for the best practices in our sector	Manufacturing	1072	67.2%	3.89	0.000	0.012
	Services	716	74.9%	4.12		
Our enterprise responds rapidly to moves by competitors	Manufacturing	1067	57.5%	3.63	0.223	0.001
	Services	711	59.2%	3.69		
We change our practices based on customer feedback	Manufacturing	1074	71.2%	3.95	0.469	0.000
	Services	716	70.8%	3.91		
Our enterprise regularly considers the consequences of changing market demand for its new products and services	Manufacturing	1070	60.9%	3.72	0.338	0.001
	Services	714	63.4%	3.76		
Our enterprise is quick to recognize changes in its market (e.g., competition, regulation, demography)	Manufacturing	1074	61.1%	3.70	0.000	0.011
	Services	717	70.2%	3.91		
We quickly identify new opportunities to better serve our customers	Manufacturing	1074	59.4%	3.70	0.000	0.008
	Services	715	68.0%	3.86		
Design activity is important in introducing new products/services to the market	Manufacturing	1056	42.8%	3.14	0.000	0.008
	Services	701	35.0%	2.90		
We implement internal and external personnel training on a regular basis	Manufacturing	1075	39.2%	3.20	0.000	0.016
	Services	717	51.2%	3.50		
Employees share practical experiences with each other on a frequent basis	Manufacturing	1072	61.0%	3.71	0.000	0.019
	Services	717	72.5%	3.99		

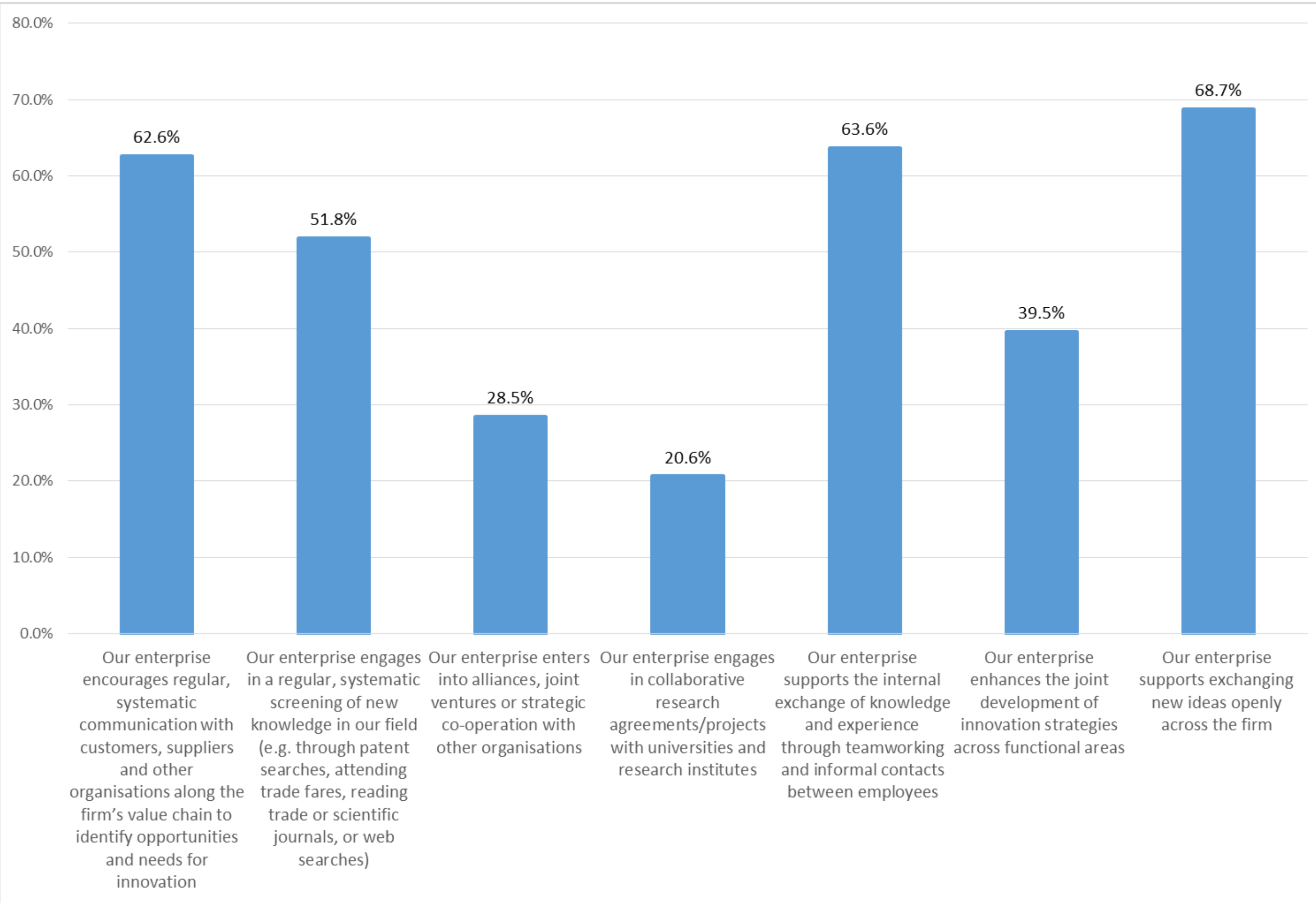
All firms are engaged in knowledge interactions both internally and with external actors (e.g., suppliers, customers, competitors, other organizations such as universities and research centers etc.) that enable or constrain the acquisition, transfer, and creation of new knowledge. These knowledge flows, in turn, shape their intentions to innovate. The subsequent question refers to dynamic capabilities related to the acquisition and exchange of new knowledge.

The largest portion of the samlpe firms seem to acquire new knowledge by encouraging cooperation with external actors across their value chain (62.6%) and systematic screening of their

[72] Responses of 4 or 5 on a five-point Likert-type scale.

field (e.g., through patent searches, attending trade fares, reading trade or scientific journals, or web searches) (51.8%). In addition, many firms (68.7%) seem to support the internal exchange of knowledge and ideas. However, a much lower percentage of firms (39.5%) enhance the joint development of innovation strategies across functional areas. Moreover, networking capabilities such as strategic cooperations/alliances with other organizations and collaborative research agreements with universities and research institutes, are far less popular knowledge acquisition practices among firms (**Figure 4.11**).

Figure 4.11 Knowledge acquisition capabilities[73]



In terms of sectors, firms in services exhibit higher level of knowledge acquisition capabilities compared to manufacturing firms and the differentiation between the two sectoral groups is statistically significant for all variables (items) except for these that refer to the communication

[73] Responses of 4 or 5 on a five-point Likert-type scale, i.e., agree or strongly agree.

with customers, suppliers and other organizations, and to the engagement in collaborative research agreements/projects with universities and research institutes (**Table 4.12**). It appears that systematic communication with external actors is equally important for both sectoral groups, while collaboration with academic institutions does not seem to be a high priority for manufacturing and services' firms as well.

Table 4.12 Knowledge acquisition capabilities by sectoral group (manufacturing vs. services)

	Sectoral Group	Number of Firms	Agree-ment[74] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
Our enterprise encourages regular, systematic communication with customers, suppliers and other organizations along the firm's value chain to identify opportunities and needs for innovation	Manufacturing	1071	61.7%	3.72	0.254	0.001
	Services	714	64.0%	3.77		
Our enterprise engages in a regular, systematic screening of new knowledge in our field (e.g,. through patent searches, attending trade fares, reading trade or scientific journals, or web searches)	Manufacturing	1074	49.0%	3.43	0.001	0.007
	Services	715	56.1%	3.60		
Our enterprise enters into alliances, joint ventures or strategic co-operation with other organizations	Manufacturing	1059	24.2%	2.48	0.000	0.020
	Services	711	34.9%	2.86		
Our enterprise engages in collaborative research agreements/projects with universities and research institutes	Manufacturing	1058	20.2%	2.25	0.251	0.001
	Services	706	21.2%	2.17		
Our enterprise supports the internal exchange of knowledge and experience through teamworking and informal contacts between employees	Manufacturing	1075	58.1%	3.65	0.000	0.025
	Services	717	71.8%	3.98		
Our enterprise enhances the joint development of innovation strategies across functional areas	Manufacturing	1059	36.0%	3.17	0.005	0.004
	Services	711	44.9%	3.31		
Our enterprise supports exchanging new ideas openly across the firm	Manufacturing	1074	64.8%	3.81	0.000	0.014
	Services	717	74.6%	4.05		

[74] Responses of 4 or 5 on a five-point Likert-type scale, i.e., agree or strongly agree.

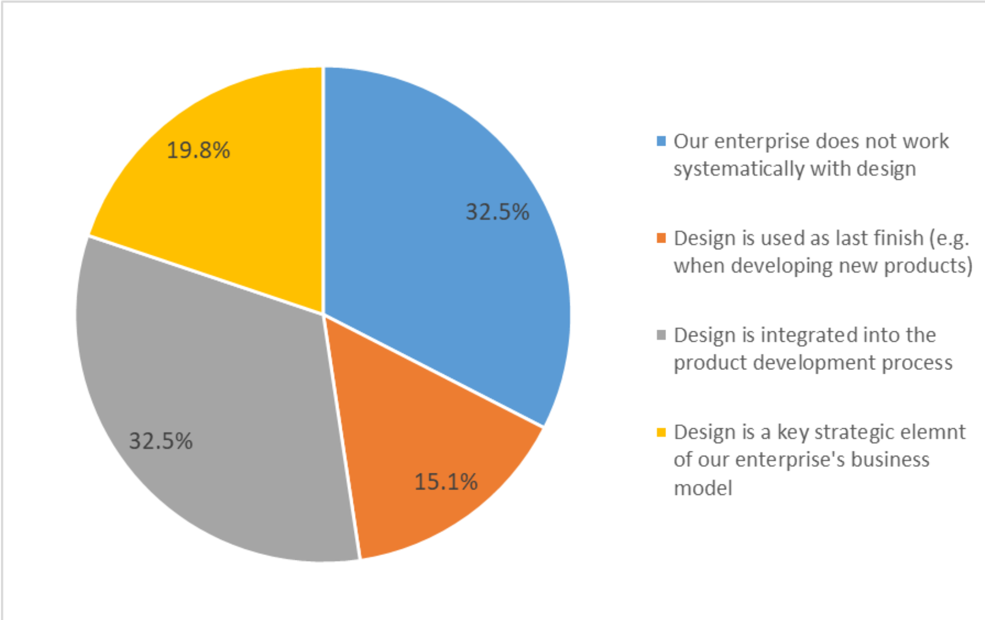
4.3.2 Design capabilities

Recently, there has been a radical shift in the understanding of design, away from "designing things" to "design thinking". This shift can be conceived as an evolution from viewing design as the creation of artefacts, to design as a problem-solving activity, to design as making sense of things, and, finally, to design as a key input to strategy. Therefore, enterprises' use of design and their relevant design capabilities can take on a variety of forms.

The importance of design capabilities to a firm's overall business strategy can be identified through questions that position a firm on a "Design Ladder", a concept developed by the Danish Design Centre (Galindo-Rueda and Millot, 2015) following four categories. In the first category design is not applied systematically (for instance, design is an invisible part of, e.g., product development and the task is not handled by trained designers). In the second category, design is used as a final form-giving or styling to new products or services. The design task may be carried out by professional designers but is typically handled by people with other professional backgrounds. In the third category design, is integrated at an early stage in the development process, is driven by the problem and the users require a wide variety of skills (e.g., process and material technicians, marketing experts and administrative employees). In the last category, the design is a key strategic element in the business process in relation to the enterprise's business visions and future role in the value chain. The designer collaborates with the enterprise's management to rethink the business concept either in part or as whole.

This section includes a question that examines how firms approach the use of design following the design ladder categories mentioned above. Almost 1 out of 3 firms responded that they do not work systematically with design and another 15.1% that design is used as last finish (e.g., when developing new products). However, the majority of firms use design more systematically as they reported that design is integrated into the product development process (32.5%) or even that design is a key strategic element of their business model (19.8%) [**Figure 4.12**].

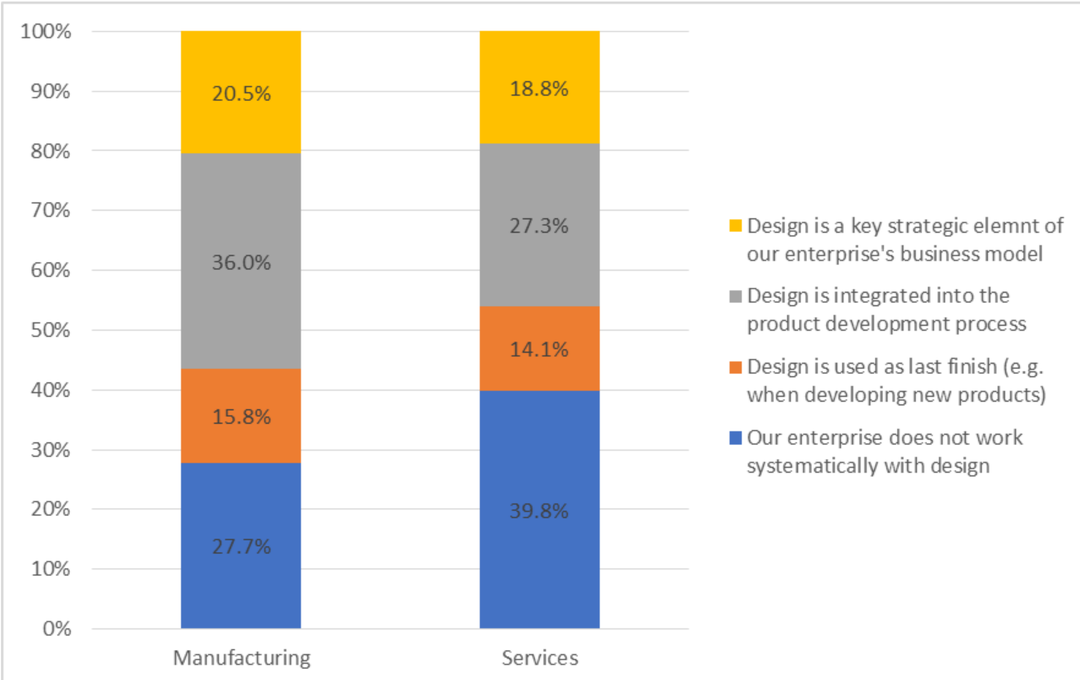
Figure 4.12 Design use in the enterprise (N = 1749)



Design use does not seem to be differentiated across firm size classes (**Figure 4A.2 in Appendix 4A**)[75] while the opposite applies in terms of sectors (Pearson Chi-square, sig. < 0.001). More specifically, a higher share of firms in services (39.8%) compared to manufacturing (27.7%) reported that they do not work systematically with design, and a quite higher share of manufacturing firms also conveyed that design is integrated into their product development process (36%) whereas the relevant percentage of service firms is 27.3% (**Figure 4.13**). This finding is aligned with previous results related to sensing and seizing opportunities (more firms in manufacturing view design activity as an important tool for introducing new products/services to the market) (**Table 4.11**) and the fact that more manufacturing firms (35%) make investments in design activities compared to service firms (30.5%) [Section 3.6].

[75] Pearson Chi-square coeff. (sig. > 0.05) for the chi-square test across categories and as the chi-square test for each pair of these three categories.

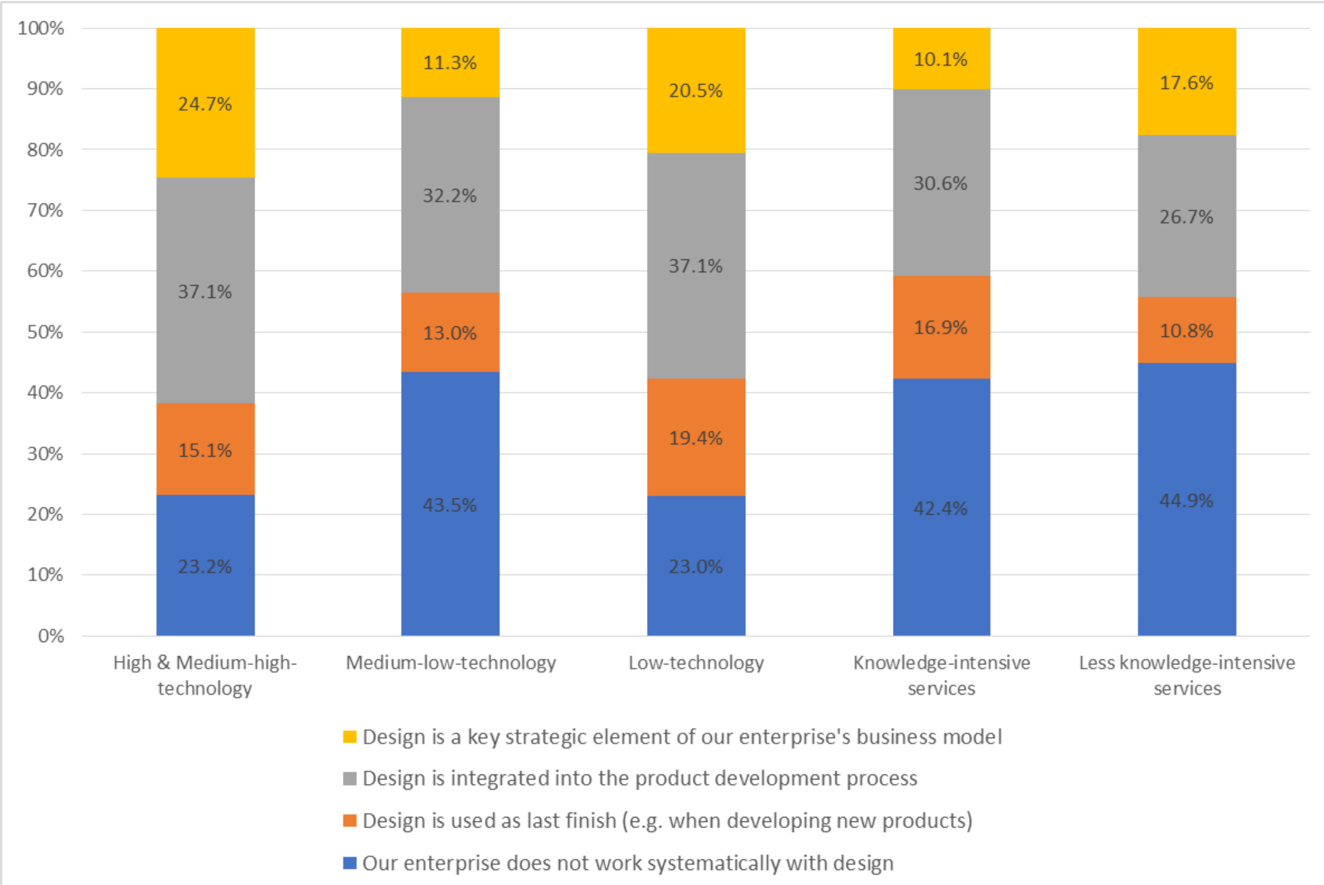
Figure 4.13 Design use in the enterprise by sectoral group (manufacturing vs. services) [N = 1749]



In terms of sector technology/knowledge intensity, for 61.8% of firms in H&MHT and for 57.6% of firms in LT, design use is an important aspect of their operation or even their strategy i.e., design is part of their product development process (37.1%) or is a key strategic element of their business model (24.7% and 20.5%). On the other hand, for the larger part of firms in MLT (56.5%), KIS (59.3%) and in KIS (55.7%), design use is not considered as an important element of their operation and strategy (**Figure 4.14**)[76]. These findings corroborate with the results of Section 3.6 showing that H&MHT and LT exhibit higher percentages of firms with investments in design.

[76] Pearson Chi-square coeff. (sig. < 0.001) for the total chi-square test across categories and the majority of chi-square tests for each pair of these five categories.

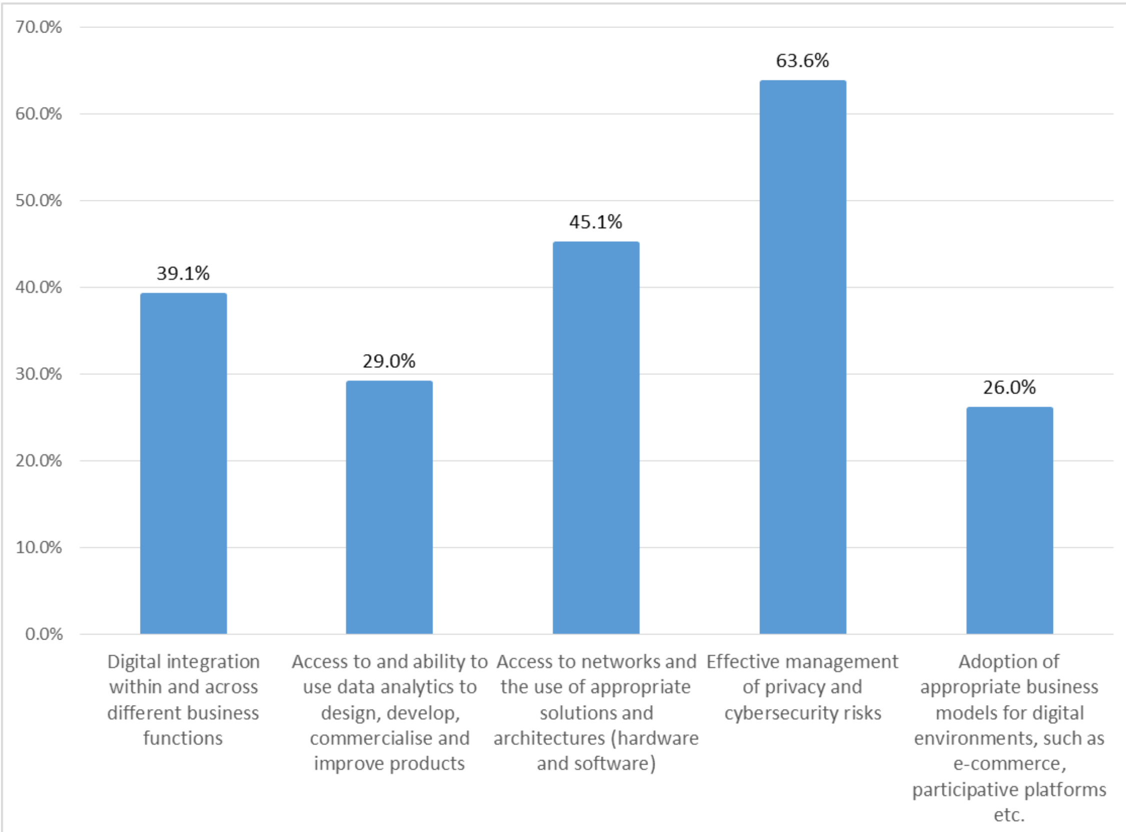
Figure 4.14 Design use in the enterprise by sectoral group (technology/knowledge intensity) [N = 1749]



4.3.3 Digital capabilities

Digital capabilities capture the ability of a firm to benefit from digitalization and address associated challenges. A question was included to the survey instrument to capture the extent to which an enterprise has developed several digital capabilities. In this respect, it focuses on specific digital capabilities as a key component of firms' innovation capabilities taking into consideration that the development, maintenance, and exercise of digital capabilities is shaped by ICT and digital resources/technologies. Therefore, it is assumed that a firm with advanced digital capabilities invests more in ICT resources and, in consequence, has the ability to connect various business activities and business functions (production/delivery of services, logistics, marketing/sales, product development, administration) forming an integrated system with structured data exchanges among different functions and units and digital connections with suppliers and customers. The development of the relevant scale was based on the concept of digital competence as introduced by Oslo Manual (OECD/Eurostat, 2018).

Figure 4.15 Digital capabilities development[77]



Firms were asked to evaluate – through a 5-point Likert-type scale - the extent to which they have developed specific digital capabilities[78]. Almost 2 out of 3 firms of the total sample seem to have a well-developed capability regarding the effective management of privacy and cybersecurity risks. In addition, less than half of the firms seem to have developed a digital integration capability within and across different business functions (39.1%) and a capability of accessing networks and using appropriate solutions and architectures (45.1%). Furthermore, much lower is the share of firms which have developed high-level capabilities relating to data analytics access and use (29%) or have adopted appropriate business models for digital environments to high degree (26%) [**Figure 4.15**]. In terms of sectors, firms in services have higher digital capabilities than firms in manufacturing, especially as regards the adoption of business models for digital environments (**Table 4.13**). This fact is aligned with the higher investments of service firms in software and databases as well as in innovative digital technologies (artificial intelligence, machine learning etc.) compared to manufacturing.

[77] Responses of 4 or 5 on a five-point Likert-type scale, i.e., to a large or great extent.
[78] We used the indicators proposed by the Oslo Manual (OECD/Eurostat, 2018) for measuring digital competence.

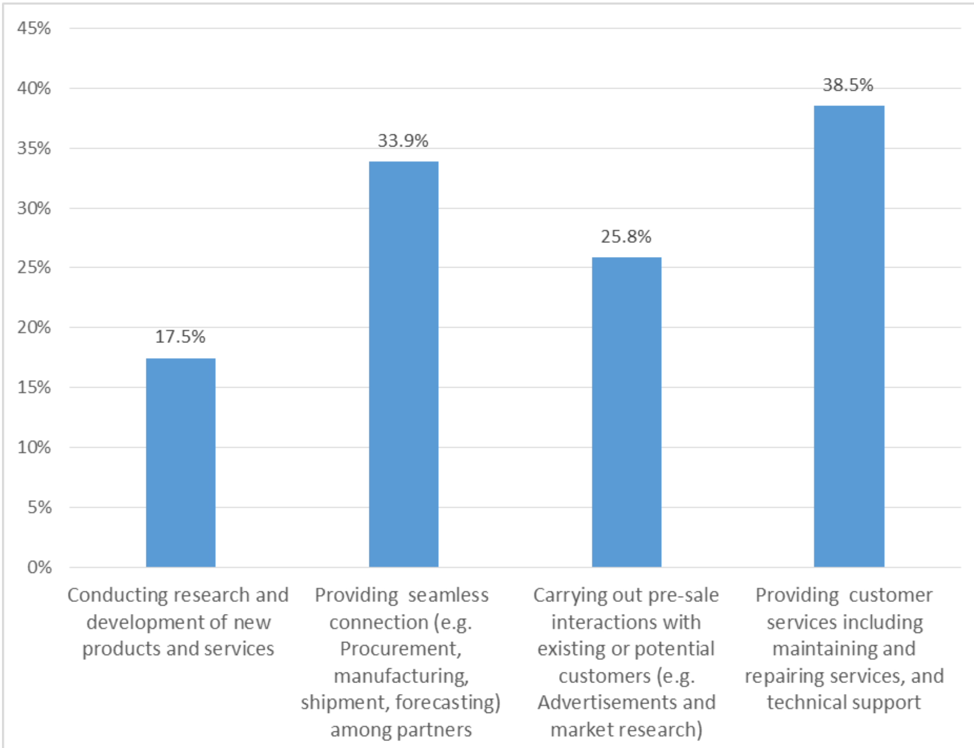
Table 4.13 Digital capabilities development by sectoral group (manufacturing vs. services)

	Sectoral Group	Number of Firms	High Extent[79] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
Digital integration within and across different business functions	Manufacturing	1054	33.6%	3.00	0.000	0.020
	Services	705	47.4%	3.33		
Access to and ability to use data analytics to design, develop, commercialize and improve products	Manufacturing	1046	24.8%	2.66	0.000	0.015
	Services	703	35.3%	2.96		
Access to networks and the use of appropriate solutions and architectures (hardware and software)	Manufacturing	1057	39.6%	3.10	0.000	0.023
	Services	708	53.2%	3.46		
Effective management of privacy and cybersecurity risks	Manufacturing	1067	58.8%	3.63	0.000	0.018
	Services	715	70.9%	3.92		
Adoption of appropriate business models for digital environments, such as e-commerce, participative platforms etc.	Manufacturing	1046	18.5%	2.42	0.000	0.056
	Services	702	37.2%	3.02		

Digital platforms integrate producers and users at various stages of the value chain. They often form an ecosystem in which new products are developed and sold, and data generated and exchanged. Strong use of digital platforms suggests a greater propensity to invest in relevant supportive ICT and digital resources. Data on the participation of firms in digital platform activities can provide information on the firm's potential to leverage the business opportunities of digital technologies which is much more important than just investing in digital technologies. The relevant scale to measure the multifaceted digital platform construct was developed by partners and aimed at measuring several aspects of digital platforms use by enterprises.

[79] Responses of 4 or 5 on a five-point Likert-type scale.

Figure 4.16 Digital platforms' use[80]



In general, the use of digital platforms is rather limited among the sample firms in all application fields examined. They use digital platforms primarily for providing customer services [(maintaining/repairing services, technical support etc. (approx. 38% of sample firms reported an extensive use, i.e., reported 4 or 5 on the relevant scale)]. In addition, 1 out of 3 firms use digital platforms for providing seamless connection with their partners, and 1 out of 4 firms for carrying out pre-sale interactions with existing or potential customers. Moreover, the percentage of firms that conduct R&D by using digital platforms is smaller than 18% (**Figure 4.16**). With regard to sectors, firms in services appear to use digital platforms to a higher degree than firms in manufacturing for 3 out of 4 fields. More specifically, differences between sectors are statistically significant when using digital platforms for conducting R&D or for carrying out pre-sale interactions with existing or potential customers. Manufacturing exhibits higher values regarding digital platforms' use for providing seamless connection among partners (**Table 4.14**).

[80] Responses of 4 or 5 on a five-point Likert-type scale, i.e., to a large or great extent.

Table 4.14 Digital platforms' use by sectoral group (manufacturing vs. services)

	Sectoral Group	Number of Firms	High Extent[81] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
Conducting research and development of new products and services	Manufacturing	1046	14.2%	2.14	0.000	0.010
	Services	707	22.2%	2.39		
Providing seamless connection (e.g., procurement, manufacturing, shipment, forecasting) among partners	Manufacturing	1061	34.5%	2.98	0.002	0.006
	Services	696	32.9%	2.79		
Carrying out pre-sale interactions with existing or potential customers (e.g., advertisements and market research)	Manufacturing	1052	22.1%	2.59	0.000	0.010
	Services	705	31.3%	2.84		
Providing customer services including maintaining and repairing services, and technical support	Manufacturing	1039	36.4%	2.95	0.111	0.001
	Services	696	41.7%	3.05		

[81] Responses of 4 or 5 on a five-point Likert-type scale.

5. Firm performance (Section D of the Questionnaire)

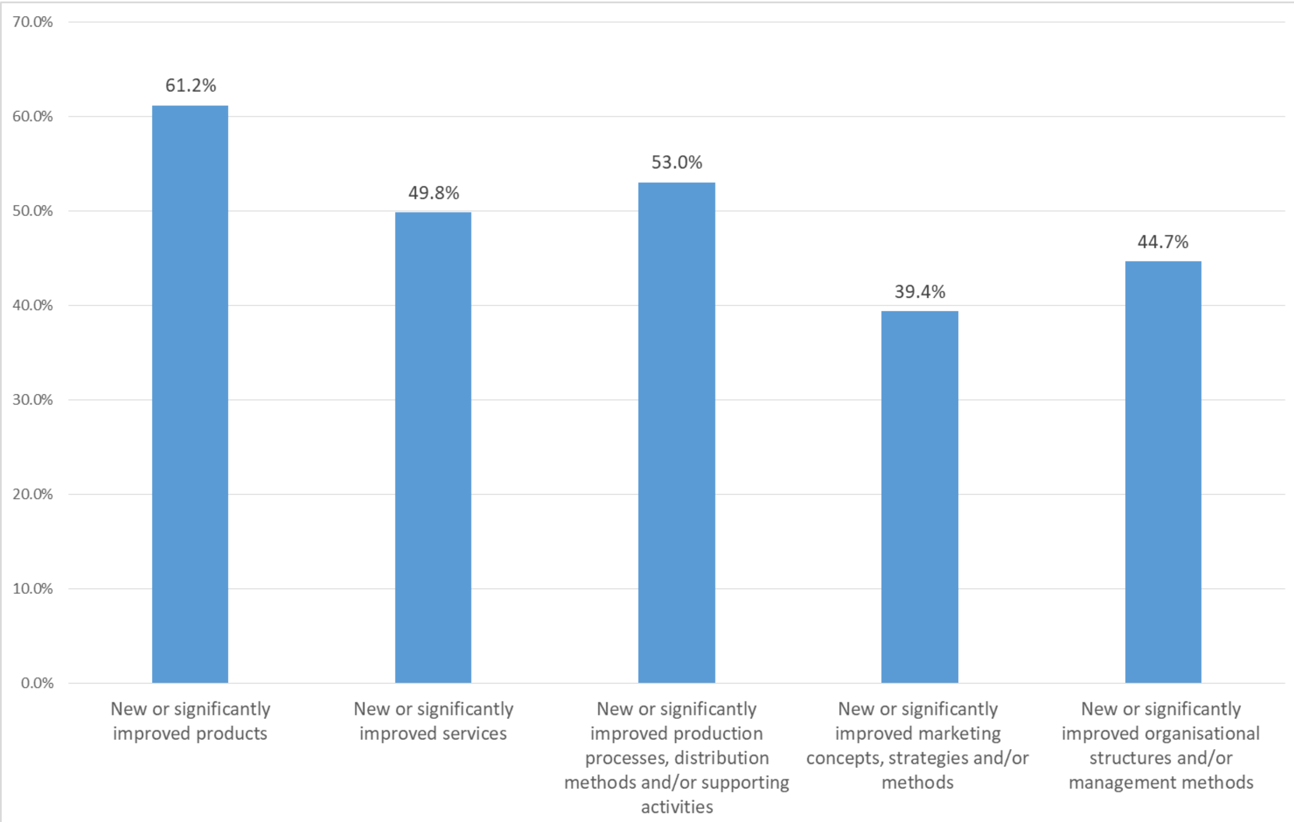
This part of the questionnaire attempts to identify the innovative capacity and performance of firms. More specifically, it addresses the introduction of new or significantly improved products and services and their contribution to firm sales, the introduction of organizational, marketing and process innovations, and the impact of investments in intangible assets on the economic performance of enterprises.

5.1 Innovation performance

The innovation performance of firms was measured by adopting the widespread approach used by CIS (Community Innovation Survey) and investigates the introduction of different types of innovation during the past three years (i.e., 2017-2019). A product or service innovation involves the introduction into the market of new or significantly improved products or services. A new product or service is a product whose technological characteristics or intended uses differ significantly from those of previously produced products or services. An improved product or service is an existing product whose performance has been significantly enhanced or updated. Process innovations involve all new or significantly improved production and delivery methods and other ancillary support activities aimed at decreasing unit costs or increasing product or service quality. Organizational innovations are related to the implementation of new or significant changes in firm structure or management methods that are intended to improve the in-house use of knowledge, the quality of goods and services, or the efficiency of workflows. Marketing innovations are related to the implementation of new or significant change in marketing methods, pricing strategies and methods, and sales and after-sales activities (Oslo Manual, 2018).

More than 6 out of 10 firms of the survey sample have introduced a product innovation, 53% of them have introduced a process innovation and half of the firms have launched a service innovation. Organizational innovation follows with 44.7% whereas marketing innovation exhibits the lowest percentage (39.4%) [**Figure 5.1**]. Furthermore, 11.5% of the survey firms introduced all these five innovation types and 12.4% of the firms did not introduce any innovation in the period examined.

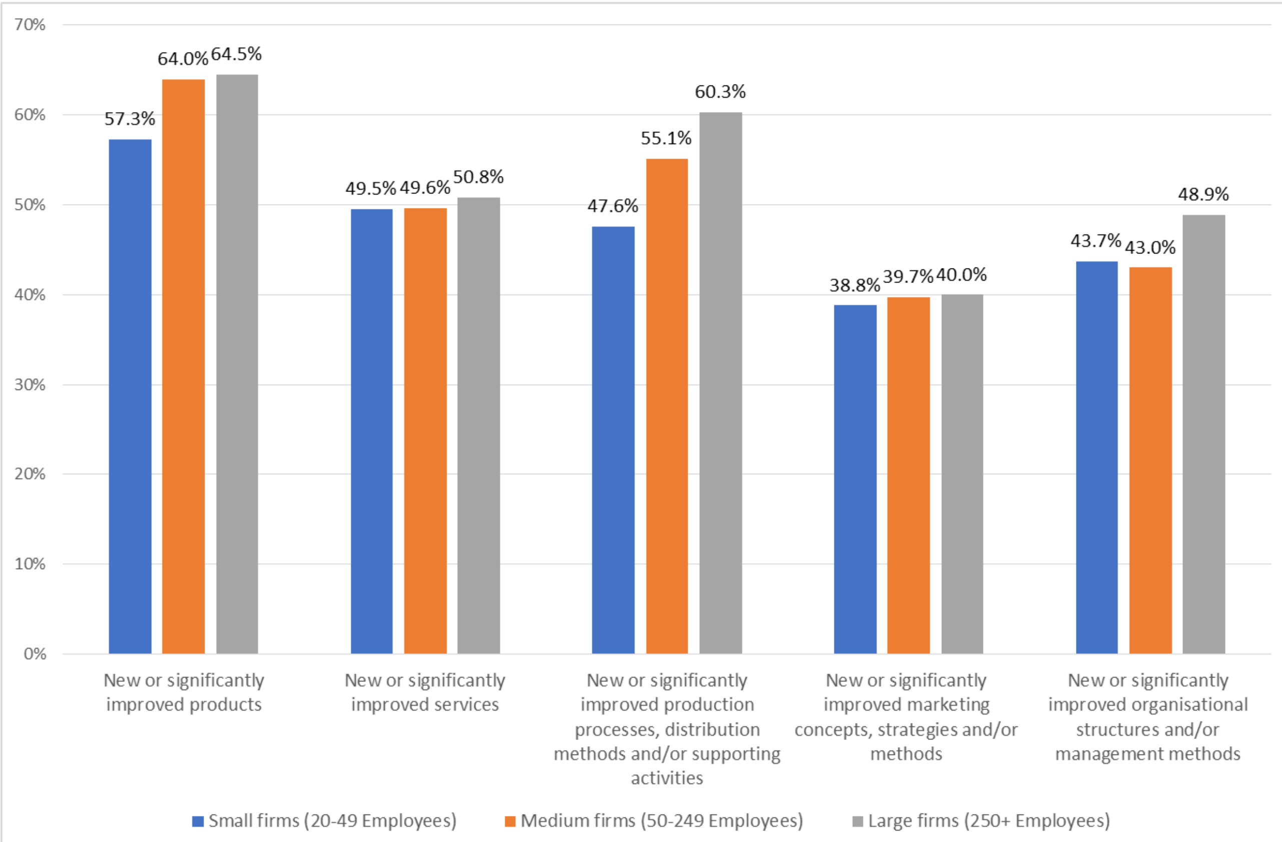
Figure 5.1 Introduction of innovations (2017-2019) [N = 1791]



In terms of firm size, size matters mainly for product and process innovation. Large and medium-sized firms are more frequent product innovators than small firms[82]. Moreover, large firms are more frequent process innovators (60.3%) compared to medium-sized enterprises (55.1%) which in turn exhibit a better record of process innovation in relation to small firms (47.6%)[83] [**Figure 5.2**].

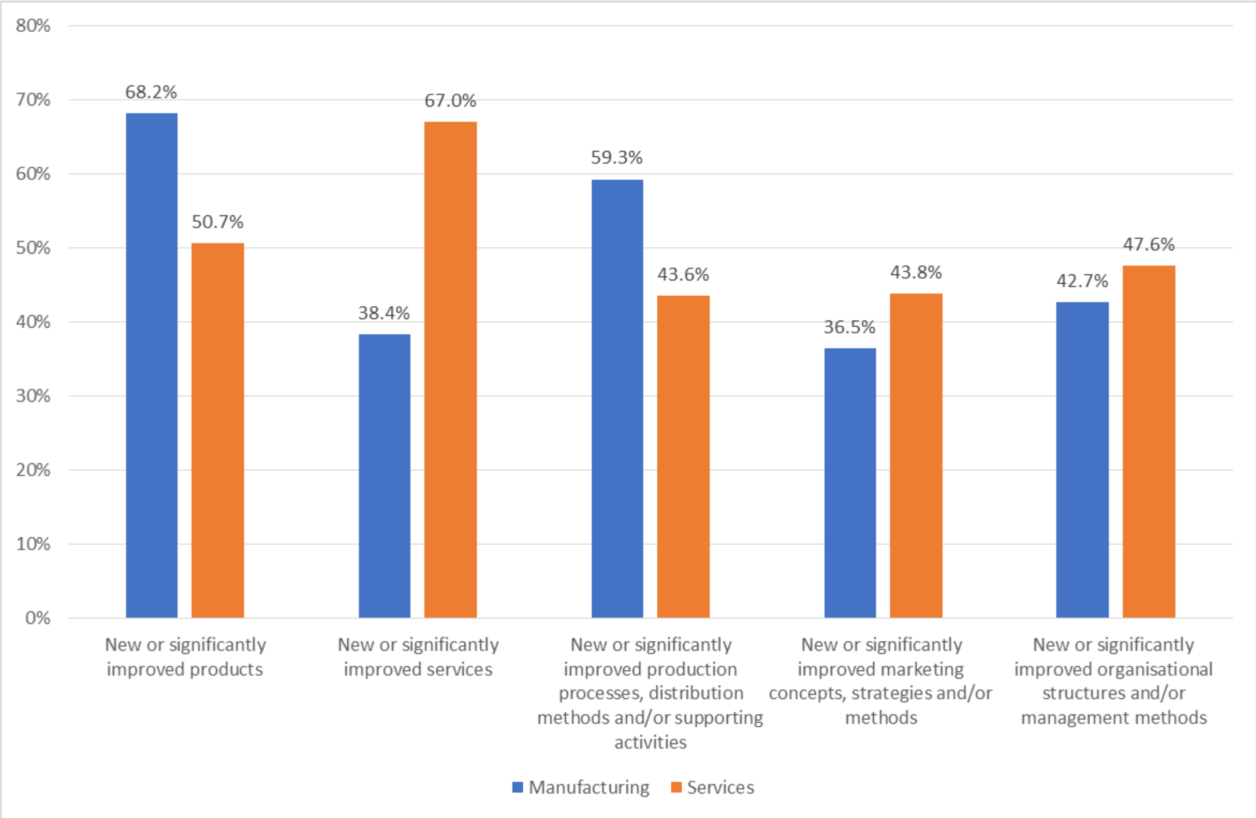
[82] Pearson Chi-square coeff. (sig. < 0.05) for the total chi-square test across categories and between small firms and the other two categories.
[83] Pearson Chi-square coeff. (sig. < 0.001) for the chi-square test across categories and the comparison between small and large firms. Pearson Chi-square coeff. (sig. < 0.01) for the comparison between small and medium-sized firms.

Figure 5.2 Introduction of innovations (2017-2019) by firm size (N = 1791)



In terms of sector, as expected, firms in manufacturing are more frequent product and process innovators whereas services demonstrate a much higher percentage in service innovation (Pearson Chi-square, sig. < 0.001). Firms in services introduce more marketing (Pearson Chi-square, sig. < 0.01) and organizational innovations (Pearson Chi-square, sig. < 0.05) as well (**Figure 5.3)**.

Figure 5.3 Introduction of innovations (2017-2019) by sectoral group (manufacturing vs. services) [N = 1791]

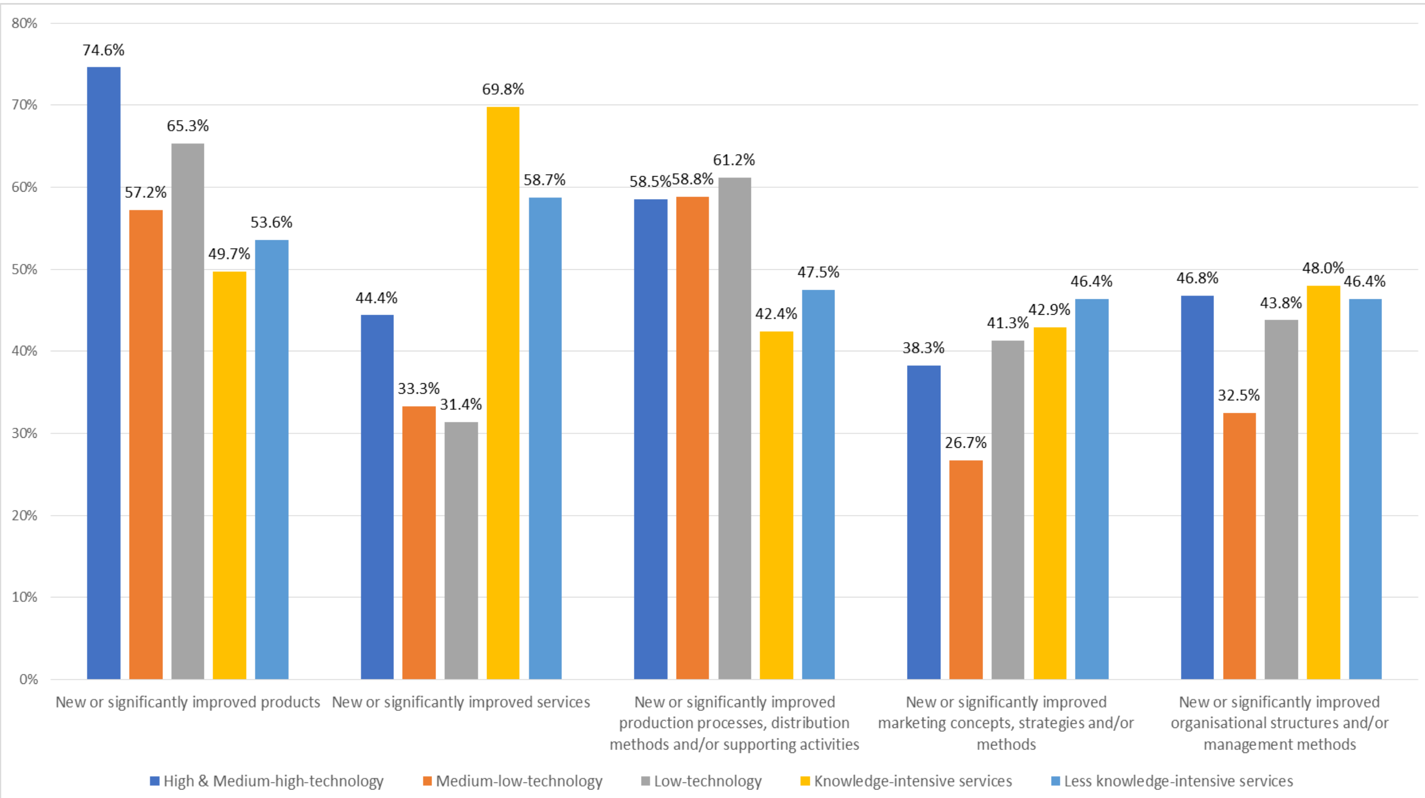


With regard to the sector technology/knowledge intensity, 3 out of 4 firms in H&MHT and 2 out of 3 firms in LT introduce a product innovation whereas MLT has the lowest share of manufacturing firms with product innovation (57.2%)[84]. Regarding service innovation, as expected, more firms in KIS (69.8%) have introduced innovations compared to less KIS (58.7%)[85]. In addition, the corresponding percentage of H&MHT is higher compared to remaining manufacturing groups[86]. Regarding process innovation, there is no significant differentiation between sectoral groups in manufacturing,[87] whereas less KIS firms (47.5%) exhibit somewhat higher percentage than KIS (42.4%), probably due to the nature of less KIS' activities i.e., wholesale and retail trade often need to improve their distribution methods. However, this differentiation

[84] Pearson Chi-square coeff. (sig. < 0.01) for the comparison between H&MHT and the other two manufacturing groups.
[85] Pearson Chi-square coeff. (sig. < 0.01) for the comparison between KIS and less KIS.
[86] Pearson Chi-square coeff. (sig. < 0.01) relating to the comparison between H&MHT and the other two sectoral groups in manufacturing.
[87] Pearson Chi-square coeff. (sig. > 0.05) for each pair of sectoral groups in manufacturing.

is not statistically significant[88]. Furthermore, a quite low share of firms in MLT has introduced marketing and organizational innovations compared to the other sectoral groups[89] (**Figure 5.4**).

Figure 5.4 Introduction of innovations (2017-2019) by sectoral group (technology/knowledge intensity) [N = 1791]



Among the 1138 firms that introduced product and/or service innovation, the average share of new or significantly improved products and/or services to total turnover is 18.14% (median = 10%). In terms of size, small firms have a higher mean and median value than medium-sized and large firms (**Table 5.1**)[90].

When comparing manufacturing and services, there is a small differentiation regarding the mean value i.e., 19.7% in services and 17.1% in manufacturing (**Table 5.2**). Furthermore, focusing on a lower level of analysis, the share of innovative products/services to total business turnover is

88 Pearson Chi-square coeff. (sig. > 0.05) for the comparison between KIS and less KIS.
89 Pearson Chi-square coeff. (sig. < 0.01) regarding the comparison between MLT and the other sectoral groups for marketing and organizational innovation.
90 Post-hoc analysis (sig. < 0.01) regarding the comparison between small firms and the other two size categories.

higher in firms that belong to more technology/knowledge intensive sectors (i.e. H&MHT and KIS) [**Table 5.3**][91].

Table 5.1 Share of new or significantly improved products and/or services to total turnover by firm size

Size Category	Number of Firms	Mean	Median	ANOVA Sig.	Eta squared
Small firms (20-49 Employees)	493	21.0%	15.0%	0.000	0.016
Medium firms (50-249 Employees)	381	16.7%	10.0%		
Large firms (250+ Employees)	264	15.0%	10.0%		

Table 5.2 Share of new or significantly improved products and/or services to total turnover by sectoral group (manufacturing vs. services)

Sectoral Group	Number of Firms	Mean	Median	T-test Sig.	Eta squared
Manufacturing	685	17.1%	10.0%	0.049	0.003
Services	453	19.7%	10.0%		

Table 5.3 Share of new or significantly improved products and/or services to total turnover by sectoral group (technology/knowledge intensity)

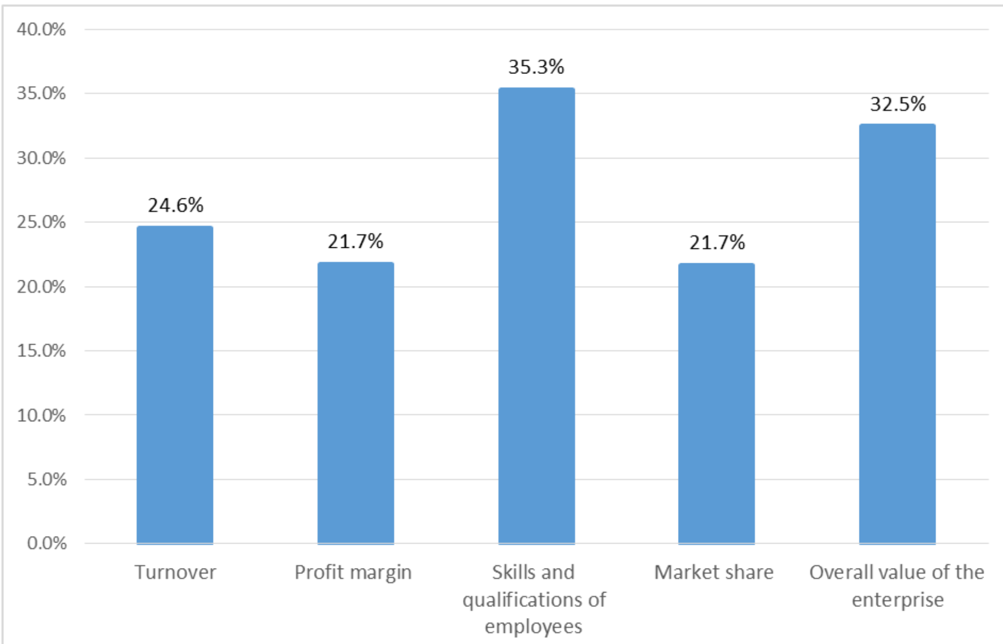
Sectoral Group	Number of Firms	Mean	Median	ANOVA Sig.	Eta squared
High & Medium-high-technology	355	20.2%	15.0%	0.000	0.033
Medium-low-technology	147	12.4%	10.0%		
Low-technology	183	14.9%	10.0%		
Knowledge-intensive services	341	21.7%	10.0%		
Less knowledge-intensive services	112	13.4%	10.0%		

[91] Post-hoc analysis (sig. < 0.01) regarding the comparison between either H&MHT or KIS and the other three categories.

5.2 Economic performance

Furthermore, firms were asked to estimate – through a 5-point Likert-type scale - to what extent they benefited from investments in intangible assets made in 2017-2019 in terms of economic indicators (i.e., turnover, profit margin, market share), the overall value of the enterprise and the skills and qualifications of employees. In their majority firms seem to benefit to a relatively low or moderate extent from investments in IAs. Higher percentages are observed regarding the skills and qualifications of employees (35.3%) and the overall value of the firm (32.5%), probably due to the more direct relationship of these variables to investments in intangible assets (**Figure 5.5**).

Figure 5.5 Benefits from investments in intangible assets made in 2017-2019[92] (N = 1697 – 1741)



Focusing on sectoral groups, firms in services seem to benefit more in terms of skills and qualifications of employees, market share and their overall value (**Table 5.4**). In addition, firms in more technology/knowledge intensive sectors (i.e., H&MHT and KIS) benefit to a higher degree in terms of employees' skills and the enterprise's overall value (**Table 5A.1 in Appendix 5A**). Finally, there is no differentiation between size categories in all types of benefits (**Table 5A.2 in Appendix 5A**).

[92] Responses of 4 or 5 on a five-point Likert-type scale.

Table 5.4 Benefits from investments in intangible assets made in 2017-2019 by sectoral group (manufacturing vs. services)

	Sectoral Group	Number of Firms	High Extent[93] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
Turnover	Manufacturing	1029	24.0%	2.63	0.154	0.001
	Services	695	25.5%	2.72		
Profit margin	Manufacturing	1021	22.4%	2.59	0.558	0.000
	Services	676	20.7%	2.63		
Skills and qualifications of employees	Manufacturing	1040	31.2%	2.91	0.000	0.012
	Services	701	41.5%	3.16		
Market share	Manufacturing	1020	20.3%	2.51	0.046	0.002
	Services	678	23.7%	2.63		
Overall value of the enterprise	Manufacturing	1030	30.9%	2.86	0.039	0.002
	Services	679	34.9%	2.98		

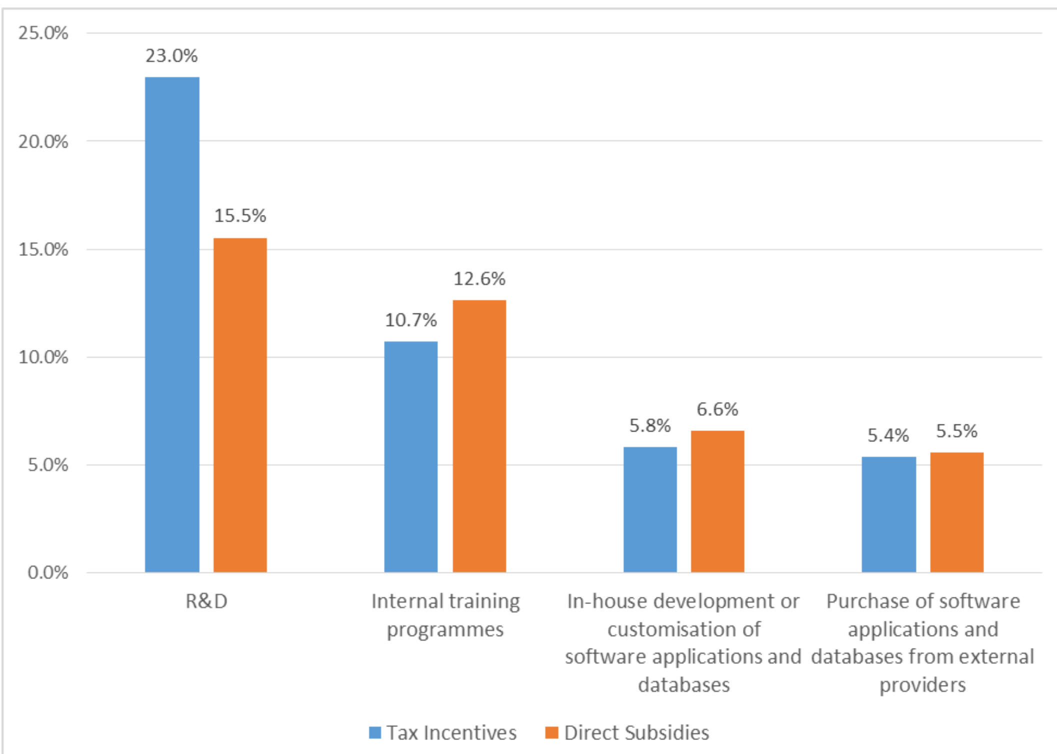
[93] Responses of 4 or 5 on a five-point Likert-type scale (i.e., to a large or great extent)

6. Policy measures (Section E of the Questionnaire)

This section investigates whether firms were provided with tax incentives (e.g., tax credits, preferential tax treatment) and/or direct subsidies during the past three years (2017-2019) for R&D, training and for in-house development or purchase of software & databases by the national government. In addition, firms that were provided with such incentives were asked to evaluate their usefulness.

For each intangible activity, the vast majority of firms were provided with neither tax incentives nor direct subsidies. In particular, 32% of firms were provided with at least one type of incentives for conducting R&D and primarily with tax incentives (23% of the total sample). In addition, only 19% of firms utilized at least one type of incentives for internal training programmes (12.6% utilized direct subsidies and 10.7% utilized tax incentives). The relevant percentages regarding software and databases activities are even lower (**Figure 6.1**).

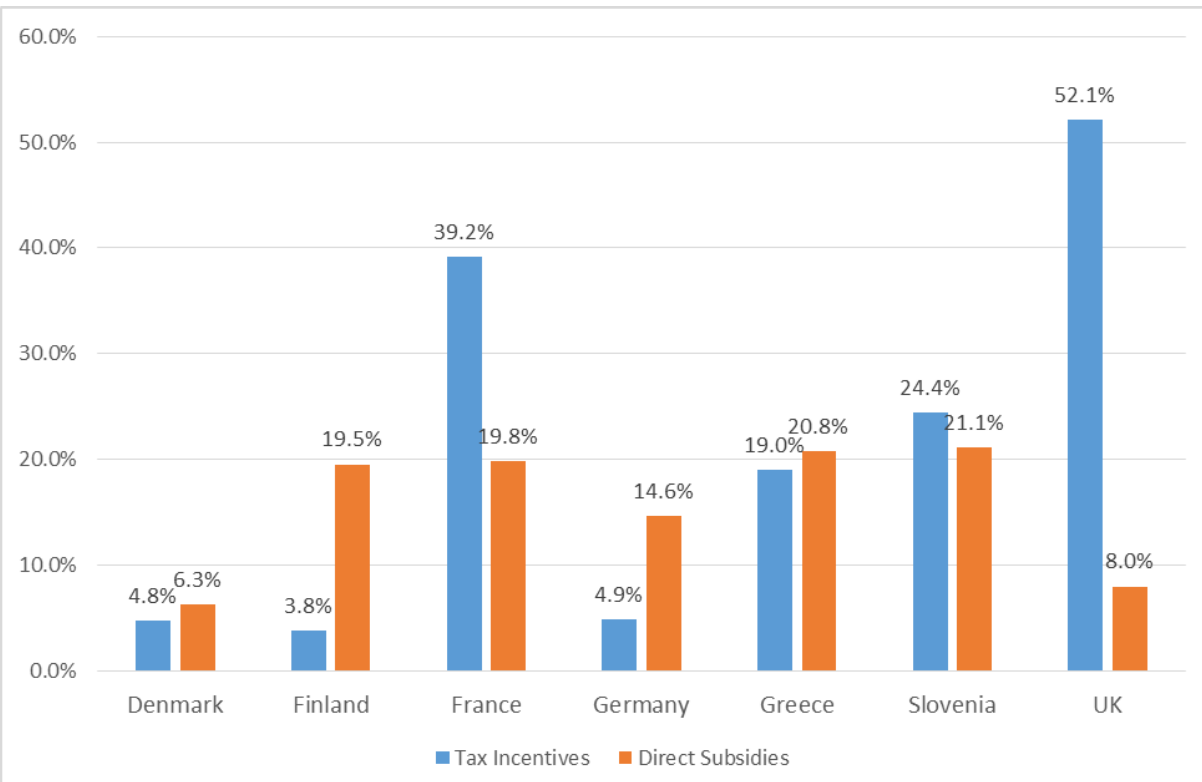
Figure 6.1 % of firms that were provided incentives for intangible activities during the period 2017-2019 (N = 1771)



In this section, it is useful to present the results at the country level. Regarding the most "popular" type of incentives, i.e., incentives that aim at enhancing R&D activity, UK has a high percentage of firms that were provided with tax incentives, namely over half of the firms (52.1%), followed by

France (39.2%). This result is aligned with the relevant OECD ranking[94] regarding the direct government funding and tax support for business R&D as percentage of GDP. Following this ranking, in 2018, France and UK were at the first and second positions respectively as regards tax support. In addition, for Slovenia and Greece the share of firms that utilized tax incentives is lower (i.e., 24.4% and 19% respectively) but much higher than the corresponding percentages of Germany, Denmark and Finland that are below 5%. Indicatively for Germany, this result is reasonable as the federal government provide only direct R&D funding to businesses. In terms of direct subsidies, Finland, France, Greece, and Slovenia constitute a group of countries presenting similar percentages (19.5% - 21.1%) and Germany follows with 14.6%. The UK, in contrast to its performance in receiving tax incentives, exhibits a rather low percentage of firms provided with direct subsidies (8%), and even lower is the corresponding percentage of Denmark (6.3%) [**Figure 6.2**].

Figure 6.2 % of firms that were provided R&D incentives during the period 2017-2019 by country (N = 1762)



Regarding the other three intangible activities, Greece ranks first with a relatively higher incidence of direct subsidies than tax incentives. An interpretation of this finding is that the country receives a high volume of funding from the Community Support Frameworks. Relating to training, the

94 https://www.oecd.org/sti/rd-tax-stats.htm

share of Slovenian firms provided with direct subsidies is also relatively high (22.2%) and close to the relevant percentage of Greek firms (26.6%). In general, except for Greece, the percentages of firms provided either with tax incentives or with direct subsidies, range from low to extremely low in some cases (**Figures 6.3, 6.4 and 6.5**).

Figure 6.3 % of firms that were provided incentives for internal training programmes during the period 2017-2019, by country (N = 1765)

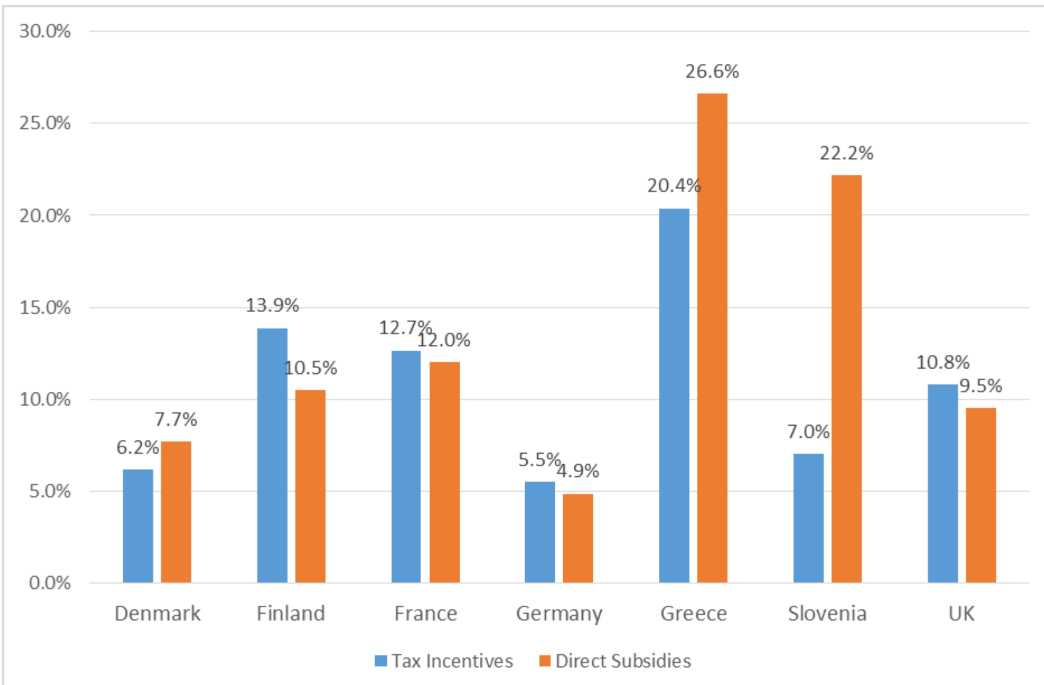


Figure 6.4 % of firms that were provided incentives for in-house development or customization of software applications and databases during the period 2017-2019, by country (N = 1768)

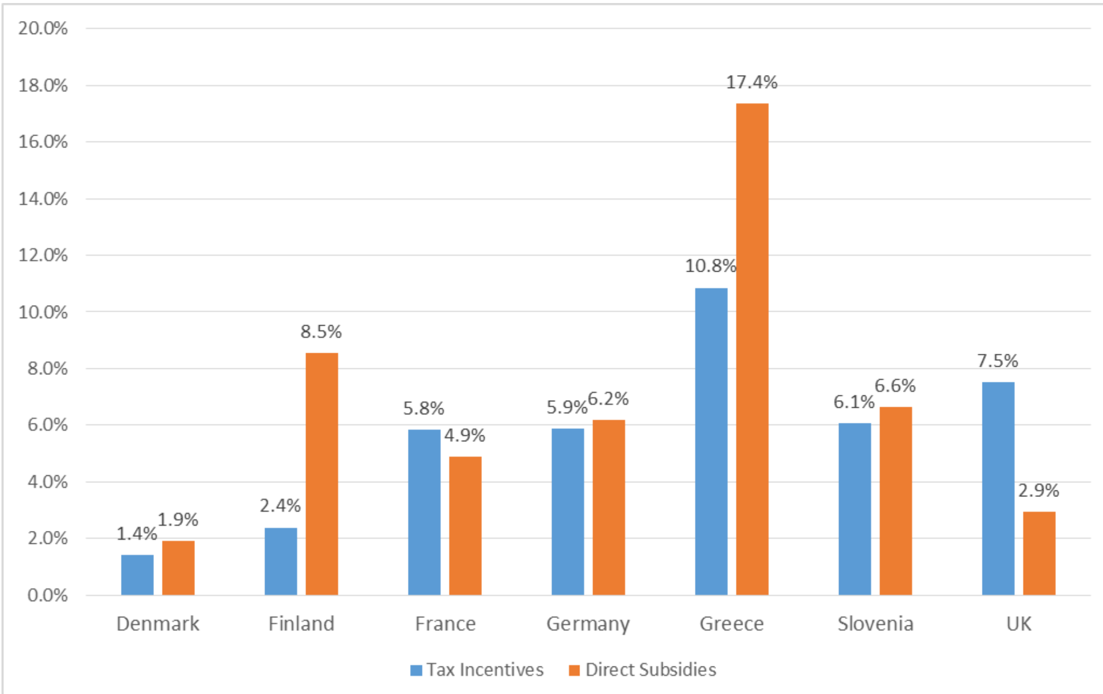
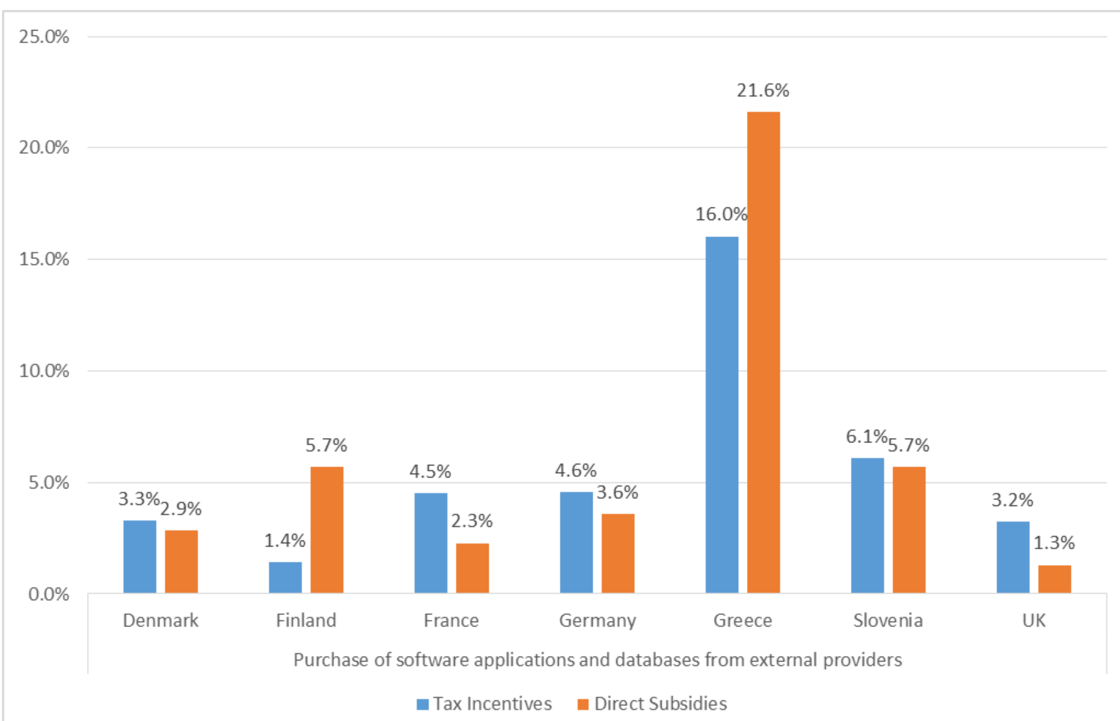
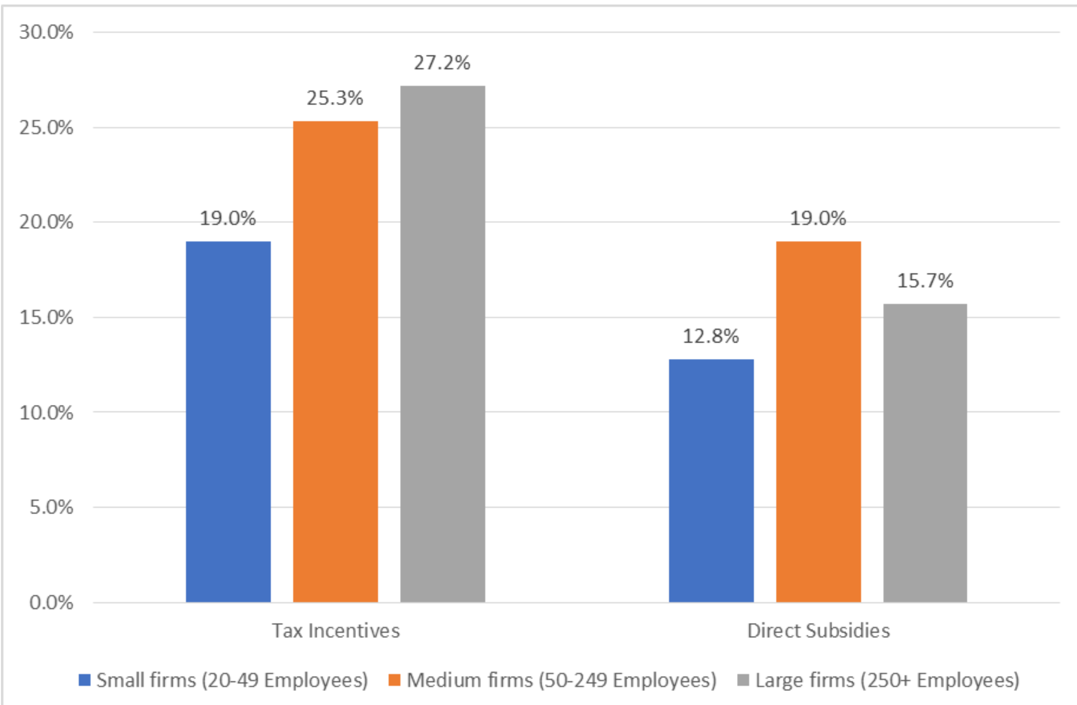


Figure 6.5 % of firms that were provided incentives for purchase of software applications and databases from external providers during the period 2017-2019, by country (N = 1771)



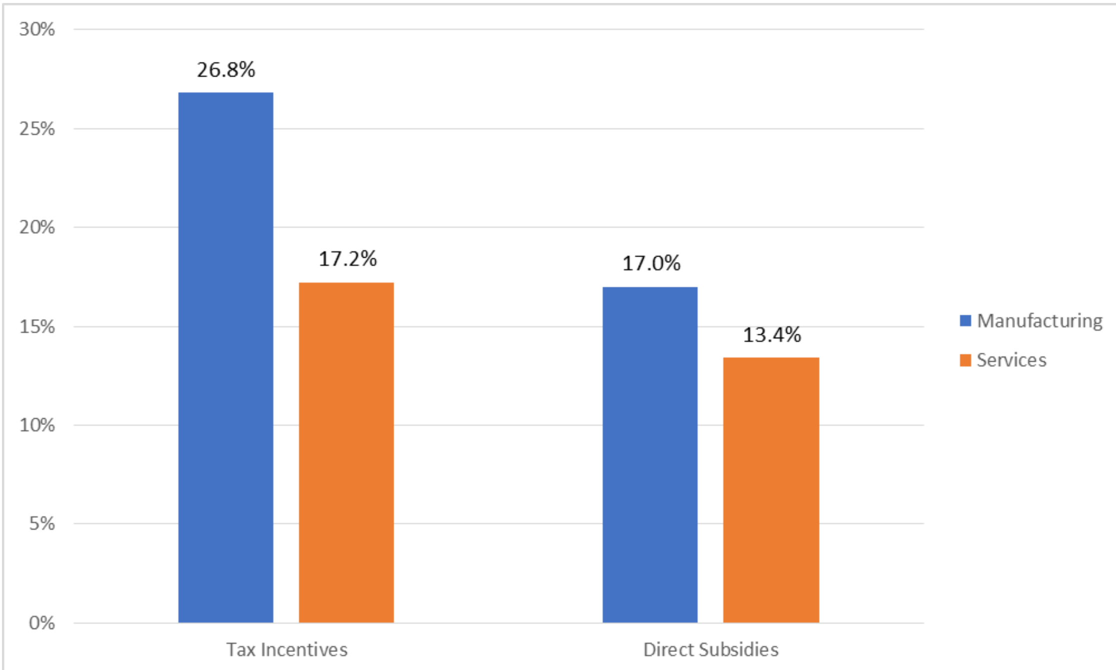
Focusing on R&D activity, a relatively higher share of large and medium-sized firms was provided with tax incentives compared to small firms[95]. In addition, medium-sized firms are characterized by the highest share regarding direct subsidies[96] (**Figure 6.6**). In terms of sector, more manufacturing firms are provided with R&D tax incentives than firms in services (Pearson Chi-square, sig. < 0.001). The same applies to direct subsidies, though the relevant differentiation is much lower (Pearson Chi-square, sig. < 0.05) [**Figure 6.7**].

Figure 6.6 % of firms that were provided R&D incentives during the period 2017-2019 by firm size (N = 1762)



95 Pearson Chi-square coeff. (sig. < 0.01) for the chi-square test across size categories and between small firms and the other two categories.
96 Pearson Chi-square coeff. (sig. < 0.01) for the chi-square test across categories and the comparison between small and medium-sized firms.

Figure 6.7 % of firms that were provided R&D incentives during the period 2017-2019 by sectoral group (manufacturing vs. services) [N = 1762]

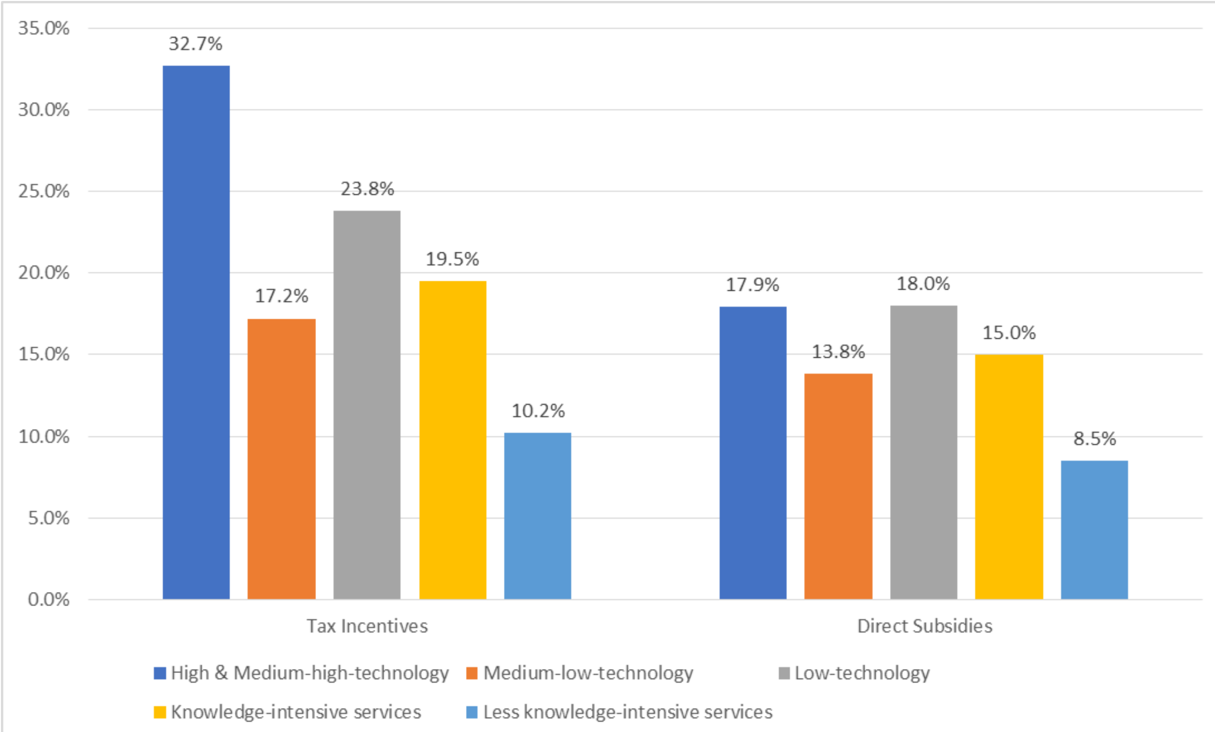


In addition, both within manufacturing and services, firms in more technology/knowledge intensive sectors (i.e., H&MHT and KIS) appear to be more frequent users of tax incentives. In addition, LT firms are also more frequent users (23.8%) than MLT firms (17.2%)[97]. With regard to direct subsidies, the trend is the same, however, the variations are smaller, and LT exhibit a similar percentage with H&MHT[98] (**Figure 6.8**).

[97] Pearson Chi-square coeff. (sig. < 0.01) for the chi-square test across sector categories, for the comparison between H&MHT and the other sector categories, and the comparison between less KIS and the other categories (except for MLT).

[98] Pearson Chi-square coeff. (sig. < 0.05) for the chi-square test across categories and the comparison between KIS and less KIS. Pearson Chi-square coeff. (sig. < 0.01) regarding the comparison of less KIS with H&MHT and LT.

Figure 6.8 % of firms that were provided R&D incentives during the period 2017-2019 by sectoral group (technology/knowledge intensity) [N = 1762]



Figures 6A.1 – 6A.6 in **Appendix 6A** depict the percentage of firms that were provided with incentives for internal training programmes and software & databases activity during the period 2017-2019, by size class and sectoral group.

Finally, firms were asked to assess – through a 5-point Likert-type scale - the value of tax incentives and/or direct subsidies per intangible activity conditional that they were provided with such incentives in the relevant activity. **Table 6.1** illustrates that the most valuable incentives seem to be R&D incentives (tax incentives to a relatively higher degree than direct subsidies). In addition, as regards the remaining three intangible activities, direct subsidies seem to be more beneficial than tax incentives, with the higher difference to be observed for internal training programmes.

Table 6.1 Value of incentives for intangible activities

	Type of Incentives	Number of Firms	High Extent[99] (% of Firms)	Mean (5-point scale)
R&D	Tax Incentives	400	62.8%	3.73
	Direct Subsidies	270	57.8%	3.57
Internal training programmes	Tax Incentives	181	33.1%	2.93
	Direct Subsidies	219	44.7%	3.25
In-house development or customization of software applications and databases	Tax Incentives	100	45.0%	3.23
	Direct Subsidies	115	48.7%	3.35
Purchase of software applications and databases from external providers	Tax Incentives	91	37.4%	3.08
	Direct Subsidies	97	45.4%	3.33

[99] Responses of 4 or 5 on a five-point Likert-type scale (i.e., to a large or great extent).

7. The impact of Covid-19 crisis (Section F of the Questionnaire)

As the survey was launched some months after the outbreak of Covid-10 pandemic, the final section of the questionnaire attempts to capture the impact of Covid-19 crisis on firms' economic performance as well as on their digital strategy and capabilities.

7.1 Impact of Covid-19 crisis on economic performance

Firstly, firms were asked to estimate whether covid-19 crisis had an impact on four dimensions of their economic performance, and if so to attempt to quantify this impact in terms of percentage change. **Table 7.1** shows that for many firms (53.9%) turnover was the indicator more negatively affected by the covid-19 crisis, while profit margin follows. With regard to employment and overall investment, almost half of firms report "no impact", whereas 1 out of 3 firms refer that they decreased their employees and/or overall investment. In addition, the percentage change of employment is lower than the other indicators, whereas the highest percentage change is observed for overall investment.

Table 7.1 Impact of Covid-19 crisis on economic performance

	Impact of Covid-19 crisis	Number of Firms	%	Number of Firms	Percentage Change (Mean)	Percentage Change (Median)
Turnover	Decrease	960	53.9%	929	-20.4%	-18%
	No Impact	462	25.9%			
	Increase	359	20.2%	349	17.3%	10%
Profit Margin	Decrease	805	45.6%	734	-30.6%	-20.0%
	No Impact	620	35.1%			
	Increase	340	19.3%	313	39.7%	10.0%
Employment	Decrease	562	31.4%	547	-14.7%	-10.0%
	No Impact	892	49.8%			
	Increase	337	18.8%	328	11.7%	10.0%
Overall Investment	Decrease	585	32.8%	544	-39.9%	-30.0%
	No Impact	874	49.0%			
	Increase	326	18.3%	310	48.4%	20.0%

In terms of sector, **Table 7.2** illustrates that manufacturing was affected more negatively than services in all economic indicators except for profit margin where there is no significant differentiation between the two sectoral groups. In terms of sector technology/knowledge intensity, a notable differentiation within services is that KIS were affected to a lower degree than less KIS regarding turnover (Pearson Chi-square, sig. < 0.01) [**Table 7A.1 in Appendix 7A**]. With regard to firm size, the variations between large, medium-sized and small firms are marginal (**Table 7A.2 in Appendix 7A**).

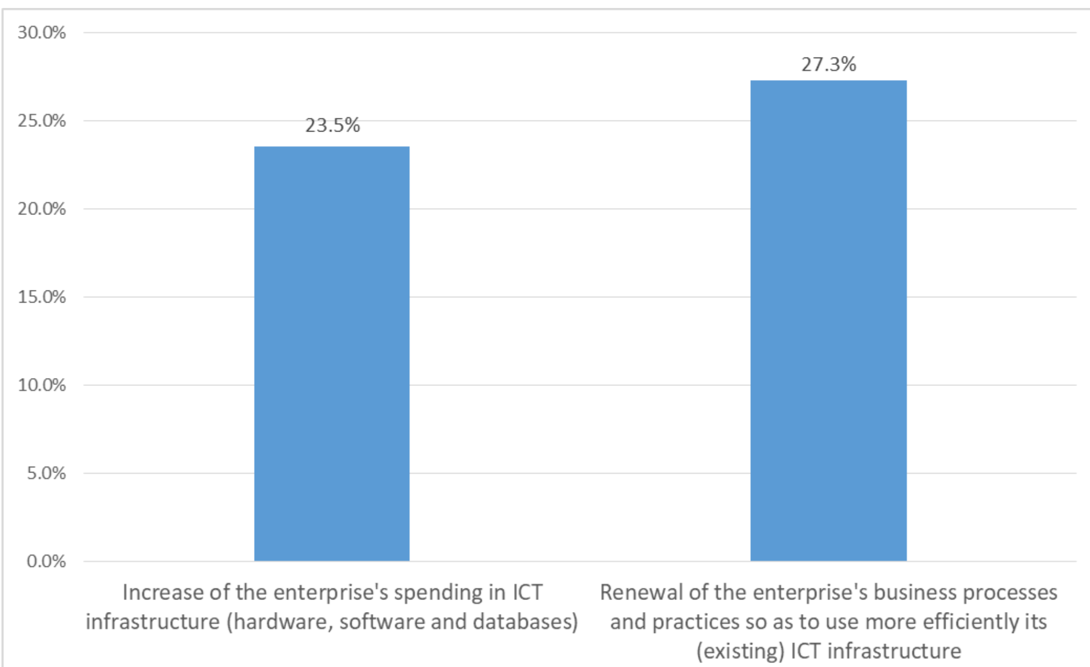
Table 7.2 Impact of Covid-19 crisis on economic performance by sectoral group (manufacturing vs. services)

	Sectoral Group	Impact of Covid-19 crisis	Number of Firms	%	Pearson Chi-square sig.
Turnover	Manufacturing	Decrease	616	57.6%	0.001
		No Impact	257	24.0%	
		Increase	196	18.3%	
	Services	Decrease	344	48.3%	
		No Impact	205	28.8%	
		Increase	163	22.9%	
Profit Margin	Manufacturing	Decrease	495	46.7%	0.328
		No Impact	373	35.2%	
		Increase	193	18.2%	
	Services	Decrease	310	44.0%	
		No Impact	247	35.1%	
		Increase	147	20.9%	
Employment	Manufacturing	Decrease	388	36.1%	0.000
		No Impact	504	46.9%	
		Increase	182	16.9%	
	Services	Decrease	174	24.3%	
		No Impact	388	54.1%	
		Increase	155	21.6%	
Overall Investment	Manufacturing	Decrease	384	35.9%	0.002
		No Impact	494	46.1%	
		Increase	193	18.0%	
	Services	Decrease	201	28.2%	
		No Impact	380	53.2%	
		Increase	133	18.6%	

7.2 Impact of Covid-19 crisis on digital transformation

An interesting issue of investigation is whether the Covid-19 crisis has affected the level of spending on ICT infrastructure and/or it has led to a more efficient and effective use and exploitation of existing ICT infrastructure which otherwise would have remained idle. In this vein, firms were asked to assess – through a 5-point Likert-type scale – to what extent the increasing requirements for digital transformation during Covid-19 crisis guided them to a) increase their spending on ICT infrastructure (hardware, software and databases), and b) renew their business processes and practices so as to use more efficiently their (existing) ICT infrastructure. **Figure 7.1** shows that most firms did not proceed to an extensive increase of ICT investments or renewal of business processes and practices as a reaction to the Covid-19 pandemic disruptive changes. In particular, only 23.5% of firms reported a large increase of spending on ICT infrastructure, i.e., reported 4 or 5 in the relevant scale. Somewhat higher but still relatively low is the percentage of firms that renewed extensively their processes and practices during the Covid-19 crisis (27.3%)[100].

Figure 7.1 Increase of spending on ICT infrastructure and renewal of business processes and practices, during the Covid-19 crisis[101] (N = 1769)



[100] For the first item: mean = 2.44 and median = 2. For the second item: mean = 2.63 and median = 3.
[101] Responses of 4 or 5 on a five-point Likert-type scale, i.e., to a large or great extent.

Table 7.3 Increase of spending on ICT infrastructure and renewal of business processes and practices, during the Covid-19 crisis, by firm size

	Size Category	Number of Firms	High Extent[102] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Increase of the enterprise's spending in ICT infrastructure (hardware, software and databases)	Small firms (20-49 Employees)	768	21.5%	2.32	0.000	0.012
	Medium firms (50-249 Employees)	588	22.3%	2.42		
	Large firms (250+ Employees)	413	29.1%	2.69		
Renewal of the enterprise's business processes and practices so as to use more efficiently its (existing) ICT infrastructure	Small firms (20-49 Employees)	771	24.5%	2.51	0.000	0.009
	Medium firms (50-249 Employees)	587	27.4%	2.67		
	Large firms (250+ Employees)	411	32.4%	2.82		

In addition, firm size matters as large firms seem to have increased their ICT investments to a higher extent than small and medium-sized firms[103]. Moreover, there is a differentiation between size categories on processes/practices reconfiguration as well, i.e., the larger the firm the higher the reaction to Covid-19 conditions[104] (**Table 7.3**).

Focusing on sectoral groups, firms in services seem to have been involved in such activities to a larger extent (**Table 7.4**). In addition, technology/knowledge intensity does not seem to play a role in ICT investments as both KIS and less KIS enterprises exhibit higher values than manufacturing. Regarding business processes/practices renewal, firms in KIS seem relatively more active than less KIS (**Table 7.5**).

[102] Responses of 4 or 5 on a five-point Likert-type scale (i.e., to a large or great extent)
[103] Post-hoc analysis (sig. < 0.01) for the comparison between large firms and the other two categories.
[104] Post-hoc analysis (sig. < 0.001) regarding the comparison between large and small firms. Post-hoc analysis (sig. < 0.05) between medium-sized and small firms.

Table 7.4 Increase of spending on ICT infrastructure and renewal of business processes and practices, during the Covid-19 crisis, by sectoral group (manufacturing vs. services)

	Sectoral group	Number of Firms	High Extent[105] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
Increase of the enterprise's spending in ICT infrastructure (hardware, software and databases)	Manufacturing	1060	20.1%	2.31	0.000	0.013
	Services	709	28.6%	2.62		
Renewal of the enterprise's business processes and practices so as to use more efficiently its (existing) ICT infrastructure	Manufacturing	1057	24.3%	2.53	0.000	0.010
	Services	712	31.7%	2.79		

[105] Responses of 4 or 5 on a five-point Likert-type scale (i.e., to a large or great extent)

Table 7.5 Increase of spending on ICT infrastructure and renewal of business processes and practices, during the Covid-19 crisis, by sectoral group (technology/knowledge intensity)

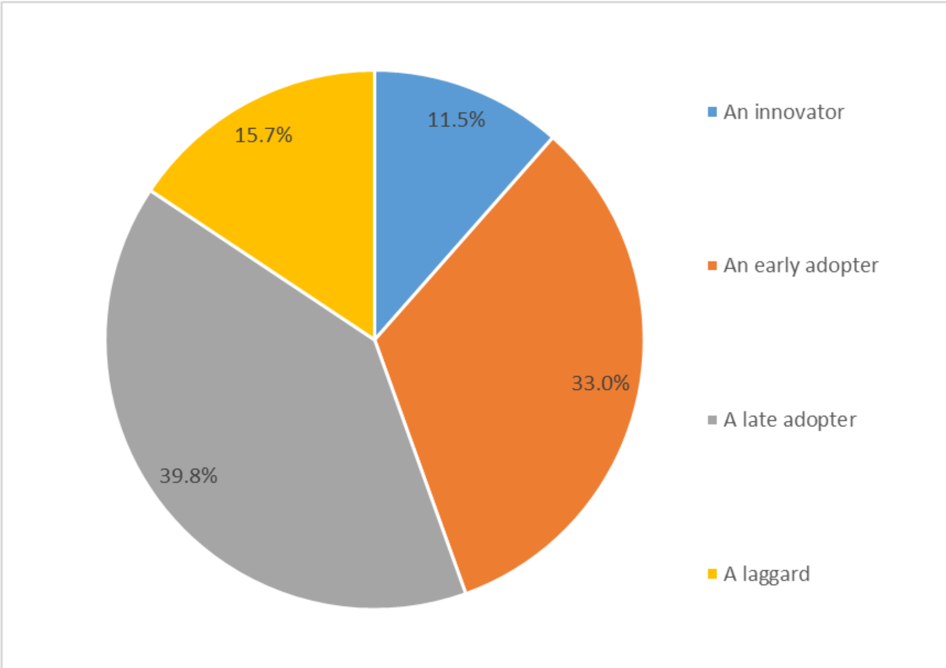
	Sectoral group	Number of Firms	High Extent[106] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Increase of the enterprise's spending in ICT infrastructure (hardware, software and databases)	High & Medium-high-technology	535	20.0%	2.27	0.000	0.014
	Medium-low-technology	240	18.8%	2.28		
	Low-technology	285	21.4%	2.41		
	Knowledge-intensive services	533	28.7%	2.63		
	Less knowledge-intensive services	176	28.4%	2.61		
Renewal of the enterprise's business processes and practices so as to use more efficiently its (existing) ICT infrastructure	High & Medium-high-technology	532	26.1%	2.57	0.000	0.016
	Medium-low-technology	240	22.5%	2.45		
	Low-technology	285	22.5%	2.51		
	Knowledge-intensive services	534	33.9%	2.87		
	Less knowledge-intensive services	178	25.2%	2.56		

Furthermore, a question on the level of firms' digital transformation performance before the outbreak of Covid-19 was included in this section to better grasp the pandemic's impact on relevant investments and strategies adopted during the crisis.

Figure 7.2 illustrates that 4 out of 10 firms seem to be late adopters of digital technologies whereas only 1 out of 3 firms appear to be early adopters. A lower share of firms perceive themselves as laggards (i.e., they report a very slow or limited adoption of digital technologies) (15.7%) and innovators (11.5%).

[106] Responses of 4 or 5 on a five-point Likert-type scale (i.e., to a large or great extent)

Figure 7.2 Digital transformation performance capability before the outbreak of Covid-19 (N = 1757)



In terms of sector, firms in services demonstrate a quite higher digital transformation performance than firms in manufacturing (Pearson Chi-square, sig. < 0.001). The share of innovators in services is twofold than in manufacturing and the sum of innovators and early adopters is 57.8% in services and 35.4% in manufacturing (**Figure 7.3**). As expected, the sector's knowledge/technology intensity matters as KIS exhibit much higher percentages of innovators and early adopters than less KIS (in total 63.3% and 41.3% respectively)[107]. Within manufacturing, H&MHT has a higher share of innovators and early adopters (39%) than MLT (31.1%) and LT (32.7%) as well as a lower percentage of laggards[108] (**Figure 7.4**). On the other hand, the differentiation between size categories is marginal[109] (**Figure 7A.1** in **Appendix 7A**).

[107] Pearson Chi-square coeff. (sig. < 0.001).
[108] Pearson Chi-square coeff. (sig. < 0.05) for the comparison between H&MHT and LT.
[109] Pearson Chi-square coeff. (sig. > 0.05) for the chi-square test across categories and for each pair of the three size categories.

Figure 7.3 Digital transformation performance capability before the outbreak of Covid-19, by sectoral group (manufacturing vs. services) [N = 1757]

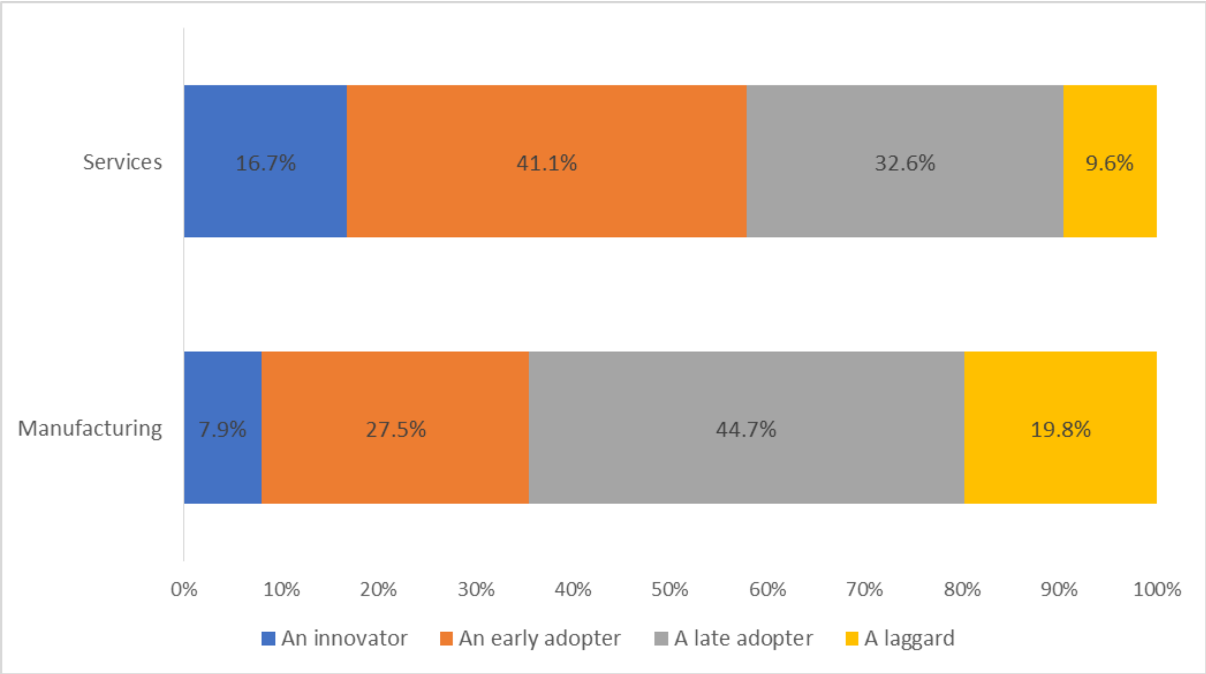
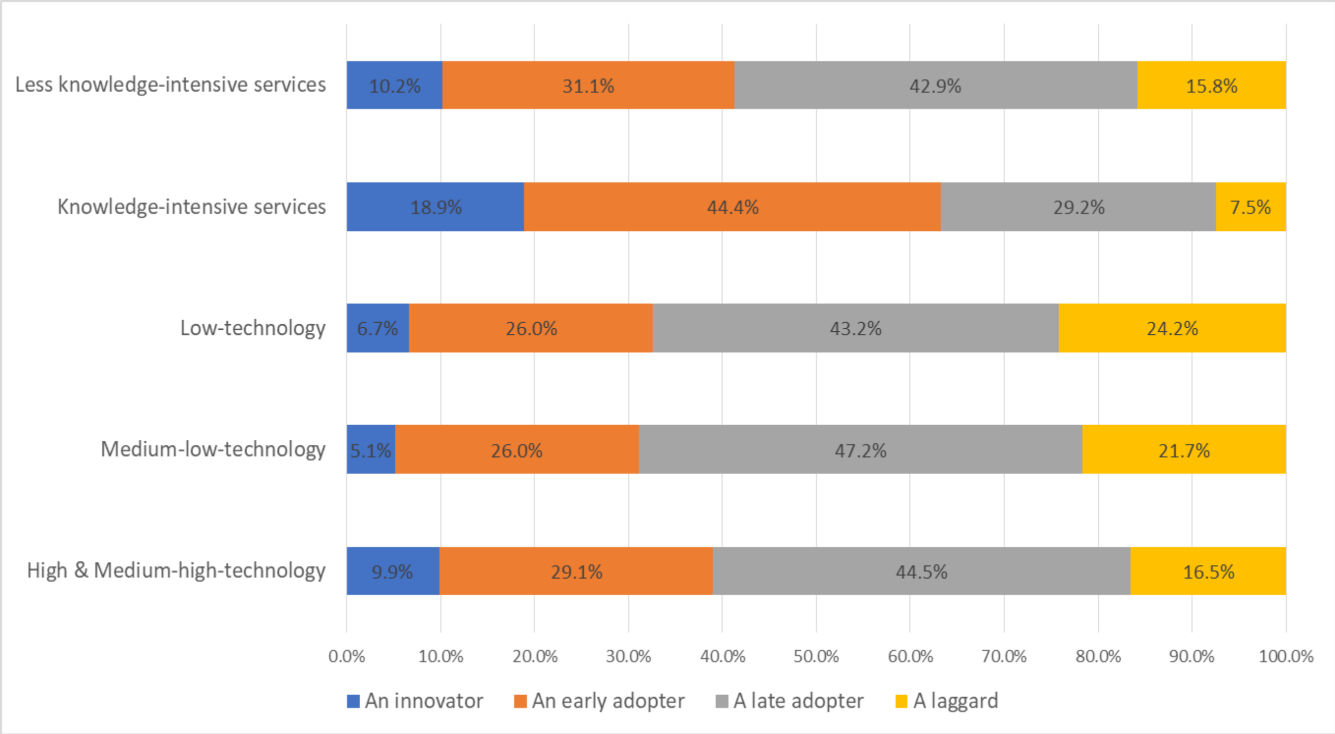
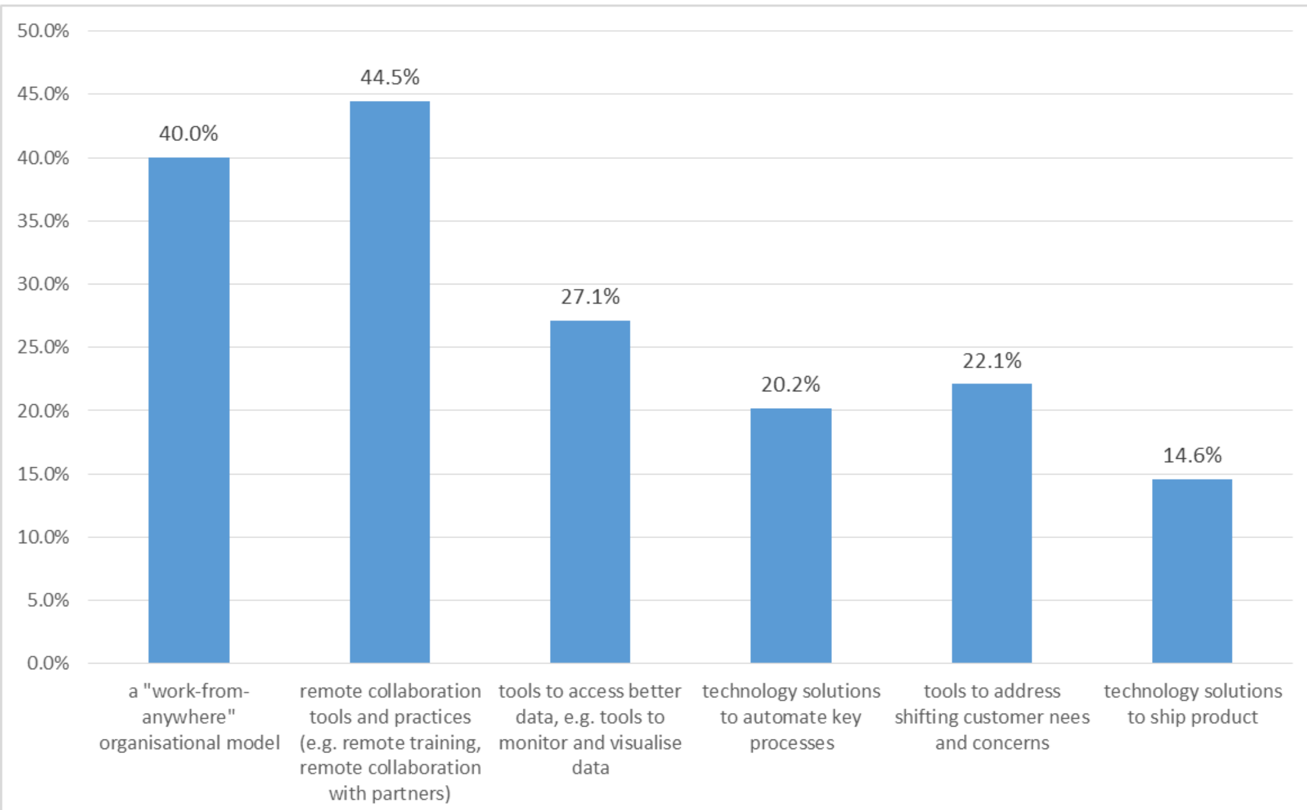


Figure 7.4 Digital transformation performance capability before the outbreak of Covid-19, by sectoral group (technology/knowledge intensity) [N = 1757]



In addition, the survey instrument measured the degree of use of specific digital work practices and tools during the crisis so as to better grasp the pandemic's effect on establishing or better exploiting specific organizational procedures and capabilities which may allow firms minimize disruptions. **Figure 7.5** shows that firms primarily adopted practices and tools for teleworking and remote collaboration (40-45% of sample firms reported an extensive use i.e., 4 or 5 in the relevant scale) whereas the use of tools to access better data, to automate business processes, to address shifting customer needs and even more to ship product, is rather limited.

Figure 7.5 Use of specific digital work practices and tools during Covid-19 crisis[110] (N = 1783)



Focusing on the sector dimension, service firms are present a much higher use of all types of tools and practices. Tools for accessing better data and even more tools for remote working, training and collaboration are especially popular among service firms due to the nature of the activities in services that make the teleworking and remote collaboration more feasible (**Table 7.6)**.

In terms of sector technology/knowledge intensity, KIS exhibit a much higher use of teleworking and remote collaboration tools than the other sectoral groups. Less KIS and H&MHT follows.

[110] Responses of 4 or 5 on a five-point Likert-type scale, i.e., to a large or great extent.

Regarding tools for accessing better data, the ranking is the same. However, the difference of KIS from the other sector categories is lower. Even smaller is the variation regarding tools for automating business processes and adapting to shifting customer needs as well as technology solutions to ship product (**Table 7A.3 in Appendix 7A**).

Table 7.6 Use of specific digital work practices and tools during Covid-19 crisis by sectoral group (manufacturing vs. services)

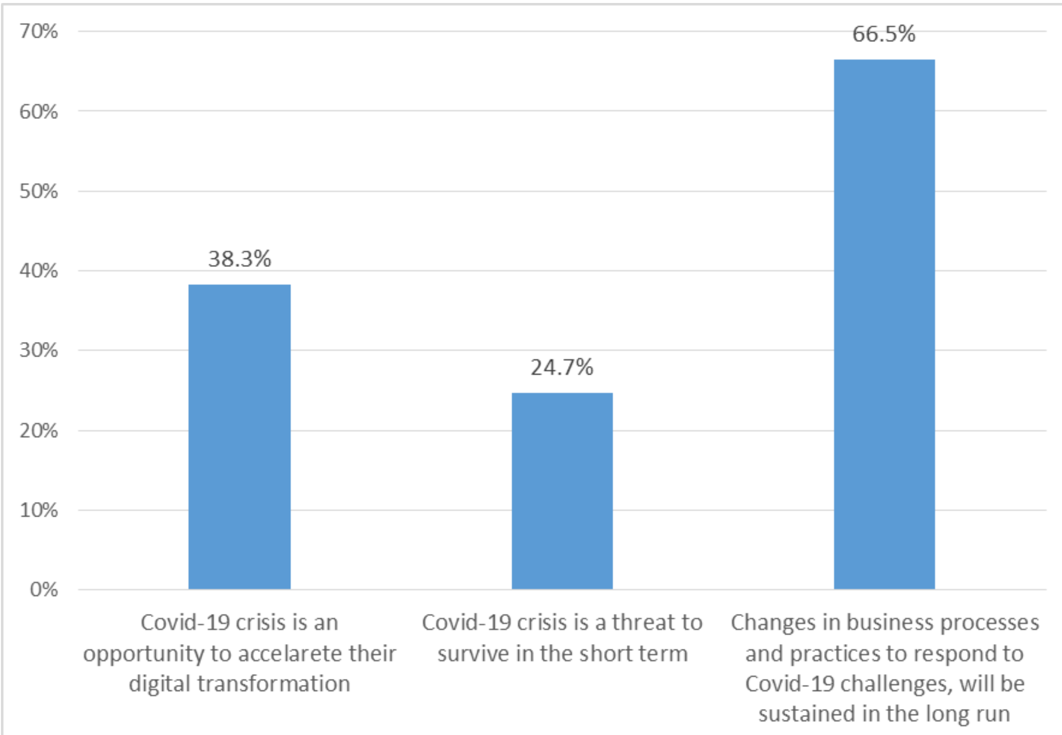
	Sectoral group	Number of Firms	High Extent[111] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
A "Work-from-anywhere" organizational model	Manufacturing	1064	29.0%	2.70	0.000	0.098
	Services	716	56.3%	3.58		
Remote collaboration tools and practices (e.g., remote training, remote collaboration with partners)	Manufacturing	1066	35.6%	2.90	0.000	0.068
	Services	717	57.7%	3.62		
Tools to access better data, e.g., tools to monitor and visualize data	Manufacturing	1053	20.9%	2.49	0.000	0.039
	Services	711	36.3%	3.00		
Technology solutions to automate key processes	Manufacturing	1049	15.8%	2.33	0.000	0.017
	Services	704	26.7%	2.67		
Tools to address shifting customer needs and concerns	Manufacturing	1041	17.0%	2.39	0.000	0.027
	Services	701	29.7%	2.78		
Technology solutions to ship product	Manufacturing	1040	11.3%	2.04	0.017	0.003
	Services	665	19.7%	2.19		

An enterprise may see the Covid-19 crisis either as an opportunity to accelerate its digital transformation and sustain the changes implemented in the long run, or simply see the Covid-19 crisis as purely a survival threat without introducing relevant digital transformation business processes and practices. Another objective of this questionnaire section was to assess the firm's digital transformation strategy orientation as an outcome of the Covid-19 crisis. In particular, the survey investigated – using a 5-point Likert-type scale – whether firms perceive the Covid-19 crisis as an opportunity to speed up their digital transformation or as a threat to survive in the short term, and whether they intend to sustain in the long run the changes implemented (in business processes and practices) as a response to Covid-19 challenges. **Figure 7.6** indicates that a high share of firms (2 out of 3) report that they will sustain changes in business processes and practices

[111] Responses of 4 or 5 on a five-point Likert-type scale.

in the long term. In addition, almost 4 out of 10 firms see Covid-19 as a digital transformation accelerator while a much lower share (1 out of 4 firms) view Covid-19 crisis as a survival threat.

Figure 7.6 Firm's digital transformation strategy orientation as an outcome of the Covid-19 crisis[112]



Focusing on size categories, it is notable that the majority of large firms (51%) see Covid-19 as an opportunity to accelerate their digital transformation whereas the relevant share of small and medium-sized firms is much lower (33.2% and 36.1%)[113]. In addition, small and medium-sized firms see Covid-19 crisis as a survival threat to a somewhat higher degree than large firms[114]. On the other hand, firms appear to be willing to sustain the changes implemented in their business processes and practices in order to address the Covid-19 challenges regardless of their size class (**Table 7.7**).

[112] Responses of 4 or 5 on a five-point Likert-type scale, i.e., agree or strongly agree.
[113] Post-hoc analysis (sig. < 0.001) for the comparison between large firms and the other two size categories. Post-hoc analysis (sig. < 0.01) regarding the comparison between small and medium-sized firms.
[114] Post-hoc analysis (sig. < 0.05) for the comparison between small and large firms.

Table 7.7 Firm's digital transformation strategy orientation as an outcome of the Covid-19 crisis, by firm size

	Size Category	Number of Firms	Agree-ment[115] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Our enterprise sees the Covid-19 crisis as an opportunity to accelerate its digital transformation	Small firms (20-49 Employees)	774	33.2%	2.78	0.000	0.029
	Medium firms (50-249 Employees)	585	36.1%	3.01		
	Large firms (250+ Employees)	414	51.0%	3.36		
Our enterprise sees the Covid-19 crisis as a threat to survive in the short term	Small firms (20-49 Employees)	780	26.4%	2.47	0.029	0.004
	Medium firms (50-249 Employees)	590	25.6%	2.45		
	Large firms (250+ Employees)	411	20.2%	2.25		
Our enterprise will sustain the changes implemented (in business processes and practices) to adapt and respond to the Covid-19 challenges in the long run	Small firms (20-49 Employees)	772	65.3%	3.77	0.313	0.001
	Medium firms (50-249 Employees)	585	66.2%	3.78		
	Large firms (250+ Employees)	413	69.2%	3.87		

In terms of sector, firms in services see Covid-19 as a digital transformation accelerator to a much higher extent than firms in manufacturing. In addition, services exhibit a relatively lower share of firms that perceive Covid-19 crisis as a survival threat compared to manufacturing, and a relatively higher share of firms that intend to sustain the changes implemented during Covid-19 compared to manufacturing (**Table 7.8**). Moreover, **Table 7A.4 in Appendix 7A** depicts the corresponding results in terms of sector technology/knowledge intensity.

[115] Responses of 4 or 5 on a five-point Likert-type scale, i.e., agree or strongly agree.

Table 7.8 Firm's digital transformation strategy orientation as an outcome of the Covid-19 crisis, by sectoral group (manufacturing vs. services)

	Sectoral group	Number of Firms	Agreement[116] (% of Firms)	Mean (5-point scale)	T-test Sig.	Eta squared
Our enterprise sees the Covid-19 crisis as an opportunity to accelerate its digital transformation	Manufacturing	1057	32.0%	2.79	0.000	0.032
	Services	716	47.6%	3.29		
Our enterprise sees the Covid-19 crisis as a threat to survive in the short term	Manufacturing	1068	27.7%	2.54	0.000	0.012
	Services	713	20.2%	2.22		
Our enterprise will sustain the changes implemented (in business processes and practices) to adapt and respond to the Covid-19 challenges in the long run	Manufacturing	1058	63.5%	3.73	0.002	0.006
	Services	712	70.9%	3.89		

Finally, groups of different digital transformation performance were compared as regards their reaction to Covid-19 conditions in terms of ICT investments enhancement and renewal of their business processes and practices so as to respond to the increasing digitalization requirements. Innovators and early adopters (of digital technologies) seem to have increased their spending on ICT infrastructure at a higher degree compared to late adopters and laggards[117]. A similar trend applies for business processes/practices renewal, although late adopters exhibit relatively higher values than laggards[118] (**Table 7.9**).

In addition, these groups were compared based on the enterprise's digital transformation strategy orientation. Findings indicate that the enterprises exhibiting higher digital transformation performance see Covid-19 crisis primarily as a digital transformation accelerator[119]. Furthermore, innovators and early adopters intend to sustain in the long run the changes implemented in their business processes and practices at a higher extent than late adopters and laggards[120] (**Table 7.10**).

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[116] Responses of 4 or 5 on a five-point Likert-type scale, i.e., agree or strongly agree.
[117] Post-hoc analysis (sig. < 0.001) regarding the comparison of laggards with early adopters and innovators. Post-hoc analysis (sig. < 0.05) as regards the comparison between late adopters and innovators.
[118] Post-hoc analysis (sig. < 0.001) regarding the comparison between laggards and the other groups. Post-hoc analysis (sig. < 0.05) as regards the comparison between late adopters and innovators.
[119] Post-hoc analysis (sig. < 0.001) for all groups except for the comparison between innovators and early adopters (sig. < 0.05).
[120] Post-hoc analysis (sig. < 0.01) regarding the comparison of laggards with early adopters and innovators. Post-hoc analysis (sig. < 0.05) as regards the comparison between laggards and late adopters.

Table 7.9 Increase of spending on ICT infrastructure and renewal of business processes and practices, during the Covid-19 crisis, by group of digital transformation performance

	Group of digital transformation performance	Number of Firms	High Extent[121] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Increase of the enterprise's spending in ICT infrastructure (hardware, software and databases)	Laggards	272	20.2%	2.13	0.000	0.021
	Late adopters	693	20.2%	2.37		
	Early adopters	572	27.6%	2.64		
	Innovators	200	31.5%	2.70		
Renewal of the enterprise's business processes and practices so as to use more efficiently its (existing) ICT infrastructure	Laggards	272	18.0%	2.22	0.000	0.034
	Late adopters	696	24.9%	2.57		
	Early adopters	573	34.2%	2.88		
	Innovators	199	32.2%	2.86		

Table 7.10 Firm's digital transformation strategy orientation as an outcome of the Covid-19 crisis, by group of digital transformation performance

	Group of digital transformation performance	Number of Firms	Agree-ment[122] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Our enterprise sees the Covid-19 crisis as an opportunity to accelerate its digital transformation	Laggards	268	21.3%	2.46	0.000	0.051
	Late adopters	699	35.6%	2.92		
	Early adopters	574	46.2%	3.21		
	Innovators	201	52.7%	3.51		
Our enterprise will sustain the changes implemented (in business processes and practices) to adapt and respond to the Covid-19 challenges in the long run	Laggards	269	55.8%	3.59	0.000	0.012
	Late adopters	696	65.5%	3.79		
	Early adopters	573	71.9%	3.88		
	Innovators	201	73.6%	3.98		

[121] Responses of 4 or 5 on a five-point Likert-type scale (i.e., to a large or great extent)
[122] Responses of 4 or 5 on a five-point Likert-type scale, i.e., agree or strongly agree.

8. Preliminary probit analysis results

8.1 Drivers of intangible investments

Although it is widely accepted that intangible assets are turning into a critical resource for a firm's competitive advantage (e.g., Barney, 2001; Teece, 2015; Haskel and Westlake, 2018), to the best of our knowledge, few empirical studies so far (e.g., Arrighetti et al., 2014) have examined the factors that may lead firms to undertake this type of investment. In most cases, the level of intangible assets has been taken as given and treated more as an explanatory variable rather than as a variable to be explained. However, this type of empirical research and analysis may help both managers and policy makers to gain a better understanding of what determines firms' propensity to invest in intangible assets and help to recognize the variables that differentiate high- from low-performing firms.

Literature largely focuses on the relative effect of intangible assets on economic performance (e.g., Marrocu et al., 2012; Bontempi and Maraisse, 2008; Corrado et al., 2009; Chappell and Jaffe, 2018). Contributions on the factors affecting intangible assets investments are relatively rare, focusing mainly on industry-related variables. On this basis, it is considered that the relative differences in the intensity and appropriability of innovation across industries leads to different incentives for the development of intangible assets, i.e., the level and growth rate of intangible assets differ across industries (e.g., Gu and Lev, 2001; Veragauwen et al., 2007).

In line with the capability view of the firm (e.g., Dosi et al., 2001; Teece et al., 1997, Teece, 2007; Helfat et al., 2007 etc.) our approach is that a firm's propensity to invest in intangible assets can be understood mainly as a bundle of resources and capabilities that the firm has evolved over time and only marginally as a result of exogenous technological contingencies (e.g., Arrighetti et. al., 2014; Montresor and Vezzani, 2016). The adoption of such a perspective in the study of intangible assets investments calls for a focus on firm-specific factors that in interaction with system-specific (external factors) can explain the firm's propensity to undertake this type of investments.

On this basis, in the context of the Globalinto survey, we chose to examine the determinants of intangible investments by focusing on variables such as strategic priorities, organizational complexity, human and technological resources as well as specific organizational capabilities (e.g., dynamic capabilities regarding the sensing and seizing of opportunities, design and digital capabilities) which we believe are important determinants of a firm's intangible investments.

In the present report we highlight some preliminary probit analysis results in order to examine the impact of the above-mentioned variables on the firm's propensity to invest in six different asset categories, i.e., in-house R&D, training, organization/business process (OBP) improvement, software and databases, design and reputation and branding. Our dependent variables measures are presented in detail in **Table 8.1**. In the following paragraphs we will outline each variable's role in the firm's decision to invest in intangible assets.

Size is a firm feature that regardless of the industry a firm operates in, is likely to have a positive impact on the propensity to invest in intangible assets. Larger firms are more likely to invest in intangible assets as a) they are better able than smaller firms to exploit economies of scale (Dierickx and Cool, 1989), b) they can be more effective in protecting their intangible assets and have a greater incentive to invest, and c) are more capable of supporting the greater uncertainty related to such investments (Arrighetti et al., 2014).

In addition to firm size, **the quality of the human capital** is a basic condition for generating and exploiting intangible assets. Firms with educated workforce have the managerial and innovative capabilities to extend their intangible asset base. Furthermore, the amount of human resources effectively employed in direct R&D activities is synonymous with the adoption of routines and procedures that facilitate the exploitation of external sources of knowledge and thus support the process of intangible asset accumulation. We use as proxies for measuring the human resources, the share of employees with university degree and the share of employees involved in R&D activities in the total workforce.

Like firm size and human resources, the **degree of organizational complexity** is another factor that can affect the process of intangible assets accumulation. According to some authors there is a direct link between the complexity of the firm's internal organization and the accumulation of organizational capital (information that the firm uses to coordinate the material factors of production namely physical capital and labor) and thus intangible assets. Furthermore, market competition may also play a role in shaping the firm's internal complexity and thus the accumulation of intangible assets. Increased competition in the markets may lead firms to combine resources to protect from imitation and update the most firm-specific internal assets to advance their distinctive know-how and product differentiation, thus, suggesting an extension of managerial resources and an increase in their complexity (Arrighetti et el., 2014).

As proxies to gauge organizational complexity we use firms' exports intensity, whether the firm makes investments abroad or it is a member of an enterprise group and the degree of market competition. The idea in this case is that a firm that is more internationalized will have a more diversified and flexible structure and therefore a more complex organization. Furthermore, a firm with a more complex relation (e.g., large number of business competitors) with markets is more likely to invest more in intangible assets.

Strategic priorities that favor innovation can also affect investments in intangible assets. Strategic priorities have been measured following the traditional Porterian approach (price vs. premium quality differentiation) and using specific strategic priorities that support and enhance a firm's innovative performance (such as developing new products and services, increasing of labor productivity and decreasing production costs). In this regard, intangible resources can be key drivers of competitive advantage when firms consider "rapid development of products/services" and 'increasing labour productivity" as their main source of competitive advantage. The opposite applies in the case of a "price strategy" which is typically more relative to tangible assets (cost advantages are typically driven by tangible assets, e.g., physical capital) (Montesor and Vezzani, 2016).

Technological resources related to innovative Industry 4.0 technologies are important for supporting and further fueling innovation. However, there is a need to complement a firm's advanced technological capital with parallel extensions of organizational, human and R&D resources. This suggests that firms which enhance their technological capital are more likely to invest in intangible assets.

Networking capabilities involves the adoption of routines and procedures that facilitate the exploitation of external knowledge sources and thus support the process of intangible asset accumulation which, in turn, suggests greater investments in intangible assets. Networking capabilities are captured through strategic cooperations/alliances with other organizations and collaborative research agreements with universities and research institutes[123].

Design capabilities, which in this study are captured using the "Design Ladder" concept (see Section C, 4.3.2) can be very important in shaping a firm's overall business strategy and innovation performance. Hence, firms which use design as a key strategic input for their business models have a greater probability of investing in intangible assets.

Digital transformation capabilities which are measured by capturing the degree of digital platforms' use[124] (see Section C, 4.3.3) and the degree of digital technologies adoption (see section F, 7.2) can enable better collaboration within and between organizations, more personalized ways of customer engagement, increased employee innovation and productivity, and more accurate insights from the use of data, all of which may help enterprises grow and give them more opportunities to thrive in the post-pandemic period. To sustain and further develop its digital transformation capabilities, agile ways of working, data literacy and next generation technologies are needed which in turn call for investments in relevant intangible assets (e.g., training, organization/business process improvement, software & databases).

Apart from the abovementioned firm-specific factors, the industry a firm operates in (manufacturing vs. services) and governments' incentives (e.g., tax incentives, direct subsidies etc.) can also be considered as important external drivers of intangible investments.

Our probit analysis results as presented in **Table 8.1** indicate that certain firm-specific factors as well as external factors related to policy measures are important drivers for investments in intangible assets (IAs). More specifically,

[123] We formulated this construct by conducting exploratory factor analysis and reliability test in items c and d of Q37 and calculating their average.
[124] We formulated this construct by conducting exploratory factor analysis and reliability test in all items of Q40 and calculating their average.

- Size matters: larger firms are likely to have a larger propensity to invest in intangible assets (important across all IAs except for design)
- Strategic priorities matter: firms pursuing "rapid development of new products and services" have of greater probability of investing in intangible assets (in-house R&D, organization/business process improvement, design, reputation & branding). Firms targeting at "increasing labor productivity" have also a greater probability of investing in IAs (training, OBP improvement, software & databases). On the contrary, lower price strategies have a negative (on in-house R&D) or non-significant effect suggesting that such strategies drive primarily investments in tangible assets.
- Organizational complexity matters: For example, more globalized firms have a greater probability in investing in R&D, firms with foreign direct investments are more likely to invest in different IAs (Organization, Software and Databases, Design and Reputation and Branding), and firms facing increased competition are also more likely to invest in IAs (in house R&D and reputation and branding)
- Human capital matters: firms with more human resources employed in R&D activities have a great probability of investing in IAs (in-house R&D, training, OBP improvement and software & databases).
- Technological resources matter: firms adopting innovative hardware and digital technologies at a higher degree have a greater probability in investing in IAs.
- Networking matters: Firms entering more into alliances and strategic cooperations and collaborating with universities and research institutes have a larger propensity to invest in intangible assets (in-house R&D, OBP improvement, design, reputation & branding).
- Design use matters: firms integrating design into product development and using design as key strategic element of their business model have a larger propensity to invest in intangible assets (in-house R&D, software & databases, design, and reputation & branding) than firms that do not work systematically with design.
- Digital transformation capabilities matter: firms using digital platforms at a higher level are more likely to invest in IAs (software & databases, reputation & branding). Moreover, firms that are first to adopt digital technologies have a larger propensity to invest in IAs (in-house R&D, software & databases) than firms slower to adopt digital technologies.
- Policy matters.
    - Tax incentives for R&D matter: firms provided with tax incentives in 2017-2019, are more likely to invest in in-house R&D.
    - Tax incentives and direct subsidies for training matter: firms provided with tax incentives or direct subsidies for developing internal training programs (2017-2019) are more likely to invest in training activities.
    - Direct subsidies for software and databases (S&D) matter: firms provided with direct subsidies (2017-2019) for purchasing software application and databases, are more likely to invest in OBP improvement and software & databases activities.

Table 8.1 Drivers of intangible investments by asset category (probit analysis results)

FACTORS	INDICATORS	**In-house R&D** [Q6a] (yes/no)	**Training** [Q11a/b] (yes/no)	**OBP improve-ment** [Q14] (yes/no)	**Software /Databases** [Q18] (yes/no)	**Design** [Q22] (yes/no)	**Reputation & Branding** [Q26] (yes/no)
Size	Log (no. of employees) [Q4]	0.057**	0.101***	0.118***	0.142***	0.017	0.088***
Sector	Manufacturing (-) vs Services (+) [Q1]	-0.140***	0.016	0.030	0.089***	-0.007	0.037
Strategy	Rapid development of new products or services [Q29a]	0.083***	-0.002	0.065**	0.001	0.074***	0.066**
	Development of tailored, customized solutions [Q29b]	0.040*	0.005	0.013	0.005	0.015	0.031
	Ensuring lower prices [Q29c]	-0.047*	0.005	-0.004	0.009	0.034	0.004
	Increasing labor productivity [Q29d]	0.010	0.032*	0.081***	0.053**	0.019	0.022
	Decreasing production costs [Q29e]	-0.034	-0.002	0.043	-0.017	0.005	0.032
Organizational Complexity	Exports as % of turnover [Q30b+c]	0.002***	0.000	-0.001	0.000	0.000	-0.001
	Few business competitors [Q31]	0.077	-0.007	0.061	0.003	-0.034	0.080
	Many business competitors [Q31]	0.090*	0.017	0.069	0.004	-0.036	0.155***
	Part of an Enterprise Group [Q2]	0.009	0.011	-0.010	-0.062**	-0.027	-0.074***
	Foreign Direct Investments [Q32]	0.047	0.004	0.127***	0.172***	0.095***	0.090**
Human Resources	% of full-time employees with university degree [Q33a+b]	0.014	0.094**	0.001	0.032	0.069	-0.011
	% of full-time employees involved in R&D [Q34]	0.650***	0.157**	0.204**	0.197**	0.059	0.133
Technological Resources	Investments in innovative hardware technologies [Q35a]	0.028***	0.001	0.041***	0.017*	0.022**	0.000
	Investments in innovative digital technologies [Q35b]	0.031***	0.015*	0.022*	0.023*	0.008	0.035***
Dynamic Capabilities	Networking [Q37c+d]	0.061***	0.009	0.027**	0.013	0.021*	0.030**
	Design is used as last finish [Q38]	0.068**	-0.008	0.033	0.078**	0.207***	0.014

Design Capabilities	Design is integrated into the product development process [Q38]	0.080***	-0.052**	0.008	0.060*	0.283***	0.119***
	Design is a key strategic element of the enterprise's business model [Q38]	0.043	-0.028	0.035	-0.022	0.386***	0.119***
Digital Transformation capabilities	Digital platforms use [Q40]	0.016	0.003	-0.008	0.030*	0.021	0.069***
	Late adopter of digital technologies [Q49]	0.055*	0.032	0.027	0.021	0.054	0.031
	Early adopter of digital technologies [Q49]	0.032	0.027	0.044	0.057	0.041	0.007
	First to adopt digital technologies [Q49]	0.101**	-0.031	0.040	0.094*	0.069	-0.035
Policy Measures	Tax Incentives for R&D [Q44a1]	0.280***					
	Direct Subsidies for R&D [Q44a2]	0.048					
	Tax Incentives for Training [Q44b1]		0.047**				
	Direct Subsidies for Training [Q44b2]		0.057***				
	Tax Incentives for S&D (in-house) [Q44c1]			0.099	0.077		
	Direct Subsidies for S&D (in-house) [Q44c2]			0.046	0.040		
	Tax Incentives for S&D (purchased) [Q44d1]			-0.062	-0.035		
	Direct Subsidies for S&D (purchased) [Q44d2]			0.163***	0.167***		
Country Dummies		*Included*	*Included*	*Included*	*Included*	*Included*	*Included*
	No. of Observations	1422	1433	1425	1429	1445	1445
	Log likelihood	-653.4683	-389.2076	-892.5758	-851.3064	-740.8199	-873.8656
	$LR(\chi^2)$	644.95***	207.86***	190.31***	275.26***	369.22***	207.33***
	Pseudo R^2	0.3304	0.2108	0.0963	0.1392	0.1995	0.1060

***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$ (The reported probit coefficients of independent variables are marginal effects)

8.2 Intangible investments and innovation propensity

Ownership (or control) of intangibles and their complements allow firms to differentiate and establish some degree of competitive advantage. The expansion and orchestration of these assets help (along with strategy) to generate longer-run enterprise competitive advantage (Teece, 2015).

Intangible assets have been generally considered as simple innovative inputs and only seldom as an asset portfolio. However, the growing empirical literature on intangibles suggests a wide spectrum of IAs together with a broader role. Drawing on the resource-based view of the firm (Wernerfelt, 1984; Barney, 1991) and the more recent dynamic capabilities approach (Teece et al., 1997; Teece et al., 2007), intangible assets can be considered as an array of heterogeneous assets driving the firm's competitive advantage, i.e., they enable the firm to embark in the different activities that constitute the innovation process at the firm level.

In last subsection of the empirical part of the report we will provide some preliminary results on the impact of investments in intangible assets on the propensity of an enterprise to innovate.

Investing in intangible assets appears to be important for different innovation types at the firm level (**Table 8.2**). More specifically,

- R&D and especially inhouse R&D activity has a significant positive impact on a firm's propensity to innovate across innovation types (except for organizational innovation).
- Firms that invest in reputation and branding (R&B) are more likely to innovate across innovation types.
- Investing in design increases the propensity to innovate in terms of product, process and marketing innovation.
- Spending on Organization and business process improvement increases the probability to innovate in terms of service, process and organizational innovation.
- Investing in Software and databases increases the probability to innovate in terms of product, service and process innovation.
- Acquiring external knowledge has a positive significant impact on the firm's probability to innovate in terms of service and organizational innovation.
- Investing in intangibles internally (in-house R&D and internal training) increases the probability to innovate. This finding is related to the strategic choice of 'making' rather than 'buying' intangibles. External development of intangible assets could pose problems of knowledge fragmentation and issues of coordination and control which could negatively affect innovation performance.

Table 8.2 Impact of Intangible Assets on Innovation (probit analysis results)

FACTORS	INDICATORS	Product Innovation [Q41a] (yes/no)	Service Innovation [Q41b] (yes/no)	Process Innovation [Q41c] (yes/no)	Marketing Innovation [Q41d] (yes/no)	Organizational Innovation [Q41e] (yes/no)
Size	Log (no. of employees) [Q4]	-0.031	-0.026	0.065***	-0.045*	0.024
Sector	Manufacturing (-) vs Services (+) [Q1]	-0.103***	0.260***	-0.165***	0.069***	0.051*
Organizational Complexity	Part of an Enterprise Group [Q2]	0.023	-0.059**	-0.038	-0.002	-0.047*
	Exports as % of turnover [Q30b+c]	0.001***	-0.000	-0.001	-0.001	0.000
Investments in Intangible Assets	In-House R&D [Q6a] (yes/no)	0.227***	0.078***	0.052*	0.096***	0.044
	R&D by external providers [Q6b] (yes/no)	-0.023	0.021	0.011	-0.006	0.023
	External Knowledge acquisition [Q7] (yes/no)	0.028	0.092***	0.022	0.046	0.088***
	Training (by external organizations) [Q11a] (yes/no)	-0.015	0.024	-0.023	0.031	0.015
	Training (using internal resources) [Q11b] (yes/no)	-0.002	0.068**	0.048*	0.038	0.024
	OBP improvement [Q14] (yes/no)	0.026	0.073***	0.105***	0.037	0.070***
	Software & Database [Q18] (yes/no)	0.041*	0.079***	0.055**	0.032	0.007
	Design [Q22] (yes/no)	0.106***	-0.014	0.054**	0.079***	0.032
	Reputation & Branding [Q26] (yes/no)	0.103***	0.083***	0.053**	0.182***	0.058**
Country Dummies		*Included*	*Included*	*Included*	*Included*	*Included*
	No. of Observations	1648	1648	1650	1647	1649
	Log likelihood	-959.81164	-998.22147	-1046.067	-996.27308	-1085.5282
	LR(χ^2)	290.09***	287.97***	188.69***	211.80***	89.39***
	Pseudo R^2	0.1313	0.1261	0.0827	0.0961	0.0395

***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$ (The reported probit coefficients of independent variables are marginal effects)

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Appendix 1A: Globalinto survey of intangible investments questionnaire

INTRODUCTION

We are contacting you as a partner of the Alliance Manchester Business School, University of Manchester. The Alliance Manchester Business School is taking part in a study funded by the European Commission that is carried out in seven countries across Europe (Denmark, Finland, France, Germany, Greece, Slovenia, United Kingdom).

This study is seeking to develop a more complete view of business spending on intangible or "soft" assets, such as R&D, training, software, databases, design, reputation and branding, organisation and business process improvement, the determinants of these investments and their link with enterprise performance. In addition, we are interested in investigating the impact of Covid-19 crisis on the level of these investments as well as on other issues such as business strategy change. In this vein, some questions refer to the Covid-19 era (2020) and some questions to the previous period (2019 or 2017-2019).

The results of this study, which will be communicated to each participating enterprise, will provide valuable recommendations for shaping EU and national policies with an impact on business investments in intangible assets and the operation of the enterprises. The questionnaire is addressed to the CEO of the enterprise and/or top-level managers (including the financial director). The interview will take approximately 25 minutes.

The information each interviewee provides will not be used at an individual level nor handed over by name to the European Commission or any other third party. The information will only be used for aggregate analysis.

A. GENERAL INFORMATION ABOUT THE ENTERPRISE

Q.1 Please indicate the main activity of your enterprise:

[ ]

Q.2 Is your enterprise part of an enterprise group?

1 ◯ No *(Go to Q.4)*
2 ◯ Yes, it is part of a national group *(Go to Q.4)*
3 ◯ Yes, it is part of a multinational group *(Go to Q.3)*

Q.3 In which country is the group's headquarters located?

[ ]

☞ ***If your enterprise is part of an enterprise group: Please answer all further questions about your enterprise <u>only</u> for its own activities in the UK. Exclude all subsidiaries or parent enterprises.***

Q.4 At the end of 2019, what was the total headcount number of full-time employees in the enterprise?

[| |],[| |] employees

Q.5 In 2019, what was the enterprise's total turnover (market sales of goods and services including all taxes except VAT)**?**

[| |],[| |],[| |],[0 | 0 | 0] GBP

B. TYPES OF ENTERPRISE SPENDING

B.1 Research and development (R&D) & acquisition of external knowledge

☞ ***R&D is creative work*** *(undertaken within the enterprise and/or contracted out to other organisations)* ***that increases the stock of knowledge and resolves scientific or technological uncertainty.***

Q.6 a) In 2019, did the enterprise fund any R&D in-house?

○1 Yes
○2 No

b) In 2019, did the enterprise fund any R&D carried out by external providers (including enterprises in your own group)?

If you answered 'No' to all three questions, go to Q.11 (section B.2).

○1 Yes
○2 No

Q.7 In 2019, did the enterprise acquire external knowledge (*e.g. purchase of patents and non-patented inventions, know-how, process blueprints and other types of knowledge)***?**

○1 Yes
○2 No

Q.8 In 2019, which percentage of the enterprise's turnover was spent on...

a) …**in-house** R&D?....................................... ☐☐.☐ %
b) …R&D carried out by **external providers** (including enterprises in your own group)? ☐☐.☐ %
c) …the acquisition of **external knowledge**?... ☐☐.☐ %

Q.9 (If the enterprise undertakes in-house R&D) **Was the in-house R&D in 2019 performed:**

○1 ...continuously (the enterprise has permanent R&D staff and/or R&D department in-house)
○2 ...occasionally (as needed only)

Q.10 Please indicate the impact, if any, of the Covid-19 crisis on your enterprise spending on R&D. Because of the Covid-19 crisis, will spending on R&D in 2020 as compared to 2019:

○1 Decrease → By approximately what percentage? ☐☐ %
○2 No impact
○3 Increase → By approximately what percentage? ☐☐ %

B.2 EMPLOYER FUNDED TRAINING

☞ ***Training of the enterprise's staff, either provided by an external organisation or using internal resources. The firm may provide to its employees training on IT systems/new technologies, new production equipment, "soft" skills development, management and financial issues, as well as health and safety issues.***

Q.11 a) In 2019, did the enterprise fund any training activities provided by external organisations?

◯1 Yes
◯2 No

b) In 2019, did the enterprise fund any training activities using internal resources?

◯1 Yes
◯2 No

If you answered 'No' to both questions, go to Q.14 (section B.3).

Q.12 In 2019, which percentage of the enterprise's turnover was spent on staff training...

a) … organised by **external** providers on-site or elsewhere? ☐☐.☐ %

b) … using **internal** resources? .... ☐☐.☐ %

Q.13 Please indicate the impact, if any, of the Covid-19 crisis on your enterprise spending on staff training. Because of the Covid-19 crisis, will spending on staff training in 2020 as compared to 2019:

◯1 Decrease → By approximately what percentage? ☐☐ %
◯2 No impact
◯3 Increase → By approximately what percentage? ☐☐ %

B.3 ORGANISATION / BUSINESS PROCESS IMPROVEMENT

☞ ***Spending on organisation or business process improvement through purchased consultancy services and/or in-house investment of managerial time.***

Q.14 In 2019, did the enterprise fund any external or internal work on organisation or business process improvement?

◯1 Yes
◯2 No *[Go to Q.18 (Section B.4)]*

Q.15 Which of the following types of organisation/business process improvement were funded?

	Yes	**No**
	1	2
a) Quality improvement programmes	◯	◯
b) Business process reengineering	◯	◯
c) Business process digitalisation	◯	◯
d) Culture improvement projects	◯	◯
e) Changes in organisational structure	◯	◯
f) Changes in management systems	◯	◯
g) Smart Factory (a factory where physical production processes and operations are combined with digital technology, smart computing and big data so as to improve processes automation and self-optimization)	◯	◯

Q.16 In 2019, which percentage of the enterprise's turnover was spent on organisation or business process improvement...

a) … carried out by **external** providers (consultants)? ☐☐.☐ %

b) … using **internal** resources? .... ☐☐.☐ %

Q.17 Please indicate the impact, <u>if any</u>, of the Covid-19 crisis on your enterprise spending on organization or business process improvement. Because of the Covid-19 crisis, will spending on organization or business process improvement in 2020 as compared to 2019:

◯1 Decrease → By approximately what percentage? ☐☐ %
◯2 No impact
◯3 Increase → By approximately what percentage? ☐☐ %

B.4 Software and databases

☞ ***Purchase and/or in-house development/customization of software and databases, excluding software R&D and web design.***

Q.18 In 2019, did the enterprise purchase or fund in-house work on software and databases?

◯1 Yes
◯2 No *[Go to Q.22 (Section B.5)]*

Q.19 Which types of software and databases did this include?

	Yes	No
	1	2
a) General purpose office applications (e.g. word processing)	◯	◯
b) Special purpose applications (e.g. accounting management software, control of production flows, business intelligence tools)	◯	◯
c) Databases and other computerised information (including big data)	◯	◯

Q.20 In 2019, which percentage of the enterprise's turnover was spent on software and databases…

a) … purchased from external providers? ☐☐.☐ %

b) … developed or customised in-house? ☐☐.☐ %

Q.21 Please indicate the impact, <u>if any</u>, of the Covid-19 crisis on your enterprise spending on software and databases. Because of the Covid-19 crisis, will spending on software and databases in 2020 as compared to 2019:

◯1 Decrease → By approximately what percentage? ☐☐ %
◯2 No impact
◯3 Increase → By approximately what percentage? ☐☐ %

B.5 DESIGN

☞ ***In-house and/or contracted out activities to design or alter the shape, appearance or usability of products and services. Design in the R&D phase of product development or design of software should be <u>excluded</u>.***

Q.22 In 2019, did the enterprise fund any in-house and/or contracted out design activities?

○1 Yes
○2 No *[Go to Q.26 (Section B.6)]*

Q.23 Which types of design did this include?

	Yes	No
	1	2
a) Technical design in the creation of products and services	○	○
b) Design of user/customer experience (e.g. ergonomics, aesthetics, user interfaces)	○	○
c) Design of promotional materials for specific products and services (e.g. design of showrooms, brochures, exhibition stands, point of sale materials)	○	○
d) Design to develop and promote your corporate identity (e.g. design of logos, websites, uniforms, business colour schemes)	○	○

Q.24 In 2019, which percentage of the enterprise's turnover was spent on design activities...

a) … carried out by **external** providers? ☐☐.☐ %

b) … using **internal** resources? .... ☐☐.☐ %

Q.25 Please indicate the impact, <u>if any</u>, of the Covid-19 crisis on your enterprise spending on design activities. Because of the Covid-19 crisis, will spending on design activities in 2020 as compared to 2019:

○1 Decrease ⟶ By approximately what percentage? ☐☐ %
○2 No impact
○3 Increase ⟶ By approximately what percentage? ☐☐ %

B.6 Reputation and branding

☞ ***Funding of any in-house and/or contracted out activities to improve reputation or brand values, either of the enterprise as a whole or individual product or service lines. Such activities can include product launches, promotional campaigns, "branding" and "rebranding" of the firm, development of promotional materials, market research and trademarks.***

Q.26 In 2019, did the enterprise fund any in-house and/or contracted out activities intended to improve reputation or brand values, either of the enterprise as a whole or individual products or service lines?

◯1 Yes
◯2 No *[Go to Q.29 (Section C)]*

Q.27 In 2019, which percentage of the enterprise's turnover was spent on activities to improve reputation or brand values...

a) … undertaken by **external** providers? ☐☐.☐ %

b) … using **internal** resources? .... ☐☐.☐ %

Q.28 Please indicate the impact, <u>if any</u>, of the Covid-19 crisis on your enterprise spending on reputation and branding. Because of the Covid-19 crisis, will spending on reputation and branding in 2020 as compared to 2019:

◯1 Decrease → By approximately what percentage? ☐☐ %
◯2 No impact
◯3 Increase → By approximately what percentage? ☐☐ %

C. FACTORS INFLUENCING INVESTMENTS IN INTANGIBLE ASSETS

C.1 STRATEGY

Q.29 Please indicate which of the following areas … *(max 3 answers possible)*

	a) … were the most important in the period 2017-2019 before the Covid-19 crisis?	**b) … are the most important during the Covid-19 crisis?**
a) Rapid development of new products or services	◯	◯
b) Development of tailored, customised solutions	◯	◯
c) Ensuring lower prices	◯	◯
d) Increasing labour productivity	◯	◯
e) Decreasing production costs	◯	◯
f) Other (write down)	◯	◯

Q.30 In 2019, what was the % of your enterprise's turnover in the:

a) National market .... |_|_|_| %

b) European market (excluding your national market) ... |_|_|_| %

c) International market (outside Europe) .... |_|_|_| %

TOTAL.. 1 0 0 %

Q.31 In 2019, were there other enterprises offering very similar products and/or services to your potential customers in your main market? *(select one of the following options)*

◯1 Yes, many business competitors
◯2 Only a few business competitors
◯3 No other business competitors

Q.32 During the past three years (2017-2019), did the enterprise make any Foreign Direct Investments (i.e. by buying, starting or expanding a firm in another country)?

◯1 Yes
◯2 No

C.2 HUMAN AND TECHNOLOGICAL RESOURCES

Q.33 At the end of 2019, what was the total number of employees in the enterprise…

a) …with a University Degree? ..... |_|_|_|,|_|_|_| employees

b) …with a postgraduate degree? |_|_|_|,|_|_|_| employees

Q.34 At the end of 2019, how many of the enterprise's employees were engaged in R&D activities?

☐☐☐,☐☐☐ employees

Q.35 During the past three years (2017-2019), to what extent the enterprise made investments in the following innovative technologies? *(answer on a 5-point scale, where 1 is not at all and 5 is to a great extent)*

	TO WHAT EXTENT?				
	1	2	3	4	5
a) Hardware technologies (e.g. robots, 3D technologies, sensor technologies)	◯	◯	◯	◯	◯
b) Digital technologies (e.g. artificial intelligence, data analytics, IoT, machine learning, virtual and augmented reality, blockchain)	◯	◯	◯	◯	◯
c) Bioinformatics-related technologies (e.g. genetics/genome editing, 3D&4D print in combination with genetics and medicine, neurotechnology)	◯	◯	◯	◯	◯

C.3 Organisational Capabilities

Q.36 Please indicate to what extent you agree or disagree with the following statements regarding the sensing and seizing of opportunities by your enterprise. *(answer on a 5-point scale, where 1 is strongly disagree and 5 is strongly agree)*

	(DIS)AGREEMENT				
	1	2	3	4	5
a) Our enterprise actively scans for the best practices in our sector	◯	◯	◯	◯	◯
b) Our enterprise responds rapidly to moves by competitors	◯	◯	◯	◯	◯
c) We change our practices based on customer feedback	◯	◯	◯	◯	◯
d) Our enterprise regularly considers the consequences of changing market demand for its new products and services	◯	◯	◯	◯	◯
e) Our enterprise is quick to recognise changes in its market (e.g. competition, regulation, demography)	◯	◯	◯	◯	◯
f) We quickly identify new opportunities to better serve our customers	◯	◯	◯	◯	◯
g) Design activity is important in introducing new products/services to the market	◯	◯	◯	◯	◯
h) We implement internal and external personnel training on a regular basis	◯	◯	◯	◯	◯
i) Employees share practical experiences with each other on a frequent basis	◯	◯	◯	◯	◯

Q.37 Please indicate to what extent you agree or disagree with the following statements regarding knowledge sources of your enterprise. *(answer on a 5-point scale, where 1 is strongly disagree and 5 is strongly agree)*

	(DIS)AGREEMENT				
	1	2	3	4	5
a) Our enterprise encourages regular, systematic communication with customers, suppliers and other organisations along the firm's value chain to identify opportunities and needs for innovation	○	○	○	○	○
b) Our enterprise engages in a regular, systematic screening of new knowledge in our field (e.g. through patent searches, attending trade fares, reading trade or scientific journals, or web searches)	○	○	○	○	○
c) Our enterprise enters into alliances, joint ventures or strategic co-operation with other organisations	○	○	○	○	○
d) Our enterprise engages in collaborative research agreements/projects with universities and research institutes	○	○	○	○	○
e) Our enterprise supports the internal exchange of knowledge and experience through teamworking and informal contacts between employees	○	○	○	○	○
f) Our enterprise enhances the joint development of innovation strategies across functional areas	○	○	○	○	○
g) Our enterprise supports exchanging new ideas openly across the firm	○	○	○	○	○

Q.38 Please indicate which of the following options best describes design use in your enterprise
(select one of the following options)

○1 Our enterprise does not work systematically with design
○2 Design is used as last finish (e.g. when developing new products)
○3 Design is integrated into the product development process
○4 Design is a key strategic element of our enterprise's business model

Q.39 Please indicate to what extent the enterprise has developed the following digital capabilities. *(answer on a 5-point scale, where 1 is not at all and 5 is to a great extent)*

	TO WHAT EXTENT?				
	1	2	3	4	5
a) Digital integration within and across different business functions	○	○	○	○	○
b) Access to and ability to use data analytics to design, develop, commercialise and improve products	○	○	○	○	○
c) Access to networks and the use of appropriate solutions and architectures (hardware and software)	○	○	○	○	○
d) Effective management of privacy and cybersecurity risks	○	○	○	○	○
e) Adoption of appropriate business models for digital environments, such as e-commerce, participative platforms etc.	○	○	○	○	○

Q.40 Please indicate to what extent your enterprise uses digital platforms for…. *(answer on a 5-point scale, where 1 is not at all and 5 is to a great extent)*

	TO WHAT EXTENT?				
	1	2	3	4	5
a) Conducting research and development of new products and services	○	○	○	○	○
b) Providing seamless connection (e.g. Procurement, manufacturing, shipment, forecasting) among partners	○	○	○	○	○
c) Carrying out pre-sale interactions with existing or potential customers (e.g. Advertisements and market research)	○	○	○	○	○
d) Providing customer services including maintaining and repairing services, and technical support	○	○	○	○	○

D. FIRM PERFORMANCE

D.1 INNOVATION PERFORMANCE

Q.41 During the past three years (2017-2019), did the enterprise introduce:

	Yes	No
	1	2
a) New or significantly improved products	◯	◯
b) New or significantly improved services	◯	◯
c) New or significantly improved production processes, distribution methods and/or supporting activities	◯	◯
d) New or significantly improved marketing concepts, strategies and/or methods	◯	◯
e) New or significantly improved organisational structures and/or management methods	◯	◯

Q.42 In 2019, what was the share of new or significantly improved products and/or services to total turnover?

☐☐ %

D.2 IMPACT OF INVESTMENTS IN INTANGIBLE ASSETS ON ECONOMIC PERFORMANCE

Q.43 Please indicate to what extent the enterprise benefited from investments in intangible assets made in 2017-2019, in terms of: *(answer on a 5-point scale, where 1 is not at all and 5 is to a great extent)*.

TO WHAT EXTENT?

	1	2	3	4	5
a) Turnover	◯	◯	◯	◯	◯
b) Profit margin	◯	◯	◯	◯	◯
c) Skills and qualifications of employees	◯	◯	◯	◯	◯
d) Market share	◯	◯	◯	◯	◯
e) Overall value of the enterprise	◯	◯	◯	◯	◯

E. QUESTIONS ON POLICY

Q.44 Did the government provide tax incentives (e.g. tax credits, preferential tax treatment) and/or direct subsidies to your enterprise in the past three years (2017-2019) before the Covid-19 crisis for the following activities?

	TAX INCENTIVES		DIRECT SUBSIDIES	
	Yes	No	Yes	No
a) R&D	◯	◯	◯	◯
b) Internal training programmes	◯	◯	◯	◯
c) In-house development or customisation of software applications and databases	◯	◯	◯	◯
d) Purchase of software applications and databases from external providers	◯	◯	◯	◯

If you answered 'Yes' to any question, go to Q.45

If you answered 'Yes' to any question, go to Q.46

Q.45 Please indicate how valuable were these tax incentives for the following activities:
(answer on a 5-point scale, where 1 is not at all and 5 is to a great extent)

	TO WHAT EXTENT?				
	1	2	3	4	5
a) R&D	◯	◯	◯	◯	◯
b) Internal training programmes	◯	◯	◯	◯	◯
c) In-house development or customisation of software applications and databases	◯	◯	◯	◯	◯
d) Purchase of software applications and databases from external providers	◯	◯	◯	◯	◯

Q.46 Please indicate how valuable were these subsidies for the following activities:
(answer on a 5-point scale, where 1 is not at all and 5 is to a great extent)

	TO WHAT EXTENT?				
	1	2	3	4	5
a) R&D	◯	◯	◯	◯	◯
b) Internal training programmes	◯	◯	◯	◯	◯
c) In-house development or customisation of software applications and databases	◯	◯	◯	◯	◯
d) Purchase of software applications and databases from external providers	◯	◯	◯	◯	◯

F. QUESTIONS RELATED TO COVID-19 CRISIS

Q.47 Please indicate the impact, <u>if any</u>, of the Covid-19 crisis on the level of economic performance.

a) Because of the Covid-19 crisis, will **turnover** in 2020 as compared to the turnover of 2019 …

◯1 Decrease → By approximately what percentage? ☐☐ %
◯2 No impact
◯3 Increase → By approximately what percentage? ☐☐ %

b) Because of the Covid-19 crisis, will **profit margin** in 2020 as compared to the profit margin of 2019 …

◯1 Decrease → By approximately what percentage? ☐☐ %
◯2 No impact
◯3 Increase → By approximately what percentage? ☐☐ %

c) Because of the Covid-19 crisis, will **employment** in 2020 as compared to the employment of 2019 …

◯1 Decrease → By approximately what percentage? ☐☐ %
◯2 No impact
◯3 Increase → By approximately what percentage? ☐☐ %

d) Because of the Covid-19 crisis, will **overall investment** in 2020 as compared to the investment of 2019 …

◯1 Decrease → By approximately what percentage? ☐☐ %
◯2 No impact
◯3 Increase → By approximately what percentage? ☐☐ %

Q.48 Please indicate to what extent the increasing requirements for digital transformation during the Covid-19 crisis *(answer on a 5-point scale, where 1 is not at all and 5 is to a great extent)*

	TO WHAT EXTENT?				
	1	2	3	4	5
a) Increased the enterprise's spending in ICT infrastructure (hardware, software and databases)	◯	◯	◯	◯	◯
b) Renewed the enterprise's business processes and practices so as to use more efficiently its (existing) ICT infrastructure	◯	◯	◯	◯	◯

Q.49 How would you characterise your enterprise in terms of digital transformation performance before the outbreak of Covid-19?

- ☐ 1 An innovator
- ☐ 2 An early adopter
- ☐ 3 A late adopter
- ☐ 4 A laggard (lagging behind due to very slow and/or limited adoption of digital technologies)

Q.50 During the outbreak of Covid-19 crisis, please indicate to what extent the enterprise in general uses:

(answer on a 5-point scale, where 1 is not at all and 5 is to a great extent)

	TO WHAT EXTENT?				
	1	2	3	4	5
a) a "work-from-anywhere" organisational model	○	○	○	○	○
b) remote collaboration tools and practices (e.g. remote training, remote collaboration with partners)	○	○	○	○	○
c) tools to access better data, e.g. tools to monitor and visualise data	○	○	○	○	○
d) technology solutions to automate key processes	○	○	○	○	○
e) tools to address shifting customer needs and concerns	○	○	○	○	○
f) technology solutions to ship product	○	○	○	○	○

Q.51 Please indicate to what extent you agree or disagree with the following statements:

(answer on a 5-point scale, where 1 is strongly disagree and 5 is strongly agree)

	(DIS)AGREEMENT				
	1	2	3	4	5
a) Our enterprise sees the Covid-19 crisis as an opportunity to accelerate its digital transformation	○	○	○	○	○
b) Our enterprise sees the Covid-19 crisis as a threat to survive in the short term	○	○	○	○	○
c) Our enterprise will sustain the changes implemented (in business processes and practices) to adapt and respond to the Covid-19 challenges in the long run	○	○	○	○	○

Appendix 1B: Accompanying manual

This manual has been developed to function as a guidance to both the interviewer and the interviewee by mainly providing explanations of the meaning of several terms used in the Globalinto Questionnaire. Many of the questions have been used in several surveys and have also undergone cognitive testing. Nevertheless, there are might be difficulties in understanding some of the terms.

General definitions

Investments in intangible assets are strategic investments in the long-run growth of individual companies and the economy as a whole. They include investment in human capital, in the form of education and training, research and development expenditures (R&D), software and information technology, design, market exploration and development, and organizational and management efficiency.[125]

To give an example having in mind a specific company, intangible assets for Microsoft include the ideas generated by investments in R&D and product design, the value of its brands, its supply chains and internal structures, and the human capital built up by training.

The observation unit for the Globalinto Survey shall be the "enterprise". **Each respondent answers questions only about his/her enterprise in his/her country.**

An enterprise is defined as "the smallest combination of legal units that is an organizational unit producing goods or services, which benefits from a certain degree of autonomy in decision making, especially for the allocation of its current resources. It may carry out one or more activities at one or more locations and it may be a combination of legal units, one legal unit or part of a legal unit."[126]

Section A

Q.2. An enterprise group has two or more legally defined enterprises. These can be 'sister' enterprises, such as other legally defined product divisions, 'daughter' enterprises such as subsidiaries, or parent enterprises, such as a regional or international head office. Each can be located in the same country as the respondent or in a different country.

[125] Thum-Thysen, A., Voigt, P., Bilbao-Osorio, B., Maier, C. and Ognyanova D. (2017). Unlocking Intangible Investments. Discussion Paper 047, Luxembourg: Publications Office of the European Union.

[126] Council Regulation (EEC) N° 696/1993 of 15 March 1993, OJ N° L76 of the 3 March on the statistical units for the observation and analysis of the production system in the Community.

Q.5. Turnover corresponds to the total value of market sales of goods and services to third parties (excluding VAT)[127].

Section B

The questionnaire aims at investigating investment decisions on six intangible assets: (i) research and experimental development and acquisition of external knowledge, (ii) employer funded training (iii) organization/business process improvement, (iv) software and databases, (v) design, and (vi) company reputation and branding.

Specifically, the questionnaire targets at capturing spending in intangible assets during the past year (i.e., 2019) in terms of expenditures as a % of the firm's turnover, the firm's choice to allocate resources to "making" internally rather than "buying" externally those intangibles, and the impact, if any, of Covid-19 pandemic on enterprise investment in intangibles (i.e., spending on intangibles in 2020 compared to 2019).

i) Research and Experimental Development

Research and experimental development (R&D) comprises creative and systematic work undertaken (in-house or provided by external providers) in order to increase the stock of knowledge and to devise new applications of available knowledge [Oslo Manual, 2018, § According to the *Frascati Manual 2015* definition (OECD, 2015: § 2.5 to 2.7)]. R&D activities must meet five criteria: (i) novel; (ii) creative; (iii) address an uncertain outcome; (iv) systematic; and (v) transferable and/or reproducible. R&D comprises basic research, applied research, and experimental development.

Q.6a. In-house R&D spending includes a) staff costs of all staff involved, b) associated costs, including facilities, overheads and materials but not capital items.
Q.6b. Spending on R&D provided by external providers includes costs of bought-in R&D services.

Q.7. Spending on external knowledge acquisition, includes costs of purchase or licensing of patents and non-patented inventions, know-how, process blueprints and other types of knowledge. Excludes the purchase of software/databases.

ii) Employer funded training

Training activities (provided by own staff or external providers) includes all activities that are paid for or subsidized by the enterprise to develop knowledge and skills required for the specific trade, occupation or tasks of a firm's employees (Oslo manual, 2018).

[127] Definition by Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Turnover_-_SBS

Q.11a. Enterprise spending on employee training carried out using internal resources

- Includes a) staff costs of trainers, b) travel and subsistence payments, c) associated costs, including facilities, overheads and materials but not capital items.
- Excludes a) cost of staff while being trained and therefore absent from work, b) on-the-job training, c) capital items

Q.11b. Enterprise spending on employee training organized by external providers

- Includes: a) training provided by external entities, either provided on-site or elsewhere

iii) Organization/Business Process Improvement

Organization or business process improvement involves work targeted at improving the efficiency and effectiveness of the enterprise, such as quality improvement programmes, business transformation projects, changes in management systems, changes in organisation structure etc. This work can be undertaken through purchased consultancy services and/or in-house investment of managerial time.

Q.14 Enterprise spending on organization or business project improvement carried out by external providers:

- Includes costs of bought-in management consultancy services

Q.14. Enterprise spending on organization or business process improvement using internal resources:

- Includes: a) staff costs, including those who do this as part of their everyday jobs (e.g. managers working to improve general business processes) b) associated costs, including office facilities and overheads for staff involved but not capital items.

iv) Software and Databases

Software and Databases: The in-house development and/or purchase of computer software, programme descriptions and supporting materials for both systems and applications software (including standard software packages and customized software solutions). The design, creation or acquisition of databases in electronic format as well as cloud services related to software and databases use and/or development should also be considered. Software developed within R&D projects and web design must be excluded.

Q.18. Enterprise spending on software and databases purchased by external providers:

- Includes: a) off-the-shelf software, b) software licenses and license renewals, c) generic and bespoke software, d) cloud services for software and/or databases use.
- Excludes: software embedded in other items of current or capital expenditure (e.g. software pre-installed on IT hardware)

Q.18. Enterprise spending on software and databases developed or customized in-house:

- Includes: a) staff costs of all staff involved, excluding contractors, b) associated costs, including office facilities, overheads and materials, as well as cloud services use for software (and/or database) development but not capital items.

v) Design

Design includes a wide range of (in-house and/or contracted out) activities to develop a new or modified function, form or appearance for goods, services or processes, including business processes to be used by the firm itself. The goal of product and service design is to improve the attractiveness (aesthetics) or ease of use (functionality) of products and services. Process design, which can be closely linked to engineering, improves the efficiency of processes. Design in the R&D phase of product development or design of software should be excluded (Oslo Manual, 2018).

Q.22. Enterprise spending on design activities carried out by external providers:

- Include: Costs of bought-in design services.
- Exclude: Costs of design embedded in other items of current or capital expenditure.

Q.22. Enterprise spending on design activities using internal resources:

- Includes: a) staff costs of all staff involved (e.g., graphic designers, product designers, architects, design engineers), b) associated costs, including office facilities, overheads and materials but not capital costs.

vi) Reputation and Branding

Reputation and Branding activities include market research and market testing, methods for product promotion, product advertising, the promotion of products at trade fairs or exhibitions. They also include advertising for trademarks that are not directly related to a specific product, such as advertising linked to the firm's name, as well as public relations activities that contribute to a firm's reputation and brand equity.

Q.26. Enterprise spending on reputation and branding undertaken by external providers:

- Includes: External costs of advertising and marketing campaigns to agencies, media organizations, trade fairs, suppliers of marketing databases etc.

Q.26. Enterprise spending on reputation and branding using internal resources:

- Includes: a) staff costs of all staff involved (e.g., product managers, sales and marketing personnel), b) associated costs, including office facilities, overheads and materials but not capital items.

Section C

This section aims at investigating drivers determining investments in intangible assets by focusing mainly on firm-specific factors such as strategic priorities, technological and human resources and organizational capabilities.

Q.32. Foreign direct investment (FDI)

A foreign direct investment occurs when a business from one country, invests in another by starting a new business or by investing in a foreign owned firm.

Q.35. attempts to capture specific investment types in **industry 4.0 technologies** the last three years (2017-2019) taking into consideration that such investments are crucial in supporting and further fuelling performance improvement and innovation.

Q.38. Design use

Design use aims at capturing the design capability of an enterprise by employing a scale of roles of design that are ordered from not systematic design use to more integrated and sophisticated uses.

Q.39. Digital capabilities

Digital capabilities capture the ability of a firm to benefit from digitalization and address associated challenges and fuel innovation. **Digitalization** is the application or increase in use of digital technologies by an organization, industry, country, etc., for example transforming existing tasks or enabling new ones.

Q.39. indicates the extent to which an enterprise has developed several **digital capabilities**. It focuses on specific digital capabilities as a key component of firms' innovation capabilities taking into consideration that the development, maintenance, and exercise of digital capabilities is shaped by ICT and digital resources/technologies. A firm with advanced digital capabilities has the ability to connect various, business activities and business functions (production/delivery of services, logistics, marketing/sales, product development, administration) forming an integrated system with structured data exchanges among different functions and units and digital connections with suppliers and customers.

Q.40. Digital platforms

Digital platforms integrate producers and users at various stages of the value chain. They often form an ecosystem in which new products are developed and sold, and data generated and exchanged. Strong use of digital platforms suggests a greater propensity to invest in relevant supportive ICT and digital resources. Data on the participation of firms in digital platform activities can provide information on the firm's potential to leverage the business opportunities of digital technologies which is much more important than just investing in digital technologies.

Section E

Policy Questions

Q.44. Tax incentives allow a firm to reduce its tax burden or other types of mandatory contributions imposed by law such as social security contributions depending on the size of- or increase in eligible activities. Tax incentives could take the following forms:

- **Accelerated depreciation schemes** for investments (machinery, equipment, buildings, software, patents, other intangibles) for the express purpose of developing above mentioned intangibles in the firm.
- Special allowances that enable a firm to **deduct** more than 100 percent of their **current eligible expenditures** on intangibles from their taxable income.
- Special exemptions on wage and/or social taxes for employees working in activities related to generation of intangibles.
- Tax credits that allow firms to directly deduct a specific share of their expenses on intangibles from their corporate tax liabilities.
- Patent box: Grants a lower corporate tax rate on profits generated from patents that are held in a certain country.

Q.44. Direct subsidies. These can take the following forms:

- **Grants** which cover a variable proportion of the anticipated or actual costs on investments in intangibles.
- **Soft loans** provided either directly by a government agency or through commercial banks or other financial intermediaries. Programmes might or might not have specific conditions (e.g., attainment of specific outcomes).
- **Government loan guarantees**: Reduce the need of the business to provide collateral for a loan for projects related to intangibles.
- Government support to seed capital, business angel networks, and early-stage venture capital funds. This could take many forms. E.g., creation of a fund of funds, co-investment, etc.

Section F

The last questionnaire section attempts to capture the impact of Covid-19 crisis on economic performance measures and firms' investments in intangible assets and digital strategy/capabilities.

Q.48. indicates the extent to which **the increasing requirements for digital transformation** during the Covid-19 pandemic may have an impact on:

- the level of spending on ICT infrastructure and/or
- a more efficient and effective use and exploitation of existing ICT infrastructure which otherwise would have remained idle.

Q.49. The level of **digital transformation performance** before the outbreak of Covid-19 assists in better capturing the impact of crisis on relevant investments and strategies adopted during the crisis. Digital transformation performance is measured using the following scale:

- **innovator** (firms that are first to adopt innovations promoting digital transformation),
- **early adopter** (the second fastest category of firms to adopt digital technologies in their sector/markets etc.),
- **late adopter** (firms that adopt digital technologies with a significant delay (after the average firm in their sector does so),
- **laggard** (firms last to adopt a digital innovation due to very slow and/or limited adoption of digital technologies).

Q.50. The degree of use of specific **digital work practices** and tools during the crisis indicates the effect of the pandemic on establishing or better exploiting specific organizational procedures and capabilities (enhancing teleworking, remote collaboration etc.) which may allow firms minimize disruptions.

Q.51. The assessment of the enterprise's **digital transformation strategy orientation** as an outcome of the Covid-19 crisis. An enterprise may see the Covid crisis as an opportunity either to accelerate its digital transformation and sustain the changes implemented in the long run, or simply see the Covid crisis as purely a survival threat without introducing relevant digital transformation business processes and practices.

Appendix 2A

Table 2A.1 Sample distribution by firm size (number of employees)

Size Category	Number of Firms	% of Firms	Number of employees (Mean)	Number of employees (Median)
Small firms (20-49 Employees)	786	43.8%	31.7	30
Medium firms (50-249 Employees)	593	33.0%	102.1	85
Large firms (250+ Employees)	417	23.2%	837.6	420

Table 2A.2 Sample distribution by firm size (annual turnover)

Size Category	Number of Firms	% of Firms	Annual turnover (Mean)	Annual turnover (Median)
0 < < 2 mil. Euros	123	6.9%	1267949.4	1344086.0
2 ≤ < 10 mil. Euros	712	39.8%	5039829.8	4651162.8
10 ≤ < 50 mil. Euros	544	30.4%	22895630.6	20000000.0
≥ 50 mil. Euros	411	23.0%	214202750.5	99000000.0

Table 2A.3 Sample distribution by 2-digit NACE Rev.2 Industry

Sector	Technology/Knowledge Intensity	NACE 2 Industry	Number of Firms	% of Firms
Manufacturing	Low-technology	10. Manufacture of food products	192	10.7
		11. Manufacture of beverages	21	1.2
		13. Manufacture of textiles	6	0.3
		14. Manufacture of wearing apparel	4	0.2
		15. Manufacture of leather and related products	3	0.2
		16. Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	21	1.2
		17. Manufacture of paper and paper products	8	0.4
		18. Printing and reproduction of recorded media	5	0.3
		31. Manufacture of furniture	9	0.5
		32. Other manufacturing	21	1.2
	Medium-low-technology	19. Manufacture of coke and refined petroleum products	2	0.1
		22. Manufacture of rubber and plastic products	31	1.7
		23. Manufacture of other non-metallic mineral products	68	3.8
		24. Manufacture of basic metals	62	3.5
		25. Manufacture of fabricated metal products, except machinery and equipment	56	3.1
		33. Repair and installation of machinery and equipment	12	0.7
		35. Electricity, gas, steam and air conditioning supply	12	0.7

	Medium-high-technology	20. Manufacture of chemicals and chemical products	69	3.8
		27. Manufacture of electrical equipment	80	4.5
		28. Manufacture of machinery and equipment n.e.c.	233	13.0
		29. Manufacture of motor vehicles, trailers and semi-trailers	39	2.2
		30. Manufacture of other transport equipment	17	0.9
	High-technology	21. Manufacture of basic pharmaceutical products and pharmaceutical preparations	28	1.6
		26. Manufacture of computer, electronic and optical products	79	4.4
Services	Less knowledge-intensive services	46. Wholesale trade, except of motor vehicles and motorcycles	142	7.9
		47. Retail trade, except of motor vehicles and motorcycles	37	2.1
	Knowledge-intensive services	58.2 Software publishing	6	0.3
		59. Motion picture, video and television programme production, sound recording, and music publishing activities	4	0.2
		61. Telecommunications	9	0.5
		62. Computer programming, consultancy and related activities (incl. PC and software installation)	112	6.2
		63. Information service activities	15	0.8
		64.1 Monetary intermediation	26	1.4
		69. Legal and accounting activities	68	3.8
		70. Activities of head offices; management consultancy activities	52	2.9
		71. Architectural and engineering activities; technical testing and analysis	130	7.2
		72. Scientific research and development	36	2.0

		73. Advertising and market research	33	1.8
		74. Other professional, scientific and technical activities (incl. design, photography, translation etc.)	33	1.8
		90. Creative, arts and entertainment activities	15	0.8
TOTAL			**1796**	**100**

Figure 2A.1 Sample distribution by firm size (annual turnover) and sectoral group (manufacturing vs. services)

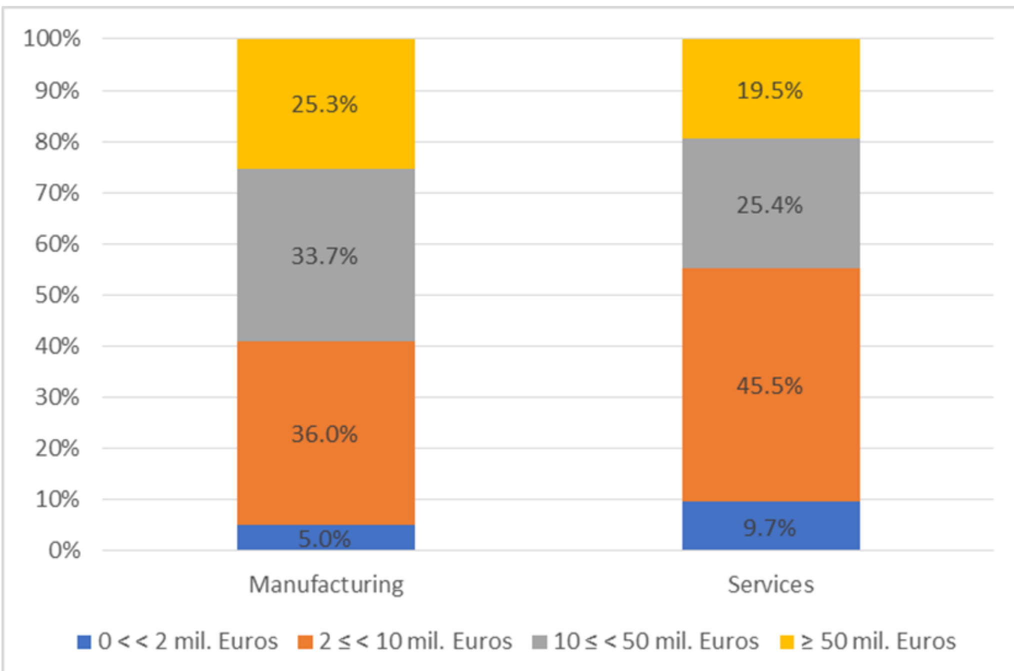
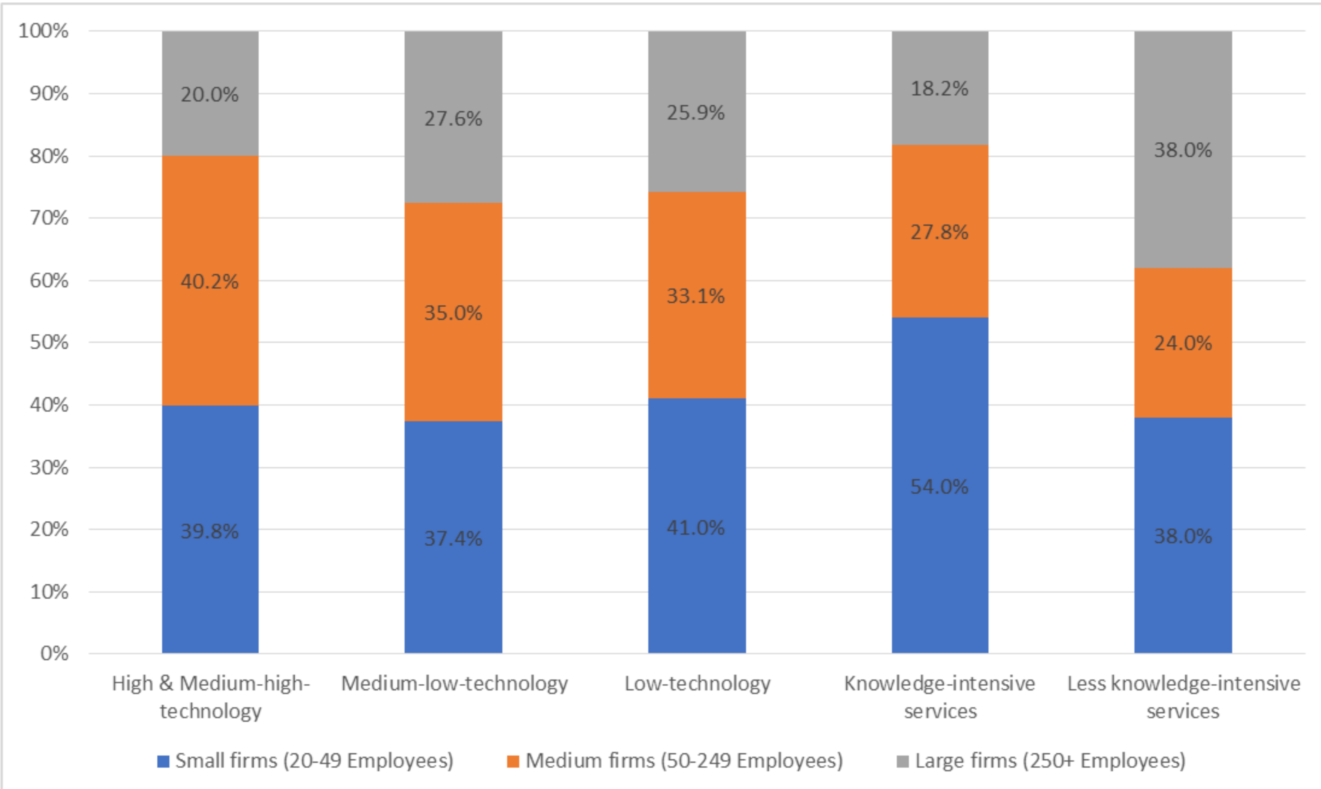


Figure 2A.2 Sample distribution by firm size (number of employees) and sectoral group (technology/knowledge intensity)



Appendix 3A

Table 3A.1 ANOVA test Post-hoc analysis for total spending on intangible activities as % of turnover, by sectoral group (technology/knowledge intensity) [N = 1351]

Sectoral Group	High- & Medium-high-technology	Medium-low-technology	Low-technology	Knowledge-intensive services	Less knowledge-intensive services
High- & Medium-high-technology		0.000	0.000	0.000	0.000
Medium-low-technology			1.000	0.000	0.309
Low-technology				0.000	0.372
Knowledge-intensive services					0.000
Less knowledge-intensive services					

Table 3A.2 ANOVA test Post-hoc analysis for total spending on intangible activities as % of turnover, by country [N = 1351]

Country	Denmark	Finland	France	Germany	Greece	Slovenia	UK
Denmark		1	0.996	0.435	0.999	1	0.147
Finland			0.974	0.734	1.000	0.999	0.402
France				0.153	0.944	1	0.031
Germany					0.858	0.383	0.999
Greece						0.995	0.573
Slovenia							0.127
UK							

Figure 3A.1 Impact of Covid-19 crisis on R&D spending by sectoral group (technology/knowledge intensity) [N = 1089]

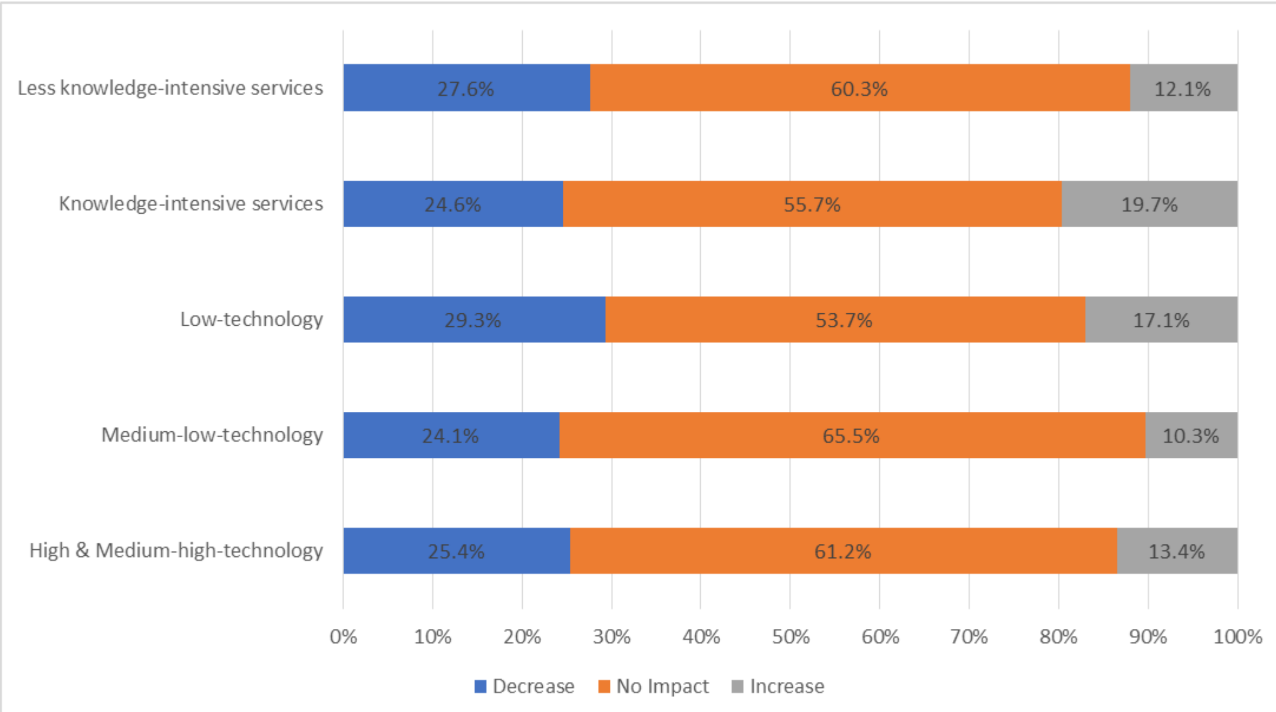


Figure 3A.2 Impact of Covid-19 crisis on training expenditure by sectoral group (technology/knowledge intensity) [N = 1595]

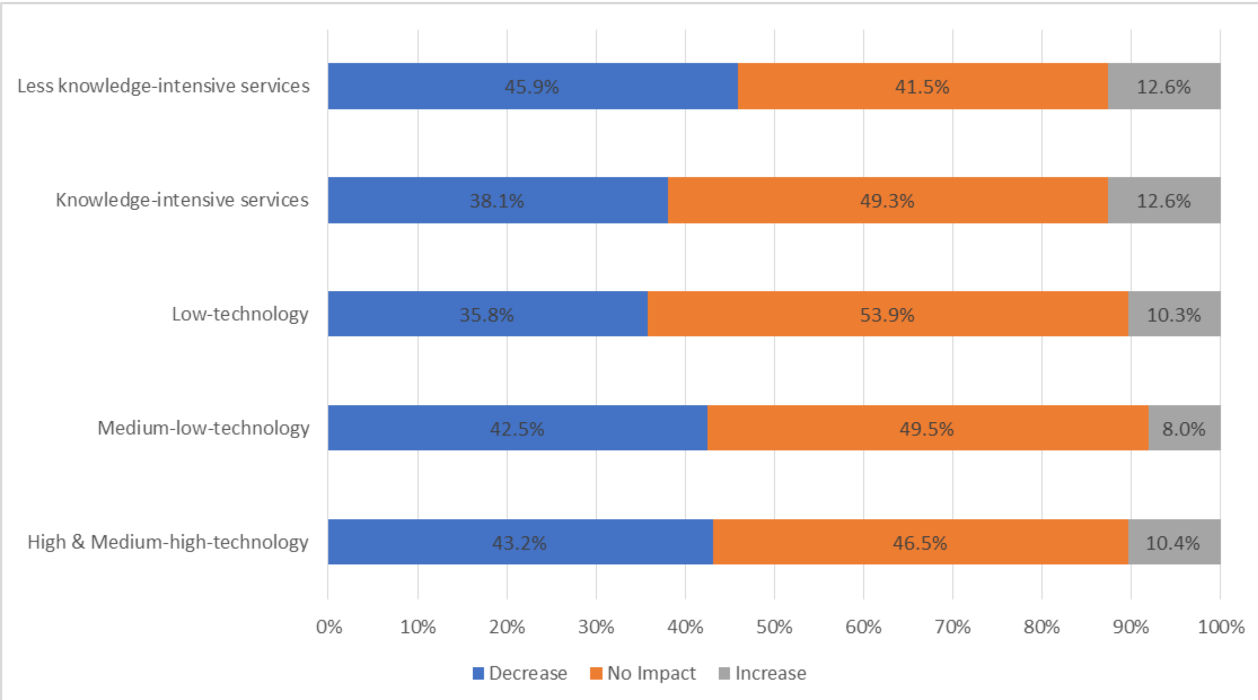


Figure 3A.3 % of firms involved in activities for OBP improvement by activity type and sectoral group (technology/knowledge intensity) [N = 878]

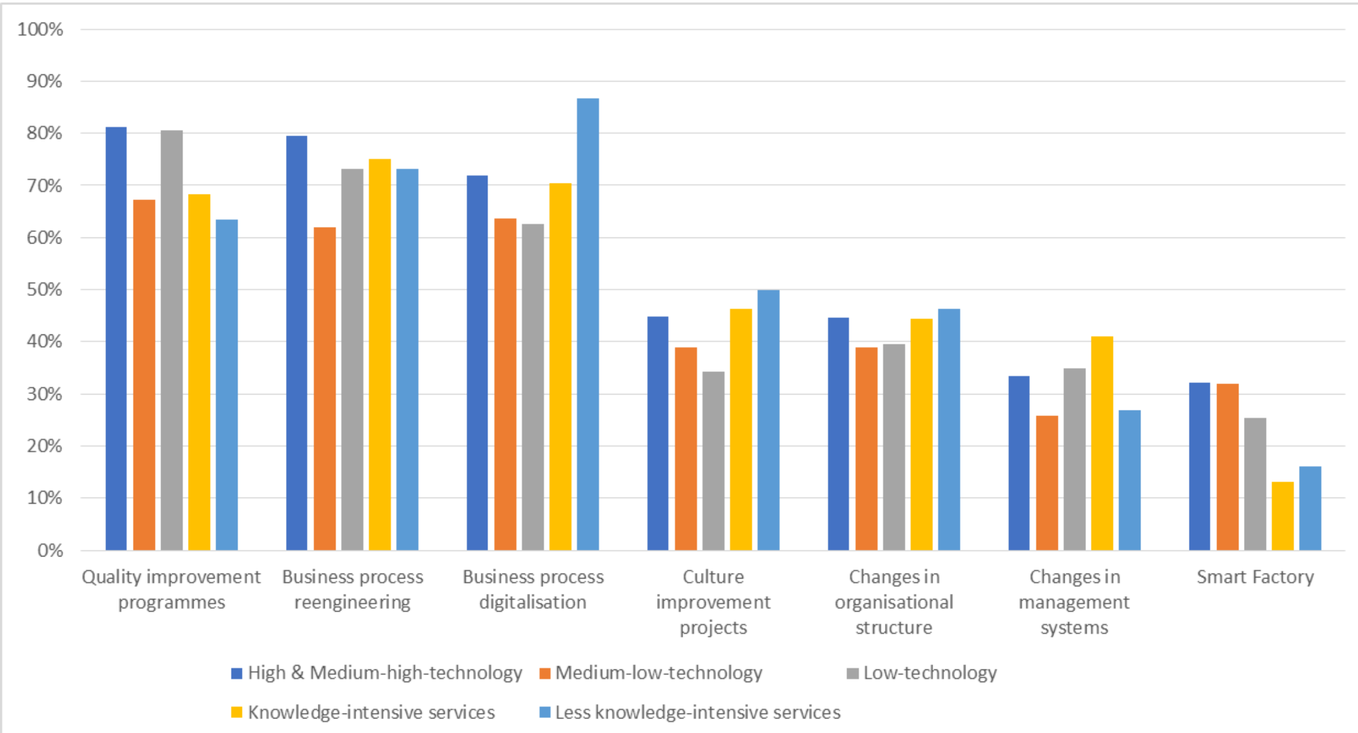


Figure 3A.4 Impact of Covid-19 crisis on OBP improvement expenditure by sectoral group (technology/knowledge intensity) [N = 875]

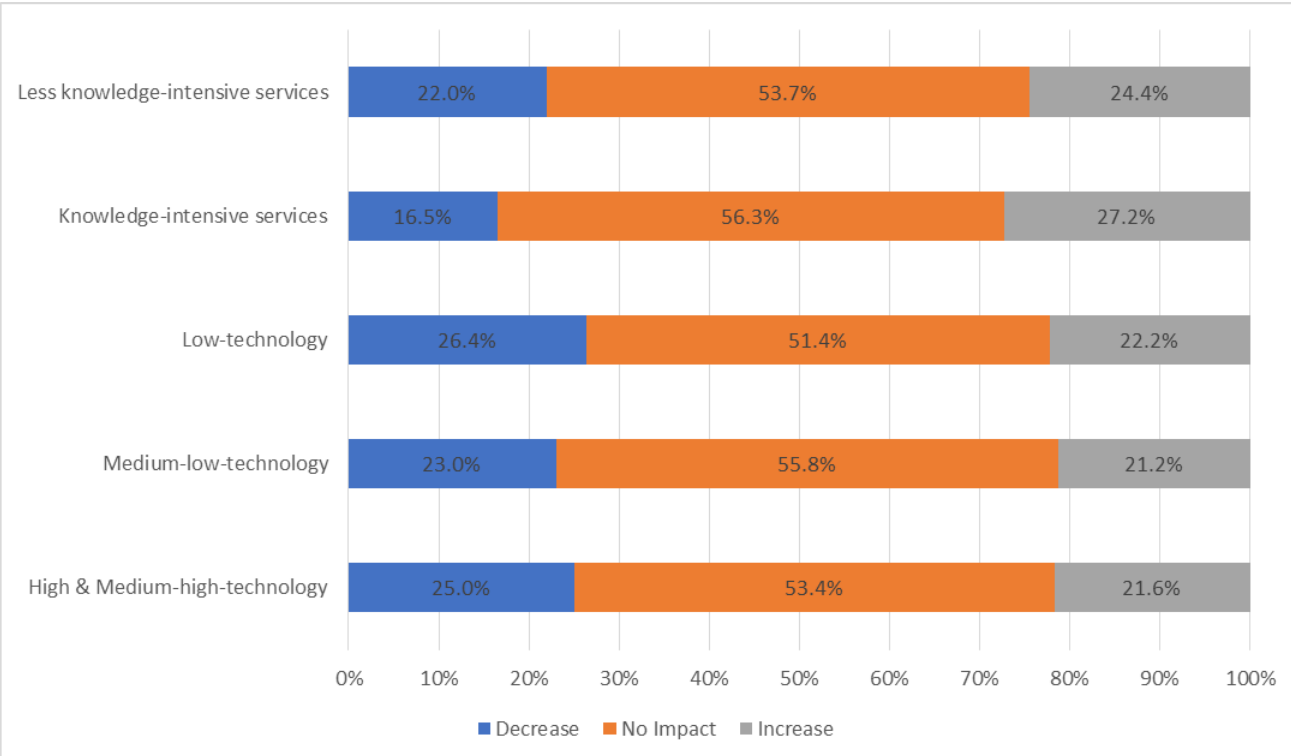


Figure 3A.5 % of firms with software and database expenditures by activity type and sectoral group (technology/knowledge intensity) [N = 917]

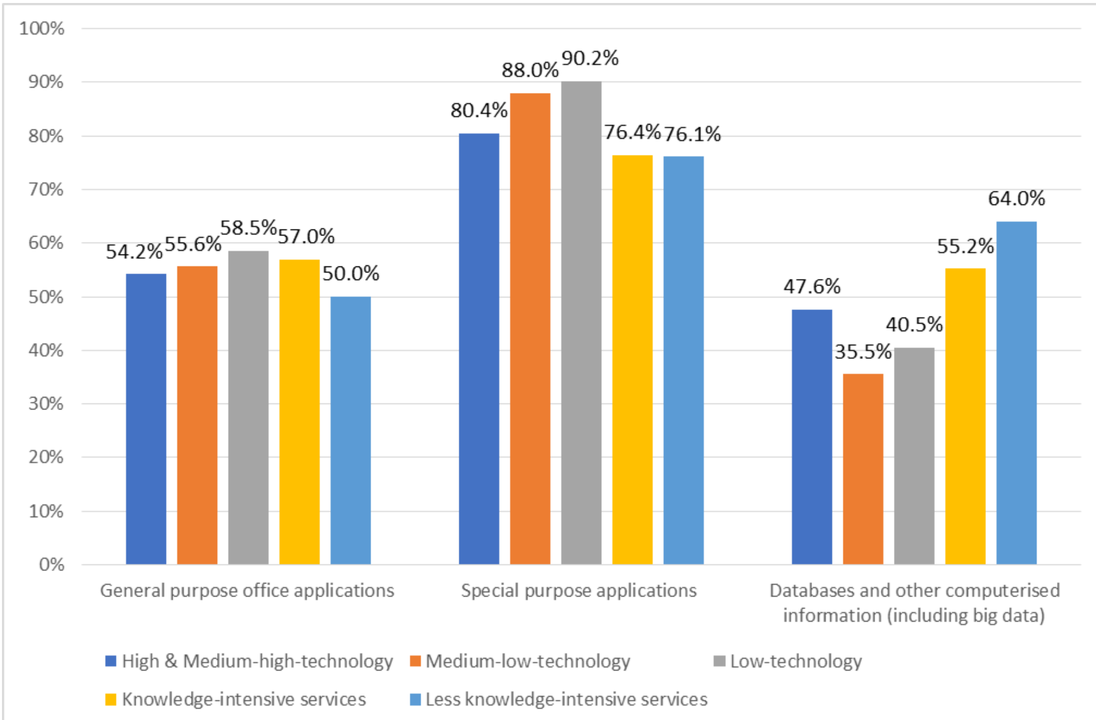


Figure 3A.6 Impact of Covid-19 crisis on Software & Databases expenditure by sectoral group (technology/knowledge intensity) [N = 918]

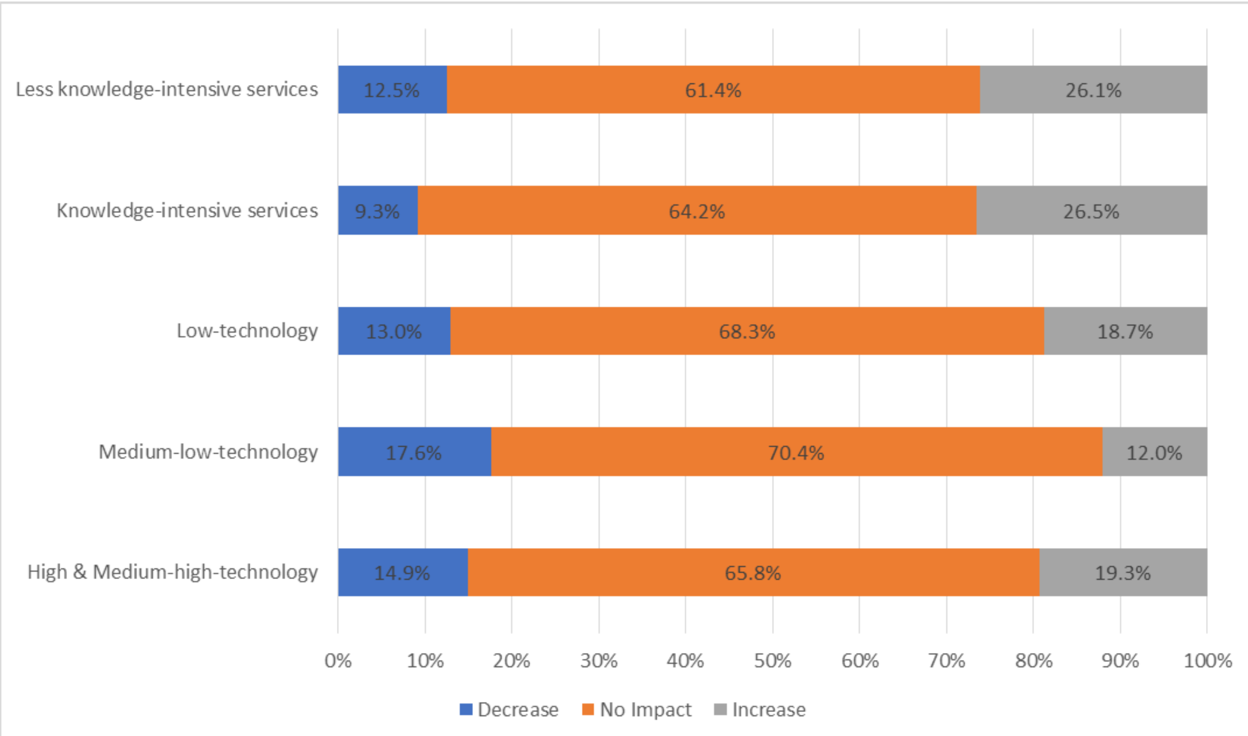


Figure 3A.7 % of firms with design expenditures by activity type and sectoral group (technology/knowledge intensity) [N = 591]

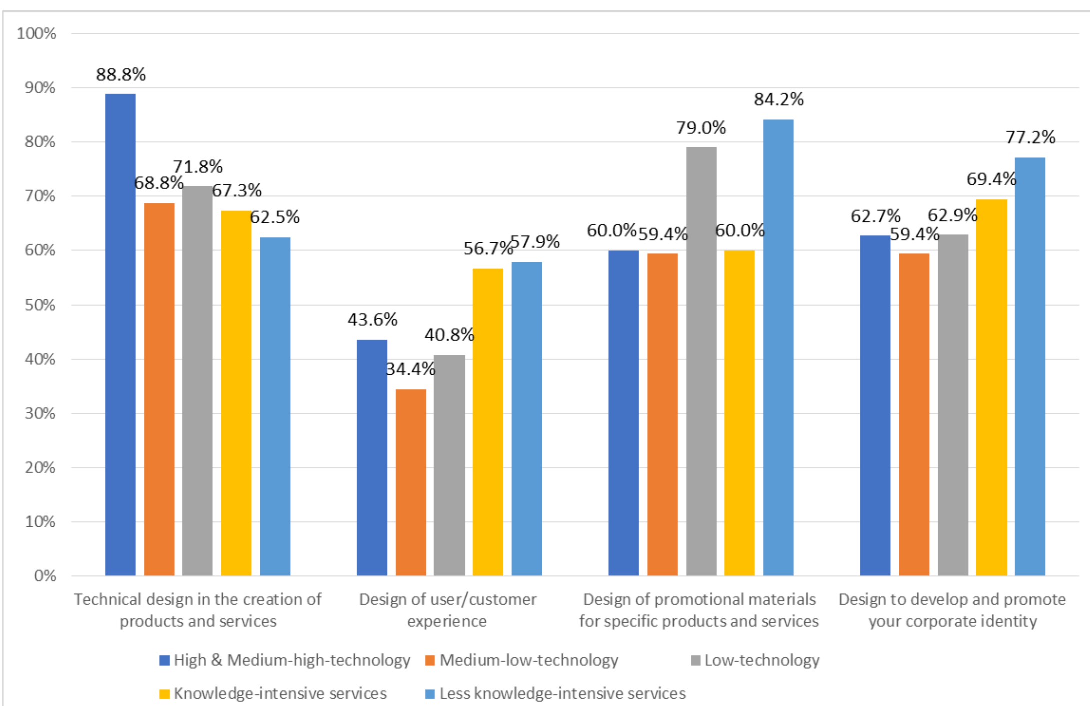


Figure 3A.8 Impact of Covid-19 crisis on design expenditure by sectoral group (technology/knowledge intensity) [N = 589]

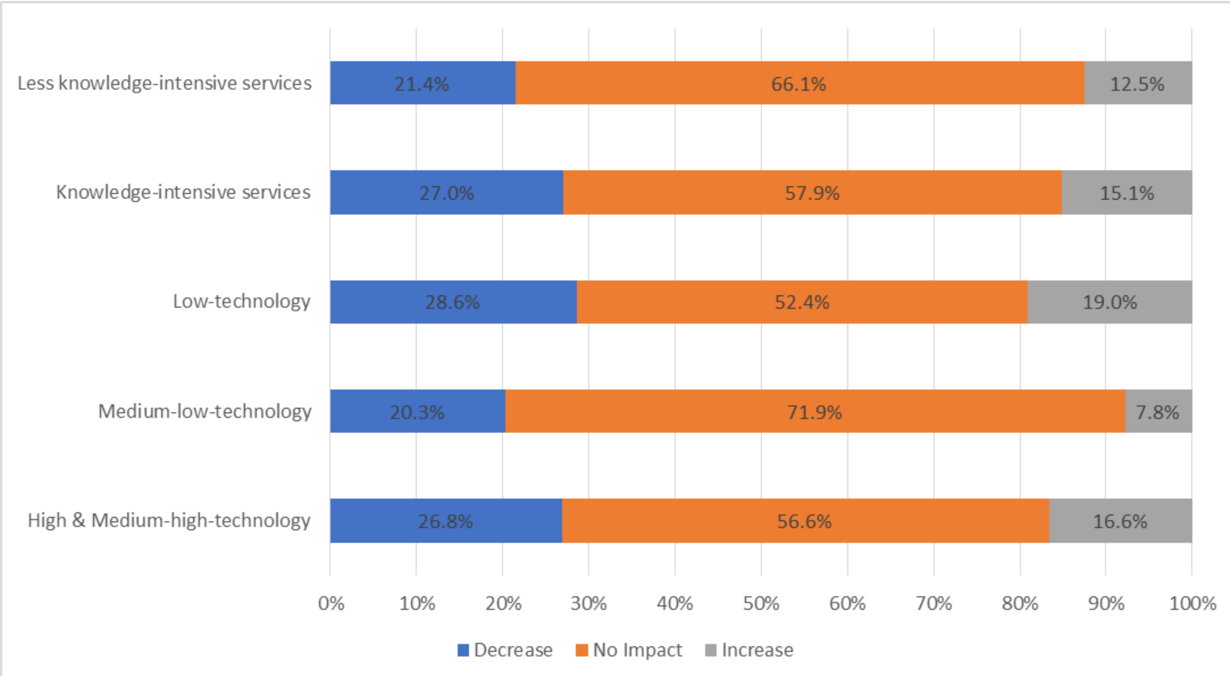
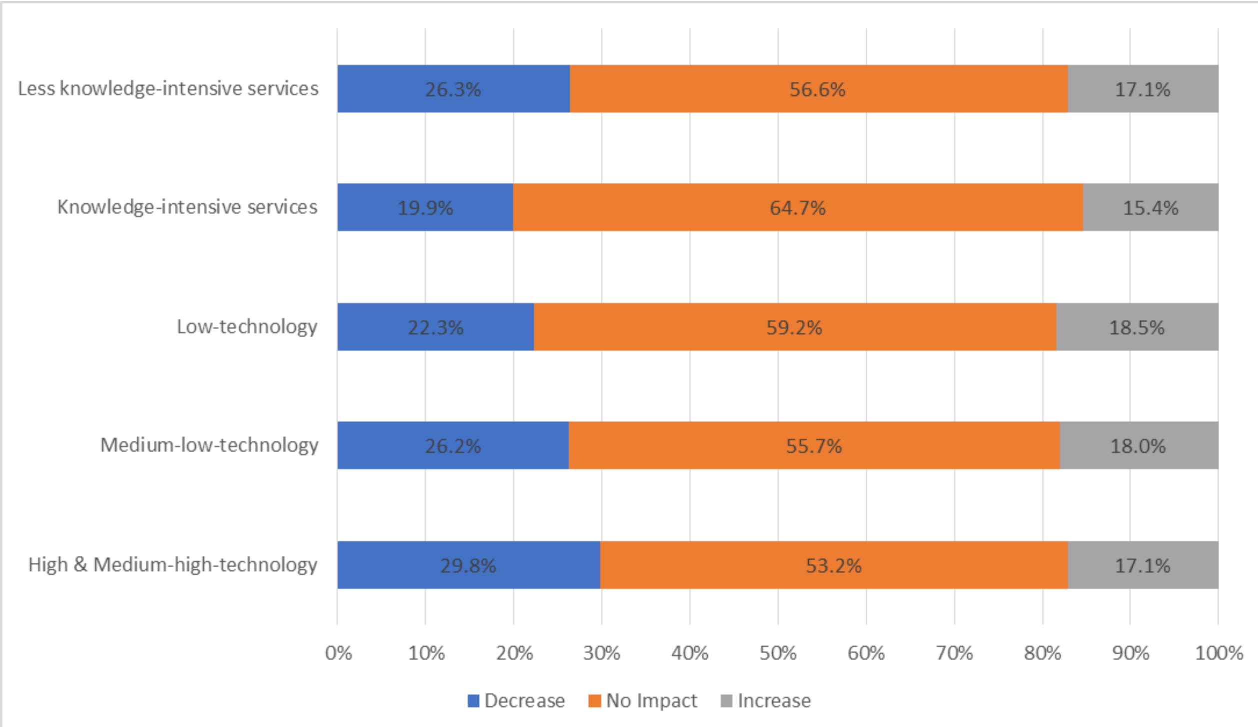


Figure 3A.9 Impact of Covid-19 crisis on Reputation & Branding expenditure by sectoral group (technology/knowledge intensity) [N = 713]



Appendix 4A

Figure 4A.1 Competition intensity in the main market by firm size (N = 1783)

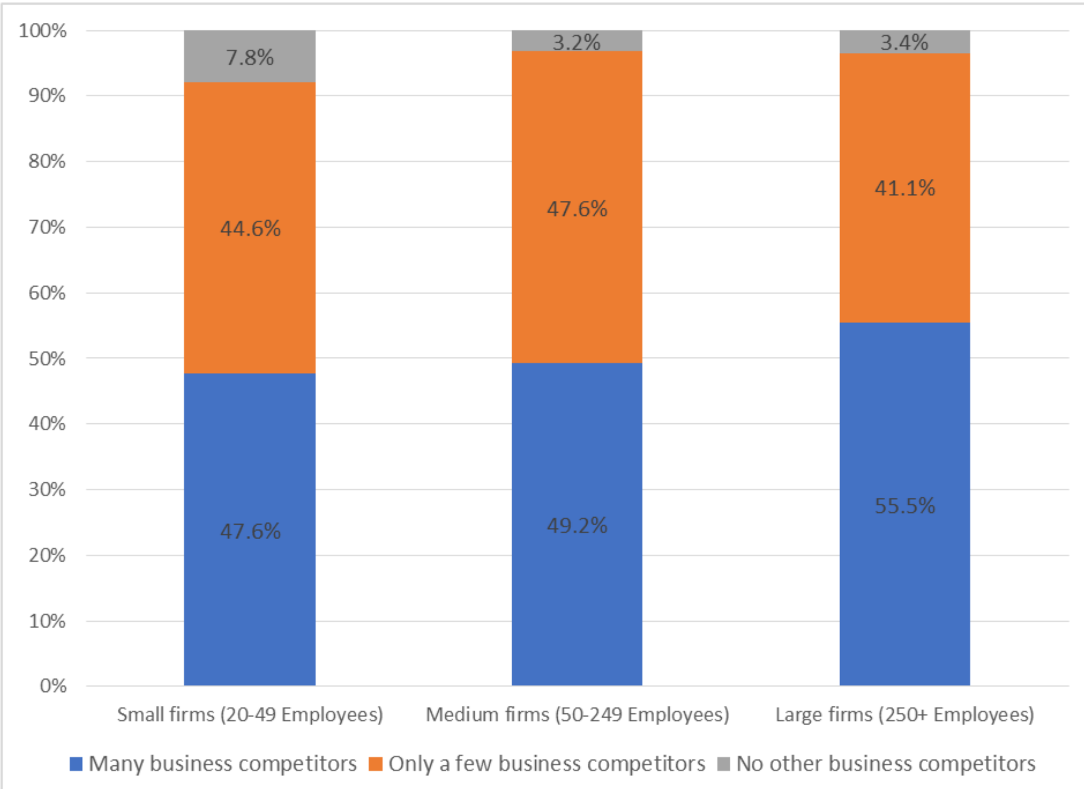


Table 4A.1 Education level of employees and engagement in R&D activities by sectoral group (technology/knowledge intensity)

% of full-time employees	Sectoral Group	Number of Firms	Mean	Median	ANOVA Sig.	Eta squared
with University Degree	High & Medium-high-technology	498	18.8%	14.0%	0.000	0.311
	Medium-low-technology	222	12.8%	9.0%		
	Low-technology	263	12.4%	9.0%		
	Knowledge-intensive services	499	45.4%	45.0%		
	Less knowledge-intensive services	164	18.4%	14.0%		
with Postgraduate Degree	High & Medium-high-technology	494	6.0%	2.0%	0.000	0.120
	Medium-low-technology	224	3.0%	1.0%		
	Low-technology	260	3.9%	1.0%		
	Knowledge-intensive services	470	17.1%	6.0%		
	Less knowledge-intensive services	156	6.8%	2.0%		
engaged in R&D activities	High & Medium-high-technology	538	10.7%	7.0%	0.000	0.078
	Medium-low-technology	241	4.1%	2.0%		
	Low-technology	281	5.1%	3.0%		
	Knowledge-intensive services	529	15.7%	4.0%		
	Less knowledge-intensive services	175	3.9%	0.0%		

Table 4A.2 Education level of employees and engagement in R&D activities by firm size

% of full-time employees	Size Category	Number of Firms	Mean	Median	ANOVA Sig.	Eta squared
with University Degree	Small firms (20-49 Employees)	761	27.5%	17.0%	0.000	0.015
	Medium firms (50-249 Employees)	549	24.9%	16.0%		
	Large firms (250+ Employees)	336	19.5%	11.0%		
with Postgraduate Degree	Small firms (20-49 Employees)	744	10.1%	3.0%	0.002	0.008
	Medium firms (50-249 Employees)	536	7.1%	2.0%		
	Large firms (250+ Employees)	324	7.5%	2.0%		
engaged in R&D activities	Small firms (20-49 Employees)	777	12.3%	6.0%	0.000	0.021
	Medium firms (50-249 Employees)	587	8.6%	4.0%		
	Large firms (250+ Employees)	399	6.3%	2.0%		

Table 4A.3 Investments in Industry 4.0 technologies by firm size

	Size Category	Number of Firms	High Extent[128] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Hardware technologies (e.g., robots, 3D technologies, sensor technologies)	Small firms (20-49 Employees)	761	12.6%	1.78	0.000	0.023
	Medium firms (50-249 Employees)	576	17.7%	2.12		
	Large firms (250+ Employees)	400	18.5%	2.24		
Digital technologies (e.g., artificial intelligence, data analytics, IoT, machine learning, virtual and augmented reality, blockchain)	Small firms (20-49 Employees)	766	10.6%	1.74	0.000	0.022
	Medium firms (50-249 Employees)	580	12.4%	1.98		
	Large firms (250+ Employees)	407	16.7%	2.18		
Bioinformatics-related technologies (e.g., genetics/genome editing, 3D&4D print in combination with genetics and medicine, neurotechnology)	Small firms (20-49 Employees)	717	0.7%	1.07	0.000	0.010
	Medium firms (50-249 Employees)	530	1.9%	1.14		
	Large firms (250+ Employees)	376	3.2%	1.20		

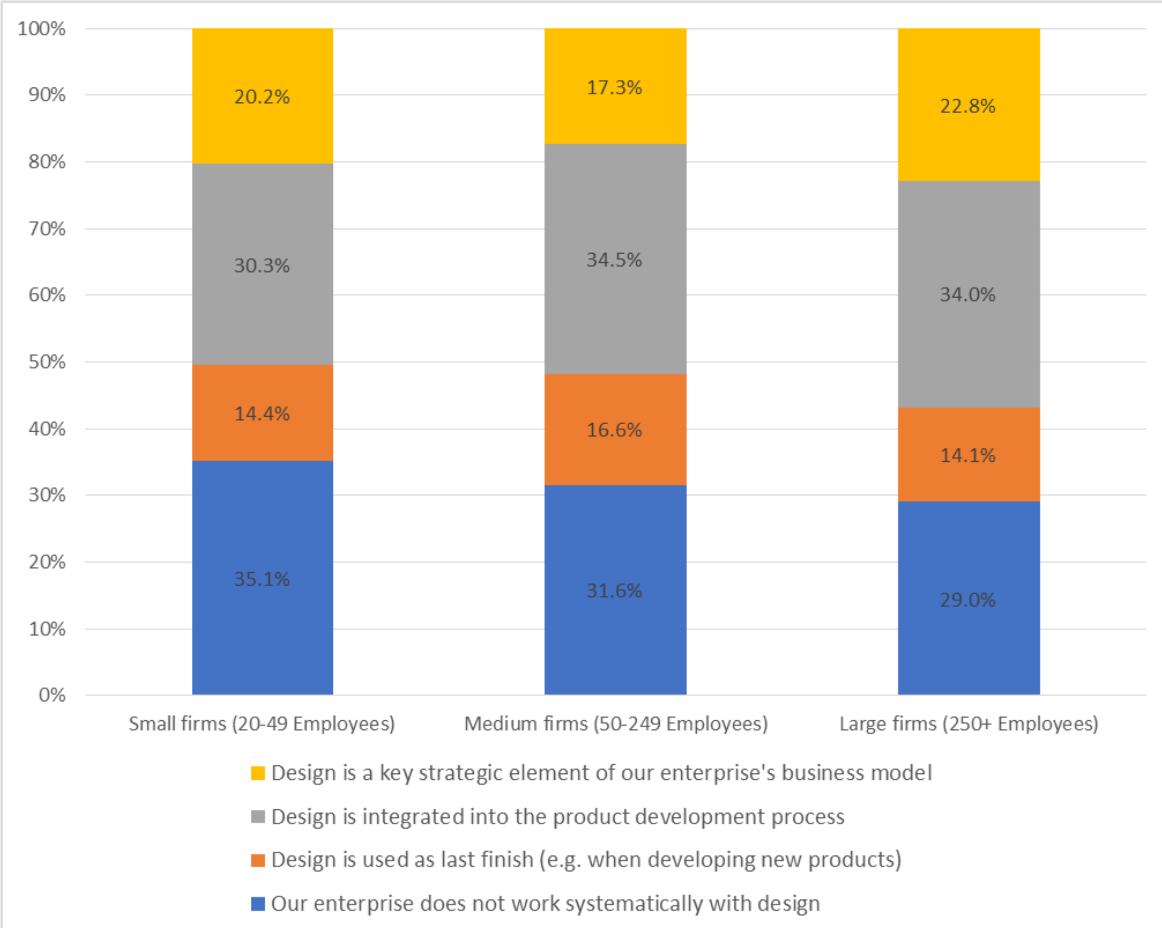
[128] Responses of 4 or 5 on a 5-point Likert-type scale.

Table 4A.4 Investments in Industry 4.0 technologies by sectoral group (technology/knowledge intensity)

	Sectoral Group	Number of Firms	High Extent[129] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Hardware technologies (e.g., robots, 3D technologies, sensor technologies)	High & Medium-high-technology	537	22.7%	2.35	0.000	0.051
	Medium-low-technology	240	19.2%	2.22		
	Low-technology	275	10.9%	1.91		
	Knowledge-intensive services	513	11.3%	1.72		
	Less knowledge-intensive services	172	9.3%	1.58		
Digital technologies (e.g., artificial intelligence, data analytics, IoT, machine learning, virtual and augmented reality, blockchain)	High & Medium-high-technology	536	11.0%	1.90	0.000	0.041
	Medium-low-technology	236	8.1%	1.67		
	Low-technology	278	5.8%	1.60		
	Knowledge-intensive services	527	20.9%	2.25		
	Less knowledge-intensive services	176	9.7%	1.85		
Bioinformatics-related technologies (e.g., genetics/genome editing, 3D&4D print in combination with genetics and medicine, neurotechnology)	High & Medium-high-technology	494	1.2%	1.11	0.001	0.011
	Medium-low-technology	213	0.5%	1.04		
	Low-technology	258	0.8%	1.12		
	Knowledge-intensive services	489	3.7%	1.20		
	Less knowledge-intensive services	169	0.0%	1.05		

[129] Responses of 4 or 5 on a 5-point Likert-type scale.

Figure 4A.2 Design use in the enterprise by firm size (N = 1749)



Appendix 5A

Table 5A.1 Benefits from investments in intangible assets made in 2017-2019 by sectoral group (technology/knowledge intensity)

	Sectoral Group	Number of Firms	High Extent[130] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Turnover	High & Medium-high-technology	520	28%	2.73	0.033	0.006
	Medium-low-technology	233	20%	2.45		
	Low-technology	276	20%	2.61		
	Knowledge-intensive services	520	25%	2.72		
	Less knowledge-intensive services	175	26%	2.70		
Profit margin	High & Medium-high-technology	513	27%	2.71	0.007	0.008
	Medium-low-technology	234	18%	2.38		
	Low-technology	274	19%	2.55		
	Knowledge-intensive services	505	20%	2.61		
	Less knowledge-intensive services	171	22%	2.67		
Skills and qualifications of employees	High & Medium-high-technology	525	36%	3.03	0.000	0.028
	Medium-low-technology	239	28%	2.79		
	Low-technology	276	25%	2.79		
	Knowledge-intensive services	524	46%	3.26		
	Less knowledge-intensive services	177	29%	2.88		
Market share	High & Medium-high-technology	511	23%	2.63	0.000	0.013
	Medium-low-technology	232	12%	2.24		
	Low-technology	277	22%	2.52		
	Knowledge-intensive services	505	24%	2.63		
	Less knowledge-intensive services	173	23%	2.61		

[130] Responses of 4 or 5 on a five-point Likert-type scale.

Overall value of the enterprise	High & Medium-high-technology	519	36%	3.02	0.000	0.023
	Medium-low-technology	233	23%	2.55		
	Low-technology	278	29%	2.81		
	Knowledge-intensive services	506	37%	3.06		
	Less knowledge-intensive services	173	28%	2.75		

Table 5A.2 Benefits from investments in intangible assets made in 2017-2019 by firm size

	Size Category	Number of Firms	High Extent[131] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Turnover	Small firms (20-49 Employees)	752	23.8%	2.63	0.467	0.001
	Medium firms (50-249 Employees)	568	26.2%	2.71		
	Large firms (250+ Employees)	404	23.8%	2.68		
Profit margin	Small firms (20-49 Employees)	742	22.0%	2.59	0.853	0.000
	Medium firms (50-249 Employees)	564	19.9%	2.63		
	Large firms (250+ Employees)	391	24.0%	2.60		
Skills and qualifications of employees	Small firms (20-49 Employees)	759	33.6%	2.98	0.369	0.001
	Medium firms (50-249 Employees)	576	38.2%	3.06		
	Large firms (250+ Employees)	406	34.5%	3.00		
Market share	Small firms (20-49 Employees)	740	20.3%	2.51	0.304	0.001
	Medium firms (50-249 Employees)	565	21.4%	2.57		
	Large firms (250+ Employees)	393	24.7%	2.63		
Overall value of the enterprise	Small firms (20-49 Employees)	743	32.8%	2.88	0.718	0.000
	Medium firms (50-249 Employees)	571	31.0%	2.92		
	Large firms (250+ Employees)	395	33.9%	2.94		

[131] Responses of 4 or 5 on a five-point Likert-type scale.

Appendix 6A

Figure 6A.1 % of firms that were provided incentives for internal training programmes during the period 2017-2019, by size (N = 1765)

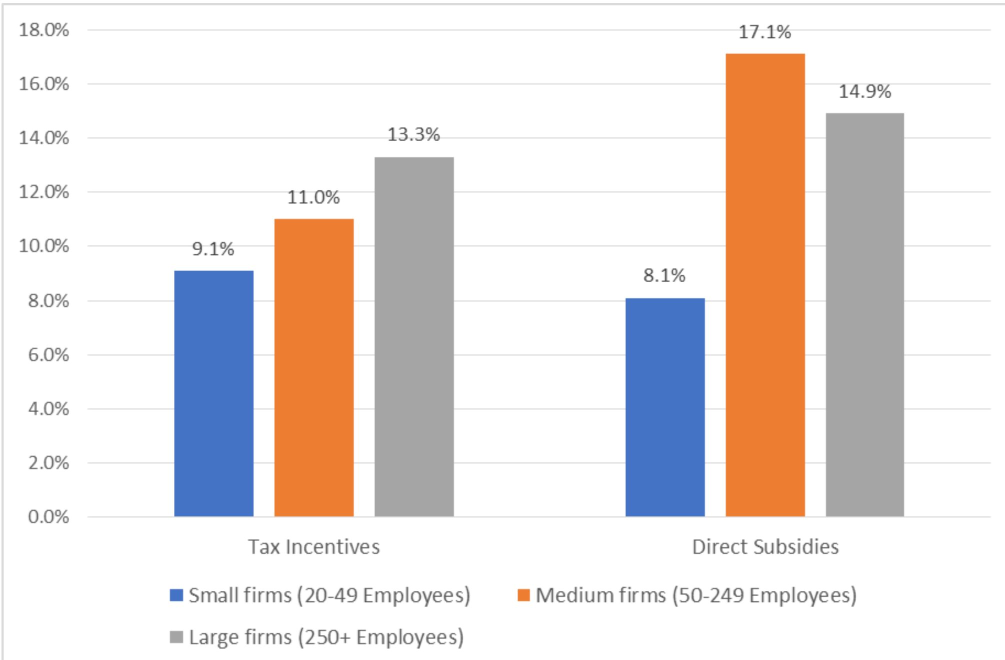


Figure 6A.2 % of firms that were provided incentives for internal training programmes during the period 2017-2019, by sectoral group (manufacturing vs. services) [N = 1765]

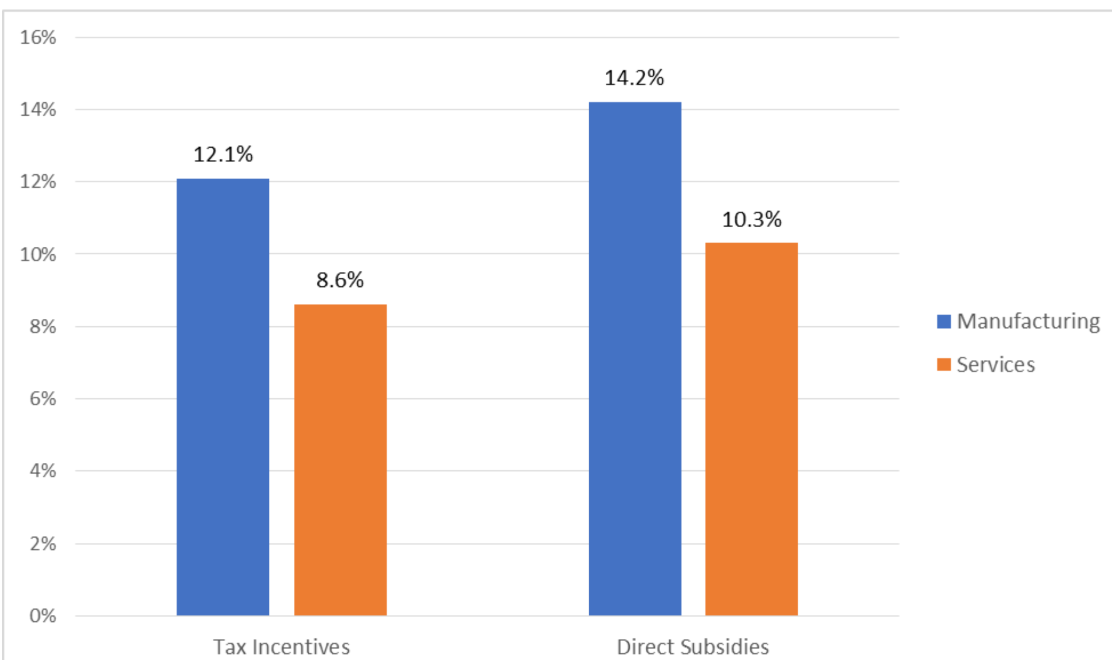


Figure 6A.3 % of firms that were provided incentives for internal training programmes during the period 2017-2019, by sectoral group (technology/knowledge intensity) [N = 1765]

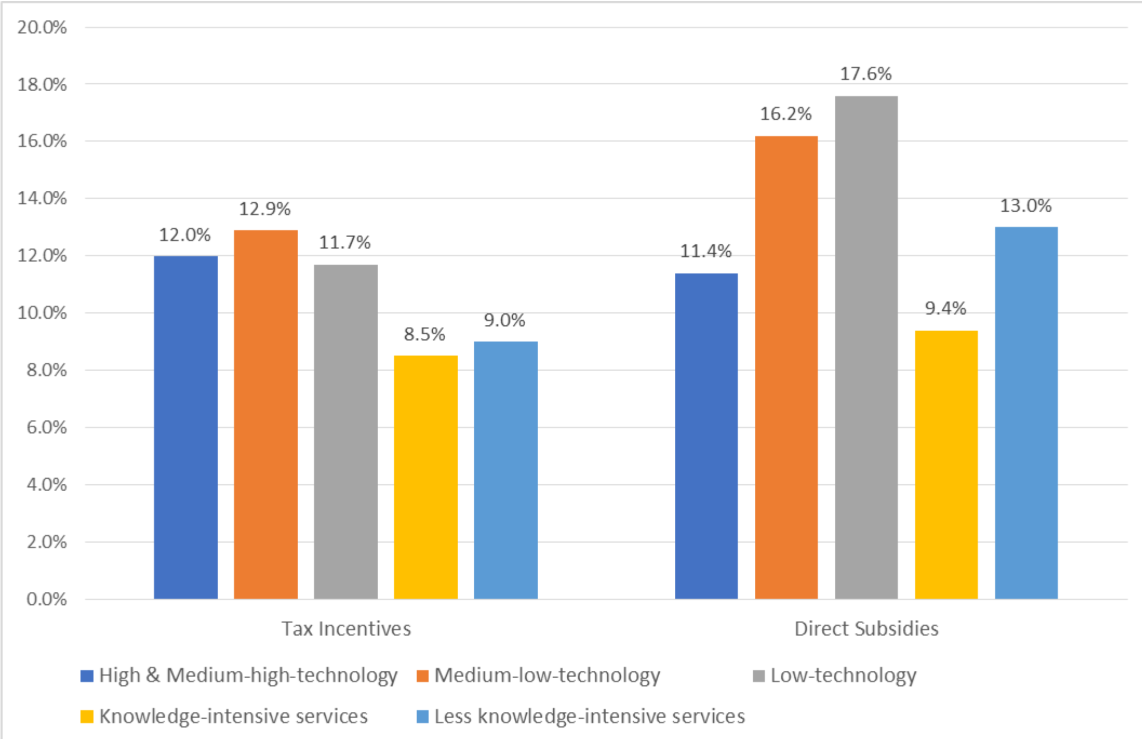


Figure 6A.4 % of firms that were provided incentives for software & databases activity during the period 2017-2019, by size (N = 1771)

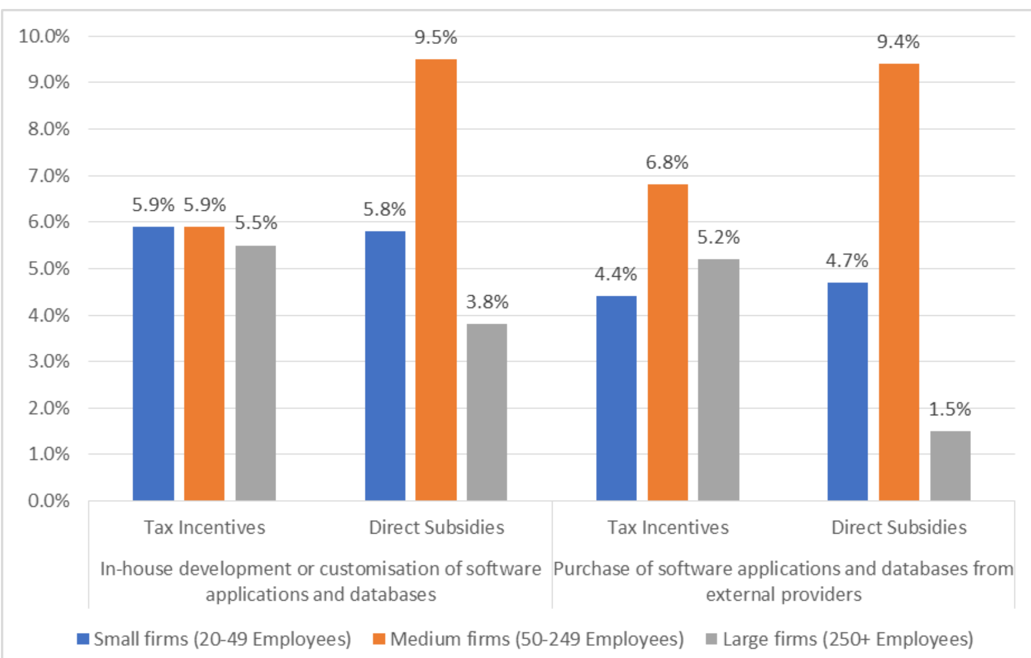


Figure 6A.5 % of firms that were provided incentives for software & databases activity during the period 2017-2019, by sectoral group (manufacturing vs. services) [N = 1771]

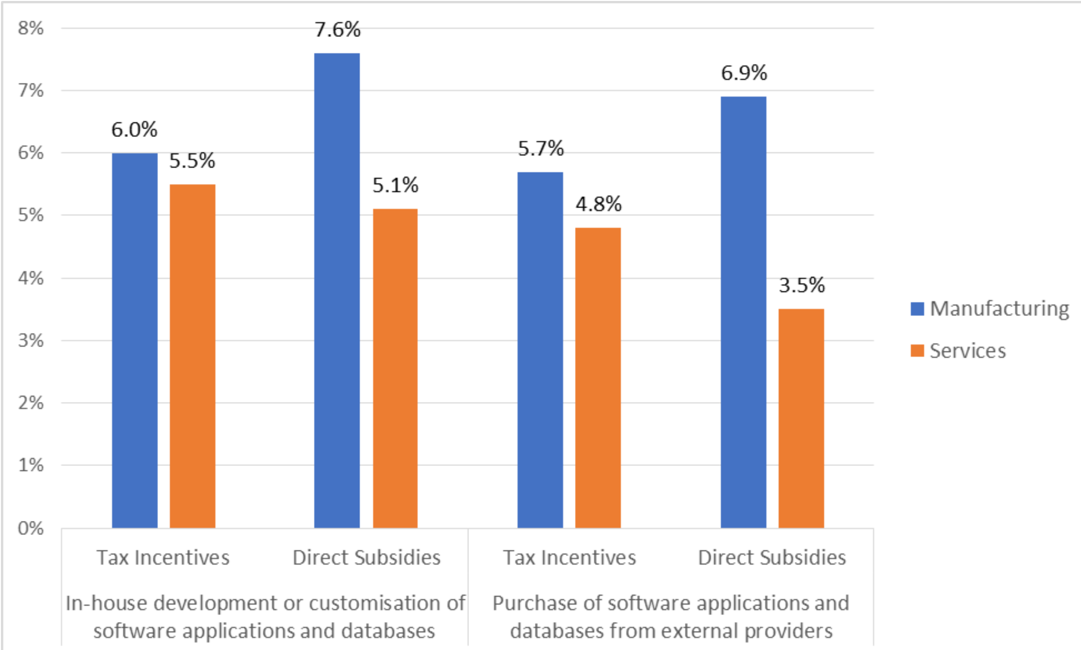
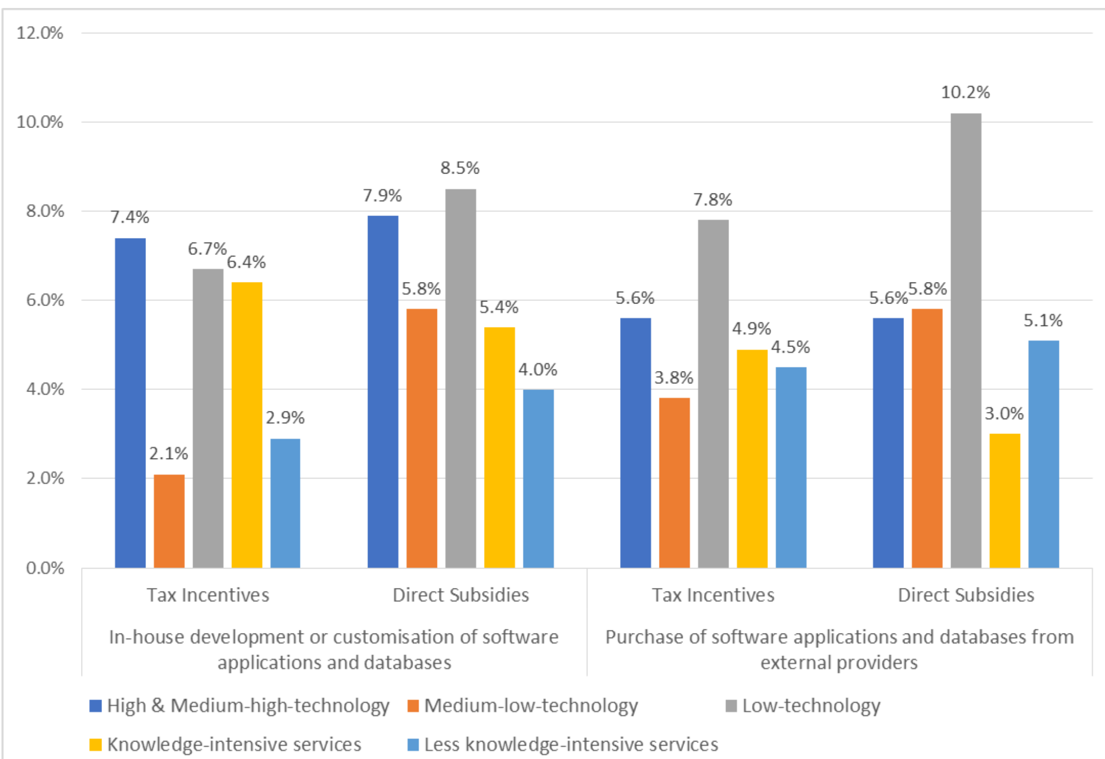


Figure 6A.6 % of firms that were provided incentives for software & databases activity during the period 2017-2019, by sectoral group (technology/knowledge intensity) [N = 1771]



Appendix 7A

Table 7A.1 Impact of Covid-19 crisis on economic performance, by sectoral group (technology/knowledge intensity)

	Sectoral Group	Impact of Covid-19 crisis	Number of Firms	%	Pearson Chi-square sig.
Turnover	High & Medium-high-technology	Decrease	311	57.7%	0.000
		No Impact	129	23.9%	
		Increase	99	18.4%	
	Medium-low-technology	Decrease	143	58.8%	
		No Impact	61	25.1%	
		Increase	39	16.0%	
	Low-technology	Decrease	162	56.4%	
		No Impact	67	23.3%	
		Increase	58	20.2%	
	Knowledge-intensive services	Decrease	241	45.0%	
		No Impact	172	32.1%	
		Increase	122	22.8%	
	Less knowledge-intensive services	Decrease	103	58.2%	
		No Impact	33	18.6%	
		Increase	41	23.2%	
Profit Margin	High & Medium-high-technology	Decrease	241	45.0%	0.579
		No Impact	195	36.4%	
		Increase	100	18.7%	
	Medium-low-technology	Decrease	114	46.9%	
		No Impact	88	36.2%	
		Increase	41	16.9%	
	Low-technology	Decrease	140	49.6%	
		No Impact	90	31.9%	
		Increase	52	18.4%	
	Knowledge-intensive services	Decrease	236	44.6%	
		No Impact	189	35.7%	
		Increase	104	19.7%	
	Less knowledge-intensive services	Decrease	74	42.3%	
		No Impact	58	33.1%	
		Increase	43	24.6%	
Employment	High & Medium-high-technology	Decrease	195	36.0%	0.000

		No Impact	246	45.4%	
		Increase	101	18.6%	
	Medium-low-technology	Decrease	94	38.7%	
		No Impact	115	47.3%	
		Increase	34	14.0%	
	Low-technology	Decrease	99	34.3%	
		No Impact	143	49.5%	
		Increase	47	16.3%	
	Knowledge-intensive services	Decrease	135	25.1%	
		No Impact	282	52.4%	
		Increase	121	22.5%	
	Less knowledge-intensive services	Decrease	39	21.8%	
		No Impact	106	59.2%	
		Increase	34	19.0%	
Overall Investment	High & Medium-high-technology	Decrease	189	34.9%	0.020
		No Impact	249	46.0%	
		Increase	103	19.0%	
	Medium-low-technology	Decrease	99	40.9%	
		No Impact	105	43.4%	
		Increase	38	15.7%	
	Low-technology	Decrease	96	33.3%	
		No Impact	140	48.6%	
		Increase	52	18.1%	
	Knowledge-intensive services	Decrease	150	28.0%	
		No Impact	280	52.3%	
		Increase	105	19.6%	
	Less knowledge-intensive services	Decrease	51	28.5%	
		No Impact	100	55.9%	
		Increase	28	15.6%	

Table 7A.2 Impact of Covid-19 crisis on economic performance by firm size

	Size Category	Impact of Covid-19 crisis	Number of Firms	%	Pearson Chi-square sig.
Turnover	Small firms (20-49 Employees)	Decrease	416	53.4%	0.832
		No Impact	198	25.4%	
		Increase	165	21.2%	
	Medium firms (50-249 Employees)	Decrease	322	54.8%	
		No Impact	150	25.5%	
		Increase	116	19.7%	
	Large firms (250+ Employees)	Decrease	222	53.6%	
		No Impact	114	27.5%	
		Increase	78	18.8%	
Profit Margin	Small firms (20-49 Employees)	Decrease	369	47.7%	0.141
		No Impact	251	32.4%	
		Increase	154	19.9%	
	Medium firms (50-249 Employees)	Decrease	257	44.0%	
		No Impact	226	38.7%	
		Increase	101	17.3%	
	Large firms (250+ Employees)	Decrease	179	44.0%	
		No Impact	143	35.1%	
		Increase	85	20.9%	
Employment	Small firms (20-49 Employees)	Decrease	234	29.8%	0.256
		No Impact	408	52.0%	
		Increase	143	18.2%	
	Medium firms (50-249 Employees)	Decrease	182	30.8%	
		No Impact	296	50.1%	
		Increase	113	19.1%	
	Large firms (250+ Employees)	Decrease	146	35.2%	
		No Impact	188	45.3%	
		Increase	81	19.5%	
Overall Investment	Small firms (20-49 Employees)	Decrease	263	33.7%	0.445
		No Impact	373	47.8%	
		Increase	145	18.6%	
	Medium firms (50-249 Employees)	Decrease	184	31.2%	
		No Impact	307	52.0%	
		Increase	99	16.8%	
	Large firms (250+ Employees)	Decrease	138	33.3%	

		No Impact	194	46.9%	
		Increase	82	19.8%	

Figure 7A.1 Digital transformation performance capability before the outbreak of Covid-19, by firm size (N = 1757)

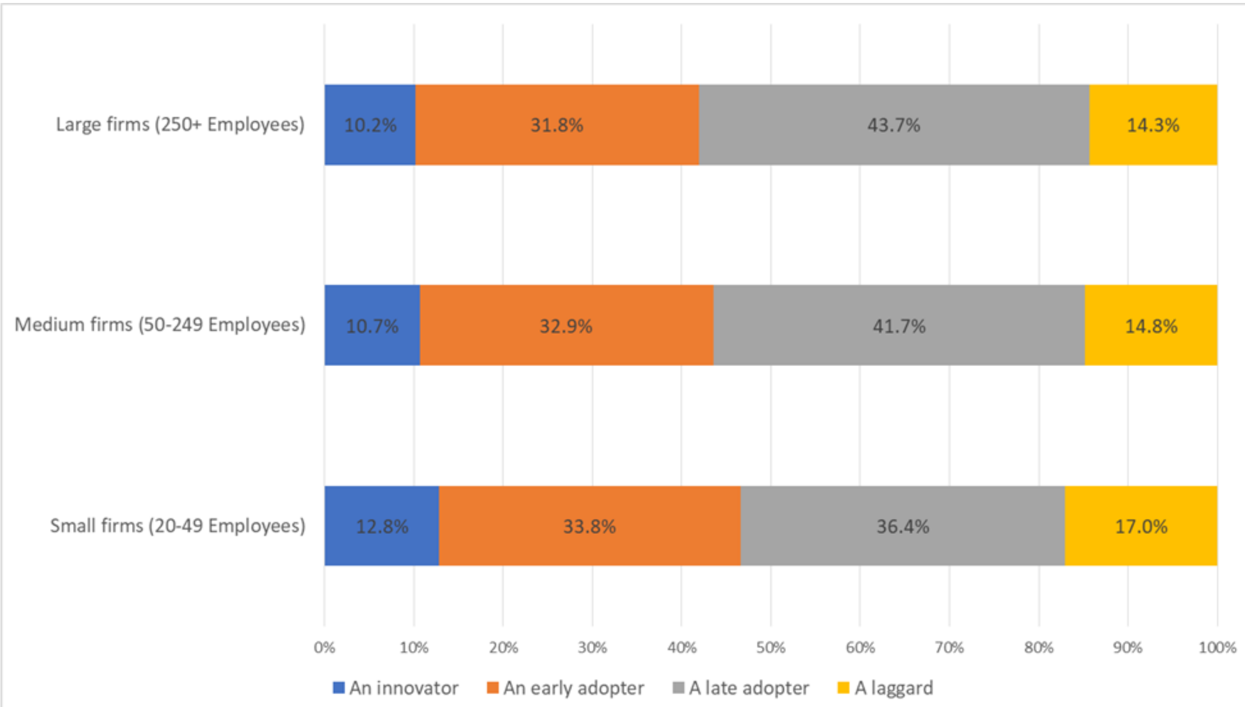


Table 7A.3 Use of specific digital work practices and tools during Covid-19 crisis, by sectoral group (technology/knowledge intensity)

	Sectoral group	Number of Firms	High Extent[132] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
A "Work-from-anywhere" organizational model	High & Medium-high-technology	541	34.0%	2.89	0.000	0.136
	Medium-low-technology	239	23.8%	2.55		
	Low-technology	284	23.9%	2.44		
	Knowledge-intensive services	537	62.8%	3.78		
	Less knowledge-intensive services	179	36.9%	2.98		
Remote collaboration tools and practices (e.g., remote training, remote collaboration with partners)	High & Medium-high-technology	540	41.9%	3.05	0.000	0.093
	Medium-low-technology	240	25.0%	2.71		
	Low-technology	286	32.5%	2.77		
	Knowledge-intensive services	539	62.2%	3.78		
	Less knowledge-intensive services	178	44.4%	3.13		
Tools to access better data, e.g., tools to monitor and visualize data	High & Medium-high-technology	531	25.0%	2.63	0.000	0.054
	Medium-low-technology	238	16.4%	2.29		
	Low-technology	284	16.9%	2.39		
	Knowledge-intensive services	534	39.1%	3.10		
	Less knowledge-intensive services	177	27.7%	2.70		
Technology solutions to automate key processes	High & Medium-high-technology	528	18.2%	2.41	0.000	0.028
	Medium-low-technology	238	14.7%	2.24		
	Low-technology	283	12.4%	2.27		
	Knowledge-intensive services	527	30.4%	2.76		
	Less knowledge-intensive services	177	15.8%	2.39		
Tools to address shifting customer needs and concerns	High & Medium-high-technology	523	20.5%	2.49	0.000	0.037
	Medium-low-technology	237	13.5%	2.22		
	Low-technology	281	13.5%	2.36		

[132] Responses of 4 or 5 on a five-point Likert-type scale.

	Knowledge-intensive services	523	32.9%	2.86		
	Less knowledge-intensive services	178	20.2%	2.55		
Technology solutions to ship product	High & Medium-high-technology	521	10.7%	2.08	0.012	0.008
	Medium-low-technology	237	10.1%	1.92		
	Low-technology	282	13.5%	2.07		
	Knowledge-intensive services	487	19.7%	2.14		
	Less knowledge-intensive services	178	19.7%	2.33		

Table 7A.4 Firm's digital transformation strategy orientation as an outcome of the Covid-19 crisis, by sectoral group (technology/knowledge intensity)

	Sectoral group	Number of Firms	Agree-ment[133] (% of Firms)	Mean (5-point scale)	ANOVA Sig.	Eta squared
Our enterprise sees the Covid-19 crisis as an opportunity to accelerate its digital transformation	High & Medium-high-technology	530	34.2%	2.84	0.000	0.033
	Medium-low-technology	241	29.9%	2.74		
	Low-technology	286	29.7%	2.74		
	Knowledge-intensive services	537	47.7%	3.29		
	Less knowledge-intensive services	179	47.5%	3.27		
Our enterprise sees the Covid-19 crisis as a threat to survive in the short term	High & Medium-high-technology	539	26.5%	2.47	0.000	0.017
	Medium-low-technology	241	29.9%	2.64		
	Low-technology	288	28.1%	2.58		
	Knowledge-intensive services	536	18.3%	2.15		
	Less knowledge-intensive services	177	26.0%	2.44		
Our enterprise will sustain the changes implemented (in business processes and practices) to adapt and respond to the Covid-19 challenges in the long run	High & Medium-high-technology	531	65.2%	3.78	0.010	0.008
	Medium-low-technology	241	59.3%	3.63		
	Low-technology	286	64.0%	3.75		
	Knowledge-intensive services	534	71.5%	3.90		
	Less knowledge-intensive services	178	69.1%	3.87		

[133] Responses of 4 or 5 on a five-point Likert-type scale, i.e., agree or strongly agree.