IARIW 2022

IARIW 2022

Monday 22 - Friday 26 August

Firms Going Digital: Tapping Into the Potential Of Data For Innovation

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Paper prepared for the 37th IARIW General Conference

August 22-26, 2022

Session 4C-2, Proposal on Big Data: Economic Value, Digital Transformation, Productivity and Policy

Time: Wednesday, August 24, 2022 [16:00-17:30 CEST]

OECD publishing

FIRMS GOING DIGITAL

TAPPING INTO THE POTENTIAL OF DATA FOR INNOVATION

OECD DIGITAL ECONOMY PAPERS

December 2021 **No. 320**

OECD

BETTER POLICIES FOR BETTER LIVES

Foreword

This paper was written by David Gierten, Steffen Viete, Raphaela Andres and Thomas Niebel under the supervision of Molly Lesher. Hanna Pawelec provided statistical support. The paper benefited from discussions in the Working Party on Measurement and Analysis of the Digital Economy and in the Committee on Digital Economy Policy, as well as from comments by Vincenzo Spiezia and Fernando Galindo-Rueda.

The micro-econometric analysis in this paper was prepared together with Steffen Viete, Raphaela Andres and Thomas Niebel (ZEW - Leibniz Centre for European Economic Research), in collaboration with Michael Polder (Statistics Netherlands, CBS), Cindy Duc, Sandrine Firquet, and Nadège Pradines (French National Institute of Statistics and Economic Studies, INSEE), Martin Andersson (Blekinge Institute of Technology, BTH, and Swedish Entrepreneurship Forum) Anna Kusetogullari (BTH), Andrea de Panizza and Stefano De Santis (Italian National Institute of Statistics, ISTAT). The OECD extends its gratitude to all collaborators for their participation and invaluable contributions, in particular to Statistics Netherlands and Michael Polder for their generous in-kind support.

This document was approved and declassified by the Committee on Digital Economy on 2 December 2021 and was prepared for publication by the OECD Secretariat.

Note to Delegations:

This document is also available on O.N.E. under the reference code:

DSTI/CDEP(2020)6/FINAL

This document is a contribution to IOR 1.3.1.1.3 Artificial Intelligence of the 2019-2020 Programme of Work of the CDEP, referenced as “The future of the firm”, and a contribution to the OECD Going Digital project, which aims to provide policy makers with the tools they need to help their economies and societies prosper in an increasingly digital and data-driven world. For more information, visit www.oecd.org/going-digital.

#GoingDigital

Table of Contents

Figures

Boxes

Executive Summary

To succeed in the digital age, firms increasingly go digital and innovate with data. In recent years, data have gained great importance for many firms, who in turn have focussed on adopting advanced information and communication technologies and activities (ICTs) that enable them to collect, store and use data, including big data analysis (BDA). Firms often adopt BDA in combination with other advanced ICTs, and need to invest in intangible assets to use ICTs effectively. Over the last decade, such investments outperformed firms' investment in ICT equipment, while demand for equally important skills, notably ICT-specialists, has risen strongly.

Meanwhile, firms' products are going digital too, providing access to user-related data and turning passive consumers into active users that contribute to innovation. Consistent with this trend, the majority of firms that carry out BDA are analysing user-related data.

To better understand whether and how BDA increases firms' potential to innovate, this paper presents new evidence from econometric analyses of microdata samples from France, Italy, the Netherlands and Sweden, which shows that:

- Firms carrying out BDA are more likely to innovate, in particular in products, but also in processes, marketing and organisation; and
- BDA with user-related data, notably from social media, correlates most frequently with these innovations, while much scope remains for BDA with firm-related data.

These findings indicate certain patterns across the analyses of the four samples. However, the results with individual samples also differ, for example, for manufacturing versus service firms and for large firms versus SMEs. Heterogeneity in results across samples may partly stem from diverging domestic and/or local factors, such as economic structures, firms' ICT-sophistication, innovation opportunities and policy environments, as well as from individual sample characteristics.

Besides econometric analyses, additional insights can be gained from examining the data-driven business models of firms that successfully innovate with data, which are often firms that were born digital. The insights provided in this paper reveal how such firms use data and often digital products to create value via continuous data-driven innovation; how they deliver value directly to users; and how they capture value over time, including across different products and markets. In addition, such firms tend to benefit from powerful economies of scale and scope that underpin their business model.

Not all firms naturally succeed in going digital and tapping into the potential of data for innovation. Public policies play an important role in improving the conditions for all firms to thrive. This paper focuses on two main approaches and respective policies that are essential in this regard:

- Boosting firms' adoption of advanced ICTs by improving framework conditions, raising awareness and supporting SMEs; and,
- Enabling firms to innovate with data by enhancing access to and sharing of data, fostering investments in intangible assets and supporting skills development.

The paper provides policy examples from across a large range of countries and discusses key aspects to further improve such policies.

Introduction

The rise of data as an economic resource has sparked firms to innovate with data. Creating new value with data-driven innovation requires firms to adopt newer and more advanced ICTs, to invest in intangible assets, and to develop or acquire relevant skills. Important potential for data collection has arisen with increasingly digital and connected products that create a direct link to users and opportunities for firms to tap into their data. While some successful firms provide examples for data-driven business models, many still lag behind. Improving the condition for all firms to thrive in the digital age requires better analysis and evidence of how firms go digital and can tap into the potential of data for innovation.

Plenty of evidence exists about ICT diffusion levels among firms across countries (OECD, 2020[1]). However, much less has been said about the evolution and specific patterns of ICT adoption, in particular for ICTs that enable firms to effectively use and innovate with data, such as BDA. Empirical evidence on whether BDA makes firms more likely to innovate is even harder to find, notably concerning different types of innovation and different data sources used for BDA. Shedding new light on these aspects, the first two sections of this paper provide insights from key trends for firms going digital and new empirical evidence from micro-econometric analysis about the innovation potential of firms carrying out BDA. Section three provides additional insights into business models of firms that have been highly successful with digital products and data-driven innovation.

Public policies are vital for improving the conditions for all firms to thrive in digital and data-driven environments. While policies to boost ICT diffusion remain a cornerstone for firms going digital, the growing importance of data brings policies to the fore that contribute to enabling firms to innovate with data. Section four of this paper provides a range of policy examples from across countries, recognising that none of them alone can act as a silver bullet. Considering these policies jointly and achieving the right policy mix is as important as co-ordinating them in the larger context of the OECD's integrated policy framework for digital transformation (OECD, 2020[2]).

1. Key trends for firms going digital

Several trends characterise firms' going digital journey and shape the digital and data-driven environments firms operate in. This section provides a brief overview of three key trends in: 1) the evolution and patterns of firms' adoption of ICTs, 2) investments in intangible assets and demand for skills, 3) the digitalisation of products and firms' focus on user (customers or consumers)-related data for carrying out BDA.

1.1. Evolution and patterns in firms' adoption of ICTs

ICTs are the bedrock for firms to go digital and use data for innovation. For several decades, firms have adopted different kinds of ICTs, including basic ones like early generation broadband and websites, ICTs for process optimisation and e-commerce, and more recently, more advanced ICTs that enable firms to collect and use large amounts of data. This section examines the evolution and patterns in the adoption of different ICTs in firms of different sizes.

Firms focus on adopting newer and more advanced ICTs

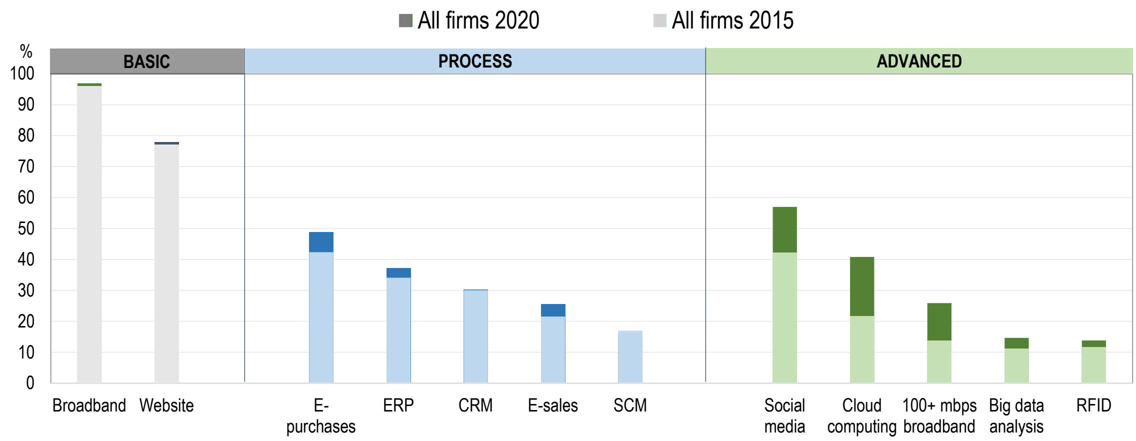
An initial step for firms to go digital is their adoption of basic ICTs such as computers, a basic broadband connection and a website. Other important steps usually involve the adoption of ICTs to digitalise processes, such as in production, support functions and distribution, or to engage in e-commerce. Relevant ICTs include software for enterprise resource planning (ERP), customer relationship management (CRM), and supply chain management (SCM), as well as e-sales and e-purchases. While these have become part of many firms' legacy systems, firms of different sizes and in different sectors may have different needs for different kinds of ICTs (OECD, 2019[3]). Overall, basic and process-related ICTs enable firms to integrate in digital and knowledge-based economies (MGI, 2019[4]), optimise processes, lower unit cost of production (DeStefano, De Backer and Ran Suh, 2019[5]), and extend market reach via e-commerce (OECD, 2019[6]).

More recently, firms have started adopting newer and more advanced ICTs that notably enable them to collect and use data. While basic and process-related ICTs are still important, they are not sufficient for firms to collect (big) data from various sources, efficiently store and exchange them, and effectively use them, including for innovation. To tap into the potential of data, firms are adopting high-speed broadband, cloud computing, BDA, social media, and radio-frequency identification (RFID).

Trends in ICT adoption over recent years indicate that firms focus on newer and more advanced ICTs. Figure 1 shows that in OECD countries, basic ICTs have reached near full diffusion and that only a limited number of additional firms adopted process-related ICTs between 2015 and 2020. In contrast, the adoption of newer and more advanced ICTs grew strongly over the same period, with average growth rates of 88% for high-speed broadband and cloud computing, respectively, 35% for social media, 31% for BDA and 18% for RFID.

Figure 1. Firms focus on adopting newer and more advanced ICTs

Percentage of firms adopting selected ICTs in OECD countries, 2015 and 2020 or latest available



Note: Data refer to firms with 10 or more employees. Further details in endnote [1].
Source: OECD, ICT Access and Usage by Businesses, http://oe.cd/bus, accessed September 2021.

High-speed broadband and cloud computing enable data-intensive activities in firms. High-speed broadband is essential for firms to exchange large volumes of data at high velocity and to make effective use of advanced cloud computing (Andres et al., 2020[79]). Cloud computing in turn is important for many data-intensive activities, including BDA. Cloud computing can also help firms improve processes and integrate traditionally siloed IT systems into a platform architecture (Bossert and Desmet, 2019[8]).

BDA is among the most advanced ICTs firms currently use and arguably crucial to tap into the potential of data for innovation. To extract useful insights from data, firms need to clean, structure and analyse the data they collect or source, which involves computing power, software and human capital, all the more the greater the volume, variety and velocity of the data. Effectively carrying out BDA thus also requires firms to invest in intangible capital and skills.

Social media enables firms to collect and use data, among other things. While many firms, smaller ones in particular, may use social media mainly as a communication tool, more advanced use of social media often involves data collection and use. Firms can collect user-related data directly, or source it from social media companies or data brokers. Such data enables firms, for example, to monitor (potential) customers or consumers, better understand their preferences, and individualise products, including targeted advertisement.

RFID allows firms to collect and use often firm-related data. When embedded in firms' own devices and sensors, RFID allows direct data collection, for example on operations, logistics or production. Data from RFID can also be sourced from third parties, for example in supply chains. Such data enables firms, for example, to monitor operations, optimise just-in-time production, and minimise supply chain interruptions.

The more data firms collect, store, exchange and analyse, the more relevant artificial intelligence (AI) becomes to support or take on parts of data analysis. While fast growing investments in AI reflect high expectations (OECD, 2019[9]), data on firms' adoption of AI cannot yet be included in Figure 1 due to limited availability of cross-country comparable and time-series data (Montagnier and Ek, 2021[10]).

ICTs tend to be adopted in combination

Each ICT is only one part of a larger technology ecosystem, and the effect of any ICT in isolation tends to be smaller than in combination with others (OECD, 2019[11]). Many firms indeed adopt ICTs in combination. Micro-data from France, Italy, the Netherlands and Sweden indicate that the majority of firms (≥ 60%) in the respective sample adopt five to eight ICTs (Annex A, Table A1). In particular, firms that carry out BDA seem to be sophisticated ICT users as indicated by the high number of ICTs adopted: eight in the Swedish and Dutch samples, seven in the French and Italian samples.

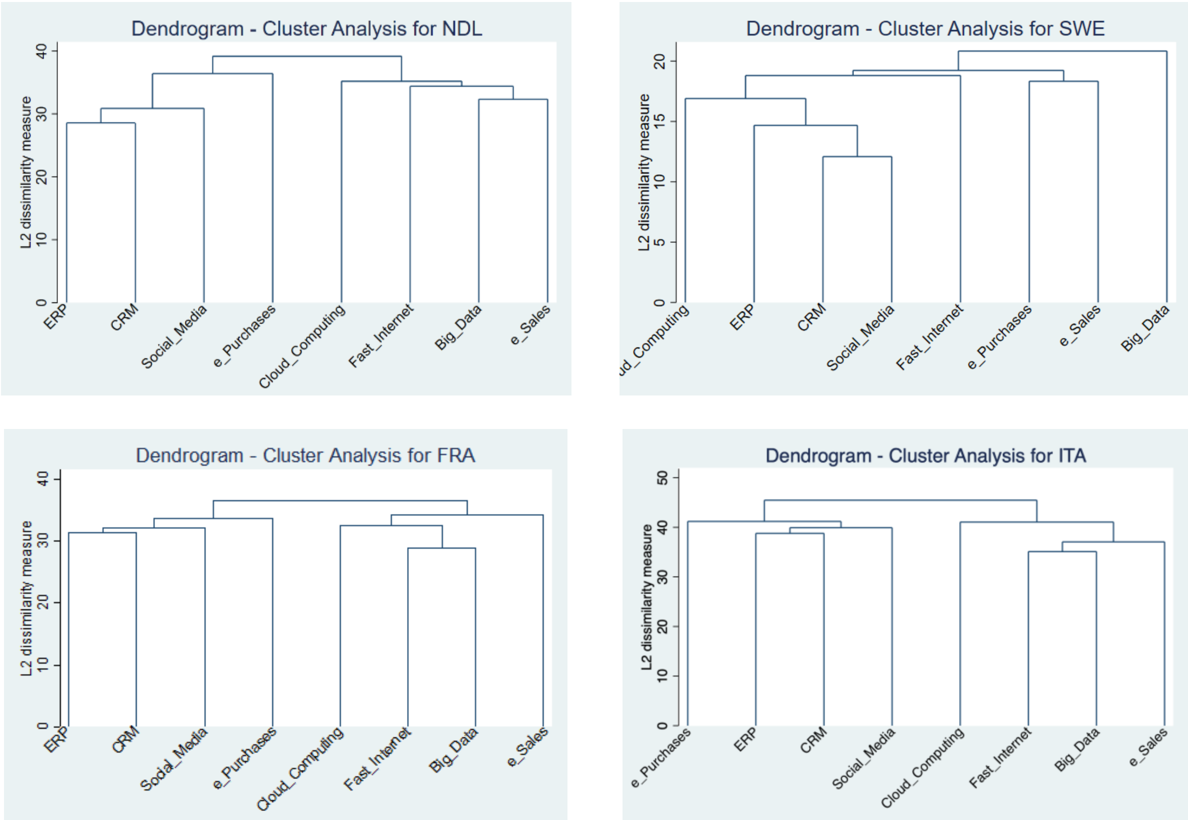
A cluster analysis using the same micro-data from the four countries reveals specific patterns of combined adoption of different ICTs (Figure 2). The lowest and most direct connections on the dendrograms indicate the most "similar" ICTs that firms adopt likely in combination. Combined adoption can in turn indicate complementarities and synergies between respective ICTs.

The analysis reveals two clusters of ICTs. First, a cluster of ICTs that contains ERP and CRM, two key process-related ICTs, and social media, notably paired with CRM. Combined adoption of different process-related ICTs can be expected because firms' digitalisation efforts may concern simultaneously back and front office processes; combined adoption of social media use with CRM reflects the shared purpose of reaching out to and maintaining relationships with customers.

The second cluster contains the more advanced ICTs of BDA, high-speed (100+ Mbps) Internet and cloud computing (except for the Swedish sample), as well as e-sales. Combined adoption of the first three can be expected because high-speed Internet should benefit the use of cloud computing and the latter can benefit BDA; the presence of e-sales in this cluster may also indicate that more advanced ICTs, notably high-speed Internet and BDA, may also enable more effective e-sales. The similarity of e-sales and e-purchases in the Swedish sample hints to joint digitalisation of sales and purchases.

Figure 2. Firms adopt ICTs in combinations

Cluster analyses (dendrograms) of ICT adoption by firms in France, Italy, the Netherlands, and Sweden



Source: Authors' analysis of microdata from INSEE France, Italian National Institute of Statistics, Statistics Netherlands, and Statistics Sweden.

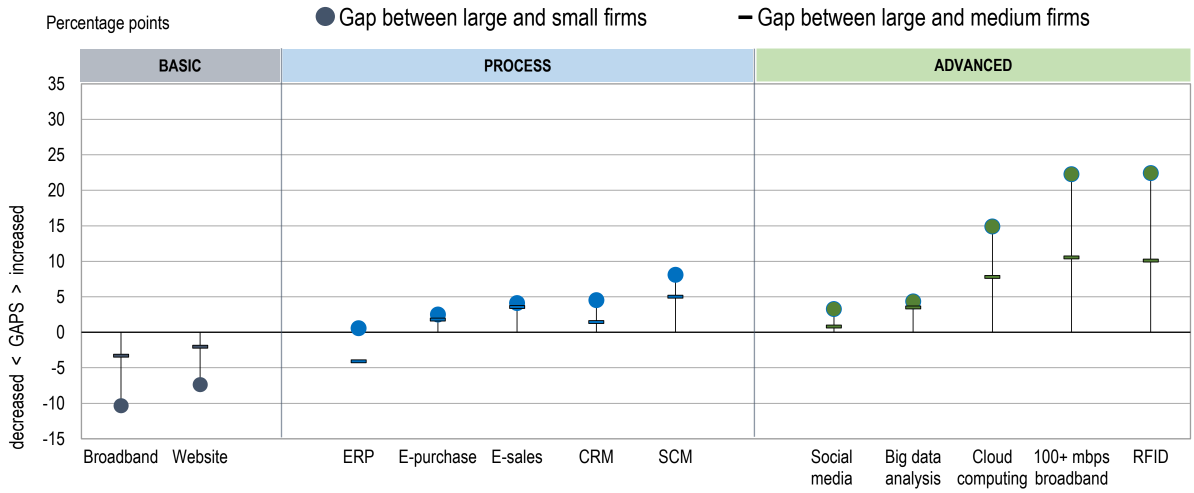
SMEs lag behind large firms in adopting and combining ICTs

Large firms currently drive the adoption of newer and more advanced ICTs. Figure 3 shows changes in average firm-size gaps in OECD countries for the adoption of basic, process and advanced ICTs over time, and reveals a clear pattern. While over the last decade, SMEs have caught up in the adoption of basic ICTs, firm-size gaps in the adoption of process-related ICTs are only starting to stabilise, and large firms are clearly driving the adoption of newer and advanced ICTs so far. This pattern suggests a "diffusion curve" on which newer and more advanced ICTs are first adopted by large firms, followed by medium-sized and small firms later on.

SMEs also lag behind large firms in the combined adoption of ICTs (Figure 4). In line with the findings above, the majority of small firms, on average across the four samples, adopt fewer ICTs (3 to 6) than the majority of large firms (6 to 9). Large firms thus not only tend to be first in adopting newer and more advanced ICTs, but also seem to be more sophisticated users, measured by the number of ICTs they adopt in combination. This might on the one hand reflect the needs of large firms, e.g. the diversity of processes, and on the other hand their capacity to invest in ICTs and complementary assets.

Figure 3. Large firms drive the adoption of advanced ICTs

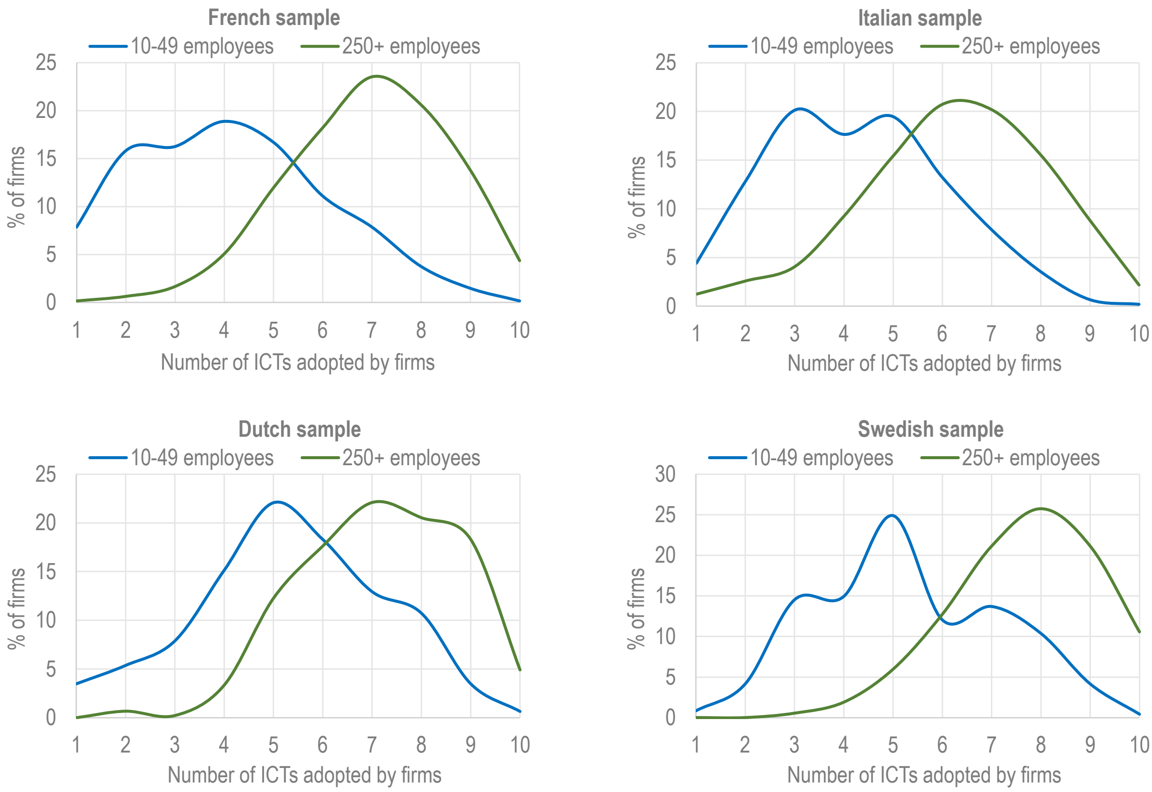
Percentage point change in average firm-size gaps in OECD countries for the adoption of ICTs, 2010 to 2020 or latest available



Note: Detailed notes in endnote [2].
Source: OECD, ICT Access and Usage by Businesses, *http://oe.cd/bus*, accessed September 2021.

Figure 4. Large firms are more sophisticated ICT-users than small firms

Shares of small and large firms by numbers of ICTs adopted



Note: Detailed notes in endnote [3].
Source: INSEE France; Italian National Institute of Statistics; Statistics Netherlands; Statistics Sweden.

1.2. Growing investment in intangible assets and demand for skills

Effective use of ICTs requires firms to invest in intangible assets (intangibles) and to develop or acquire relevant skills. This section reviews trends in investment in ICT equipment and intangibles as well as in shares of ICT task-intensive occupations and ICT-specialists. Investment in intangibles has outperformed investment in physical assets for some time, albeit not equally across countries and types of firms. Skills used in ICT task-intensive occupations have become more widespread, but demand for key skills still outstrips supply.

Firms' investment in intangible assets has grown fast in many countries

Firms' investments in intangible, non-physical assets such as software, data, organisational capital, R&D, intellectual property, and design and training, has become a substantial share of investment in many countries and has outpaced investment in tangible assets, physical capital (machinery, equipment, buildings), in some (OECD, 2013[12]). Such investments have also become an increasingly important driver of productivity growth in OECD countries (Demmou, Stefanescu and Arquié, 2019[13]). With significant cross-country differences, investment in intellectual property products, R&D in particular, has accounted for an increasing share of total investment in most economies over the past 20 years (OECD, 2019[14]). Since the 2008 crisis, investment in tangibles has recovered slowly, while investment in intangibles performed much better (Corrado et al., 2016[15]).

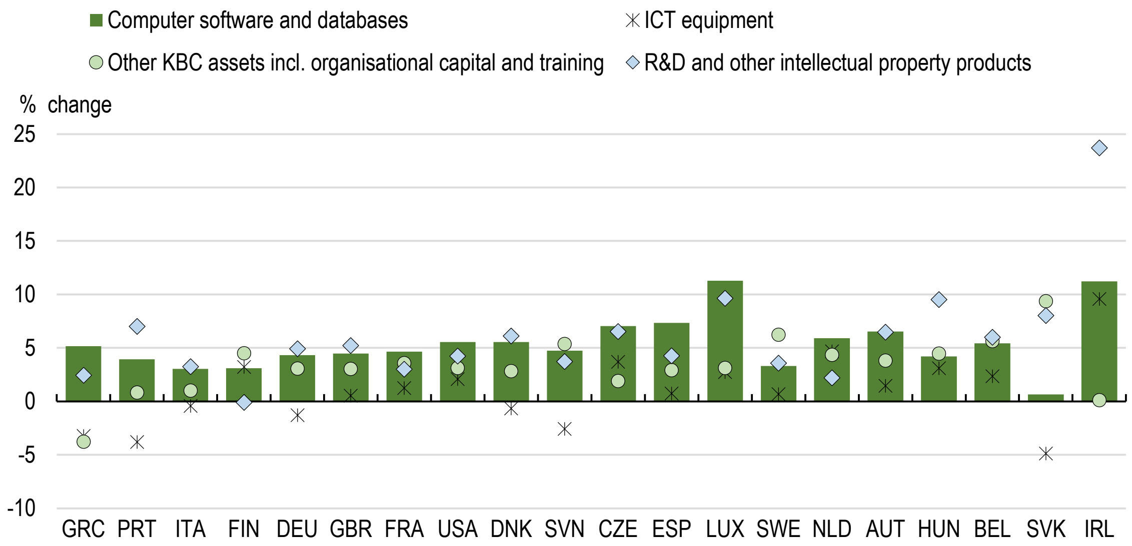
Particularly relevant for firms going digital and tapping into the potential of data, investments in intangible assets also seem to grow faster in many countries than investments in ICT equipment. Between 2005 and 2016, on average, the latter were outpaced by investment in R&D and other intellectual property products, followed by investment in computer software and databases and other knowledge-based capital (KBC) assets, including organisational capital and training (Figure 5). While true for most industries, between 1996 and 2015, investments in software and databases grew notably strong in wholesale trade; professional, scientific and technical services; public administration; and electricity, gas and steam supply (OECD, 2019[16]).

It should be noted that differences in the changes in investment in ICT equipment versus investment in software and databases (and possibly in other intangibles) are likely to also reflect the evolution of prices. Between 1999 and 2015, investment in ICT equipment relative to GDP increased in fact as much as investment in software and databases (65%) when measured in volume, i.e. controlling for the increase in ICT prices relative to GDP prices (OECD, 2019[16]).

In any case, investment in intangibles are an essential complement to investment in physical assets and insufficient investment in the former limits firms' potential to succeed in digital and data-intensive environments. Recent OECD analysis finds that firms with high complementary investments in ICTs and intangibles are the most productive ones and that notably in digital-intensive sectors firms risk falling behind or are failing to catch up when not investing sufficiently in intangibles (Corrado et al., 2021[17]). Investment in software, databases and skills can also help laggard firms to catch up (Berlingieri et al., 2020[18]).

Figure 5. Investments in intangible assets have outpaced investment in ICT equipment

Annual percentage change in ICT and knowledge based capital (KBC) investment, current prices, 2005-2016



Note: For Greece, data refers to 2005-2015. For more details, see endnote [4].
Source: OECD calculations based on OECD National Accounts database and INTAN-Invest data, http://www.intaninvest.net/, accessed September 2021.

Skills needed for the effective use of ICTs are in strong demand

To use ICTs and data effectively, including for innovation, firms require employees with good fundamental skills, notably STEM skills, generic and ICT specialist skills, and complementary soft and interdisciplinary skills, spanning to management level. Discussing trends for each type of skill would go beyond the scope of this paper; however, trends on ICT task-intensive occupations and ICT specialists provide important insights into skills that are needed by firms going digital and using data.

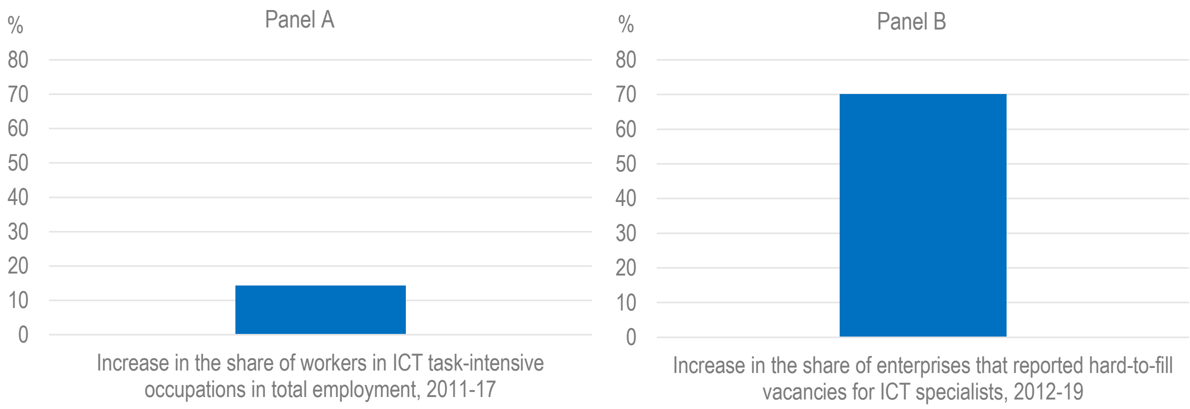
The share of ICT task-intensive occupations in the workforce is growing and demand for ICT-specialists is outstripping supply. Together, ICT-specialists and other ICT task-intensive occupations contributed 39% of all new employment created in the EU28 between 2011 and 2017. While still representing only 10.8% of total employment in 2017 (EU28), the share of ICT task-intensive occupations has increased by 14% between 2011 and 2017, (Figure 6, panel A).

ICT-specialists were in particularly strong demand, as indicated by a 70% increase in the share of firms reporting hard-to-fill vacancies for ICT-specialists between 2012 and 2019 (Figure 6, panel B). However, the share of firms in the EU28 that offers ICT-specialist positions remains still modest, with 9% in 2019, and the share of ICT-specialists in total employment grows only slowly (OECD, 2019[19]), suggesting sluggish supply, while demand may further increase when ICT-specialists are needed in more firms across the economy.

Without the right skills, firms will not succeed in using ICTs and data effectively for innovation. Prior OECD analysis showed that high-skilled employees make firms more likely to adopt ICTs (Andrews, Nicoletti and Timiliotis, 2018[20]) and, in turn, that shortages can inhibit firms' ability to reap the productivity benefits of ICTs (Gal et al., 2019[21]).

Figure 6. Increasing shares of ICT task-incentive occupations and ICT-specialist demand

Percentage change in ICT task-intensive occupations (Panel A) and in demand for ICT-specialists (Panel B), EU28



Note: Panel A: Data for Canada refer to 2016 and for Japan to 2015, instead of 2017. Panel B: Data for Germany and Portugal refer to 2014 instead of 2012. For more details, see endnote [5].
Source: OECD calculations based on data from (OECD, 2019[19]).

1.3. The rise of digital products, connected users and firms' use of their data

Not only firms are going digital, products do as well. From goods like cars that increasingly include digital components to services like banking that go online, a wide range of products is becoming digital or digitally delivered. This creates new opportunities for firms that can directly connect with users of digital products and collect data on the products' use and users. User-related data are in turn becoming an important firm-external resource and input to innovation, complementing firm-internal resources like R&D and skills.

Digitalisation blurs the boundary between goods and services

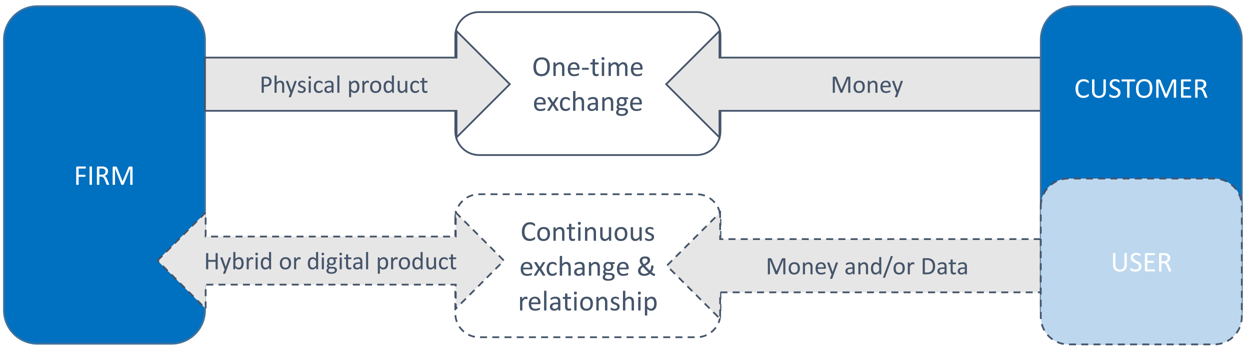
Products can be distinguished into being primarily physical versus being primarily digital (OECD, 2019[22]). Products are never only digital, as bits rely on atoms to exist[6]. As digital transformation progresses, products without any digital component are becoming increasingly rare. Products can also be classified into goods[7] and services[8]. However, the boundary between goods and services can be blurry, for example, when a service is bundled with a good, and digital transformation is further blurring this boundary (Cadestin and Miroudot, 2020[23]).

More and more, products are hybrid bundles with different aspects that characterise them as being a digital and/or physical good and/or service. Even goods that are known for being physical, such as cars, are going digital and are becoming hybrid products. Most of today's cars are not only a chassis with a motor (physical good) that offers mobility (physical service), but are enhanced with digital hardware and software (digital components or goods), such as a sim-card and a screen with a digital map, which can provide connectivity, itineraries and real-time traffic information (digital services). These digital components and services make the car a hybrid product.

Digital products create opportunities for firms to collect user-related data

One important benefit of digital products comes with the possibility they create for firms to connect to product users, i.e. customers or consumers. A firm that produces physical products, e.g. a car manufacturer in the 1980s, would have little interest in knowing its customers, aiming mainly for the money it receives in exchange for the car. While such a firm may relate to consumers via after-sale services, the latter are perceived rather as a cost than an opportunity. To the contrary, a firm selling digital or hybrid products, e.g. one of today's car manufacturers, can establish continuous relations with its customers, easily deliver product updates (e.g. software) after sale and collect data over time about the use and users of the products. Rather than a cost, the relation with its product users becomes an opportunity and a resource (Figure 7), in particular the data that the firm can collect and use to improve, market and innovate its products.

Figure 7. Digital products create opportunities for firms to collect user-related data



Source: Authors.

Product users and their data have become an increasingly important input to firms' innovation activities (Sichel and von Hippel, 2019[24]). More generally, the Internet, smartphones and digital products have transformed the 20th century's anonymous mass of consumers into connected and identifiable users. While traditional science, engineering and R&D intensive innovation still flourishes in industries with high declining unit costs, firms increasingly design products around user needs and preferences. On the one hand, these users can provide active feedback on products, for example in the form of ratings and reviews that affect reputation, create and share content, and even compete with firms by selling goods and services themselves. On the other hand, connected users become key data sources for firms, providing passive input to innovation via the data they share when using digital products (Zuboff, 2019[25]), including big data from social media, geolocation, online searches and communications.

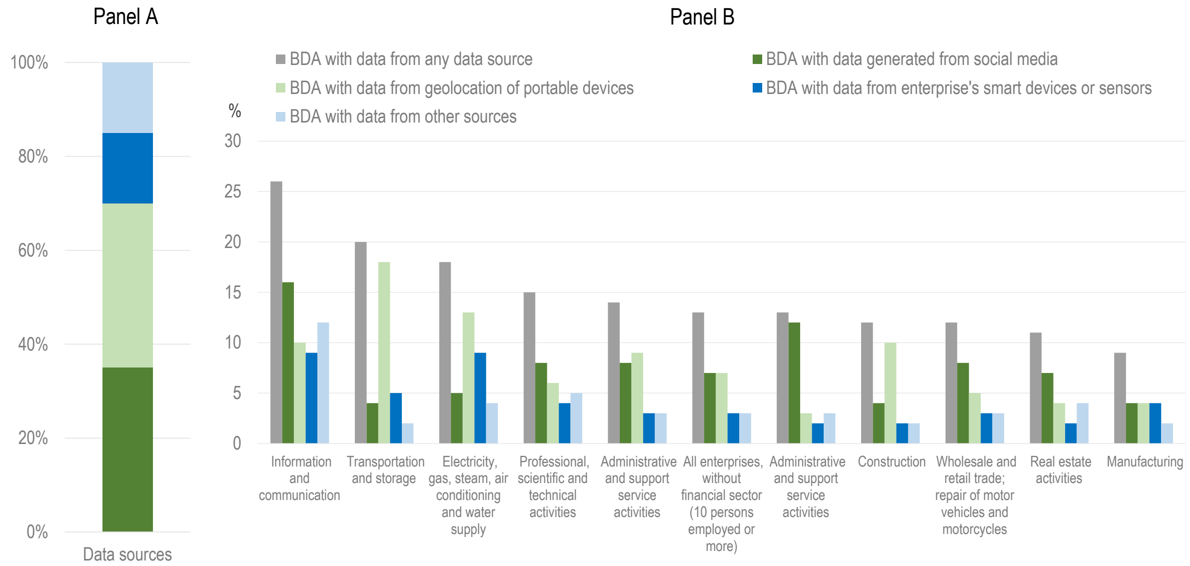
User-related data are an important source for big data analysis

User-related data is becoming an important resource for firms. User-related data appear indeed as the most commonly used data for BDA in firms. In 2020, on average in the European Union (27), 34% of large, 21% of medium and 12% of small firms carried out BDA. Among these firms carrying out BDA, 70% analysed big data that are likely user-related, i.e. data from social media and from the geolocation of portable devices[9] (Figure 8, Panel A), up from 65% in 2016. Still among these firms, data from smart devices or sensors, which is more likely firm-related, accounted for only 15% of the data used for BDA in 2020, down from 21% in 2016.

The ICT sector is a frontrunner in carrying out BDA, although not for all types of data sources. For example, transport and storage have a higher share of firms analysing geolocation data and utilities (electricity, gas, etc.) have the same share of firms as the ICT sector analysing data from smart devices and sensors, which is likely firm-related (Figure 8, Panel B).

Figure 8. Many firms analyse user-related data in big data analysis

% of firms carrying out BDA, by sectors and data sources, European Union (27), 2020 or latest available



Source: Eurostat, ICT Usage in Enterprises Survey, https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database, accessed September 2021.

2. Firms' big data analysis and innovation

Firms' big data analysis arguably holds important potential for innovation. Anecdotal evidence of individual firms abounds. However, little empirical evidence exists on firms being more innovative when analysing big data. To understand this potential better, this section presents micro-econometric analysis of firm-level data from four countries that aims to answer two questions: 1) Does firms' BDA correlate with their innovation in product, process, marketing, and organisation? And, 2) do specific data sources used by firms for BDA play a particular role for any of these types of innovation?

2.1. Related literature

Increasingly available micro-data on the adoption of ICTs and on innovation by firms have enabled a growing body of empirical literature over the past decade, examining the links between firms' ICT usage and innovation and other aspects of firm performance. For example, (Polder et al., 2010[26]) analyse Dutch micro-data on the use of broadband and e-commerce and find positive effects on product, process, and organisational innovation, in particular in service sectors. Based on data of eight OECD countries, (Spiezia, 2011[27]) finds that the use of web facilities, automatic IT links, broadband, website and e-commerce increases the likelihood of firms to innovate in product, processes, marketing and organisation; however the use of such ICTs does not seem to favour new-to-the market product innovation. Analysing German micro-data, (Fabritz, 2015[28]) finds that ICT investment increases firms' propensity to innovate in products, and (Galindo-Rueda, Verger and Ouellet, 2020[29]) find a positive relationship between innovation and the use of advanced technologies, including ICTs, and business practices in Canadian firms.

One frequently studied aspect of firm performance related to innovation is productivity. Firms' ICT adoption is generally found to favour innovation and productivity (Bartelsman and Doms, 2000[30]) (OECD, 2004[31]) (Brynjolfsson and Saunders, 2010[32]) and firm-level productivity seems to hinge particularly on firms' innovation efforts (Hempell, v. Leeuwen and v.d. Wiel, 2004[33]) (Syverson, 2011[34]). Findings differ as to which type of innovation may drive productivity most. For example, analysing micro-data for ten European countries over 2002-2010, (Bartelsman et al., 2018[35]) find that firm-level productivity is significantly correlated with product innovation, whereas (Polder et al., 2010[26]) find a strong correlation of organisational innovation and productivity in Dutch firms.

The above and most other existing studies on the links between firms' use of ICTs and innovation or productivity consider firm's use of basic and/or process-related ICTs. A few studies for the United States examine firms' use of more advanced ICTs, including BDA, and firm performance, but do not focus on innovation outcomes (Brynjolfsson, Hitt and Kim, 2011[36]) (Tambe, 2014[37]) (Brynjolfsson and McElheran, 2016[38]). As highlighted in section 1.1. on the adoption of ICTs by firms, BDA can be considered a more advanced ICT that firms can use to not only to improve processes, but also to innovate in products, marketing and organisation. Hence the focus of our analysis on firms' use of BDA and these different types of innovation outcomes. As suggested by (Syverson, 2011[34]), going beyond examining effects of ICTs on firms' processes and related firm performance would constitute an important contribution to the existing literature.

The analysis presented below builds on (Niebel, Rasel and Viete, 2019[39]) who find a significant positive relationship between BDA and product innovation in German firms. The analysis extends this approach and further examines potential links between BDA carried out with data from different sources and different types of innovations. To the best of our knowledge, this is the first empirical analysis with this focus, using firm-level data from harmonised data collection in several countries.

2.2. Data sources and estimation samples

The analysis is conducted with data from four countries: France, Italy, the Netherlands and Sweden. The data comes from the participating countries' ICT Usage in Enterprises Survey (ICTS) and Community Innovation Survey (CIS). The ICTS contains data on firms' BDA by data source, i.e. BDA with data from any source, from social media, from the geolocation of portable devices, from firms' smart devices and sensors, and from other sources. The ICTS also contains data on firms' use of cloud computing, e-sales, e-purchases, and broadband subscriptions by speed tiers, which are used for control variables in the analysis. In accordance with the OECD/Eurostat Oslo Manual, the CIS contains data on firms' innovation outcomes, i.e. product, process, marketing and organisational innovation. It further contains data on firms' R&D expenditure, human capital, turnover and size, which are used as control variables.

Each country participating in the analysis created a custom merged data set, the estimation sample (hereafter sample) containing observations of firms that feature in both their ICTS and CIS. The merging of the ICTS and CIS micro-data was done similarly as for previous studies, such as (Polder et al., 2010[26]) or (Spiezia, 2011[27]), and in the Eurostat micro moments database (Bartelsman, Polder and Hagsten, 2018[40]). Summary statistics for the four countries' samples are reported in the Annex (Tables A.2. France, A.3. Italy, A.4. Netherlands, A.5. Sweden). While the samples were harmonised to the extent possible, for example, they contain data only on firms in sectors that are mandatory in each country's ICTS and CIS, remaining individual characteristics of each sample imply that the results of the analysis are not necessarily comparable across the samples.

The process of merging the CIS and ICTS data can entail selection biases, which may result in samples that are not fully representative of each country's firm population. For example, in the French sample, large firms are significantly over-represented as compared to the

French firm population. However, this bias is less pronounced in the other samples (cf. Annex Tables A.2 - A.5). A biased sample can have implications for the analysis, for example in that larger firms tend to adopt more ICTs and are more likely to innovate. To mitigate potential effects related to firm size, the samples exclude firms below 10 employees and the analysis controls for firm size. Nonetheless, the results should be interpreted with caution, to the extent that the samples may contain a lower proportion of firms that are weak on ICT usage and innovation than the respective firm population.

In some cases, the representativeness of samples can be improved through weighting. One possibility used in prior OECD work is to apply a weighting procedure based on inverse probabilities of selection (Berlingieri et al., 2017[41]). Weighting is particularly useful to make descriptive statistics fully representative in cases where samples are systematically unrepresentative. In any case, corrections by weighting requires knowledge about the way in which a sample is unrepresentative, such as in stratified sampling design (Solon, Haider and Wooldridge, 2013[42]). However, in the present case, the merge of two datasets with different sampling designs may introduce selection effects that are unknown, which in turn severely limits the possibilities to correct for such effects. Therefore, and in line with approaches taken in the literature on ICTs and innovation reviewed above, no weighting procedure is applied.[10]

The samples are designed to exploit a temporal structure between the innovation input and output by virtue of capturing firms' BDA via the ICTS 2016 and innovation outcomes via the CIS 2018. This should help mitigate some reverse causation concerns related to the possibility that a positive correlation between firms' BDA and innovation may be caused by either firms' use of BDA and/or their innovativeness. Given that the ICTS introduced questions on BDA only in 2016, it is not possible to work with panel data in addition. The time lag introduced in the data should minimise the risk of reverse causation, but may not fully eliminate it.

In order to mitigate a potential simultaneity issue with regards to BDA as an innovation input and process innovation, the subset "methods for information processing or communication" is excluded from process innovation, given that this could be considered as a measure for introducing BDA practices.

2.3. Empirical framework

The empirical analysis seeks to look into the relationship between BDA and innovation outcomes, conditional on important firm characteristics that might confound this relationship. Conceptually, the micro-econometric analysis is based on the knowledge production function framework introduced by (Griliches, 1979[43]). This framework postulates a transformation process linking inputs associated with knowledge accumulation, such as investments in R&D or human capital, to the firms' innovative output. The present analysis accounts explicitly for the role of BDA in the firms' knowledge production process, besides other knowledge sources.

Let y_i^* denote the latent propensity of firm i to achieve a particular type of innovation and this propensity depend on the firm carrying out BDA, $bigdata_i$, as well as the firm's R&D intensity and other firm- and market-specific characteristics, denoted by the vector $\boldsymbol{c}_i$. For the empirical model of the knowledge production function, a linear additive relationship is assumed in the form of:

$$y_i^* = \beta \quad bigdata_i + \gamma' \boldsymbol{c}_i + \epsilon_i \quad (1)$$

where β denotes the parameter of interest, capturing the effect of the firms' BDA on the propensity to innovate. ϵ_i denotes an idiosyncratic error term, which captures unobserved variables affecting y_i^* and is assumed to be identically and independently normally distributed, $\epsilon_i \sim NID(0,1)$. The observed variable is the innovation success, i.e. the event of realising an innovation, y_i, which is defined by the following observation rule:

$$y_i = \mathbf{1}[y_i^* > 0] \qquad (2)$$

Here, $\mathbf{1}[]$ is the indicator function taking the value 1 if the condition is satisfied and 0 otherwise. Equations (1) and (2) together describe the model, which estimates the relationship between firms' BDA and their innovation propensity via Probit regressions.[1]

It should be noted that due to the cross-sectional nature of the data, the analysis may be subject to endogeneity, which is a common concern in the empirical literature. Omitted variables might confound the relation between the analysis of big data and firms' innovation performance. For instance, a change in firm leadership, which is not possible to observe in the data, might trigger investments in new technology and increased innovation efforts at the same time. To mitigate endogeneity concerns, a variety of background characteristics that can be observed in the data are accounted for, including R&D, human capital, firm size and export status and in particular the adoption of other ICTs, which are commonly observed across countries in the ICTS. This also helps to disentangle the quality and features of BDA from the firms' more general ICT sophistication.

In some cases, endogeneity concerns can be further addressed by using an instrumental variable (IV) approach. In principle, an instrumental variable can allow for the estimation of the coefficient of interest consistently and free from asymptotic bias from omitted variables, without even knowing what they are (Angrist and Krueger, 2001[44]). However, in many situations, a valid IV is difficult or impossible to identify, as it would have to affect the innovation outcome only through the potentially endogenous input. This is particularly relevant for the present case where instruments for different types of BDA would be required.

In the context of analysing firms' ICT use and innovation outcomes, (Spiezia, 2011[27]) used e-government and a lagged ICT variable as IVs. These strategies cannot be implemented here, since data for e-government is not collected anymore by the countries participating in the analysis and the BDA variable is not available before 2016. Additional tests of an alternative IV from the ICTS and of a technical IV, as used in (Hottenrott, 2016[45]), did not yield any other valid IV of use for this analysis.

The mentioned caveats should be kept in mind when interpreting the results. Nevertheless, providing controlled correlations based on new cross-sectional data and linking different types of innovation outcomes to different data sources generates valuable insights on innovation by firms carrying out BDA.

2.4. Results

This section summarises the results of the analysis. The full results are presented in Annex A: tables A.6-A.9 for the French sample[11], tables A.10-A.17 for the Italian sample, tables A.18-A.25 for the Dutch sample, tables A.26-A.33 for the Swedish sample. All results reported below are statistically significant at $p<0.01$ or $p<0.05$.

Product innovation correlates with firms' BDA across all samples. The results are particularly strong for the Swedish sample, with positive correlations between firms' product innovation and BDA using data from geolocation, social media and any big data.

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[1] Given the distributional assumption in Equation (1), $P(y_i = 1|\boldsymbol{x}_i) = P(y_i^* > 0|\boldsymbol{x}_i) = P(\epsilon_i \leq \boldsymbol{x}_i'\beta) = \Phi(\boldsymbol{x}_i'\beta)$, where big data and control variables are collected in the vector $\boldsymbol{x} \equiv (bigdata, \boldsymbol{c})$. The model can be estimated by Maximum Likelihood.

Service firms carrying out BDA with geolocation data are 26 percentage points (pp) more likely to innovate in products for the Swedish sample and 8pp for the Italian sample. For the French sample, correlations are strongest for manufacturing, where firms' propensity to innovate in products increases by 19 pp when analysing big data from social media and by 21pp when analysing big data from other sources. For the Dutch sample, large firms see their propensity to innovate increase by 13pp when analysing big data from social media.

Process innovation correlates with firms' BDA for the French, the Swedish and the Italian sample. For the French sample, correlations are strongest for services, where firms are 18pp more likely to innovate in processes when analysing big data from any source and 16pp when using big data from their smart sensors and devices. For the Swedish sample, manufacturing firms are 14pp more likely to innovate in processes when carrying out BDA with big data from other sources and SMEs 11pp when using any big data. For the Italian sample, manufacturing firms carrying out BDA with social media data are 11pp more likely to innovate in processes.

Marketing innovation correlates with firms' BDA for the French, the Dutch, and the Italian sample. For the French sample, correlations with marketing innovation are positive for firms carrying out BDA with all types of data, except other data, and strongest when using social media data. When carrying out BDA with social media data, for the Dutch sample, manufacturing firms are 20pp more likely and for the French sample, all firms are 14pp more likely to innovate in marketing. Also carrying out BDA with social media data, for the Italian sample, manufacturing firms see their propensity to innovate in marketing increase by 13pp and SMEs by 10pp. For the Italian sample, correlations with marketing innovation are also positive for service firms carrying out BDA with geolocation data.

Organisational innovation correlates with BDA for the French, the Italian and the Swedish sample. For the French sample, service firms are 16pp more likely to innovate in organisation when analysing geolocation data, and correlations are positive too for the full French sample for BDA with data from social media, from firms' devices and sensors and from any source. For the Italian sample, the likelihood to innovate in organisation increases by 7pp for manufacturing firms and by 5pp for all firms when carrying BDA with any big data. For the Swedish sample, firms analysing big data from social media are 11pp more likely to innovate in organisation.

With regards to the different data sources used for BDA, across the samples, correlations with innovation outcomes - all types of innovation confounded - are most frequent for BDA with data from social media, followed by BDA with data from any source and geolocation data. Per type of innovation, across the samples, product innovation correlates most often with BDA using social media or geolocation data; no single data source seems to dominate in the correlations of BDA with process innovation; marketing innovation correlates most often with BDA using social media data; and organisational innovation correlates mostly with BDA using data from any source.

Among the control variables, human capital appears to be the most relevant to innovation, notably in products. Across the samples, estimates for firms with higher shares of employees with tertiary degrees show strong positive correlations with product innovation as well as slightly weaker correlations with process innovation, except for the Swedish sample, and for marketing, except for the French sample. For the French and the Italian sample, higher human capital also correlates positively with organisational innovation.

Controls for R&D and ICTs also appear relevant, but to more varying degrees. Firms' R&D expenditures correlate positively with product innovation in manufacturing for the French, Swedish and Italian samples, with process innovation in manufacturing for the Italian sample and in services for the French sample, as well as with marketing innovation in manufacturing for the Italian sample. Among the ICT controls, firms' use of e-sales, e-purchases and cloud computing correlates positively most frequently with different innovation outcomes, while internet connectivity at different speeds (30-100 Mbps and 100+ Mbps) appears less relevant.

Firm size and exports also play a significant role for innovation, notably in products. The effect of firm size, estimated with log employees and log turnover, is most evident for the Italian sample across all types of innovation as well as for the French sample, except for marketing innovation. For the Dutch sample, firm size correlates positively with product and process innovation and for the Swedish samples with product and organisational innovation. Firms' exports are positively correlated for the French sample, in manufacturing in particular, with product, process and marketing innovation, and with the latter also for the Dutch sample. For the Italian sample, exports are positively correlated most notably with product and process innovation. Due to data availability, the Swedish sample does not contain the export control variable.

2.5. Discussion

The results summarised above and detailed in Annex A. help better understand: 1) whether BDA in firms correlates with innovation in products, processes, marketing, and organisation; and, 2) if data from specific sources used for firms' BDA play a particular role for any of these types of innovation.

On the first question, the results indicate that firms carrying out BDA are indeed more likely to innovate, most notably in products, but also in processes, marketing and organisation. This seems coherent with observations in section 1 on trends affecting firms going digital and with section 4 on data-driven business models, notably with regards to data-driven innovation opportunities arising with digital products.

On the second question, across all samples and types of innovation confounded, innovation correlates most often with BDA using social media data, followed by BDA using geolocation data. This resonates again with observations in sections 1 and 4, in particular the importance of user-related data for BDA and data-driven innovation. In addition, the correlations of BDA (with different data sources) and innovation in products (social media and geolocation data), processes (different types of data, including data from firms' devices and sensors), marketing (social media data) and organisation (data from any source) clearly reflect real world examples, most notably the benefits of user-related data for product innovation and of social media for marketing innovation. It is worth noting that the use of firm-related data appears more limited than may have been expected, in particular in manufacturing.

These findings indicate certain patterns across the analyses of the four samples. However, the results with the individual samples also differ, for example with regards to manufacturing versus services firms and large firms versus SMEs. Heterogeneity in results across samples may partly stem from diverging domestic and/or local factors, such as economic structures, firms' ICT-sophistication, innovation opportunities and policy environments, as well as from individual sample characteristics.

In particular, regressions with the French sample result more often in positive and statistically significant correlations between BDA and all types of innovation than in the analyses with the other samples. One possible explanation could be that the French sample has higher shares of firms that innovate in the different types of innovation than: i) the respective aggregate shares in the French firm population and ii) than most respective shares in the other samples[12]. This fact is likely a function of the high share of large firms in the French sample as compared to the share of large firms in the full French firm population and in the other samples. As discussed in section 1.1, large firms are also more likely than smaller firms to adopt BDA and other more advanced ICTs in combination.

In sum, the results clearly indicate that firms carrying out BDA are more likely to innovate, in particular in products but also in processes, marketing and organisation. Positive and statistically significant correlations appear most often between innovation and BDA with user-related data (from social media and geolocation), while BDA with firm-related data (from firms' devices and sensors) correlates less often with the different types of innovation. The latter may in turn imply that significant scope remains for data-driven innovation with firm-related data.

3. Data-driven business models

Data-driven innovation is at the heart of value creation with data-driven business models. A business model is here understood as "the rationale of how an organisation creates, delivers, and captures value" (Osterwalder and Pigneur, 2010[46])[13]. Respectively, this section examines three dimensions of data-driven business models, namely how they create value (3.1), how they deliver value (3.2), and how they capture value (3.3). In addition, the section reflects on why firms with digital products and data-driven business models can benefit from powerful economies of scale and scope (3.4).

3.1. Value creation

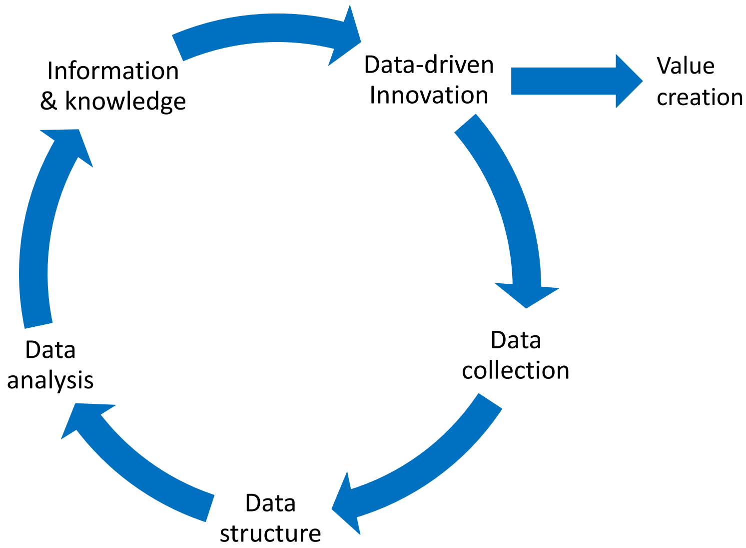
Value created by firms is mostly measured in monetary terms accruing to the firm via increased sales, revenue, profit, and market valuations. To increase any of these over time, firms need to innovate and some firms very successfully do so with data. Data-driven innovation allows firms to improve many aspects of their business. Besides applying to administrative functions, processes and operations, data-driven innovation has great potential to enhance products and digital products in particular.

Value creation with data-driven innovation tends to be an iterative cycle. For example, a digital product may be launched as a beta version and tested with lead users first. This allows the firm to collect data on the product's use, improve it in several iterations and finally scale it up with demand (Ries, 2011[47]). Once established, a digital product can be improved continuously with updates and new versions, allowing the firm to keep collecting data.

The data-driven innovation cycle entails several key steps (Figure 9). First, firms need to get access to data, for example by collecting data on their operations, on markets or on product users. Second, the (big) data need to be cleaned and structured to be of use for analytics. Skilled employees such as data analysts (and/or artificial intelligence) then extract insights from data and put it in context. Such information in turn enriches the firms' knowledge base for innovation. If an innovation succeeds, it creates value. For example, a a process innovation can make operations cheaper and faster and a product innovation can attract more users, increasing sales and allowing the firm to grow its market share.

Many of the world's most successful firms that operate data-driven business models have a digital product, for example an online platform, and collect data on its use and users. The larger the network of users the more data a firm can collect as input for continuous data-driven innovation. Connected hybrid goods, for example a connected car, can also enable data-collection via the good's digital components. Continuously collecting user-related data enables firms to keep learning about users' behaviours, desires or needs and process these insights for innovation and value creation.

Figure 9. Creating value with data-driven innovation



Source: Adapted from (OECD, 2015[48]).

Over the past two decades, several firms with digital products and data-driven innovation have become the most valueable companies worldwide. Some have favoured – at least in their early years, such as Amazon (Bezos, 1997[49]) – scale and innovation over profit and dividends. Re-investing profits, notably into intangible assets such as user networks and data that underpin data-driven innovation can ultimately boost growth and revenue and lead to higher market valuation, reflecting the firms' innovativeness, growth potential and market power, among others.

3.2. Value delivery

The direct relationship with users, enabled by digital products, also serve firms to personalise value and deliver it digitally, without intermediation. Where the typical 20th century firm produced a best guess version of a product and sold it to an anonymous mass of consumers with assumed similar tastes, in most cases through one or several intermediaries, firms today can design products based on evidence about users' preferences and deliver value directly, without intermediary and in some cases on-demand.

Online advertisement is a case in point. Traditional advertisement on billboards and via broadcasted media addresses anonymous consumer masses, roughly distinguished consumer groups at best. In contrast, online advertisement, e.g. on websites or mobile applications, can be targeted to fine-grained consumer groups, if not directly to individual users, based on their known behaviours, needs or desires.

The more digital a product, its purchase and/or its use, the better firms can deliver value directly to users. Dis-intermediation has been a feature of business models from the early days of digital transformation (Perset, 2010[50]). Primarily digital products, such as digital content, are easiest to deliver directly to users, over the Internet (Box 1). But also physical and hybrid goods, such as cars, that have resisted e-commerce for a while, are now sold by manufacturers directly to consumers, for example Tesla cars, including online. In addition, continuous improvements of digital services embedded in physical goods, for example autonomous driving software, are delivered to end users directly via the Internet.

Box 1. Netflix

Over the past two decades, Netflix evolved from a simple online retailer into a firm that keeps innovating in digital products and thrives with a data-driven business model.

Scale. In 1998, Netflix started offering DVD rental and sales on netflix.com. A year later, it debuted a monthly subscription service with unlimited DVD rentals. By 2006, it had grown its subscriber base to 5 million. As of 2007, Netflix introduced streaming of television shows and movies and grew its subscriber base to 25 million by 2012. In early 2020, Netflix counted over 167 million paid subscriptions in over 190 countries.

Scope. After its focus on scale, Netflix diversified. First, it entered partnerships with major technology companies who offered Netflix on multiple products, including connected televisions, computers, tablets and smartphones. Around 2012, Netflix made a major step in adding scope by entering production and distribution of digital content, landing important successes with content exclusively streamed via Netflix, e.g. House of Cards. Today, Netflix' offers include TV series, documentaries and feature films across multiple genres and languages.

Value creation. Netflix started continuous data-driven innovation with user data in its digital product netflix.com as of the year 2000, when it introduced personalised recommendations based on data from members' ratings. While it keeps innovating its core product, e.g. the introduction of the "profiles" feature, which allows users to create different profiles for different users and/or different moods, it also introduces new and innovative products on a regular basis, i.e. the various forms of digital content it produces.

Value delivery. Netflix went from being a basic digital intermediary to delivering personalised value, when it introduced personalised recommendations, and delivering value directly to users, when it started video streaming. It further applied dis-intermediation upstream by becoming a digital content producer, and can now exploit insights from data collected in its direct relationships with users for both innovation in netflix.com and in the digital content that Netflix produces.

Value capture. Almost from the start of its operations, Netflix used a subscription model. This helped Netflix grow its user base and to collect user data from early on. Independently from the cost of content production and distribution, Netflix can flexibly price subscriptions in all countries, as a function of respective users' willingness to pay and use.

Source: (Netflix, 2020[51]).

Some of the value firms can deliver with a digital product, notably if it comes as a service, accrues in the product's use rather than in its production or sale (Koch and Windsperger, 2017[52]). A product's use value reflects the service it delivers during its use. Firms with digital products, services in particular, thus focus less on producing and selling as many units as cheap as possible and on increasing users' willingness to pay (as do firms producing and selling physical goods), but on attracting as many users as possible to their product and on increasing users' willingness to use, by maximising users' time and attention spent with the product.

The more digital the delivery, the easier it can be on-demand. The difference between traditional and non-linear media (e.g. Netflix) illustrates this well. Digital products enable users to not only consume what firms push, but to pull the desired offer at any time and many times. Digital products also facilitate on-demand delivery in the context of physically delivered goods or services, for example food delivery or mobility services, sold via mobile applications (e.g. Uber).

3.3. Value capture

Firms eventually have to capture value to generate revenue. Traditional firms tend to capture value by selling products, i.e. either by transferring ownership rights of goods through one-off market transactions or by providing contracted services. With digital products that deliver services over time, firms often use subscriptions or pay-as-you-use models, including renting, leasing or licensing, that enable more continuous forms of value capture.

Products with a high service value tend to be monetised through subscription models, for example a mobile phone or a data subscription. Subscription models, including "freemium" models, are common among data-driven firms with digital products (e.g. Spotify), because they help attracting users to a product, increase user loyalty or lock in, deliver predictable revenue, enable service bundles, and facilitate product personalisation, including personalised and/or dynamic pricing.

When the delivery of a service significantly depends on a physical good or asset, firms tend to favour pay-as-you-use models. Digitally enabled pay-as-you-use models allow maximising the service value of a physical good or asset by increasing its capacity utilisation (e.g. Airbnb). For example, connected shared cars in an urban car sharing system (e.g. ShareNow) are rented in shorter intervals at higher frequency than in a traditional rental car rental system, which increases capacity utilisation of the cars. Pay-as-you-use models are prominent among a range of digital products too, including digital content and data, in particular when the product use is less regular and permanent.

Revenue is a function of quantity and price and both can be determined more flexibly for digital than for physical products. Contrary to physical goods, relevant metrics for digital products are their users and user time rather than units sold. Prices of physical products depend significantly on supply factors, such as input, production and distribution costs. Prices of digital products depend less on supply factors, as marginal cost of production tends to be low and distribution and delivery is often direct. Traditionally, prices have inertia, reflecting inflation or deflation, except for auctions or negotiations. Digital transformation has made prices more prone to be dynamic, for example, if they are personalised or change as a function of real-time supply and demand of a digital service (Box 2). These aspects make for greater flexibility in pricing and related value capture, in particular for firms with digital products.

The optimal price of some digital products is zero. Digital products, services in particular, tend to be offered for "free" in order to grow user networks and/or to maximise user time and the value a firm can create from it. Firms can capture large value from free products once they have created large networks, such as through the firm's sale (cf. WhatsApp sale to Facebook) or via sales in a second network using the product, such as advertisers (e.g. YouTube). The latter approach typically involves (non-monetary) value capture from the initial user network, in form of data, to optimise (monetary) value capture in the related network. Firms with an ecosystem of digital products (e.g. Google) can collect and connect data from different products and thereby increase the volume, variety and sometimes the velocity of such data and hence grow its value for innovation.

Value created with "free" digital products is partly captured by users. Such consumer surplus can accrue in addition to producer surplus, notably for firms with digital products (Brynjolfsson, Hu and Smith, 2003[55]). Firms with "free" digital products not only optimise their production but also tend to optimise the consumption of users, for example by enabling them time and cost savings. While measuring consumer surplus remains a challenge, using the proxy of consumers' willingness to accept annual compensation for losing access to "free" digital products (Brynjolfsson, Eggers and Gannamaneni, 2018[56]) estimate particularly high consumer surplus for search engines, email and digital maps.

Box 2. Uber

Over the past decade, Uber emerged with an innovative digital product and a data-driven business model. It scaled up fast and diversified its offerings in markets across the globe.

Scale. Founded in 2009, Uber started offering a mobile application to match drivers with people searching rides, facilitating personal point-to-point transportation. Within a decade, Uber scaled to over 700 cities in 63 countries, with 91 million monthly active users and 14 million trips per day as of December 2018. Uber's market cap was around USD 100 billion in mid-2021.

Scope. Uber diversified its core product into an ecosystem of digital products. Beyond selling personal car-rides, e.g. via Uber- X, Pool, XL, Select, Black, WAV, or Lux, Uber offers multiple other urban transport services, (e.g. scooters, helicopters, public transit information), businesses services (e.g. business travel, health care), logistics services (e.g. food delivery, freight carries and shipments), job placement services (e.g. retail, restaurants).

Value creation. Uber's products are fundamentally data-driven, relying significantly on high velocity user data collected via its mobile applications. This data is essential for Uber to create value for users, for example, convenience and time-savings compared to traditional taxi or VTC services. Uber also offers greater work-time flexibility to drivers than traditional taxi or VTC firms, and enables higher capacity utilisation of vehicles used for Uber enabled mobility and logistics services.

Value delivery. As in traditional mobility and logistics services, drivers deliver most value of Uber enabled mobility and logistics. In addition, Uber delivers value through fast matching, for example ride-seekers with drivers, and through information it provides, such as information on the car and the driver, including his/her rating, estimated waiting time, and trip cost provided, before a ride. Uber also enables direct communication between the user and the driver as soon as a ride is booked.

Value capture. Uber captures value from each successful match it makes via a service fee. It mainly uses a pay-as-you-use model, except in its business services, where Uber also offers subscriptions. While users pay per use, they also volunteer data that Uber uses for the functioning of its products and for innovation. Uber implemented dynamic pricing, considering real-time supply and demand, including higher than average "surge" prices, intended to attract more drivers to the road during peaks of surging demand for rides.

Source: (Uber, 2020[53]); (Statista, 2020[54]).

3.4. Economies of scale and scope

Many firms that create, deliver and capture value with data-driven innovation, notably in digital products, can benefit from powerful economies of scale and scope. These economies of scale and scope are different from and complementary to the ones known from the production of physical goods.

Digital connected products enable powerful economies of scale, especially when being delivered as a service via an online platform[14]. The networks of online platform users underpin economies of scale (on the demand side) that enable firms to scale without mass (on the supply side), given that users can be added to a network at near zero marginal cost (Brynjolfsson et al., 2006[57]). For example, Spotify's tangible assets (plant and equipment) represented less than one percent of its market valuation in 2018 (Birkinshaw, 2018[58]). In addition, positive network externalities enable increasing returns to scale (Arthur, 1996[59]) and can include direct- (Katz and Shapiro, 1985[60]), indirect- (Economides and Salop, 1992[61]) and two-sided network effects (Rochet and Tirole, 2003[62]). Firms with large and growing user networks of their digital products have enjoyed faster growth in market valuations than any other type of firm in recent history (Libert, Beck and Wind, 2016[63]).

The software and data that power digital products facilitate firms to also benefit from powerful economies of scope. Data and software can be copied, re-used without degradation, as well as versioned and combined indefinitely at very low cost. This makes them ideal components in ecosystems of interoperable and often interdependent digital products. Such an ecosystem can include physical, hybrid and digital goods such as networks, devices, services, and content, all operated across boundaries of firms, markets, industries and jurisdictions. Some of today's most successful firms with data-driven business models benefit from strong economies of scope of their digital products in such ecosystems.

Some firms with data-driven business models can benefit from combined economies of scale and scope enabled by their digital products. In primarily physical production, returns to scale decrease with increasing scope and related complexity. By removing human bottlenecks and physical constraints, software, data, analytics, AI and automation can reduce complexity of processes and operations and enable wider scope at larger scale (Iansiti and Lakhani, 2020[64]). This means that returns to scope do not have to decline with complexity, as for most firms that produce primarily physically, but can continue to increase with scale. Amazon is an example for a firm that achieves to grow scope and scale, while benefitting from increasing returns to both.

4. Policies for firms going digital and innovating with data

Public policies play an important role to improve the conditions for firms to go digital and to innovate with data. To help identify and improve such policies, this section discusses two major approaches and respective policies: 1) boosting firms' adoption of advanced ICTs, with policies to a) improve framework conditions, b) raise awareness and c) support SMEs; and 2) enabling firms to innovate with data, with policies to a) enhance access to and sharing of data, b) boost investment in intangible assets and c) strengthen skills development. For each of these, this section provides examples of policies from across a large range of countries and discusses key aspects to further improve such policies.

However important they may be, none of the policies discussed below can act as a silver bullet. Considering these policies jointly to achieve a policy mix that helps all firms to thrive is as important as co-ordinating them in the larger context of the OECD's Going Digital integrated policy framework for digital transformation (OECD, 2020[2]).

4.1. Boosting firms' adoption of advanced ICTs

Many firms that go digital beyond initial steps are adopting newer and more advanced ICTs, in particular to effectively use (big) data. The trends presented in section 1 reveal large remaining potential for more widespread adoption of ICTs such as BDA, cloud computing and high-speed broadband, notably among smaller firms. In addition, section 2 provides empirical evidence on the importance of such ICTs – in particular of BDA – for innovation. Public policies can play a key role in boosting firms' adoption of newer and more advanced ICTs, in particular policies that improve framework conditions, that raise awareness and that support SMEs.

Framework conditions

Framework conditions can significantly affect firms' propensity to adopt ICTs. Some countries improve the conditions for ICT investment, e.g. by overhauling depreciation rules and introducing tax deductions (Denmark) or by designing public venture capital (VC) funds such as to spur private co-investments (United Kingdom). Other countries focus on laws and regulation, including initiatives to future-proof legislation (Netherlands), targeted experimental legal regimes (Russia), agile regulation (Denmark), the harmonisation of standards and regulation (Australia), and the reduction of legal barriers to new business models (Switzerland) (Box 3). Some countries also create new or improve existing standards, e.g. for electronic invoicing (Estonia, Thailand).

Box 3. Reviewing laws and regulation

Denmark works towards more agile regulation by: i) formulating principles for agile regulation on trade and industry, ii) establishing a single point of entry for new business models, iii) performing a digital check-up as to whether existing commercial regulation is up-to-date compared with neighbouring countries, and iv) improving opportunities for testing in fields with particular potential for digital growth. Denmark is also introducing tax deductions for wage and salary costs associated with setting up and expanding a company, e.g. by simplifying the administration of digital business development (Ministry of Industry, Business and Financial Affairs, 2018[65]).

Australia improves the regulatory market environment through ongoing efforts towards 'digital ready' legislation and through the Government's support of Australia's states and territories to adopt, or recognise as equivalent, each other's regulations and standards to lower costs for businesses. This concerns one-third of the 5 600 Australian standards that are referenced in Commonwealth, state and territory regulation (Department of Industry, Science, Energy and Resources, 2018[66]).

Switzerland reduces legal barriers to new business models by first having carried out a 'digital test' to identify where existing legislation unnecessarily hampers digitalisation or becomes redundant and, second, by examining measures to reduce legal obstacles, for example formal requirements stemming from both public and private law, with the aim to reduce barriers to digital business models and to improve the framework conditions for the digital economy. To further reduce administrative burden on businesses, Switzerland also works on centralising the exchanges between public authorities and business (OFCOM, 2020[67]).

Sources: (Ministry of Industry, Business and Financial Affairs, 2018[65]); (Department of Industry, Science, Energy and Resources, 2018[66]); (OFCOM, 2020[67]).

Many studies promoting structural policies to boost ICT diffusion among firms, e.g. (Sorbe et al., 2019[68]) (Calvino and Criscuolo, 2019[69]) (Berlingieri et al., 2020[18]), analysed firms' use of basic and process-related ICTs, such as basic broadband connections, ERP and CRM, which primarily enable firms to digitise and improve internal processes. Further work on potential benefits of structural policies for ICT diffusion among firms would benefit from assessing whether such policies equally favour the diffusion of newer and more advanced ICTs, such as BDA.

The findings on firms' combined adoption of different ICTs presented above (cf. section 1.1) indicate that firms often adopt BDA in combination with cloud computing and high-speed broadband. This may imply that policies favouring firms' adoption of any of these ICTs may also positively affect the adoption of ICTs adopted in combination.

Awareness raising

Even if framework conditions are favourable to firms' ICT adoption, smaller firms in particular and those in less digital-intensive sectors are often still not well aware of digital opportunities, notably those involving more advanced ICTs. Most countries have awareness raising measures in place. Several countries offer an online self-assessment tool for firms to evaluate their state of digitalisation and to identify digital opportunities (e.g. Australia, Greece, the Netherlands, Luxembourg, Box 4), while others work with digital transformation laboratories and technology extension centres (e.g. Colombia, Chile, Box 4) or networking initiatives, connecting digitally advanced with lagging firms (Denmark, Korea). Another approach are national online platforms, programmes or regional centres that raise awareness, educate and provide success cases of firms' digitalisation (Australia, Germany, Greece, Singapore); in some cases focused on specific sectors, such as health (United States), or on particular technologies like artificial intelligence (Finland).

Box 4. Raising awareness of digital opportunities

Luxembourg's DigiCheck self-assessment tool assesses firms' state of digitalisation and provides recommendations according to the firms' profile. DigiCheck's questions are designed to guide firms in their digitalization path and inspire new ideas and approaches. Entrepreneurs can use the tool on their own or receive help from an eHandwierk expert. The results of DigiCheck can also constitute a basis for discussions with experts from the Fit4Digital programme. Anonymised statistics from the tool's use provide Luxembourg's Chambre des Métiers up-to-date insights into firms' state of digitalisation (Department of Media, Telecommunications and Digital Policy, 2018[70]).

Colombia's digital transformation laboratory helps firms identify digital transformation opportunities and challenges with the aim to increase productivity. The laboratory is conceived as space for firms from eight productive sectors to collaborate with ICT sector companies to find digital solutions to their challenges. An additional measure foresees to deploy a team of facilitators across the national territory to support at least 10 000 entrepreneurs during on year with at least one digital transformation action, such as the engagement in electronic commerce (MinTIC, 2018[71]).

Chile's Technology Extension Centres help Chilean firms, SMEs in particular, to discover technologies that are successfully applied in other countries. Implemented by Chile's Production Development Corporation, firms are grouped based on shared needs and introduced to proven technology applications that may help address their challenges. The centres are also meant to operate in association with universities and training centres and to sign transfer agreements with international entities (Gobierno de Chile, 2015[72]).

Sources: (Department of Media, Telecommunications and Digital Policy, 2018[70]); (MinTIC, 2018[71]); (Gobierno de Chile, 2015[72]).

One common shortcoming of many initiatives that raise firms' awareness of digital opportunities is that most are still focused on promoting basic and/or process-related ICTs and their potential to improve firm-internal processes. As illustrated in section 1.1, firms at the frontier of ICT adoption rather focus on newer and more advanced ICTs that enable firms to use data more effectively. Measures to raise awareness about such ICTs in general and the potential of data for innovation in particular would benefit in particular firms that are lagging behind.

SME support

Many SMEs lag behind larger firms in the adoption of newer and more advanced ICTs (cf. section 1.1). A large number of countries are implementing targeted measures to support SMEs. Among the most frequent ones are financial support schemes for different aspects of SMEs' digitalisation (Japan, Spain, Denmark), including to enhance business processes, business models, skills and digital security (Germany), and sometimes tailored to specific industries (Singapore, Box 5). Some countries also support SMEs to engage in e-commerce (Israel, Denmark) and to integrate in data-driven international markets (BRA).

Box 5. Supporting SMEs going digital

Singapore's SMEs Go Digital programme was designed to help SMEs digitalise and prepare for the future economy. The programme operates Industry Digital Plans, which are step-by-step guides for SMEs on their digital journey, customised for SMEs by industry, in six priority sectors: retail, logistics, food services, wholesale trade, environmental services and security. SMEs can also seek advisory services and assistance to customise and design their digitalisation journey and financial support for pre-approved technology solutions (IMDA, 2018[73]).

Austria's Digital Innovation Hubs support ICT adoption and digital innovation in SMEs. Three hubs have been created in different locations with foci on sub-themes ranging from digital transformation and industry 4.0 over digital co-creation to the internet of things and blockchain. Three additional hubs are planned to focus on specific sectors and additional technologies such as robotics, big data and artificial intelligence. Providing expertise and infrastructure, these hubs raise awareness, help explore digital opportunities and challenges with SMEs and build their digital competences and innovation capabilities (FFG, 2021[74]). Austria also offers a „Patent.Scheck", allowing firms to verify the patentability of an idea or product once per year for free and providing financial support - unconditional for SMEs - to file and monitor a patent (FFG, 2020[75]).

Spain's AcceleraPyme programme includes several measures implemented in public-private collaboration to support and advance the digitalisation of SMEs across sectors, ranging from advice over technical solutions to training and financing. In the context of the COVID-19 pandemic, it also offers targeted support to maintain SMEs short-term economic activity, rethink business models and strengthen managerial and digital skills (OECD, 2021[76]). Of the total EUR 250 million budget, the programme's three largest posts are allocated to artificial intelligence and other enabling technologies, to boost the data and content economy and to provide training (red.es, 2021[77]).

Sources: (IMDA, 2018[73]); (FFG, 2021[74]); (FFG, 2020[75]); (OECD, 2021[76]); (red.es, 2021[77]).

To support SMEs' digital and data-driven innovation, approaches range from innovation competitions (Netherlands, United Kingdom) or vouchers (Italy) over support for digital product development (Korea) to digital innovation hubs and patenting support (Austria, Box 5 above). Other types of support include public procurement favouring SMEs' supply for public digital service delivery (United Kingdom, Australia) and support for buying SME-provided digital services more generally (Estonia).

One potential issue to keep in mind when designing ICT investment incentives is that ICT capital investment policies may dis-incentivise the adoption digital services, if firms treat them as operating expenditure rather than as capital investment. This is especially important for the common case of firms that finance digitalisation projects with cash flow (Saam, Viete and Schiel, 2016[78]). In particular, the adoption of cloud computing has been found to be negatively associated with ICT capital incentive programmes in the UK and in Germany (Andres et al., 2020[79]). Evidence from Germany also shows that firms conducting loan negotiations on digitalisation projects are more likely to face difficulties accessing credit than firms negotiating loans for capital expenditure (KfW, 2020[80]). ICT investment policies would thus benefit from distinguishing between ICT capital goods and services and between ICT hardware and software.

4.2. Enabling firms to innovate with data

Many firms going digital have focused on adopting ICTs over recent years that enable them to use data for innovation (cf. section 1). The empirical evidence provided above also shows that – in addition to BDA making firms more likely to innovate – firms' innovation also benefits strongly from their investment in R&D and from skilled employees (cf. section 2). Public policies can play an important role in enabling more firms to innovate with data, in particular policies that enhance access to and sharing of data, policies that foster investment in intangible capital, and policies that support skills development.

Access to and sharing of data

Enhancing access to and sharing of data is key to fostering data-driven innovation in firms. A number of different policy approaches to this end have emerged over recent years. Some countries are exploring the potential of data sharing among firms and across sectors (Finland, the Netherlands), enhance data portability, including via APIs (e.g. United Kingdom, Box 8), or address inconsistencies among relevant legal regimes (Colombia, Japan). Others create new standards, e.g. for self-driving machines, and clarify data rights of machine owners (Austria), implement FAIR (findable, accessible, interoperable, reusable) data and open data by default principles (Greece), or create guidelines for firms' data use (Denmark). A few countries have developed or are developing dedicated national data strategies (e.g. Germany, Box 6) and/or data ethics frameworks (Australia, United Kingdom). Among the most established measures are initiatives to open up government data, including to foster innovation in the private sector (OECD, 2018[81]) (e.g. Sweden, Box 8).

Enhancing access to and sharing of data, including public sector data, has great potential but also limitations, as the usefulness and value of data to firms is context dependent. For example, data collected by one firm on its product users may be valuable to this specific firm but of little value to other firms with different products and/or different users. Mandating firms to share data might thus not always be beneficial to other firms. However, the reverse can be true as well. Some firms may hold data that would benefit others and lack the incentives to grant access to such data.

The OECD has identified common approaches to enhancing access to and sharing of data, such as open data, data portability, contractual agreements, and restricted data-sharing arrangements (OECD, 2019[85]). In addition, the *OECD Recommendation of the Council on*

Enhancing Access to and Sharing of Data provides overarching recommendations for policy makers on i) reinforcing trust across the data ecosystem, ii) stimulating investment in data and incentivising data access and sharing, and iii) fostering effective and responsible data access, sharing and use across society (OECD, 2021[86]).

Box 6. Enhancing access to and sharing of data

The United Kingdom's "Midata" initiative. The "Midata" data portability initiative was launched in 2011 with the aim to empower consumers and stimulate innovation. Midata enables consumers to download their transaction data in a standardised, portable and machine-readable format for easy comparison against alternative offers in the energy supply, mobile phones and financial sectors. Steps to implement the initiative have been taken in the energy sector. Firms implement it on a voluntary basis, but could also be regulated if failing to comply (OECD, forthcoming[82]). The government also works with organisations such as the Open Data Institute to create an environment to open up user data across more sectors through the use of APIs (DCMS, 2017[83]).

Germany's Data Strategy. Developed in a multistakeholder process, Germany's Data Strategy aims to make the country a leader in the innovative use of data and data sharing. It focuses on four main action areas: i) making data infrastructure effective and sustainable, ii) enhancing the innovative and responsible use of data, iii) developing data competency and establishing a data culture, iv) making the state lead by example (Bundesregierung, 2021[84]). Established by the Chancellery, the strategy provides over 200 policy measures and co-ordinates their implementation across the responsible federal ministries.

Sweden's Hack4Sweden. Hack4Sweden aims to stimulate data-driven innovation through open government data. It promotes the use and re-use of such data through collaboration among public authorities, firms, academia and civil society, the emergence of data markets and the development of digital services, including via hackathons. The responsibility for the initiative rotates among different public sector organisations.

Sources: (OECD, 2018[81]); (OECD, forthcoming[82]); (DCMS, 2017[83]); (Bundesregierung, 2021[84]).

One approach that gained much attention over recent years is data portability. Data portability can apply to public and private sector data and is often considered a useful tool to promote data access and sharing while also strengthening the control of firms over their data, potentially offering important opportunities for data-driven innovation (OECD, forthcoming[82]). For example, the use of APIs in the financial sector has shown to enable new fin-tech start-ups to enter or to collaborate with established players (Axway, 2021[87]).

However, there may also be downsides to data portability that could undermine incentives for firms to invest in data, e.g. potentially higher data management costs and the risk of losing customers, e.g. if interoperability of their data is high and switching costs to alternative products are low. More generally, the development and implementation of data portability initiatives should carefully consider potential challenges, for example regarding the scope of data portability, digital security and privacy risks, responsibility and liability challenges, interoperability specifications including standards and APIs, and compliance costs (OECD, forthcoming[82]).

Innovative firms can also benefit significantly from access to research data. The *OECD Recommendation Concerning Access to Research Data from Public Funding* provides key aspects for policy makers to consider when developing and implementing mechanisms, strategies, or policies to make research data from public funding openly accessible and reusable, while taking into account the need to restrict access for legitimate private, public, and community interests. Key aspects concern data governance, technical standards, incentives and rewards, infrastructures, human capital, and international co-operation (OECD, 2021[88]).

Investment in intangible assets

To effectively use data for innovation, firms also need to invest in other intangible assets, including software, databases and R&D. Investment in software is fostered partly through policy measures aiming to boost firms' adoption of newer and more advanced ICTs (cf. section 4.1) and investment in databases can also benefit from measures to enhance access to and sharing of data discussed above.

One well-established policy measure in this context are incentives for firms to invest in R&D. The most common forms of R&D support are direct funding and R&D tax incentives, which include tax credits and allowances for different current R&D business expenditures and other forms of tax relief to accelerate the depreciation of related capital expenditures (e.g. France, Italy, Box 7). Expenditure-based tax incentives have become a widespread approach to R&D support across the OECD, with 30 countries having had such an instrument in place in 2019 (Appelt et al., 2020[89]). Public funding of R&D is also likely to increase returns to other intangible assets (Alsamawi et al., 2020[90]).

Box 7. Supporting investment in intangible assets

France's R&D tax relief. There are two R&D tax incentives in France, a volume-based tax credit, the Crédit d'Impôt Recherche (CIR) and an exemption from social security contributions for young and innovative firms (JEI/JEU). Key features include a 30% headline rate of the R&D tax credit, reduced to 5% for R&D expenditure above EUR 100 million. For SMEs, unused tax credits are refunded and large firms can benefit from a three year carry-forward. After that period, any outstanding credits are refundable. Subcontracted R&D is subject to different ceilings, depending on the R&D service provider (OECD, 2020[91]).

Italy's fiscal framework for innovative companies was recently revised as a result of the country's Industria 4.0 plan and provides tax incentives available to any type of company. These include in particular: i) tax incentives for investments in innovative start-ups and SMEs; ii) hyper-depreciation rules to encourage firms to invest in the digital transformation of their production processes and supply chains; iii) a R&D tax credit; and a special fiscal regime consisting of a 50% reduction in corporate tax on income deriving from direct and indirect use of intangible assets (i.e. industrial patent rights, industrial design and models, know-how and copyrighted software) (Governo Italiano, 2021[92]).

Canada's Scale AI Supercluster. With the Scale AI Supercluster the Government of Canada links up firms from the retail, manufacturing, transportation, infrastructure and information and communications technology (ICT) sectors to build intelligent supply chains. The cluster receives CAD 230 million in federal funding for several programmes to facilitate AI-enabled supply chain solutions, assist SME and start-ups to scale-up AI products and services, improve AI skills, strengthen academia-industry links, and encourage collaboration, data sharing, and access to IP, among other things (Government of Canada, 2020[93]).

Sources: (OECD, 2020[91]); (Governo Italiano, 2021[92]); (Government of Canada, 2020[93]).

R&D policies are crucial but only one piece in the policy mix to foster data-driven innovation by firms. Making R&D policies the dominant approach in innovation policies may even hamper business model innovation (OECD, 2019[22]). Other measures discussed above and below should be considered in combination, much as more holistic approaches such as Canada's Scale AI Supercluster (Box 7). In particular, in a context where firms also innovate with resources that are external to the firm, notably user-related data (cf. sections 1 and 2), it may be beneficial to pay more attention also to householder R&D. The latter has been largely overlooked by research and policy makers so far, but is likely to represent a sizeable fraction of overall R&D spending: (Sichel and von Hippel, 2019[24]) estimate for the USA that in 2017, household R&D amounted to about half of producers' R&D spending to develop new consumer products.

Another issue to consider is the insufficient measurement of intangible assets and their value, which can complicate firms' access to finance, in particular asset-based financing. In the absence of better measurement, lenders face challenges to recognise intangible assets as collateral, struggling to value these assets and to understand their role for firms' success and how to realise value in case of a default (Brassell and Boschmans, 2019[94]). Such constraints may dis-incentivise firms to invest in intangible assets in the first place, notably SMEs, and hinder firms with intangible assets to access asset-based financing. Indeed, firms' productivity growth has been found to suffer from financial constraints in particular in intangible intensive sectors (Demmou, Franco and Stefanescu, 2020[95]). Reviewing accounting rules and improving measurement of key intangible assets in firms would be an important step to improve the conditions for more firms to invest in such assets.

Skills development

For the increasing use of ICTs, data and other intangible assets to bear fruit, firms need the right skills. Initiatives to support skill development abound. Some countries directly support firms' digital skills training of employees (Colombia), including targeted at SMEs (Spain), or offer fast-track coding courses for adults for career development or change (Luxembourg). Other countries either match large with small companies and entrepreneurs to help them find relevant skills, knowledge and talent (Denmark) or match established firms with start-ups and academics to share expertise and engage in collaborative digital problem-solving (United Kingdom). Some countries also support industry-led initiatives like Australia's digital skills finder platform that aggregates digital skills training providers or help firms attract talent from abroad (Korea).

Focusing on professional training and job placement, some countries strengthen apprenticeship programmes to develop a talent pool of data specialists (Singapore), reinforce professional qualifications for ICT and data-intensive occupations (Austria), support the development of programming skills in partnership with employers (e.g. Israel, Box 8), or strengthen the acquisition of advanced ICT-skills and data analytics skills in the context of vocational training (e.g. Estonia, Box 8). Initiatives aiming to improve medium and long-term skills development include the introduction of computational thinking and/or coding in primary and secondary education (Colombia, Japan, Thailand, Norway) as well as in higher education (e.g. Norway, Box 8).

Box 8. Improving training and education

Israel's Coding Boot Camps involve intensive training in programming languages, combining theoretical study with practical application. In addition to technical knowledge, they also strive to provide soft skills, including independent learning, teamwork and tools for long-term career development. This extra-academic training programme is intended for companies, including from high-tech sectors, non-profit organizations and academic institutions. It is supported, including with grants, by Israel's Innovation Authority in the context of implementing Israel's National Program for Increasing Skilled High-Tech Personnel (Israel Innovation Authority, 2018[96]).

Estonia's approach to skills development includes several initiatives such as ***Proge Tiger,*** a programme to encourage preschool, general, and vocational education teachers to use technology more widely, including programming, to attract young people to ICT fields. To garner women's interest in ICTs, the ***Unicorn Squad*** movement offers girls aged 8-12 opportunities to participate in hands-on activities to learn about digital technologies. Applying to later stages of education, the government initiated an ***IT Academy***, involving employers to help shape the education of ICT graduates and to ensure the pertinence and success of their studies (education estonia, 2021[97]).

Norway's Knowledge Promotion 2020 reform introduced programming as an elective in lower and upper secondary education and as a compulsory part of several subjects in primary and secondary education (OECD, 2020[98]). After assessing the potential of increasing ICT-related positions in higher education and stimulating the business community to better use PhD programmes to increase their advanced ICT competences and innovation capabilities (Norwegian Ministry of Local Government and Modernisation, 2016[99]), the government recently allocated new funding to significantly increase the number of study places in advanced ICTs.

Sources: (Israel Innovation Authority, 2018[96]); (education estonia, 2021[97]); (OECD, 2020[98]); (Norwegian Ministry of Local Government and Modernisation, 2016[99]).

Several aspects are worth highlighting for further improving skills development policies. Training policies would benefit from being more targeted to lower-skilled workers and smaller firms, since lower-skilled workers are generally less likely to receive firm-based training (OECD, 2019[11]) and workers employed in SMEs are more likely to be disengaged from adult learning than those working in large firms (OECD, 2021[100]). Adult's training participation rates also differ by industry, e.g. the lowest is in agriculture, accommodation and food, and construction versus the highest in finance and insurance and in education (OECD, 2019[101]). More generally, higher shares of workers receiving training in highly digital-intensive sectors than in other sectors (OECD, 2019[19]).

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Annex

Table A.1. Shares of firms by number of ICT tools and activities adopted

Number of digital tools adopted	French sample % of firms	Dutch sample % of firms	Italian sample % of firms	Swedish sample % of firms
1	7.25	0.97	2.13	0.35
2	8.65	2.08	5.91	2.88
3	12.02	3.42	10.31	6.23
4	16.11	7.88	13.93	6.00
5	15.63	19.03	17.57	12.57
6	16.14	18.22	18.64	13.61
7	11.71	20.45	15.28	17.30
8	6.94	15.61	10.12	22.61
9	2.09	10.04	4.90	12.46
10	3.47	2.3	1.21	5.88
Number of firms	2912	1345	4228	867
Source	ICTS 2016/2017	ICTS 2016/2017	ICTS 2016/2017	ICTS 2016/19

Note: The French, Italian, Dutch and Swedish samples include firms that use at least one of the following ten ICT tools and activities: fixed broadband, website, enterprise resource planning, customer relationship management, e-sales, e-purchases, high-speed broadband, cloud computing, social media, big data analysis. The values reported are only representative for the French, Italian, Dutch and Swedish samples used for this table and may differ from official statistics reported by INSEE France, the Italian National Institute of Statistics, Statistics Netherlands, Statistics Sweden, Eurostat or the OECD due to different sectoral coverage and aggregation methods (e.g. weighting, imputation, treatment of item non-response, etc.) used for official statistics and/or selection effects in the sample. ICTS stands for ICT Usage in Enterprises Survey.
Source: INSEE France; Italian National Institute of Statistics; Statistics Netherlands; Statistics Sweden.

Table A.2. France – summary statistics

		French estimation sample	**Firms in France**
Number of firms with 10 or more employees		1318	65600
In NACE Rev 2 sectors		10-39; 46; 49-53; 58-63; 71-73	10-39; 46; 49-53; 58-63; 71-73
Description	NACE Rev 2	Sample mean	Population mean
Firms with 10-49 employees	All listed below	0.11	0.80
Firms with 50-249 employees	All listed below	0.08	0.16
Firms with 250+ employees	All listed below	0.82	0.04
Food/Beverages/Tobacco	10/11/12	0.10	0.10
Textiles/Clothing	13/14/15	0.02	0.02
Wood/Paper	16/17	0.02	0.04
Chemicals/Pharmaceuticals	20/21	0.06	0.02
Rubber/Plastics	22	0.03	0.02
Glass/Ceramics/Concrete	23	0.02	0.01
Metals	24/25	0.06	0.09
Electronics/Electrical	26/27	0.07	0.02
Machinery/Equipment	28/33	0.09	0.03
Vehicles	29/30	0.06	0.01
Furniture/Other Manufacturing	31/32	0.02	0.06
Energy/Oil	19/35	0.01	0.00
Water Supply/Waste/Recycling	36/37/38/39	0.03	0.02
Wholesale Trade	46	0.14	0.21
Transportation/Postal Services	49/50/51/52/53	0.12	0.15
Printing/Publishing/Media	18/58/59/60	0.04	0.04
IT-Services/Telecommunications	61/62/63	0.06	0.06
Technical Engineering/R&D	71/72	0.06	0.07
Advertising	73	0.01	0.02

Note: The estimation sample contains firms observed in both the French CIS 2018 and ICTS 2016 with 10 or more employees. The firm population data refer to 2016. The values reported for the firm population stem from microdata provided by INSEE France and may differ from aggregated official statistics, such as reported by the OECD.
Source: INSEE France; OECD Structural and Demographic Business Statistics Database, ISIC 4, http://dx.doi.org/10.1787/sdbs-data-en, accessed April 2020.

Table A.3. Italy – summary statistics

		Italian estimation sample	Firms in Italy
Number of firms with 10 or more employees		4826	111537
In NACE Rev 2 sectors		10-39; 46; 49-53; 58-63; 71-73	10-39; 46; 49-53; 58-63; 71-73
Description	NACE Rev 2	Sample mean	Population mean
Firms with 10-49 employees	All listed below	0.37	0.86
Firms with 50-249 employees	All listed below	0.31	0.12
Firms with 250+ employees	All listed below	0.31	0.02
Food/Beverages/Tobacco	10/11/12	0.07	0.07
Textiles/Clothing	13/14/15	0.06	0.10
Wood/Paper	16/17	0.03	0.03
Chemicals/Pharmaceuticals	20/21	0.04	0.02
Rubber/Plastics	22	0.03	0.03
Glass/Ceramics/Concrete	23	0.03	0.03
Metals	24/25	0.08	0.12
Electronics/Electrical	26/27	0.04	0.03
Machinery/Equipment	28/33	0.09	0.11
Vehicles	29/30	0.03	0.02
Furniture/Other Manufacturing	31/32	0.04	0.04
Energy/Oil	19/35	0.04	0.01
Water Supply/Waste/Recycling	36/37/38/39	0.09	0.02
Wholesale Trade	46	0.15	0.16
Transportation/Postal Services	49/50/51/52/53	0.09	0.12
Printing/Publishing/Media	18/58/59/60	0.03	0.03
IT-Services/Telecommunications	61/62/63	0.05	0.05
Technical Engineering/R&D	71/72	0.01	0.01
Advertising	73	0.01	0.01

Note: The estimation sample contains firms observed in both the Italian CIS 2018 and ICTS 2016 with 10 or more employees. The firm population data refer to 2016.
Source: Italian National Institute of Statistics; OECD.

Table A.4. Netherlands – summary statistics

		Dutch estimation sample	**Firms in the Netherlands**
Number of firms with 10 or more employees		1312	25271
In NACE Rev 2 sectors		10-39; 46; 49-53; 58-63; 71-73	10-39; 46; 49-53; 58-63; 71-73
Description	NACE Rev 2	Sample mean	Population mean
Firms with 10-49 employees	All listed below	0.24	0.77
Firms with 50-249 employees	All listed below	0.42	0.20
Firms with 250+ employees	All listed below	0.34	0.03
Food/Beverages/Tobacco	10/11/12	0.05	0.05
Textiles/Clothing	13/14/15	0.01	0.01
Wood/Paper	16/17	0.02	0.02
Chemicals/Pharmaceuticals	20/21	0.06	0.02
Rubber/Plastics	22	0.01	0.02
Glass/Ceramics/Concrete	23	0.02	0.01
Metals	24/25	0.04	0.07
Electronics/Electrical	26/27	0.05	0.02
Machinery/Equipment	28/33	0.05	0.06
Vehicles	29/30	0.03	0.01
Furniture/Other Manufacturing	31/32	0.05	0.02
Energy/Oil	19/35	0.02	0.00
Water Supply/Waste/Recycling	36/37/38/39	0.03	0.01
Wholesale Trade	46	0.20	0.30
Transportation/Postal Services	49/50/51/52/53	0.10	0.14
Printing/Publishing/Media	18/58/59/60	0.04	0.03
IT-Services/Telecommunications	61/62/63	0.10	0.10
Technical Engineering/R&D	71/72	0.11	0.07
Advertising	73	0.02	0.03

Note: The estimation sample contains firms observed in both the Dutch CIS 2016 and ICTS 2018 with 10 or more employees. The firm population data refer to 2016.
Source: Statistics Netherlands; OECD.

Table A.5. Sweden – summary statistics

		Swedish estimation sample	**Firms in Sweden**
Number of firms with 10 or more employees		1019	18052
In NACE Rev 2 sectors		10-39; 46; 49-53; 58-63; 71-73	10-39; 46; 49-53; 58-63; 71-73
Description	NACE Rev 2	Sample mean	Population mean
Firms with 10-49 employees	All listed below	0.33	0.80
Firms with 50-249 employees	All listed below	0.33	0.17
Firms with 250+ employees	All listed below	0.34	0.03
Food/Beverages/Tobacco	10/11/12	0.06	0.04
Textiles/Clothing	13/14/15	0.04	0.01
Wood/Paper	16/17	0.07	0.03
Chemicals/Pharmaceuticals	20/21	0.03	0.01
Rubber/Plastics	22	0.02	0.02
Glass/Ceramics/Concrete	23	0.03	0.01
Metals	24/25	0.07	0.09
Electronics/Electrical	26/27	0.06	0.02
Machinery/Equipment	28/33	0.08	0.05
Vehicles	29/30	0.04	0.02
Furniture/Other Manufacturing	31/32	0.03	0.02
Energy/Oil	19/35	0.05	0.01
Water Supply/Waste/Recycling	36/37/38/39	0.03	0.01
Wholesale Trade	46	0.08	0.22
Transportation/Postal Services	49/50/51/52/53	0.10	0.16
Printing/Publishing/Media	18/58/59/60	0.08	0.05
IT-Services/Telecommunications	61/62/63	0.08	0.10
Technical Engineering/R&D	71/72	0.06	0.08
Advertising	73	0.02	0.03

Note: The estimation sample contains firms observed in both the Swedish CIS 2018 and ICTS 2016 with 10 or more employees. The firm population data refer to 2016.
Source: Statistics Sweden; OECD.

Table A.6. France – Product Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.030					0.029					0.037				
	(0.029)					(0.040)					(0.045)				
BDA, firm data (f)		0.052					0.030					0.092			
		(0.036)					(0.046)					(0.058)			
BDA, geolocation data (g)			0.023					0.019					0.029		
			(0.040)					(0.066)					(0.054)		
BDA, social media data (m)				0.088**					0.185***					0.042	
				(0.042)					(0.052)					(0.065)	
BDA, other data (o)					0.089*					0.208***					0.055
					(0.053)					(0.063)					(0.078)
log turnover	0.019	0.018	0.019	0.017	0.018	0.051**	0.051**	0.051**	0.048**	0.051**	0.006	0.005	0.007	0.006	0.006
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.024)	(0.024)	(0.024)	(0.024)	(0.023)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
log employees	0.045***	0.045***	0.046***	0.047***	0.046***	-0.004	-0.003	-0.002	-0.001	-0.004	0.066***	0.065***	0.066***	0.067***	0.067***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.028)	(0.028)	(0.028)	(0.028)	(0.027)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
cloud computing	0.056**	0.057**	0.058**	0.055**	0.057**	0.068**	0.068**	0.069**	0.066**	0.067**	0.030	0.032	0.032	0.030	0.031
	(0.026)	(0.025)	(0.025)	(0.025)	(0.025)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
e-sales	0.049*	0.048*	0.050*	0.047*	0.049*	0.060*	0.061*	0.062*	0.058*	0.061*	0.041	0.034	0.041	0.040	0.040
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.044)	(0.044)	(0.044)	(0.045)	(0.044)
e-purchases	0.041	0.041	0.042	0.042	0.043	0.042	0.042	0.043	0.042	0.048	0.047	0.049	0.048	0.049	0.048
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
broadband 30-100 Mbps	0.056*	0.057*	0.056*	0.056*	0.057*	0.008	0.009	0.009	0.005	0.010	0.139**	0.141***	0.138**	0.139**	0.138**
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.038)	(0.038)	(0.038)	(0.038)	(0.037)	(0.055)	(0.054)	(0.055)	(0.055)	(0.054)
broadband 100+ Mbps	0.027	0.027	0.029	0.026	0.025	-0.034	-0.033	-0.032	-0.032	-0.046	0.118**	0.118**	0.119**	0.117**	0.116**
	(0.033)	(0.033)	(0.032)	(0.032)	(0.033)	(0.041)	(0.041)	(0.040)	(0.040)	(0.040)	(0.055)	(0.054)	(0.055)	(0.054)	(0.055)
% of R&D expenses	0.005*	0.005*	0.005*	0.005*	0.005*	0.023***	0.023***	0.023***	0.023***	0.023***	0.003	0.003	0.003	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.107***	0.106***	0.109***	0.108***	0.110***	0.130***	0.131***	0.133***	0.125***	0.131***	0.064	0.056	0.063	0.065	0.066
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.068)	(0.067)	(0.068)	(0.068)	(0.068)
25% - 75% w tert degree	0.098**	0.096**	0.100**	0.099**	0.099**	0.116**	0.117**	0.119**	0.115**	0.111**	0.026	0.017	0.026	0.029	0.029
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.050)	(0.050)	(0.050)	(0.049)	(0.049)	(0.064)	(0.064)	(0.065)	(0.064)	(0.064)
75% + w tert degree	0.163***	0.159***	0.165***	0.160***	0.165***	0.216***	0.217***	0.219***	0.210***	0.217***	0.085	0.069	0.085	0.085	0.088
	(0.052)	(0.052)	(0.052)	(0.053)	(0.052)	(0.072)	(0.072)	(0.072)	(0.072)	(0.071)	(0.078)	(0.078)	(0.078)	(0.078)	(0.078)
% exports	0.002***	0.002***	0.002***	0.002***	0.002***	0.001**	0.001**	0.001**	0.001**	0.001**	0.001	0.001	0.001	0.002	0.002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.165	0.165	0.165	0.166	0.166	0.202	0.202	0.202	0.208	0.208	0.120	0.122	0.119	0.119	0.119
Observations	1318	1318	1318	1318	1318	772	772	772	772	772	546	546	546	546	546
Log likelihood	-709.796	-709.333	-710.147	-708.580	-709.044	-366.467	-366.527	-366.686	-363.784	-363.713	-329.236	-328.392	-329.433	-329.373	-329.325

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.7. France – Process Innovation

Dependent Variable: Dummy for Process Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.117***					0.060					0.179***				
	(0.030)					(0.041)					(0.044)				
BDA, firm data (f)		0.106***					0.074					0.158***			
		(0.037)					(0.047)					(0.058)			
BDA, geolocation data (g)			0.077*					-0.010					0.132**		
			(0.041)					(0.070)					(0.054)		
BDA, social media data (m)				0.112**					0.162**					0.088	
				(0.045)					(0.063)					(0.065)	
BDA, other data (o)					0.154***					0.162*					0.159**
					(0.055)					(0.087)					(0.077)
log turnover	-0.003	-0.004	-0.002	-0.004	-0.002	0.012	0.011	0.013	0.008	0.013	-0.010	-0.010	-0.007	-0.009	-0.008
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.025)	(0.025)	(0.026)	(0.025)	(0.025)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
log employees	0.087***	0.089***	0.090***	0.091***	0.089***	0.069**	0.069**	0.070**	0.074**	0.068**	0.098***	0.101***	0.101***	0.103***	0.101***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
cloud computing	0.028	0.034	0.035	0.032	0.033	0.001	0.002	0.004	-0.000	0.002	0.068	0.079*	0.082*	0.076*	0.076*
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
e-sales	0.052*	0.051*	0.054**	0.052*	0.054*	0.088**	0.089**	0.090***	0.085**	0.089**	0.000	-0.009	-0.000	0.001	0.001
	(0.027)	(0.027)	(0.028)	(0.027)	(0.027)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.044)	(0.044)	(0.044)	(0.045)	(0.045)
e-purchases	0.016	0.017	0.018	0.019	0.021	0.008	0.006	0.009	0.007	0.012	0.036	0.045	0.039	0.045	0.045
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
broadband 30-100 Mbps	0.021	0.023	0.024	0.021	0.023	-0.014	-0.012	-0.011	-0.017	-0.011	0.064	0.063	0.061	0.058	0.057
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.042)	(0.042)	(0.043)	(0.043)	(0.042)	(0.054)	(0.054)	(0.055)	(0.054)	(0.054)
broadband 100+ Mbps	0.016	0.019	0.023	0.020	0.016	-0.002	-0.002	0.004	0.002	-0.005	0.047	0.051	0.051	0.047	0.043
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.053)	(0.054)	(0.054)	(0.054)	(0.054)
% of R&D expenses	0.007***	0.007***	0.007***	0.008***	0.007***	0.009*	0.009*	0.009*	0.009*	0.009*	0.006***	0.007***	0.007***	0.007***	0.006***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.185***	0.186***	0.192***	0.191***	0.195***	0.168***	0.170***	0.174***	0.167***	0.173***	0.229***	0.218***	0.225***	0.234***	0.236***
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.068)	(0.069)	(0.068)	(0.069)	(0.068)
25% - 75% w tert degree	0.163***	0.164***	0.171***	0.170***	0.170***	0.168***	0.169***	0.172***	0.168***	0.167***	0.146**	0.139**	0.149**	0.160**	0.160**
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.055)	(0.055)	(0.055)	(0.054)	(0.055)	(0.064)	(0.066)	(0.065)	(0.065)	(0.065)
75% + w tert degree	0.100*	0.099*	0.110*	0.105*	0.110*	0.104	0.107	0.114	0.099	0.107	0.101	0.085	0.108	0.112	0.115
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.083)	(0.083)	(0.083)	(0.084)	(0.083)	(0.078)	(0.079)	(0.078)	(0.078)	(0.078)
% exports	0.001***	0.001***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.000	0.000	0.000	0.001	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.162	0.159	0.156	0.157	0.158	0.166	0.166	0.164	0.169	0.167	0.137	0.126	0.125	0.119	0.122
Observations	1318	1318	1318	1318	1318	772	772	772	772	772	546	546	546	546	546
Log likelihood	-754.470	-757.889	-760.016	-758.960	-757.977	-421.759	-421.656	-422.718	-420.410	-420.999	-325.815	-330.115	-330.706	-332.700	-331.525

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.8. France – Marketing Innovation

Dependent Variable: Dummy for Marketing Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.092***					0.075*					0.103**				
	(0.031)					(0.043)					(0.043)				
BDA, firm data (f)		0.129***					0.114**					0.144**			
		(0.039)					(0.051)					(0.060)			
BDA, geolocation data (g)			0.090**					0.008					0.131**		
			(0.044)					(0.071)					(0.054)		
BDA, social media data (m)				0.135***					0.194**					0.081	
				(0.050)					(0.077)					(0.066)	
BDA, other data (o)					0.001					-0.013					0.015
					(0.054)					(0.084)					(0.071)
log turnover	0.013	0.012	0.014	0.012	0.015	0.040	0.039	0.041	0.036	0.041	0.004	0.003	0.006	0.005	0.007
	(0.016)	(0.015)	(0.016)	(0.016)	(0.016)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
log employees	0.026	0.026	0.028	0.029	0.028	-0.012	-0.012	-0.010	-0.008	-0.010	0.044*	0.044*	0.044*	0.046**	0.045*
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.031)	(0.030)	(0.031)	(0.030)	(0.031)	(0.023)	(0.023)	(0.024)	(0.023)	(0.023)
cloud computing	0.053**	0.057**	0.060**	0.055**	0.059**	0.033	0.035	0.038	0.034	0.038	0.099**	0.104***	0.108***	0.103***	0.106***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.033)	(0.032)	(0.033)	(0.032)	(0.033)	(0.040)	(0.039)	(0.039)	(0.039)	(0.039)
e-sales	0.039	0.035	0.039	0.035	0.041	0.046	0.046	0.049	0.042	0.049	0.024	0.012	0.017	0.019	0.023
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.034)	(0.034)	(0.034)	(0.033)	(0.034)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
e-purchases	0.054**	0.054**	0.055**	0.055**	0.057**	0.071**	0.069**	0.073**	0.069**	0.072**	0.025	0.031	0.024	0.029	0.030
	(0.027)	(0.026)	(0.027)	(0.027)	(0.027)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.042)	(0.042)	(0.042)	(0.042)	(0.043)
broadband 30-100 Mbps	0.020	0.022	0.024	0.020	0.022	0.064	0.066	0.069	0.063	0.069	-0.062	-0.059	-0.062	-0.066	-0.067
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.048)	(0.048)	(0.049)	(0.048)	(0.048)
broadband 100+ Mbps	-0.001	-0.000	0.007	0.002	0.007	0.012	0.010	0.021	0.018	0.021	-0.032	-0.029	-0.029	-0.033	-0.028
	(0.032)	(0.031)	(0.032)	(0.032)	(0.032)	(0.041)	(0.041)	(0.042)	(0.041)	(0.042)	(0.049)	(0.049)	(0.050)	(0.050)	(0.050)
% of R&D expenses	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.002	0.003	0.002	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.045	0.045	0.049	0.049	0.052	0.049	0.053	0.055	0.046	0.055	0.054	0.045	0.050	0.061	0.059
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)
25% - 75% w tert degree	0.047	0.045	0.051	0.051	0.055	0.054	0.055	0.059	0.053	0.059	0.028	0.020	0.025	0.040	0.040
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.051)	(0.050)	(0.051)	(0.050)	(0.050)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)
75% + w tert degree	0.020	0.014	0.022	0.018	0.027	0.078	0.081	0.085	0.073	0.086	-0.016	-0.036	-0.020	-0.013	-0.008
	(0.051)	(0.051)	(0.051)	(0.051)	(0.051)	(0.075)	(0.075)	(0.075)	(0.075)	(0.075)	(0.074)	(0.073)	(0.073)	(0.073)	(0.073)
% exports	0.001**	0.001**	0.001**	0.001**	0.001**	0.001*	0.001*	0.001*	0.001*	0.001*	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.087	0.089	0.084	0.086	0.081	0.102	0.104	0.098	0.106	0.098	0.082	0.083	0.082	0.075	0.073
Observations	1318	1318	1318	1318	1318	772	772	772	772	772	546	546	546	546	546
Log likelihood	-721.173	-719.830	-723.710	-721.723	-725.989	-420.057	-418.954	-421.694	-418.005	-421.687	-295.602	-295.254	-295.445	-297.683	-298.560

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.9. France – Organisational Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.070**					0.047					0.088*				
	(0.033)					(0.046)					(0.046)				
BDA, firm data (f)		0.095**					0.086					0.104*			
		(0.040)					(0.053)					(0.061)			
BDA, geolocation data (g)			0.088*					-0.062					0.160***		
			(0.046)					(0.074)					(0.056)		
BDA, social media data (m)				0.119**					0.094					0.131*	
				(0.051)					(0.076)					(0.068)	
BDA, other data (o)					0.087					0.141					0.050
					(0.061)					(0.096)					(0.077)
log turnover	-0.003	-0.004	-0.003	-0.005	-0.002	0.007	0.007	0.010	0.006	0.009	-0.006	-0.006	-0.005	-0.007	-0.004
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
log employees	0.067***	0.068***	0.068***	0.070***	0.068***	0.053	0.053	0.054	0.056*	0.051	0.073***	0.074***	0.073***	0.076***	0.075***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
cloud computing	0.033	0.036	0.038	0.034	0.036	-0.028	-0.028	-0.025	-0.028	-0.028	0.131***	0.137***	0.140***	0.133***	0.137***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.037)	(0.036)	(0.037)	(0.037)	(0.037)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
e-sales	-0.013	-0.015	-0.013	-0.015	-0.012	-0.007	-0.007	-0.005	-0.008	-0.005	-0.033	-0.040	-0.038	-0.038	-0.034
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.038)	(0.037)	(0.037)	(0.038)	(0.038)	(0.045)	(0.046)	(0.045)	(0.045)	(0.045)
e-purchases	0.056*	0.057*	0.057*	0.057*	0.059**	0.093**	0.091**	0.094**	0.092**	0.095**	-0.000	0.005	-0.001	0.004	0.004
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
broadband 30-100 Mbps	-0.025	-0.023	-0.022	-0.025	-0.023	0.015	0.016	0.017	0.014	0.018	-0.108**	-0.107**	-0.105**	-0.109**	-0.112**
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.053)	(0.052)	(0.053)	(0.052)	(0.052)
broadband 100+ Mbps	-0.003	-0.003	0.002	-0.002	-0.002	0.016	0.014	0.021	0.020	0.015	-0.047	-0.044	-0.045	-0.051	-0.048
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.054)	(0.054)	(0.054)	(0.054)	(0.054)
% of R&D expenses	0.003*	0.003*	0.003**	0.003**	0.003*	0.004	0.004	0.004	0.004	0.004	0.003	0.003	0.003*	0.003*	0.003*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.107**	0.106**	0.110**	0.109**	0.112***	0.081	0.082	0.085	0.081	0.085	0.166**	0.159**	0.159**	0.170**	0.169**
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.068)	(0.068)	(0.068)	(0.068)	(0.068)
25% - 75% w tert degree	0.128***	0.126***	0.131***	0.130***	0.131***	0.109*	0.108*	0.111**	0.110*	0.108*	0.148**	0.143**	0.141**	0.155**	0.155**
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.064)	(0.065)	(0.064)	(0.064)	(0.064)
75% + w tert degree	0.119**	0.115**	0.121**	0.116**	0.123**	0.186**	0.187**	0.193**	0.184**	0.184**	0.094	0.082	0.090	0.092	0.101
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.085)	(0.085)	(0.086)	(0.085)	(0.086)	(0.078)	(0.078)	(0.077)	(0.078)	(0.078)
% exports	0.000	-0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.068	0.068	0.067	0.068	0.066	0.070	0.072	0.070	0.071	0.071	0.084	0.083	0.090	0.084	0.080
Observations	1318	1318	1318	1318	1318	772	772	772	772	772	546	546	546	546	546
Log likelihood	-835.586	-835.091	-836.087	-835.130	-836.850	-490.495	-489.736	-490.707	-490.272	-489.834	-337.089	-337.431	-334.871	-337.032	-338.756

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.10. Italy – Product Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.007					-0.017					0.051*				
	(0.017)					(0.021)					(0.029)				
BDA, firm data (f)		-0.014					-0.035					0.034			
		(0.020)					(0.024)					(0.040)			
BDA, geolocation data (g)			0.024					-0.019					0.083**		
			(0.027)					(0.036)					(0.041)		
BDA, social media data (m)				0.023					0.054					-0.005	
				(0.034)					(0.050)					(0.046)	
BDA, other data (o)					-0.025					-0.028					-0.015
					(0.025)					(0.034)					(0.037)
log turnover	0.029***	0.030***	0.030***	0.029***	0.030***	0.044***	0.044***	0.043***	0.043***	0.044***	0.009	0.010	0.010	0.011	0.011
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
log employees	0.011	0.012	0.011	0.012	0.011	0.010	0.011	0.010	0.010	0.010	0.008	0.008	0.007	0.009	0.009
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
cloud computing	0.042***	0.043***	0.042***	0.042***	0.044***	0.049***	0.048***	0.048***	0.046***	0.048***	0.025	0.028	0.027	0.030	0.031
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
e-sales	0.086***	0.087***	0.086***	0.085***	0.088***	0.076***	0.076***	0.075***	0.073***	0.076***	0.098***	0.101***	0.101***	0.103***	0.104***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
e-purchases	0.052***	0.053***	0.052***	0.052***	0.053***	0.041**	0.041**	0.040**	0.039**	0.040**	0.073***	0.075***	0.074***	0.075***	0.075***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
broadband 30-100 Mbps	-0.000	-0.000	-0.000	-0.001	-0.000	-0.013	-0.013	-0.014	-0.014	-0.013	0.017	0.016	0.016	0.016	0.016
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
broadband 100+ Mbps	0.005	0.005	0.005	0.004	0.007	-0.006	-0.005	-0.006	-0.007	-0.005	0.025	0.027	0.025	0.027	0.027
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
% of R&D expenses	0.007**	0.007**	0.007**	0.007**	0.007**	0.010**	0.010**	0.010**	0.009**	0.010**	0.004	0.004	0.004	0.004	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
10% - 25% w tert degree	0.001	0.001	0.001	0.002	0.001	0.003	0.003	0.003	0.003	0.003	-0.021	-0.021	-0.021	-0.022	-0.022
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
25% - 75% w tert degree	0.059***	0.059***	0.059***	0.059***	0.059***	0.049**	0.049**	0.049**	0.048**	0.049**	0.080***	0.079***	0.081***	0.079***	0.079***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
75% + w tert degree	0.082***	0.082***	0.081***	0.081***	0.083***	0.035	0.035	0.035	0.033	0.035	0.143***	0.144***	0.143***	0.145***	0.145***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
% exports	0.002***	0.002***	0.002***	0.002***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.158	0.158	0.158	0.158	0.158	0.161	0.161	0.160	0.161	0.161	0.120	0.119	0.121	0.119	0.119
Observations	4826	4826	4826	4826	4826	3216	3216	3216	3216	3216	1610	1610	1610	1610	1610
Log likelihood	-2791.488	-2791.332	-2791.180	-2791.317	-2791.046	-1871.250	-1870.557	-1871.425	-1870.861	-1871.206	-907.240	-908.437	-906.749	-908.805	-908.728

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.11. Italy – Product Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Large Firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	-0.006					0.020				
	(0.024)					(0.023)				
BDA, firm data (f)		-0.021					-0.006			
		(0.027)					(0.030)			
BDA, geolocation data (g)			0.057					-0.008		
			(0.036)					(0.039)		
BDA, social media data (m)				0.022					0.043	
				(0.046)					(0.048)	
BDA, other data (o)					-0.082**					0.027
					(0.036)					(0.036)
log turnover	0.043***	0.043***	0.043***	0.043***	0.047***	0.023**	0.023**	0.023**	0.023**	0.023**
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
log employees	0.006	0.007	0.004	0.007	0.006	-0.003	-0.002	-0.002	-0.002	-0.002
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
cloud computing	0.041*	0.041*	0.037	0.039*	0.045*	0.036*	0.038**	0.038**	0.036**	0.037**
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
e-sales	0.056**	0.057**	0.053**	0.054**	0.057**	0.095***	0.096***	0.096***	0.094***	0.094***
	(0.025)	(0.025)	(0.024)	(0.025)	(0.025)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
e-purchases	0.057**	0.058**	0.057**	0.057**	0.056**	0.054***	0.056***	0.056***	0.055***	0.055***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
broadband 30-100 Mbps	-0.006	-0.006	-0.004	-0.006	-0.005	-0.001	-0.000	-0.000	-0.001	-0.000
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
broadband 100+ Mbps	0.019	0.020	0.018	0.018	0.024	-0.027	-0.027	-0.027	-0.028	-0.028
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
% of R&D expenses	0.019***	0.019***	0.019***	0.019***	0.019***	0.006**	0.006**	0.006**	0.006**	0.006**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
10% - 25% w tert degree	-0.009	-0.009	-0.009	-0.009	-0.009	0.006	0.006	0.006	0.006	0.006
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
25% - 75% w tert degree	0.029	0.029	0.029	0.029	0.028	0.075***	0.075***	0.075***	0.075***	0.075***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
75% + w tert degree	0.041	0.041	0.035	0.038	0.044	0.104***	0.104***	0.104***	0.103***	0.104***
	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
% exports	0.001***	0.001***	0.001***	0.001***	0.001***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.195	0.195	0.196	0.195	0.198	0.104	0.104	0.104	0.104	0.104
Observations	1516	1516	1516	1516	1516	3310	3310	3310	3310	3310
Log likelihood	-813.298	-813.026	-812.055	-813.206	-810.558	-1949.424	-1949.776	-1949.778	-1949.355	-1949.509

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.12. Italy – Process Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.006					0.006					0.005				
	(0.018)					(0.022)					(0.030)				
BDA, firm data (f)		0.003					-0.004					0.012			
		(0.021)					(0.025)					(0.041)			
BDA, geolocation data (g)			0.031					0.043					0.020		
			(0.028)					(0.037)					(0.043)		
BDA, social media data (m)				0.018					0.105**					-0.054	
				(0.034)					(0.048)					(0.048)	
BDA, other data (o)					-0.031					-0.027					-0.033
					(0.025)					(0.033)					(0.039)
log turnover	0.051***	0.051***	0.051***	0.051***	0.051***	0.054***	0.054***	0.055***	0.054***	0.054***	0.045***	0.045***	0.045***	0.046***	0.046***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
log employees	0.006	0.006	0.005	0.006	0.006	0.017	0.018	0.016	0.018	0.018	-0.016	-0.016	-0.016	-0.016	-0.016
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
cloud computing	0.005	0.005	0.004	0.004	0.006	0.003	0.003	0.002	0.001	0.004	0.009	0.009	0.009	0.012	0.011
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
e-sales	0.028	0.028	0.028	0.027	0.029*	0.017	0.017	0.017	0.012	0.017	0.049	0.049	0.049	0.052*	0.052*
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
e-purchases	0.059***	0.060***	0.059***	0.059***	0.060***	0.055***	0.055***	0.054***	0.054***	0.056***	0.061**	0.061**	0.061**	0.062**	0.062**
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
broadband 30-100 Mbps	0.006	0.006	0.006	0.006	0.006	0.001	0.001	0.001	-0.001	0.001	0.012	0.012	0.012	0.013	0.011
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
broadband 100+ Mbps	0.012	0.012	0.011	0.011	0.014	-0.017	-0.016	-0.017	-0.019	-0.015	0.051	0.051	0.051	0.053	0.053
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.031)	(0.031)	(0.031)	(0.030)	(0.031)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
% of R&D expenses	0.006**	0.006**	0.006**	0.006**	0.006**	0.011**	0.011**	0.011**	0.011**	0.011**	0.003	0.003	0.003	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.028	0.028	0.028	0.029	0.028	0.004	0.004	0.003	0.004	0.004	0.076*	0.077*	0.077*	0.075*	0.076*
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
25% - 75% w tert degree	0.033*	0.033*	0.033*	0.033*	0.033*	0.017	0.017	0.016	0.015	0.017	0.067**	0.067**	0.068**	0.066**	0.067**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
75% + w tert degree	-0.010	-0.010	-0.011	-0.011	-0.009	-0.007	-0.007	-0.010	-0.010	-0.006	0.030	0.030	0.030	0.031	0.030
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
% exports	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001	0.001	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.118	0.118	0.118	0.118	0.118	0.121	0.121	0.121	0.122	0.121	0.058	0.058	0.058	0.058	0.058
Observations	4826	4826	4826	4826	4826	3216	3216	3216	3216	3216	1610	1610	1610	1610	1610
Log likelihood	-2946.790	-2946.828	-2946.212	-2946.695	-2946.133	-1948.913	-1948.945	-1948.283	-1946.530	-1948.655	-983.796	-983.765	-983.691	-983.183	-983.451

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.13. Italy – Process Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Large Firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	-0.007									
	(0.025)					0.019				
BDA, firm data (f)		-0.008				(0.024)				
		(0.028)					0.014			
BDA, geolocation data (g)			0.031				(0.032)			
			(0.035)					0.049		
BDA, social media data (m)				0.019				(0.042)		
				(0.046)					0.028	
BDA, other data (o)					-0.033				(0.049)	
					(0.036)					-0.032
log turnover	0.049***	0.049***	0.049***	0.049***	0.051***					(0.036)
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	0.053***	0.053***	0.053***	0.053***	0.053***
log employees	-0.019	-0.018	-0.020	-0.018	-0.019	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	-0.014	-0.014	-0.014	-0.013	-0.013
cloud computing	-0.008	-0.008	-0.010	-0.009	-0.007	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	0.003	0.004	0.003	0.004	0.005
e-sales	0.002	0.002	0.001	0.001	0.002	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	0.037	0.038	0.039	0.037	0.040
e-purchases	0.058**	0.058**	0.058**	0.058**	0.058**	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	0.065***	0.066***	0.065***	0.066***	0.067***
broadband 30-100 Mbps	0.007	0.007	0.008	0.007	0.008					
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	0.005	0.005	0.004	0.004	0.005
broadband 100+ Mbps	0.045	0.044	0.044	0.043	0.046	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	-0.032	-0.032	-0.032	-0.032	-0.031
% of R&D expenses	0.018**	0.018**	0.018**	0.018**	0.018**	(0.034)	(0.033)	(0.034)	(0.034)	(0.034)
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	0.005**	0.005**	0.005**	0.005**	0.005**
10% - 25% w tert degree	0.024	0.024	0.023	0.024	0.024					
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	0.036	0.036	0.036	0.036	0.036
25% - 75% w tert degree	0.025	0.024	0.024	0.024	0.024	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	0.037*	0.037*	0.037*	0.037*	0.037*
75% + w tert degree	-0.026	-0.027	-0.031	-0.030	-0.026	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	-0.008	-0.007	-0.008	-0.008	-0.007
% exports	0.001***	0.001***	0.001***	0.001***	0.001***	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	0.001***	0.001***	0.001***	0.001***	0.001***
Industry Dummies	Yes	Yes	Yes	Yes	Yes	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pseudo R^2	0.128	0.128	0.128	0.128	0.128	Yes	Yes	Yes	Yes	Yes
Observations	1516	1516	1516	1516	1516	0.070	0.070	0.071	0.070	0.070
Log likelihood	-849.427	-849.422	-849.106	-849.381	-849.040	3310	3310	3310	3310	3310

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.14. Italy – Marketing Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.026					0.012					0.051*				
	(0.016)					(0.020)					(0.029)				
BDA, firm data (f)		-0.001					-0.017					0.040			
		(0.019)					(0.022)					(0.038)			
BDA, geolocation data (g)			0.027					-0.016					0.083**		
			(0.026)					(0.034)					(0.041)		
BDA, social media data (m)				0.084**					0.133***					0.023	
				(0.033)					(0.047)					(0.045)	
BDA, other data (o)					0.015					0.027					-0.007
					(0.023)					(0.031)					(0.036)
log turnover	0.029***	0.030***	0.030***	0.029***	0.029***	0.042***	0.042***	0.042***	0.042***	0.042***	0.013	0.014	0.015	0.014	0.015
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
log employees	-0.005	-0.004	-0.004	-0.003	-0.004	-0.016	-0.015	-0.016	-0.016	-0.016	0.007	0.008	0.006	0.009	0.009
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
cloud computing	0.057***	0.059***	0.058***	0.056***	0.058***	0.053***	0.054***	0.054***	0.050***	0.053***	0.064***	0.068***	0.066***	0.069***	0.070***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
e-sales	0.126***	0.128***	0.128***	0.124***	0.127***	0.107***	0.108***	0.107***	0.101***	0.107***	0.156***	0.159***	0.159***	0.160***	0.161***
	(0.017)	(0.017)	(0.017)	(0.018)	(0.017)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
e-purchases	0.040***	0.041***	0.041***	0.040***	0.041***	0.047***	0.049***	0.048***	0.046***	0.048***	0.022	0.024	0.023	0.024	0.024
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
broadband 30-100 Mbps	-0.005	-0.004	-0.004	-0.006	-0.004	-0.020	-0.020	-0.020	-0.022	-0.020	0.023	0.023	0.023	0.022	0.023
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
broadband 100+ Mbps	0.017	0.019	0.018	0.015	0.018	0.011	0.014	0.013	0.009	0.011	0.021	0.023	0.021	0.021	0.023
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.027)	(0.028)	(0.028)	(0.027)	(0.028)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
% of R&D expenses	0.004***	0.004***	0.004***	0.004***	0.004***	0.007***	0.007***	0.007***	0.006***	0.007***	0.002	0.002	0.002	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
10% - 25% w tert degree	0.034*	0.034*	0.034*	0.035*	0.034*	0.015	0.015	0.015	0.015	0.015	0.078**	0.078**	0.077**	0.078**	0.077**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
25% - 75% w tert degree	0.062***	0.062***	0.062***	0.061***	0.062***	0.044**	0.044**	0.044**	0.042**	0.044**	0.093***	0.092***	0.094***	0.093***	0.092***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
75% + w tert degree	0.094***	0.095***	0.094***	0.092***	0.095***	0.040	0.041	0.041	0.038	0.040	0.152***	0.152***	0.152***	0.154***	0.154***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
% exports	0.000**	0.000**	0.000**	0.000**	0.000**	0.001**	0.001**	0.001**	0.001**	0.001**	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.095	0.094	0.095	0.096	0.094	0.094	0.094	0.094	0.096	0.094	0.107	0.106	0.108	0.106	0.105
Observations	4826	4826	4826	4826	4826	3216	3216	3216	3216	3216	1610	1610	1610	1610	1610
Log likelihood	-2594.393	-2595.752	-2595.166	-2591.974	-2595.538	-1731.035	-1730.926	-1731.094	-1726.383	-1730.837	-853.269	-854.406	-852.689	-854.837	-854.960

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.15. Italy – Marketing Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Large Firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.025					0.029				
	(0.026)					(0.021)				
BDA, firm data (f)		-0.002					0.003			
		(0.029)					(0.027)			
BDA, geolocation data (g)			0.017					0.041		
			(0.040)					(0.037)		
BDA, social media data (m)				0.079					0.100**	
				(0.052)					(0.045)	
BDA, other data (o)					0.027					-0.003
					(0.038)					(0.031)
log turnover	0.034**	0.035**	0.035**	0.033**	0.034**	0.026***	0.027***	0.027***	0.027***	0.027***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
log employees	0.018	0.019	0.018	0.020	0.019	-0.017	-0.016	-0.016	-0.016	-0.016
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
cloud computing	0.067***	0.069***	0.068***	0.066***	0.068***	0.051***	0.053***	0.052***	0.050***	0.053***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
e-sales	0.115***	0.117***	0.117***	0.112***	0.117***	0.137***	0.139***	0.139***	0.134***	0.139***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
e-purchases	0.004	0.004	0.004	0.004	0.004	0.054***	0.056***	0.055***	0.054***	0.056***
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
broadband 30-100 Mbps	-0.024	-0.023	-0.023	-0.025	-0.023	0.010	0.010	0.010	0.009	0.010
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
broadband 100+ Mbps	0.019	0.022	0.021	0.018	0.020	0.000	0.001	0.001	-0.001	0.001
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
% of R&D expenses	0.001	0.001	0.001	0.001	0.001	0.004***	0.004***	0.004***	0.004**	0.004***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
10% - 25% w tert degree	-0.010	-0.010	-0.010	-0.008	-0.010	0.044**	0.044**	0.043**	0.044**	0.044**
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
25% - 75% w tert degree	0.010	0.010	0.010	0.009	0.010	0.077***	0.077***	0.077***	0.077***	0.077***
	(0.036)	(0.035)	(0.035)	(0.035)	(0.035)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
75% + w tert degree	0.027	0.030	0.028	0.022	0.029	0.109***	0.109***	0.109***	0.109***	0.109***
	(0.052)	(0.052)	(0.052)	(0.051)	(0.052)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
% exports	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.092	0.091	0.091	0.093	0.091	0.079	0.079	0.079	0.080	0.079
Observations	1516	1516	1516	1516	1516	3310	3310	3310	3310	3310
Log likelihood	-917.027	-917.478	-917.386	-916.160	-917.216	-1657.867	-1658.820	-1658.146	-1655.863	-1658.821

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.16. Italy – Organisational Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.045**					0.068***					0.002				
	(0.018)					(0.023)					(0.029)				
BDA, firm data (f)		0.020					0.034					-0.015			
		(0.022)					(0.026)					(0.040)			
BDA, geolocation data (g)			0.032					0.068*					-0.015		
			(0.028)					(0.038)					(0.041)		
BDA, social media data (m)				0.028					0.085*					-0.032	
				(0.035)					(0.049)					(0.047)	
BDA, other data (o)					0.032					0.058					-0.004
					(0.027)					(0.036)					(0.038)
log turnover	0.027***	0.028***	0.028***	0.028***	0.027***	0.028**	0.029**	0.030***	0.029**	0.028**	0.025**	0.025**	0.025**	0.026**	0.025**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
log employees	0.014	0.014	0.014	0.015	0.015	0.018	0.019	0.019	0.021	0.021	0.006	0.006	0.006	0.006	0.006
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
cloud computing	0.039**	0.041***	0.041***	0.041***	0.041***	0.041**	0.043**	0.042**	0.042**	0.043**	0.033	0.034	0.034	0.035	0.034
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
e-sales	0.017	0.018	0.019	0.018	0.018	-0.009	-0.008	-0.007	-0.011	-0.007	0.064**	0.065**	0.065**	0.066**	0.065**
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.030)	(0.029)	(0.029)	(0.030)	(0.030)
e-purchases	0.048***	0.050***	0.050***	0.050***	0.050***	0.029	0.032*	0.032*	0.032*	0.033*	0.080***	0.081***	0.081***	0.081***	0.081***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
broadband 30-100 Mbps	0.002	0.002	0.002	0.002	0.002	-0.010	-0.009	-0.008	-0.010	-0.009	0.017	0.017	0.017	0.018	0.017
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
broadband 100+ Mbps	0.050**	0.052**	0.052**	0.052**	0.051**	0.045	0.049	0.050	0.048	0.048	0.055	0.055	0.055	0.057	0.055
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.031)	(0.031)	(0.031)	(0.031)	(0.032)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
% of R&D expenses	0.000	0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.002	0.002	0.002	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.034	0.034	0.034	0.034	0.034	0.013	0.013	0.013	0.014	0.014	0.078**	0.078**	0.078**	0.077**	0.078**
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
25% - 75% w tert degree	0.072***	0.072***	0.072***	0.072***	0.072***	0.061***	0.062***	0.061***	0.060***	0.062***	0.094***	0.094***	0.094***	0.093***	0.094***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
75% + w tert degree	0.105***	0.106***	0.106***	0.106***	0.106***	0.040	0.041	0.039	0.040	0.041	0.187***	0.187***	0.187***	0.188***	0.187***
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
% exports	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.069	0.068	0.068	0.068	0.068	0.061	0.060	0.060	0.060	0.060	0.085	0.085	0.085	0.085	0.085
Observations	4826	4826	4826	4826	4826	3216	3216	3216	3216	3216	1610	1610	1610	1610	1610
Log likelihood	-3005.887	-3008.730	-3008.512	-3008.803	-3008.390	-2047.464	-2051.228	-2050.492	-2050.477	-2050.735	-947.201	-947.128	-947.137	-946.959	-947.198

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.17. Italy – Organisational Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Large Firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.051*					0.039*				
	(0.028)					(0.024)				
BDA, firm data (f)		0.019					0.015			
		(0.031)					(0.031)			
BDA, geolocation data (g)			0.033					0.017		
			(0.041)					(0.039)		
BDA, social media data (m)				-0.012					0.068	
				(0.053)					(0.049)	
BDA, other data (o)					0.050					0.018
					(0.040)					(0.036)
log turnover	0.028	0.029*	0.029*	0.030*	0.027	0.031***	0.031***	0.032***	0.032***	0.031***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
log employees	0.015	0.015	0.015	0.016	0.016	0.003	0.004	0.005	0.005	0.005
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
cloud computing	0.042	0.045*	0.044*	0.046*	0.043	0.037**	0.039**	0.039**	0.038**	0.039**
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
e-sales	0.019	0.021	0.022	0.023	0.022	0.018	0.020	0.020	0.017	0.019
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
e-purchases	0.035	0.036	0.037	0.037	0.037	0.053***	0.055***	0.055***	0.054***	0.055***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
broadband 30-100 Mbps	-0.033	-0.032	-0.031	-0.031	-0.032	0.032	0.033	0.033	0.032	0.033
	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
broadband 100+ Mbps	0.077**	0.081**	0.081**	0.083**	0.079**	0.019	0.020	0.020	0.019	0.019
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
% of R&D expenses	-0.000	-0.000	-0.000	-0.000	-0.000	0.003*	0.003*	0.003*	0.003	0.003*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.009	0.010	0.009	0.009	0.009	0.039	0.038	0.038	0.039	0.038
	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
25% - 75% w tert degree	0.029	0.030	0.030	0.031	0.030	0.089***	0.088***	0.088***	0.088***	0.089***
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
75% + w tert degree	0.075	0.081	0.079	0.084	0.080	0.103***	0.103***	0.103***	0.102***	0.103***
	(0.053)	(0.053)	(0.053)	(0.054)	(0.053)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
% exports	0.001***	0.001***	0.001***	0.001***	0.001***	0.000	-0.000	-0.000	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.050	0.048	0.049	0.048	0.049	0.053	0.053	0.053	0.053	0.053
Observations	1516	1516	1516	1516	1516	3310	3310	3310	3310	3310
Log likelihood	-997.099	-998.588	-998.447	-998.755	-997.979	-1987.369	-1988.663	-1988.699	-1987.703	-1988.654

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.18. Netherlands – Product Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.045					0.031					0.047				
	(0.028)					(0.044)					(0.036)				
BDA, firm data (f)		0.024					0.016					0.022			
		(0.031)					(0.048)					(0.039)			
BDA, geolocation data (g)			0.034					0.009					0.028		
			(0.038)					(0.074)					(0.046)		
BDA, social media data (m)				0.074*					0.094					0.062	
				(0.038)					(0.065)					(0.046)	
BDA, other data (o)					0.053					0.031					0.064
					(0.046)					(0.086)					(0.053)
log turnover	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	-0.014	-0.013	-0.014	-0.013	-0.014	-0.014	-0.014	-0.014
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
log employees	0.038***	0.039***	0.040***	0.038***	0.039***	0.035*	0.036*	0.037*	0.033*	0.036*	0.041**	0.043**	0.043**	0.043**	0.042**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
cloud computing	0.009	0.012	0.012	0.009	0.009	-0.039	-0.036	-0.035	-0.039	-0.037	0.041	0.043	0.043	0.040	0.038
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
e-sales	0.100***	0.105***	0.104***	0.099***	0.104***	0.126***	0.128***	0.128***	0.126***	0.128***	0.070*	0.076**	0.076**	0.068*	0.073*
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.041)	(0.041)	(0.042)	(0.041)	(0.041)	(0.038)	(0.037)	(0.037)	(0.038)	(0.037)
e-purchases	0.036	0.038	0.039	0.037	0.038	0.005	0.005	0.006	0.006	0.005	0.052	0.057	0.056	0.054	0.054
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
broadband 30-100 Mbps	-0.000	-0.002	-0.002	-0.002	-0.001	0.003	0.002	0.001	0.004	0.003	0.001	-0.000	-0.001	-0.001	0.001
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
broadband 100+ Mbps	-0.010	-0.009	-0.010	-0.013	-0.009	-0.043	-0.044	-0.044	-0.045	-0.044	0.006	0.009	0.008	0.003	0.010
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
% of R&D expenses	0.000	0.000	0.000	0.000	0.000	0.021*	0.021*	0.021*	0.021*	0.021*	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10% - 25% w tert degree	0.129***	0.128***	0.128***	0.131***	0.129***	0.174***	0.175***	0.176***	0.177***	0.176***	0.080	0.077	0.078	0.081	0.079
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.050)	(0.051)	(0.051)	(0.050)	(0.050)	(0.050)	(0.051)	(0.051)	(0.050)	(0.051)
25% - 75% w tert degree	0.188***	0.189***	0.190***	0.190***	0.190***	0.265***	0.268***	0.269***	0.266***	0.269***	0.101*	0.099*	0.099*	0.099*	0.098*
	(0.040)	(0.040)	(0.040)	(0.039)	(0.040)	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)
75% + w tert degree	0.227***	0.230***	0.229***	0.227***	0.228***	0.214*	0.216*	0.218**	0.219**	0.216*	0.153**	0.155**	0.153**	0.150**	0.151**
	(0.051)	(0.050)	(0.051)	(0.050)	(0.050)	(0.111)	(0.111)	(0.111)	(0.111)	(0.111)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)
% exports	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.153	0.152	0.152	0.153	0.152	0.188	0.187	0.187	0.189	0.187	0.119	0.118	0.118	0.120	0.119
Observations	1312	1312	1312	1312	1312	582	582	582	582	582	730	730	730	730	730
Log likelihood	-746.491	-747.469	-747.410	-745.816	-747.119	-327.559	-327.745	-327.793	-326.862	-327.726	-405.200	-405.931	-405.904	-405.098	-405.417

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.19. Netherlands – Product Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Large Firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.040					0.026				
	(0.045)					(0.035)				
BDA, firm data (f)		0.014					0.009			
		(0.047)					(0.040)			
BDA, geolocation data (g)			0.026					0.044		
			(0.055)					(0.053)		
BDA, social media data (m)				0.127**					0.034	
				(0.055)					(0.052)	
BDA, other data (o)					0.072					-0.001
					(0.069)					(0.062)
log turnover	-0.016	-0.017	-0.017	-0.018	-0.018	-0.023**	-0.023**	-0.022**	-0.023**	-0.023**
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
log employees	0.033	0.034	0.033	0.029	0.030	0.079***	0.080***	0.079***	0.080***	0.081***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.023)	(0.023)	(0.022)	(0.022)	(0.022)
cloud computing	0.068	0.073*	0.073*	0.065	0.068	-0.006	-0.005	-0.005	-0.006	-0.004
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.032)	(0.032)	(0.032)	(0.032)	(0.033)
e-sales	0.050	0.054	0.051	0.040	0.053	0.112***	0.115***	0.114***	0.112***	0.115***
	(0.047)	(0.047)	(0.048)	(0.047)	(0.047)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
e-purchases	-0.004	-0.001	-0.001	-0.006	-0.004	0.052	0.055*	0.054*	0.054*	0.055*
	(0.043)	(0.043)	(0.043)	(0.043)	(0.042)	(0.033)	(0.033)	(0.033)	(0.033)	(0.032)
broadband 30-100 Mbps	-0.054	-0.058	-0.056	-0.052	-0.050	0.018	0.017	0.016	0.017	0.017
	(0.062)	(0.062)	(0.062)	(0.060)	(0.062)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
broadband 100+ Mbps	-0.030	-0.029	-0.029	-0.036	-0.024	-0.002	-0.003	-0.005	-0.004	-0.002
	(0.062)	(0.063)	(0.063)	(0.062)	(0.062)	(0.040)	(0.040)	(0.041)	(0.041)	(0.040)
% of R&D expenses	-0.001	-0.001	-0.000	-0.001	-0.000	0.000	0.000	0.000	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10% - 25% w tert degree	0.011	0.009	0.008	0.014	0.010	0.164***	0.163***	0.164***	0.165***	0.163***
	(0.063)	(0.063)	(0.063)	(0.062)	(0.063)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
25% - 75% w tert degree	0.198***	0.200***	0.198***	0.196***	0.197***	0.164***	0.165***	0.165***	0.165***	0.165***
	(0.075)	(0.075)	(0.075)	(0.075)	(0.075)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
75% + w tert degree	0.089	0.087	0.083	0.093	0.083	0.251***	0.253***	0.251***	0.251***	0.254***
	(0.100)	(0.100)	(0.100)	(0.099)	(0.100)	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)
% exports	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.189	0.188	0.188	0.197	0.190	0.149	0.149	0.149	0.149	0.149
Observations	428	428	428	428	428	865	865	865	865	865
Log likelihood	-228.964	-229.313	-229.242	-226.659	-228.782	-493.865	-494.102	-493.811	-493.904	-494.128

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.20. Netherlands – Process Innovation

Dependent Variable: Dummy for Process Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.027					0.010					0.033				
	(0.028)					(0.046)					(0.035)				
BDA, firm data (f)		0.023					0.025					0.014			
		(0.031)					(0.051)					(0.038)			
BDA, geolocation data (g)			0.013					-0.050					0.044		
			(0.039)					(0.073)					(0.046)		
BDA, social media data (m)				0.022					0.085					0.002	
				(0.037)					(0.069)					(0.043)	
BDA, other data (o)					0.066					0.056					0.076
					(0.048)					(0.091)					(0.057)
log turnover	0.005	0.005	0.005	0.005	0.005	-0.000	-0.001	-0.001	-0.000	-0.001	0.011	0.011	0.011	0.010	0.011
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
log employees	0.031**	0.031**	0.032**	0.032**	0.031**	0.044**	0.043**	0.046**	0.042**	0.044**	0.022	0.023	0.022	0.024	0.022
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
cloud computing	0.028	0.029	0.030	0.029	0.025	0.023	0.022	0.024	0.020	0.021	0.026	0.028	0.026	0.029	0.022
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.042)	(0.041)	(0.041)	(0.041)	(0.041)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
e-sales	0.055*	0.057**	0.058**	0.056*	0.056*	0.096**	0.095**	0.100**	0.092**	0.095**	0.014	0.018	0.016	0.019	0.014
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.045)	(0.045)	(0.045)	(0.044)	(0.044)	(0.038)	(0.037)	(0.037)	(0.038)	(0.038)
e-purchases	0.059**	0.060**	0.061**	0.060**	0.059**	0.073*	0.072*	0.072*	0.072*	0.073*	0.044	0.048	0.046	0.048	0.044
	(0.026)	(0.026)	(0.025)	(0.026)	(0.026)	(0.040)	(0.040)	(0.039)	(0.039)	(0.039)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
broadband 30-100 Mbps	0.019	0.019	0.018	0.018	0.020	0.008	0.008	0.005	0.010	0.010	0.027	0.026	0.027	0.025	0.028
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
broadband 100+ Mbps	0.012	0.012	0.012	0.011	0.012	-0.012	-0.012	-0.010	-0.014	-0.013	0.030	0.032	0.031	0.032	0.033
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.052)	(0.052)	(0.053)	(0.052)	(0.052)	(0.043)	(0.044)	(0.043)	(0.044)	(0.043)
% of R&D expenses	0.000	0.000	0.000	0.000	0.000	-0.000*	-0.000*	-0.000*	-0.000*	-0.000*	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10% - 25% w tert degree	0.010	0.009	0.009	0.010	0.010	0.081	0.080	0.083	0.084	0.081	-0.057	-0.059	-0.057	-0.058	-0.056
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.055)	(0.056)	(0.055)	(0.055)	(0.055)
25% - 75% w tert degree	-0.012	-0.012	-0.011	-0.011	-0.011	0.095	0.094	0.100	0.094	0.097	-0.119**	-0.120**	-0.120**	-0.120**	-0.120**
	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.067)	(0.066)	(0.066)	(0.066)	(0.066)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
75% + w tert degree	0.043	0.045	0.045	0.045	0.042	0.316***	0.314***	0.320***	0.317***	0.314***	-0.099	-0.098	-0.101	-0.098	-0.101
	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)	(0.101)	(0.101)	(0.100)	(0.101)	(0.101)	(0.062)	(0.063)	(0.063)	(0.063)	(0.063)
% exports	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002**	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.089	0.088	0.088	0.088	0.089	0.093	0.093	0.094	0.095	0.094	0.059	0.058	0.059	0.058	0.060
Observations	1312	1312	1312	1312	1312	582	582	582	582	582	730	730	730	730	730
Log likelihood	-759.703	-759.868	-760.103	-759.997	-759.134	-359.800	-359.704	-359.588	-359.115	-359.608	-391.941	-392.319	-391.911	-392.384	-391.381

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.21. Netherlands – Process Innovation

Dependent Variable: Dummy for Process Innovation - Probit Regression - Average Marginal Effects

	Large Firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	-0.002					0.021				
	(0.046)					(0.035)				
BDA, firm data (f)		0.004					0.006			
		(0.047)					(0.040)			
BDA, geolocation data (g)			-0.003					0.010		
			(0.055)					(0.055)		
BDA, social media data (m)				0.070					-0.021	
				(0.055)					(0.049)	
BDA, other data (o)					0.043					0.065
					(0.070)					(0.067)
log turnover	0.019	0.019	0.019	0.018	0.018	-0.004	-0.004	-0.004	-0.005	-0.004
	(0.016)	(0.016)	(0.016)	(0.015)	(0.016)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
log employees	0.006	0.006	0.006	0.003	0.003	0.049**	0.050**	0.050**	0.051**	0.049**
	(0.029)	(0.029)	(0.030)	(0.030)	(0.030)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)
cloud computing	0.079*	0.078*	0.079*	0.075*	0.074*	-0.010	-0.008	-0.008	-0.007	-0.013
	(0.043)	(0.043)	(0.042)	(0.043)	(0.043)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
e-sales	0.029	0.028	0.029	0.020	0.027	0.039	0.041	0.041	0.043	0.039
	(0.050)	(0.050)	(0.050)	(0.049)	(0.049)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
e-purchases	0.030	0.029	0.030	0.025	0.028	0.084***	0.086***	0.086***	0.087***	0.084***
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
broadband 30-100 Mbps	-0.070	-0.070	-0.070	-0.066	-0.065	0.036	0.035	0.035	0.034	0.037
	(0.064)	(0.064)	(0.064)	(0.063)	(0.064)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
broadband 100+ Mbps	-0.036	-0.036	-0.036	-0.040	-0.033	0.033	0.033	0.033	0.035	0.032
	(0.064)	(0.064)	(0.064)	(0.064)	(0.064)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
% of R&D expenses	-0.000	-0.000	-0.000	-0.001	-0.000	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10% - 25% w tert degree	0.004	0.004	0.005	0.007	0.005	-0.031	-0.031	-0.031	-0.031	-0.030
	(0.066)	(0.067)	(0.066)	(0.067)	(0.066)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
25% - 75% w tert degree	0.006	0.006	0.007	0.004	0.007	-0.070	-0.069	-0.069	-0.069	-0.070
	(0.075)	(0.075)	(0.075)	(0.075)	(0.075)	(0.051)	(0.051)	(0.051)	(0.051)	(0.051)
75% + w tert degree	-0.067	-0.067	-0.066	-0.066	-0.068	0.029	0.031	0.031	0.033	0.028
	(0.099)	(0.099)	(0.099)	(0.098)	(0.099)	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)
% exports	0.001**	0.001**	0.001**	0.001**	0.001**	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.156	0.156	0.156	0.159	0.157	0.083	0.082	0.082	0.082	0.083
Observations	445	445	445	445	445	865	865	865	865	865
Log likelihood	-249.406	-249.404	-249.406	-248.602	-249.193	-488.216	-488.386	-488.380	-488.313	-487.875

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.22. Netherlands – Marketing Innovation

Dependent Variable: Dummy for Marketing Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	-0.001					0.062					-0.038				
	(0.021)					(0.039)					(0.025)				
BDA, firm data (f)		-0.020					0.021					-0.049*			
		(0.023)					(0.042)					(0.025)			
BDA, geolocation data (g)			0.011					0.028					0.009		
			(0.031)					(0.065)					(0.034)		
BDA, social media data (m)				0.044					0.200***					-0.013	
				(0.032)					(0.069)					(0.031)	
BDA, other data (o)					0.001					0.039					-0.014
					(0.035)					(0.072)					(0.038)
log turnover	-0.003	-0.003	-0.003	-0.003	-0.003	0.001	0.001	0.001	0.002	0.001	-0.008	-0.008	-0.008	-0.008	-0.008
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
log employees	0.004	0.005	0.003	0.002	0.003	-0.011	-0.007	-0.006	-0.017	-0.007	0.014	0.015	0.011	0.012	0.012
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
cloud computing	0.024	0.026	0.024	0.021	0.024	0.020	0.027	0.028	0.018	0.026	0.029	0.029	0.024	0.026	0.027
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.034)	(0.034)	(0.034)	(0.033)	(0.034)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
e-sales	0.057**	0.059**	0.056**	0.053**	0.057**	0.086**	0.091**	0.091**	0.084**	0.092**	0.041	0.040	0.034	0.036	0.036
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.038)	(0.038)	(0.037)	(0.037)	(0.037)	(0.029)	(0.028)	(0.028)	(0.029)	(0.029)
e-purchases	0.021	0.022	0.021	0.019	0.021	0.066**	0.068**	0.070**	0.065**	0.069**	-0.012	-0.016	-0.017	-0.015	-0.016
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	(0.026)	(0.026)	(0.027)	(0.027)	(0.027)
broadband 30-100 Mbps	-0.025	-0.027	-0.025	-0.024	-0.025	0.012	0.007	0.007	0.014	0.008	-0.049	-0.050	-0.048	-0.048	-0.048
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.041)	(0.041)	(0.041)	(0.040)	(0.041)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
broadband 100+ Mbps	-0.031	-0.031	-0.031	-0.034	-0.031	-0.043	-0.047	-0.047	-0.049	-0.047	-0.016	-0.019	-0.019	-0.018	-0.019
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.042)	(0.043)	(0.043)	(0.042)	(0.043)	(0.035)	(0.036)	(0.036)	(0.036)	(0.036)
% of R&D expenses	0.000	0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000*	0.000*	0.000*	0.000*	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10% - 25% w tert degree	0.052**	0.053**	0.052**	0.054**	0.052**	0.057	0.059	0.060	0.066*	0.059	0.040	0.043	0.042	0.041	0.041
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.041)	(0.041)	(0.041)	(0.040)	(0.041)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
25% - 75% w tert degree	0.093***	0.094***	0.093***	0.092***	0.093***	0.089*	0.095*	0.095*	0.094*	0.097*	0.078**	0.079**	0.078**	0.079**	0.078**
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.051)	(0.050)	(0.050)	(0.049)	(0.050)	(0.034)	(0.034)	(0.035)	(0.035)	(0.035)
75% + w tert degree	0.096**	0.098**	0.095**	0.092**	0.096**	0.109	0.116	0.118	0.118	0.117	0.070*	0.068*	0.065	0.068*	0.067
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.084)	(0.085)	(0.086)	(0.086)	(0.085)	(0.041)	(0.041)	(0.041)	(0.040)	(0.041)
% exports	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.001	0.001	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.062	0.063	0.062	0.064	0.062	0.082	0.078	0.078	0.096	0.079	0.055	0.057	0.052	0.052	0.052
Observations	1296	1296	1296	1296	1296	558	558	558	558	558	730	730	730	730	730
Log likelihood	-526.073	-525.721	-526.016	-525.028	-526.074	-251.569	-252.675	-252.702	-247.967	-252.636	-264.839	-264.325	-265.846	-265.802	-265.824

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.23. Netherlands – Marketing Innovation

Dependent Variable: Dummy for Marketing Innovation - Probit Regression - Average Marginal Effects

	Large firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.003					-0.029				
	(0.035)					(0.026)				
BDA, firm data (f)		-0.037					-0.036			
		(0.035)					(0.029)			
BDA, geolocation data (g)			0.014					0.007		
			(0.045)					(0.044)		
BDA, social media data (m)				0.063					0.015	
				(0.046)					(0.042)	
BDA, other data (o)					0.042					-0.068*
					(0.059)					(0.036)
log turnover	-0.006	-0.006	-0.006	-0.006	-0.006	-0.004	-0.004	-0.004	-0.004	-0.004
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
log employees	-0.003	-0.003	-0.004	-0.008	-0.006	0.003	0.004	0.001	0.000	0.003
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
cloud computing	0.076**	0.081**	0.075**	0.072**	0.071**	0.001	0.000	-0.001	-0.002	0.004
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
e-sales	0.023	0.028	0.021	0.016	0.023	0.072**	0.071**	0.069**	0.068**	0.072**
	(0.039)	(0.039)	(0.038)	(0.039)	(0.039)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
e-purchases	0.025	0.027	0.026	0.020	0.024	0.018	0.018	0.015	0.015	0.017
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
broadband 30-100 Mbps	-0.037	-0.041	-0.035	-0.034	-0.032	-0.028	-0.028	-0.027	-0.027	-0.028
	(0.051)	(0.051)	(0.051)	(0.051)	(0.051)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
broadband 100+ Mbps	-0.036	-0.036	-0.036	-0.040	-0.033	-0.036	-0.036	-0.037	-0.037	-0.036
	(0.051)	(0.052)	(0.051)	(0.051)	(0.051)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
% of R&D expenses	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10% - 25% w tert degree	-0.008	-0.006	-0.008	-0.007	-0.008	0.072**	0.073**	0.072**	0.073**	0.071**
	(0.049)	(0.048)	(0.049)	(0.049)	(0.049)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
25% - 75% w tert degree	0.098	0.102*	0.097	0.094	0.098	0.084**	0.084**	0.083**	0.083**	0.084**
	(0.063)	(0.062)	(0.063)	(0.062)	(0.062)	(0.033)	(0.033)	(0.034)	(0.034)	(0.033)
75% + w tert degree	0.030	0.031	0.028	0.027	0.028	0.101**	0.100**	0.096**	0.095**	0.103**
	(0.079)	(0.079)	(0.079)	(0.079)	(0.079)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)
% exports	0.001*	0.001*	0.001*	0.001*	0.001*	0.001**	0.001**	0.001**	0.001**	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.126	0.128	0.126	0.131	0.127	0.071	0.071	0.069	0.069	0.072
Observations	435	435	435	435	435	851	851	851	851	851
Log likelihood	-172.019	-171.533	-171.974	-171.091	-171.717	-336.493	-336.366	-337.011	-336.959	-335.895

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.24. Netherlands – Organisational Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	-0.002					-0.016					0.002				
	(0.025)					(0.039)					(0.032)				
BDA, firm data (f)		-0.003					-0.031					0.009			
		(0.027)					(0.041)					(0.035)			
BDA, geolocation data (g)			0.025					0.025					0.028		
			(0.036)					(0.066)					(0.043)		
BDA, social media data (m)				0.026					0.058					0.013	
				(0.035)					(0.064)					(0.041)	
BDA, other data (o)					-0.028					-0.062					-0.007
					(0.039)					(0.064)					(0.048)
log turnover	0.005	0.005	0.005	0.005	0.005	0.014	0.014	0.014	0.014	0.013	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
log employees	-0.002	-0.002	-0.003	-0.003	-0.001	-0.012	-0.011	-0.014	-0.017	-0.012	0.006	0.006	0.005	0.006	0.007
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.019)	(0.019)	(0.019)	(0.018)	(0.018)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
cloud computing	0.036	0.036	0.035	0.034	0.038	0.054	0.054	0.052	0.049	0.056	0.022	0.021	0.020	0.021	0.023
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.031)	(0.030)	(0.030)	(0.031)	(0.031)
e-sales	0.053**	0.053**	0.050*	0.049*	0.054**	0.052	0.052	0.048	0.047	0.051	0.051	0.050	0.049	0.049	0.052
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.035)	(0.034)	(0.034)	(0.035)	(0.035)
e-purchases	0.009	0.009	0.009	0.008	0.010	0.030	0.032	0.030	0.028	0.029	-0.010	-0.010	-0.011	-0.011	-0.010
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.032)	(0.031)	(0.032)	(0.032)	(0.032)
broadband 30-100 Mbps	0.017	0.017	0.018	0.018	0.016	0.026	0.026	0.029	0.029	0.024	0.024	0.024	0.025	0.024	0.024
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
broadband 100+ Mbps	0.007	0.007	0.006	0.005	0.007	-0.027	-0.026	-0.027	-0.028	-0.026	0.042	0.042	0.041	0.041	0.042
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
% of R&D expenses	0.000*	0.000*	0.000*	0.000*	0.000*	0.004	0.004	0.004	0.004	0.004	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10% - 25% w tert degree	0.003	0.003	0.003	0.003	0.003	-0.004	-0.004	-0.007	-0.004	-0.004	0.007	0.007	0.008	0.007	0.007
	(0.032)	(0.032)	(0.032)	(0.032)	(0.031)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.045)	(0.046)	(0.046)	(0.046)	(0.045)
25% - 75% w tert degree	0.052	0.052	0.051	0.051	0.052	0.050	0.051	0.046	0.046	0.048	0.040	0.040	0.040	0.039	0.040
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.057)	(0.057)	(0.058)	(0.057)	(0.057)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
75% + w tert degree	0.070	0.070	0.067	0.067	0.071	0.087	0.089	0.083	0.082	0.090	0.043	0.043	0.041	0.042	0.044
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.098)	(0.098)	(0.098)	(0.099)	(0.098)	(0.054)	(0.054)	(0.054)	(0.054)	(0.055)
% exports	0.000	0.000	0.000	0.000	0.000	0.001*	0.001*	0.001*	0.001**	0.001*	-0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.037	0.037	0.037	0.037	0.037	0.059	0.059	0.059	0.060	0.060	0.032	0.032	0.032	0.032	0.032
Observations	1312	1312	1312	1312	1312	582	582	582	582	582	730	730	730	730	730
Log likelihood	-648.740	-648.738	-648.501	-648.456	-648.490	-292.128	-291.945	-292.139	-291.771	-291.804	-351.041	-351.011	-350.816	-350.992	-351.033

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.25. Netherlands – Organisational Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Large firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	-0.036					0.006				
	(0.041)					(0.031)				
BDA, firm data (f)		-0.032					0.010			
		(0.039)					(0.036)			
BDA, geolocation data (g)			-0.007					0.046		
			(0.048)					(0.052)		
BDA, social media data (m)				0.008					0.022	
				(0.048)					(0.047)	
BDA, other data (o)					-0.004					-0.059
					(0.058)					(0.049)
log turnover	0.010	0.010	0.011	0.010	0.011	0.001	0.001	0.001	0.001	0.001
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
log employees	0.004	0.003	0.003	0.003	0.003	0.013	0.013	0.012	0.013	0.015
	(0.028)	(0.028)	(0.029)	(0.029)	(0.029)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
cloud computing	0.030	0.028	0.023	0.022	0.023	0.033	0.033	0.032	0.032	0.037
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
e-sales	0.023	0.020	0.018	0.016	0.017	0.059*	0.060*	0.059*	0.058*	0.063*
	(0.043)	(0.043)	(0.043)	(0.044)	(0.043)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
e-purchases	-0.024	-0.024	-0.026	-0.026	-0.025	0.028	0.028	0.027	0.028	0.030
	(0.039)	(0.038)	(0.038)	(0.039)	(0.038)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
broadband 30-100 Mbps	-0.069	-0.069	-0.066	-0.064	-0.065	0.041	0.041	0.040	0.041	0.039
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
broadband 100+ Mbps	-0.013	-0.015	-0.014	-0.015	-0.014	0.012	0.012	0.010	0.011	0.013
	(0.059)	(0.059)	(0.059)	(0.059)	(0.059)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
% of R&D expenses	0.001	0.001	0.001	0.001	0.001	0.000*	0.000*	0.000*	0.000*	0.000*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
10% - 25% w tert degree	-0.031	-0.031	-0.032	-0.032	-0.032	0.006	0.006	0.007	0.006	0.006
	(0.056)	(0.056)	(0.056)	(0.057)	(0.056)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
25% - 75% w tert degree	0.081	0.080	0.079	0.077	0.078	0.027	0.027	0.027	0.027	0.027
	(0.069)	(0.069)	(0.069)	(0.069)	(0.069)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)
75% + w tert degree	-0.030	-0.030	-0.030	-0.031	-0.031	0.076	0.076	0.074	0.075	0.080
	(0.085)	(0.085)	(0.086)	(0.085)	(0.085)	(0.054)	(0.054)	(0.054)	(0.054)	(0.055)
% exports	0.001*	0.001*	0.001*	0.001*	0.001*	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.084	0.084	0.082	0.082	0.082	0.051	0.051	0.052	0.051	0.053
Observations	444	444	444	444	444	865	865	865	865	865
Log likelihood	-208.756	-208.850	-209.119	-209.118	-209.128	-422.292	-422.269	-421.862	-422.196	-421.671

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.26. Sweden – Product Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.124***					0.057					0.208***				
	(0.037)					(0.052)					(0.056)				
BDA, firm data (f)		0.068					-0.026					0.199***			
		(0.045)					(0.059)					(0.069)			
BDA, geolocation data (g)			0.237***					0.191**					0.263***		
			(0.057)					(0.091)					(0.078)		
BDA, social media data (m)				0.156***					0.181**					0.167**	
				(0.052)					(0.079)					(0.071)	
BDA, other data (o)					0.103**					0.077					0.116*
					(0.046)					(0.069)					(0.063)
log turnover	0.002	0.001	0.001	-0.001	0.002	0.021	0.021	0.021	0.018	0.020	-0.016	-0.020	-0.019	-0.022	-0.017
	(0.022)	(0.022)	(0.021)	(0.022)	(0.022)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.029)	(0.028)	(0.028)	(0.029)	(0.029)
log employees	0.055**	0.059**	0.057**	0.063**	0.059**	0.032	0.036	0.031	0.038	0.035	0.069**	0.072**	0.073**	0.082**	0.076**
	(0.026)	(0.026)	(0.025)	(0.026)	(0.026)	(0.042)	(0.042)	(0.042)	(0.041)	(0.042)	(0.034)	(0.033)	(0.033)	(0.033)	(0.034)
cloud computing	0.112***	0.121***	0.120***	0.115***	0.116***	0.137***	0.138***	0.137***	0.132***	0.135***	0.043	0.060	0.071	0.064	0.063
	(0.033)	(0.033)	(0.032)	(0.033)	(0.033)	(0.041)	(0.041)	(0.040)	(0.041)	(0.041)	(0.054)	(0.053)	(0.053)	(0.054)	(0.054)
e-sales	0.058*	0.067**	0.069**	0.065**	0.063**	0.074*	0.078*	0.078*	0.074*	0.073*	0.044	0.057	0.074	0.068	0.066
	(0.031)	(0.032)	(0.031)	(0.031)	(0.031)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.050)	(0.050)	(0.049)	(0.050)	(0.050)
e-purchases	-0.037	-0.035	-0.036	-0.032	-0.034	-0.078**	-0.073*	-0.075**	-0.079**	-0.076**	0.032	0.032	0.024	0.043	0.032
	(0.029)	(0.030)	(0.029)	(0.030)	(0.030)	(0.037)	(0.038)	(0.037)	(0.037)	(0.037)	(0.047)	(0.047)	(0.047)	(0.048)	(0.048)
broadband 30-100 Mbps	-0.082*	-0.081*	-0.075*	-0.081*	-0.084**	-0.050	-0.052	-0.046	-0.049	-0.052	-0.191***	-0.187**	-0.181**	-0.197***	-0.192**
	(0.042)	(0.043)	(0.042)	(0.042)	(0.042)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)	(0.074)	(0.075)	(0.076)	(0.075)	(0.075)
broadband 100+ Mbps	-0.033	-0.027	-0.028	-0.032	-0.031	-0.037	-0.036	-0.039	-0.040	-0.039	-0.088	-0.074	-0.070	-0.084	-0.080
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.048)	(0.048)	(0.048)	(0.048)	(0.048)	(0.066)	(0.067)	(0.068)	(0.067)	(0.067)
% of R&D expenses	0.005	0.005	0.004	0.005	0.005	0.024**	0.024**	0.024**	0.024***	0.024**	0.003	0.003	0.003	0.003	0.003
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)
10% - 25% w tert degree	0.106***	0.108***	0.113***	0.112***	0.110***	0.103**	0.107**	0.105**	0.105**	0.105**	0.063	0.067	0.086	0.079	0.076
	(0.039)	(0.039)	(0.038)	(0.039)	(0.039)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.074)	(0.074)	(0.074)	(0.075)	(0.075)
25% - 75% w tert degree	0.186***	0.200***	0.209***	0.199***	0.198***	0.173***	0.184***	0.182***	0.173***	0.174***	0.075	0.097	0.125*	0.106	0.108
	(0.045)	(0.045)	(0.044)	(0.045)	(0.045)	(0.061)	(0.062)	(0.061)	(0.061)	(0.062)	(0.073)	(0.073)	(0.072)	(0.073)	(0.073)
75% + w tert degree	0.218***	0.241***	0.247***	0.245***	0.243***	0.296	0.324	0.301	0.310	0.305	0.088	0.125	0.156*	0.136	0.143
	(0.076)	(0.076)	(0.074)	(0.076)	(0.076)	(0.202)	(0.199)	(0.204)	(0.197)	(0.201)	(0.096)	(0.097)	(0.094)	(0.096)	(0.097)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.149	0.143	0.152	0.147	0.145	0.179	0.178	0.183	0.182	0.179	0.156	0.146	0.149	0.141	0.138
Observations	1019	1019	1019	1019	1019	617	617	617	617	617	402	402	402	402	402
Log likelihood	-600.863	-604.895	-598.957	-602.474	-603.648	-350.453	-350.938	-349.054	-349.233	-350.459	-235.171	-237.859	-237.166	-239.323	-240.279

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.27. Sweden – Product Innovation

Dependent Variable: Dummy for Product Innovation - Probit Regression - Average Marginal Effects

	Large firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.045					0.189***				
	(0.052)					(0.052)				
BDA, firm data (f)		-0.014					0.144**			
		(0.059)					(0.064)			
BDA, geolocation data (g)			0.147*					0.358***		
			(0.085)					(0.071)		
BDA, social media data (m)				0.167**					0.171**	
				(0.075)					(0.072)	
BDA, other data (o)					0.095					0.117*
					(0.065)					(0.064)
log turnover	0.051	0.050	0.046	0.040	0.051	-0.009	-0.010	-0.011	-0.011	-0.009
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.026)	(0.026)	(0.025)	(0.026)	(0.026)
log employees	0.057	0.065	0.052	0.068	0.054	0.044	0.048	0.046	0.052	0.050
	(0.059)	(0.060)	(0.060)	(0.058)	(0.059)	(0.035)	(0.035)	(0.034)	(0.035)	(0.035)
cloud computing	0.154***	0.163***	0.156***	0.156***	0.152**	0.101**	0.111***	0.110***	0.105***	0.105***
	(0.059)	(0.058)	(0.058)	(0.058)	(0.059)	(0.039)	(0.039)	(0.039)	(0.040)	(0.040)
e-sales	0.074	0.084	0.081	0.070	0.063	0.051	0.062	0.069*	0.063	0.062
	(0.058)	(0.058)	(0.057)	(0.057)	(0.059)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
e-purchases	-0.109**	-0.107**	-0.110**	-0.104**	-0.110**	-0.022	-0.022	-0.018	-0.016	-0.018
	(0.051)	(0.051)	(0.051)	(0.051)	(0.051)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
broadband 30-100 Mbps	-0.004	-0.005	0.004	0.006	-0.006	-0.102**	-0.102**	-0.094*	-0.104**	-0.105**
	(0.082)	(0.082)	(0.081)	(0.082)	(0.082)	(0.050)	(0.050)	(0.050)	(0.050)	(0.051)
broadband 100+ Mbps	0.017	0.019	0.023	0.022	0.011	-0.053	-0.041	-0.044	-0.049	-0.043
	(0.074)	(0.074)	(0.074)	(0.074)	(0.073)	(0.048)	(0.049)	(0.048)	(0.049)	(0.049)
% of R&D expenses	0.035**	0.035**	0.035***	0.035***	0.035**	0.003	0.003	0.003	0.003	0.003
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
10% - 25% w tert degree	0.011	0.019	0.020	0.009	0.012	0.140***	0.137***	0.139***	0.144***	0.141***
	(0.071)	(0.071)	(0.071)	(0.070)	(0.071)	(0.045)	(0.046)	(0.045)	(0.046)	(0.046)
25% - 75% w tert degree	0.098	0.115	0.112	0.099	0.101	0.186***	0.199***	0.203***	0.202***	0.198***
	(0.081)	(0.081)	(0.079)	(0.080)	(0.080)	(0.056)	(0.056)	(0.054)	(0.055)	(0.056)
75% + w tert degree	0.132	0.147	0.149	0.118	0.143	0.198**	0.223**	0.226**	0.240**	0.229**
	(0.140)	(0.140)	(0.136)	(0.144)	(0.138)	(0.097)	(0.097)	(0.095)	(0.096)	(0.097)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.210	0.208	0.214	0.216	0.212	0.129	0.120	0.133	0.121	0.119
Observations	332	332	332	332	332	675	675	675	675	675
Log likelihood	-174.215	-174.513	-173.186	-172.876	-173.641	-404.543	-408.540	-402.571	-408.309	-409.056

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.28. Sweden – Process Innovation

Dependent Variable: Dummy for Process Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.028					0.071					-0.025				
	(0.039)					(0.055)					(0.056)				
BDA, firm data (f)		0.049					0.027					0.054			
		(0.047)					(0.062)					(0.070)			
BDA, geolocation data (g)			0.052					-0.110					0.168*		
			(0.065)					(0.091)					(0.090)		
BDA, social media data (m)				0.046					0.110					0.030	
				(0.056)					(0.090)					(0.073)	
BDA, other data (o)					0.063					0.141**					-0.011
					(0.048)					(0.072)					(0.064)
log turnover	0.037*	0.036*	0.037*	0.036*	0.037*	0.059*	0.058*	0.059*	0.058*	0.058*	0.014	0.013	0.013	0.013	0.014
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.033)	(0.034)	(0.033)	(0.033)	(0.033)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
log employees	0.022	0.022	0.022	0.024	0.022	0.006	0.009	0.011	0.010	0.008	0.038	0.036	0.034	0.038	0.038
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
cloud computing	0.079**	0.080**	0.081**	0.079**	0.077**	0.072*	0.076*	0.076*	0.072*	0.070	0.088	0.080	0.082	0.081	0.085
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.056)	(0.056)	(0.055)	(0.055)	(0.056)
e-sales	0.112***	0.111***	0.114***	0.113***	0.110***	0.085**	0.088**	0.089**	0.087**	0.082*	0.167***	0.156***	0.160***	0.161***	0.164***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)
e-purchases	-0.009	-0.011	-0.009	-0.008	-0.010	-0.025	-0.024	-0.022	-0.024	-0.023	0.019	0.018	0.010	0.021	0.020
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.049)	(0.049)	(0.049)	(0.049)	(0.049)
broadband 30-100 Mbps	-0.089**	-0.087**	-0.088**	-0.088**	-0.090**	-0.086	-0.086	-0.089*	-0.085	-0.091*	-0.110	-0.107	-0.100	-0.110	-0.110
	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.053)	(0.053)	(0.053)	(0.053)	(0.052)	(0.078)	(0.079)	(0.078)	(0.079)	(0.078)
broadband 100+ Mbps	-0.019	-0.017	-0.018	-0.018	-0.020	-0.042	-0.039	-0.036	-0.041	-0.046	0.007	0.007	0.009	0.005	0.006
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.052)	(0.052)	(0.052)	(0.052)	(0.052)	(0.074)	(0.074)	(0.073)	(0.074)	(0.074)
% of R&D expenses	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.004	0.003	0.005	0.005	0.004	-0.004	-0.003	-0.002	-0.003	-0.003	0.008	0.004	0.013	0.006	0.006
	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.077)	(0.077)	(0.077)	(0.077)	(0.077)
25% - 75% w tert degree	-0.052	-0.052	-0.046	-0.049	-0.053	-0.038	-0.031	-0.028	-0.032	-0.042	-0.094	-0.106	-0.097	-0.103	-0.099
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.061)	(0.062)	(0.061)	(0.061)	(0.061)	(0.076)	(0.075)	(0.075)	(0.076)	(0.076)
75% + w tert degree	-0.059	-0.059	-0.052	-0.054	-0.055	0.250	0.263*	0.285*	0.272*	0.250	-0.144	-0.158	-0.149	-0.155	-0.151
	(0.081)	(0.081)	(0.081)	(0.081)	(0.081)	(0.161)	(0.159)	(0.150)	(0.154)	(0.163)	(0.098)	(0.098)	(0.096)	(0.097)	(0.098)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.081	0.082	0.082	0.082	0.082	0.091	0.089	0.091	0.091	0.094	0.086	0.087	0.093	0.086	0.086
Observations	1019	1019	1019	1019	1019	617	617	617	617	617	402	402	402	402	402
Log likelihood	-641.251	-640.964	-641.174	-641.183	-640.672	-385.346	-386.101	-385.514	-385.530	-384.293	-250.294	-250.099	-248.425	-250.312	-250.379

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.29. Sweden – Process Innovation

Dependent Variable: Dummy for Process Innovation - Probit Regression - Average Marginal Effects

	Large firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	-0.064					0.109**				
	(0.058)					(0.055)				
BDA, firm data (f)		-0.010					0.095			
		(0.064)					(0.071)			
BDA, geolocation data (g)			0.031					0.102		
			(0.096)					(0.093)		
BDA, social media data (m)				-0.048					0.100	
				(0.084)					(0.080)	
BDA, other data (o)					0.045					0.075
					(0.073)					(0.066)
log turnover	0.084*	0.083*	0.083*	0.085*	0.083*	0.028	0.026	0.027	0.027	0.027
	(0.044)	(0.044)	(0.044)	(0.044)	(0.044)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
log employees	0.034	0.028	0.026	0.026	0.023	0.025	0.027	0.027	0.030	0.029
	(0.060)	(0.060)	(0.061)	(0.060)	(0.061)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
cloud computing	0.129**	0.118*	0.116*	0.120*	0.112*	0.050	0.055	0.056	0.051	0.052
	(0.063)	(0.062)	(0.062)	(0.062)	(0.063)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
e-sales	0.189***	0.180***	0.178***	0.182***	0.171***	0.093**	0.097**	0.102***	0.098**	0.098**
	(0.061)	(0.061)	(0.061)	(0.061)	(0.063)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
e-purchases	-0.103*	-0.102*	-0.104*	-0.105*	-0.102*	0.032	0.030	0.034	0.034	0.034
	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)
broadband 30-100 Mbps	-0.090	-0.088	-0.086	-0.093	-0.090	-0.075	-0.072	-0.071	-0.075	-0.076
	(0.093)	(0.093)	(0.093)	(0.094)	(0.093)	(0.050)	(0.051)	(0.051)	(0.051)	(0.050)
broadband 100+ Mbps	-0.003	-0.006	-0.005	-0.009	-0.010	-0.030	-0.022	-0.023	-0.026	-0.023
	(0.083)	(0.083)	(0.083)	(0.083)	(0.083)	(0.051)	(0.051)	(0.051)	(0.051)	(0.051)
% of R&D expenses	-0.001	-0.001	-0.001	-0.001	-0.001	0.004*	0.004*	0.004*	0.004*	0.004*
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.063	0.055	0.054	0.057	0.052	-0.012	-0.015	-0.013	-0.010	-0.012
	(0.077)	(0.076)	(0.076)	(0.077)	(0.076)	(0.047)	(0.046)	(0.046)	(0.047)	(0.047)
25% - 75% w tert degree	-0.018	-0.036	-0.039	-0.034	-0.044	-0.053	-0.046	-0.040	-0.044	-0.047
	(0.085)	(0.084)	(0.083)	(0.084)	(0.083)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
75% + w tert degree	0.063	0.038	0.034	0.044	0.029	-0.085	-0.073	-0.066	-0.064	-0.068
	(0.134)	(0.133)	(0.131)	(0.133)	(0.132)	(0.098)	(0.099)	(0.099)	(0.100)	(0.100)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.102	0.099	0.100	0.100	0.100	0.071	0.068	0.068	0.068	0.068
Observations	340	340	340	340	340	675	675	675	675	675
Log likelihood	-209.766	-210.313	-210.273	-210.193	-210.140	-414.365	-415.484	-415.752	-415.602	-415.785

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.30. Sweden – Marketing Innovation

Dependent Variable: Dummy for Marketing Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.010					0.019					-0.016				
	(0.030)					(0.043)					(0.041)				
BDA, firm data (f)		0.017					-0.016					0.043			
		(0.036)					(0.045)					(0.052)			
BDA, geolocation data (g)			0.049					-0.089					0.142*		
			(0.052)					(0.055)					(0.074)		
BDA, social media data (m)				0.031					0.089					-0.029	
				(0.044)					(0.083)					(0.046)	
BDA, other data (o)					0.032					0.077					-0.018
					(0.037)					(0.060)					(0.045)
log turnover	0.033**	0.033*	0.033*	0.032*	0.033*	0.018	0.019	0.018	0.017	0.018	0.045**	0.043*	0.041*	0.046**	0.045**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.026)	(0.025)	(0.025)	(0.026)	(0.026)	(0.023)	(0.023)	(0.022)	(0.023)	(0.023)
log employees	-0.025	-0.025	-0.025	-0.024	-0.025	-0.008	-0.007	-0.006	-0.007	-0.009	-0.025	-0.028	-0.029	-0.026	-0.026
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.032)	(0.032)	(0.031)	(0.032)	(0.032)	(0.029)	(0.028)	(0.028)	(0.028)	(0.028)
cloud computing	0.078***	0.079***	0.079***	0.077***	0.077***	0.048	0.048	0.049	0.045	0.045	0.143***	0.138***	0.140***	0.144***	0.143***
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.033)	(0.033)	(0.032)	(0.033)	(0.033)	(0.038)	(0.038)	(0.037)	(0.037)	(0.038)
e-sales	0.076***	0.076***	0.077***	0.076***	0.075***	0.059*	0.060*	0.061*	0.058*	0.056*	0.103**	0.094**	0.096**	0.102**	0.102**
	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.043)	(0.043)	(0.042)	(0.042)	(0.042)
e-purchases	-0.016	-0.016	-0.016	-0.015	-0.016	-0.024	-0.022	-0.023	-0.026	-0.024	-0.012	-0.013	-0.019	-0.014	-0.012
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)	(0.039)	(0.040)	(0.039)	(0.040)	(0.040)
broadband 30-100 Mbps	0.028	0.029	0.030	0.029	0.028	0.059	0.058	0.058	0.061	0.058	-0.044	-0.041	-0.033	-0.043	-0.043
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.040)	(0.039)	(0.039)	(0.040)	(0.040)	(0.071)	(0.070)	(0.069)	(0.071)	(0.071)
broadband 100+ Mbps	0.042	0.042	0.042	0.042	0.041	0.079**	0.080**	0.083**	0.077*	0.076*	-0.033	-0.033	-0.027	-0.033	-0.033
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.066)	(0.065)	(0.063)	(0.065)	(0.065)
% of R&D expenses	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002	-0.002	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
10% - 25% w tert degree	-0.024	-0.023	-0.023	-0.023	-0.023	-0.044	-0.043	-0.043	-0.044	-0.044	0.030	0.029	0.037	0.028	0.029
	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.050)	(0.050)	(0.049)	(0.050)	(0.050)
25% - 75% w tert degree	0.051	0.051	0.053	0.051	0.050	-0.005	-0.001	-0.001	-0.005	-0.009	0.141***	0.136***	0.144***	0.141***	0.140***
	(0.038)	(0.037)	(0.037)	(0.037)	(0.037)	(0.051)	(0.051)	(0.050)	(0.051)	(0.051)	(0.054)	(0.053)	(0.050)	(0.053)	(0.053)
75% + w tert degree	0.098	0.099	0.101	0.100	0.100	-0.003	0.015	0.022	0.009	-0.005	0.181**	0.175**	0.183**	0.179**	0.177**
	(0.071)	(0.071)	(0.070)	(0.071)	(0.071)	(0.149)	(0.157)	(0.156)	(0.154)	(0.154)	(0.082)	(0.081)	(0.078)	(0.081)	(0.081)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.079	0.079	0.080	0.079	0.080	0.058	0.058	0.060	0.060	0.061	0.141	0.142	0.152	0.141	0.141
Observations	1019	1019	1019	1019	1019	617	617	617	617	617	402	402	402	402	402
Log likelihood	-452.798	-452.743	-452.387	-452.603	-452.465	-273.909	-273.955	-273.188	-273.297	-273.090	-172.315	-172.053	-170.212	-172.241	-172.313

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.31. Sweden – Marketing Innovation

Dependent Variable: Dummy for Marketing Innovation - Probit Regression - Average Marginal Effects

	Large firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.008					0.014				
	(0.051)					(0.039)				
BDA, firm data (f)		0.047					-0.022			
		(0.055)					(0.045)			
BDA, geolocation data (g)			0.012					0.059		
			(0.080)					(0.065)		
BDA, social media data (m)				0.110					-0.014	
				(0.081)					(0.050)	
BDA, other data (o)					0.091					-0.004
					(0.067)					(0.045)
log turnover	0.013	0.011	0.013	0.009	0.014	0.033*	0.034*	0.032*	0.034*	0.033*
	(0.039)	(0.039)	(0.039)	(0.040)	(0.039)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
log employees	0.031	0.027	0.031	0.033	0.023	-0.037	-0.037	-0.037	-0.037	-0.037
	(0.053)	(0.053)	(0.053)	(0.053)	(0.054)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
cloud computing	0.071	0.069	0.072	0.066	0.064	0.084***	0.085***	0.085***	0.086***	0.085***
	(0.049)	(0.049)	(0.049)	(0.049)	(0.050)	(0.029)	(0.029)	(0.029)	(0.029)	(0.029)
e-sales	0.095*	0.090*	0.096*	0.088*	0.081	0.067**	0.070**	0.068**	0.069**	0.069**
	(0.051)	(0.052)	(0.050)	(0.051)	(0.053)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
e-purchases	-0.043	-0.045	-0.044	-0.040	-0.043	-0.010	-0.007	-0.010	-0.009	-0.009
	(0.057)	(0.057)	(0.057)	(0.057)	(0.057)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
broadband 30-100 Mbps	-0.035	-0.032	-0.035	-0.022	-0.042	0.046	0.046	0.047	0.046	0.046
	(0.081)	(0.081)	(0.081)	(0.081)	(0.081)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)
broadband 100+ Mbps	-0.034	-0.034	-0.033	-0.025	-0.044	0.069*	0.071*	0.069*	0.072*	0.071*
	(0.076)	(0.076)	(0.076)	(0.076)	(0.077)	(0.038)	(0.037)	(0.037)	(0.038)	(0.037)
% of R&D expenses	-0.000	-0.000	-0.000	-0.001	-0.001	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
10% - 25% w tert degree	-0.008	-0.010	-0.007	-0.016	-0.012	-0.038	-0.039	-0.038	-0.039	-0.039
	(0.061)	(0.061)	(0.060)	(0.061)	(0.060)	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
25% - 75% w tert degree	0.030	0.023	0.032	0.026	0.024	0.064	0.067	0.065	0.066	0.066
	(0.072)	(0.070)	(0.069)	(0.069)	(0.069)	(0.047)	(0.047)	(0.046)	(0.047)	(0.047)
75% + w tert degree	0.028	0.016	0.033	0.016	0.026	0.122	0.127	0.122	0.125	0.126
	(0.124)	(0.122)	(0.123)	(0.123)	(0.122)	(0.088)	(0.088)	(0.087)	(0.087)	(0.088)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.087	0.089	0.087	0.092	0.092	0.108	0.108	0.109	0.108	0.108
Observations	336	336	336	336	336	675	675	675	675	675
Log likelihood	-160.618	-160.276	-160.622	-159.705	-159.630	-279.050	-279.012	-278.745	-279.075	-279.108

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.32. Sweden – Organisational Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Full sample					Manufacturing					Services				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	0.014					0.010					0.015				
	(0.032)					(0.045)					(0.046)				
BDA, firm data (f)		0.027					-0.004					0.066			
		(0.039)					(0.048)					(0.062)			
BDA, geolocation data (g)			0.095					0.134					0.048		
			(0.059)					(0.095)					(0.073)		
BDA, social media data (m)				0.113**					0.145					0.088	
				(0.053)					(0.089)					(0.064)	
BDA, other data (o)					-0.013					-0.004					-0.033
					(0.037)					(0.056)					(0.048)
log turnover	0.003	0.002	0.002	-0.000	0.004	0.011	0.011	0.011	0.009	0.011	0.001	-0.001	-0.000	-0.003	0.002
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
log employees	0.024	0.024	0.023	0.026	0.024	0.011	0.011	0.009	0.012	0.011	0.034	0.032	0.033	0.036	0.035
	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
cloud computing	0.053*	0.053*	0.053*	0.049*	0.055**	0.052	0.053	0.051	0.048	0.053	0.057	0.053	0.058	0.052	0.062
	(0.028)	(0.028)	(0.027)	(0.028)	(0.028)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
e-sales	0.014	0.013	0.015	0.011	0.016	0.010	0.011	0.010	0.008	0.011	0.029	0.023	0.031	0.024	0.036
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.045)	(0.045)	(0.044)	(0.044)	(0.045)
e-purchases	0.049*	0.048*	0.048*	0.049*	0.050*	0.014	0.015	0.015	0.010	0.015	0.095**	0.094**	0.092**	0.100**	0.097**
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)	(0.041)	(0.041)	(0.042)	(0.041)	(0.041)
broadband 30-100 Mbps	-0.021	-0.020	-0.018	-0.018	-0.022	-0.013	-0.014	-0.011	-0.009	-0.014	-0.026	-0.023	-0.023	-0.026	-0.027
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.068)	(0.068)	(0.068)	(0.068)	(0.069)
broadband 100+ Mbps	-0.007	-0.006	-0.006	-0.007	-0.006	-0.020	-0.019	-0.020	-0.021	-0.019	0.018	0.021	0.021	0.019	0.019
	(0.037)	(0.037)	(0.036)	(0.036)	(0.037)	(0.046)	(0.046)	(0.046)	(0.045)	(0.046)	(0.062)	(0.061)	(0.061)	(0.061)	(0.062)
% of R&D expenses	-0.000	-0.000	-0.001	-0.001	-0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000	-0.001	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
10% - 25% w tert degree	-0.008	-0.009	-0.007	-0.008	-0.008	-0.001	-0.001	-0.001	-0.002	-0.001	-0.024	-0.025	-0.020	-0.023	-0.024
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)
25% - 75% w tert degree	-0.007	-0.008	-0.004	-0.010	-0.004	-0.011	-0.010	-0.011	-0.015	-0.010	-0.008	-0.012	-0.002	-0.012	-0.002
	(0.039)	(0.039)	(0.038)	(0.038)	(0.039)	(0.052)	(0.052)	(0.051)	(0.051)	(0.052)	(0.063)	(0.062)	(0.062)	(0.062)	(0.063)
75% + w tert degree	0.008	0.009	0.011	0.005	0.013	-0.081	-0.076	-0.088	-0.076	-0.077	0.018	0.016	0.024	0.013	0.024
	(0.068)	(0.068)	(0.067)	(0.067)	(0.068)	(0.121)	(0.124)	(0.121)	(0.124)	(0.123)	(0.086)	(0.086)	(0.086)	(0.085)	(0.086)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.043	0.043	0.046	0.048	0.043	0.039	0.039	0.043	0.044	0.039	0.064	0.067	0.065	0.069	0.065
Observations	1019	1019	1019	1019	1019	617	617	617	617	617	402	402	402	402	402
Log likelihood	-499.953	-499.811	-498.573	-497.537	-499.993	-306.543	-306.565	-305.424	-305.029	-306.566	-190.310	-189.717	-190.117	-189.397	-190.151

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Table A.33. Sweden – Organisational Innovation

Dependent Variable: Dummy for Organisational Innovation - Probit Regression - Average Marginal Effects

	Large firms					SMEs				
	(a)	(f)	(g)	(m)	(o)	(a)	(f)	(g)	(m)	(o)
BDA, any data source (a)	-0.048					0.047				
	(0.049)					(0.044)				
BDA, firm data (f)		0.002					0.039			
		(0.055)					(0.057)			
BDA, geolocation data (g)			0.072					0.136		
			(0.088)					(0.083)		
BDA, social media data (m)				0.157*					0.046	
				(0.085)					(0.064)	
BDA, other data (o)					-0.079					0.014
					(0.053)					(0.050)
log turnover	-0.035	-0.036	-0.036	-0.041	-0.036	0.007	0.007	0.005	0.007	0.007
	(0.043)	(0.043)	(0.043)	(0.043)	(0.043)	(0.020)	(0.020)	(0.019)	(0.020)	(0.020)
log employees	0.119**	0.113**	0.109**	0.114**	0.122**	0.010	0.012	0.011	0.012	0.012
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
cloud computing	0.004	-0.004	-0.006	-0.012	0.005	0.073**	0.075**	0.075**	0.074**	0.075**
	(0.055)	(0.055)	(0.055)	(0.055)	(0.055)	(0.031)	(0.031)	(0.030)	(0.031)	(0.031)
e-sales	0.064	0.057	0.057	0.046	0.071	0.021	0.023	0.025	0.023	0.024
	(0.054)	(0.055)	(0.054)	(0.054)	(0.054)	(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
e-purchases	-0.011	-0.011	-0.014	-0.005	-0.011	0.081***	0.081***	0.081***	0.082***	0.082***
	(0.054)	(0.055)	(0.055)	(0.054)	(0.054)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
broadband 30-100 Mbps	-0.026	-0.024	-0.020	-0.005	-0.022	-0.002	-0.002	0.001	-0.003	-0.003
	(0.087)	(0.088)	(0.087)	(0.087)	(0.086)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
broadband 100+ Mbps	-0.050	-0.052	-0.048	-0.038	-0.043	0.028	0.031	0.030	0.029	0.031
	(0.076)	(0.076)	(0.075)	(0.074)	(0.075)	(0.040)	(0.039)	(0.039)	(0.040)	(0.040)
% of R&D expenses	0.002	0.002	0.002	0.002	0.002	-0.003	-0.002	-0.003	-0.002	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
10% - 25% w tert degree	0.070	0.065	0.067	0.054	0.067	-0.020	-0.022	-0.020	-0.020	-0.021
	(0.057)	(0.058)	(0.058)	(0.059)	(0.057)	(0.039)	(0.039)	(0.038)	(0.039)	(0.039)
25% - 75% w tert degree	0.125*	0.113*	0.113*	0.103	0.120*	-0.050	-0.048	-0.045	-0.047	-0.047
	(0.067)	(0.067)	(0.066)	(0.067)	(0.066)	(0.045)	(0.045)	(0.044)	(0.045)	(0.045)
75% + w tert degree	0.112	0.089	0.089	0.058	0.098	-0.027	-0.021	-0.023	-0.018	-0.020
	(0.122)	(0.118)	(0.117)	(0.113)	(0.119)	(0.077)	(0.078)	(0.076)	(0.078)	(0.077)
Industry Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.072	0.070	0.071	0.079	0.074	0.068	0.067	0.072	0.067	0.067
Observations	340	340	340	340	340	675	675	675	675	675
Log likelihood	-178.471	-178.890	-178.553	-177.143	-178.088	-304.075	-304.401	-303.037	-304.386	-304.614

Note: Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01. All models include an intercept.

Endnotes

[1] Instead of 2020, ERP, CRM, Broadband 100+ Mbps, and Social Media refer to 2019, E-purchase to 2018, RFID and SCM to 2017. Instead of 2015, RFID and SCM refer to 2014, Big data analysis to 2016.
Data from +/- 1 year is used for countries that have no data for the indicated year.
Missing data for Canada, Chile, Costa Rica, Israel, Mexico, and United States.
Broadband: missing data for Iceland, Switzerland.
Website: missing data for Colombia, Iceland, and Switzerland.
E-purchases: missing data for Finland, Iceland, Slovenia, and Turkey.
ERP: missing data for Australia, Colombia, Iceland, Japan, New Zealand, and Switzerland.
CRM: missing data for Australia, Colombia, Iceland, Japan, New Zealand, and Switzerland.
E-sales: missing data for Colombia, Japan, and Switzerland.
SCM: missing data for Australia, Colombia, Japan, Korea, New Zealand, and Turkey.
Social media: missing data for Colombia, Korea, New Zealand, and Switzerland.
Cloud computing: missing data for Australia, Colombia, Iceland, Korea, New Zealand, Switzerland, and United Kingdom.
Big data analysis: missing data for Australia, Colombia, Austria, Iceland, Ireland, Japan, Korea, Latvia, New Zealand, Switzerland, Turkey and United Kingdom.
Broadband 100+ Mbps: missing data for Australia, Iceland, Japan, Korea, New Zealand, and Switzerland.
RFID: missing data for Australia, Colombia, Iceland, New Zealand, Switzerland, and Turkey.

[2] Firm size by number of persons employed: 10-49 (small), 50-249 (medium), 250 or more (large).
Instead of 2020, ERP, CRM, Broadband 100+ Mbps, and Social media refer to 2019, E-purchase to 2018; RFID and SCM to 2017. Instead of 2010, Broadband 100+ Mbps refers to 2011, Social media to 2013, Cloud computing to 2014, Big data analysis to 2016, and RFID to 2009.
Data from +/- 1 year is used for countries that have no data for the indicated year.
Missing data for Chile, Colombia, Costa Rica, Israel, Japan, Mexico, and United States.
Broadband: missing data for Canada, Iceland, Switzerland.
Website: missing data for Canada, Iceland, Portugal, and Switzerland.
E-purchases: missing data for Canada, Finland, Iceland, Slovenia, and Turkey.
ERP: missing data for Australia, Canada, Iceland, New Zealand, Portugal, and Switzerland.
CRM: missing data for Australia, Canada, New Zealand, and Switzerland.
E-sales: missing data for Canada, Portugal, and Switzerland.
SCM: missing data for Australia, Canada, Korea, New Zealand, and Switzerland.
Social media: missing data for Korea, New Zealand, Switzerland, and Turkey.
Cloud computing: missing data for Australia, Canada, Greece, Iceland, Korea, New Zealand, Portugal, Switzerland, Turkey, and United Kingdom.
Big data analysis: missing data for Australia, Austria, Canada, Greece, Iceland, Ireland, Korea, Latvia, New Zealand, Norway, Switzerland, and Turkey.
Broadband 100+ Mbps: missing data for Australia, Canada, Iceland, Korea, New Zealand, Portugal, Switzerland, and Turkey.
RFID: missing data for Australia, Canada, Greece, Iceland, Latvia, New Zealand, Poland, Portugal, Switzerland, and Turkey.

[3] The figures for the French, Italian, Dutch and Swedish samples include small and large firms that use at least one of the following ten ICTs tools and activities: fixed broadband, website, enterprise resource planning, customer relationship management, e-sales, e-purchases, high speed broadband, cloud computing, social media, big data analysis. The French sample includes firms from ICTS 2016/2017, N=2912. The Italian sample includes firms from ICTS 2016/2017, N=4228. The Dutch samples includes firms from ICTS 2016/2017, N=1345. The Swedish sample includes firms from ICTS 2016/19, N=866. ICTS stands for ICT Usage in Enterprises Survey. The values reported are only representative for the French, Dutch and Swedish samples used for these figures and may differ from official statistics reported by INSEE France, Statistics Netherlands, Statistics Sweden, Eurostat or the OECD due to different sectoral coverage and aggregation methods (e.g. weighting, imputation, treatment of item non-response, etc.) used for official statistics and/or selection effects in the sample.

[4] Other KBC assets are estimated on the basis of INTAN Invest data and cover all industries excluding real estate activities, public administration, education, health and households; other KBC include economic competencies (brand, organisational capital, training), design and new product development costs in the financial industry.

[5] A: ICT task-intensive occupations are defined by three-digit Groups of the 2008 revision of the International Standard Classification of Occupations (ISCO-08): Business services and administration managers (121); Sales, marketing and development managers (122); Information and communications technology service managers (133); Professional services managers (134); Physical and earth science professionals (211); Electrotechnology engineers (215); Architects, planners, surveyors and designers (216); University and higher education teachers (231); Finance professionals (241); Administration professionals (242); Sales, marketing and public relations professionals (243); Software and applications developers and analysts (251); Database and network professionals (252) and Information and communications technology operations and user support (351).

B: ICT specialist occupations are defined by three-digit groups of the 2008 revision of the International Standard Classification of Occupations (ISCO-08): Information and communications technology service managers (133), Electrotechnology engineers (215), Software and applications developers and analysts (251), Database and network professionals (252), Information and communications technology operations and user support (351), Telecommunications and broadcasting technicians (352) and Electronics and telecommunications installers and repairers (742). For Iceland, data are for 2017 instead of 2019.

[6] Respectively, digital products referred to in this paper are products whose function and/or value rely to an important extent on their digital component(s).

[7] Goods are physical objects over which ownership rights can be established and whose ownership can be transferred in market transactions (OECD, 2020[104]).

[8] Services are outputs that cannot be traded separately from their production and are not separate entities over which ownership rights can be established (OECD, 2020[104]).

[9] Data from the geolocation of portable devices can arguably also be data from the geolocation of employees' portable devices, although such data could be expected to rather be accounted for in data from smart devices and sensors.

[10] (Solon, Haider and Wooldridge, 2013[42]) further argue that in correctly specified linear regression models, selection is exogenous if the sampling probabilities are independent of the model's error term. It should also be noted that the model used here controls for firm size and industry affiliation, thereby mitigating potential bias due to selection along the size and industry dimensions.

[11] Due to specific sample characteristics, the regressions with the French sample were not possible for the analysis by firm size (large firms and SMEs).

[12] However, the relatively high shares of large firms in the French sample cannot alone explain the differences in the results with the other samples, for at least two reasons. First, the other samples also have higher shares of large firms than their respective country's firm population. Second, there

are positive and statistically significant correlations with BDA also in cases where the sample contains a lower share of firms with a specific type of innovation than measured by the country's aggregate share of firms for that innovation type, for example marketing innovation in the Dutch sample. In addition, differences in the results with samples from different countries are likely to also reflect other factors such as firms' ICT-sophistication, innovation opportunities and possibly the policy environment.

While the frequent and strong correlations of BDA with innovation as indicated by the results with the French sample may speak in particular to large (and hence likely more ICT intensive and more innovative) firms, these results – and the differences to the results with the samples that have a better firm size balance – may also be interpreted as indicating the large potential for smaller firms of carrying out BDA for innovation and, more generally, for firms that are lagging behind in adopting newer and more advanced ICTs that enable firms to effectively use big data for innovation.

[13] The term business model takes different meanings across communities and streams of literature (OECD, 2018[105]). An innovative business model is generally understood as affecting either a firm's business processes and/or its product(s) (OECD/Eurostat, 2018[103]).

[14] An online platform is a digital service that facilitates interactions between two or more distinct but interdependent sets of users (whether firms or individuals) who interact through the service via the Internet (OECD, 2019[102]).