Data Project 1: The prediction of digital skills based on SME characteristics

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1. Introduction

Futures by Design (FBD) aims to support Small and Medium Sized Enterprises (SMEs) from six regions to innovate, grow and increase productivity by making better use of data and their digital skills. In this report, we study the key determinants of digital skills based on SME characteristics.

By looking at data from over 200 SMEs from across the North Sea region (UK, Germany, the Netherlands, Sweden, and Belgium) we analyze the companies' digital skills in terms of potential and realized absorptive capacity. Absorptive Capacity reflects an SME's ability to recognise, internalize and apply the value of newly acquired external information to its work processes (Cohen and Levinthal, 1990). Absorptive capacity is seen as a precondition for the adoption of innovations in general (Leahy et al., 2007) and digital innovation in the specific.

Whilst SMEs are the backbone of most OECD economies (OECD, 2019), they face extra pressures compared to their larger counterparts due to their limited financial and human resources (Ghobadian and Gallear, 1997). However, digitalization and data driven innovation provide SMEs with an opportunity to overcome some of the challenges posed by their size, specifically, to identify opportunities, grow and access markets across regions and countries (OECD, 2019). Therefore, this report aims to gain a better understanding of the digital skills needs and barriers faced by SMEs in each of these six regions in order to be able to inform regional policies on how and where to target policy interventions that would support SMEs in realising their absorptive capacity.

To identify the key drivers and barriers of absorptive capacity in SMEs, we focus on two aspects: Potential absorptive capacity (PAC), comprising of acquisition and assimilation; and Realized absorptive capacity (RAC), comprising of transformation and exploitation (Zahra and George, 2002). Figure 1 presents the breakdown of the absorptive capacity concept. The division allows us to clearly identify which SME characteristics drive the companies' ability to identify and assimilate knowledge from external sources and which characteristics enable companies to process and make use of that external knowledge.

Figure 1 Absorptive capacity

The paper analyses a set of primary data collected from "The Jumpstart Questionnaire", a digital awareness survey, conducted with over 200 SMEs during the implementation of the EU Interreg Project "Futures By Design". The survey consists of a set of 40 questions that dive deeper into various aspects of an SME absorptive capacity, including infrastructure, tools, and culture within the organization. In the next section, we present the overview of absorptive capacity in the North Sea region and per industry and then analyze the determinants of potential and realised absorptive capacity by looking at six aspects of organizational characteristics, i.e., target market, awareness of digital tools, availability of data (data per business segments), time allocation across data processes, security and compliance and data quality. This analysis represents the first step in our investigation into how digital skills and better use of data can lead to an increase in innovation, growth, and productivity. Figure 2 presents the conceptual framework for the two-stage analysis model.

Data Project 1 Data Project 2

Figure 2 Conceptual framework

In the first stage of the analysis, we investigate SMEs characteristics and how they impact a company's PAC and RAC. Specifically, we investigate whether companies that target markets on a wider geographical scale reported a better absorptive capacity. Furthermore, we look at a company's approach to data collection, processing and visualisation (including data security and quality) and its impact on PAC and RAC. The aim is to identify the key characteristics relating to data that can support businesses increase their PAC and RAC so that, in the long term, SMEs increase their capabilities and ability to innovate and grow (this relationship is analysed and discussed in the Data Project 2). Table 1 summarizes the aspects investigated under each characteristic.

Potential determinants	Components				
Target Market	Local	Re-	National	EU Wide	Worldwide
Awareness of digital tools			Visualisation	Application program interface (API)	Reinforcement learning
Availability of data	Product Data	Financial Data		Customer Data	Employee Data
Time allocation across data processes	Gathering Data	Managing Data		Analyzing Data	Visualizing Data
Security and compliance	Overall data security importance		Consistency	Regulatory awareness	Regulation compliance
Data Quality	A synthetic measure of the overall SME data quality.				

Table 1 Digital Skills Determinants

2. Potential versus Realised Absorptive capacity

In this report we base our construct on potential and realized absorptive capacity, we adapt the items used by

Jansen, Van den Bosch, and Volberda (2005), which, in turn, are based on Zahra and George (2002) and Szulansky (1996). The items composing potential absorptive capacity (PAC), capture how companies explore, acquire and assimilate external knowledge relating to data and innovation. Realized absorptive capacity (RAC) encompasses a company's ability to transform and exploit, i.e., incorporate external technological knowledge into their firm. In Table 2, below, we match the questions from our *Jumpstart Questionnaire*, with the key items composing PAC and RAC, as identified in the above literature. The scores obtained for these variables are then obtained from a 5-point disagree-agree scale, as expressed by the respondents.

No.	Items	Matched questionnaire questions
Potential absorptive capacity (PAC)		
1	New opportunities to serve our clients are understood rapidly	*Q191 My colleagues often bring new ideas and developments with regard to data to the table*
2	We analyze and interpret changing market demands promptly	*Q193 My organization strives for fast adoption of innovations in the field of data*
3	Employees record and store newly acquired knowledge for future reference	*Q201 My Organization is aware of the possibilities of working with data*
4	We quickly recognize the usefulness of new external knowledge to existing knowledge	*Q204 My organization often takes part in events with data as one of the main topics*
Realized absorptive capacity (RAC)		
1	We incorporate external technological knowledge into our firm	*Q202 My organization likes to work with external parties when it comes to data gathering and analyses*
2	We thoroughly grasp the opportunities new external knowledge offers our company	*Q206 When new data becomes available, I use this to review my opinion*
3	We periodically meet to discuss the consequences of market trends and new product development	*Q192 My colleagues in general know their way around with new data-related technologies*
4	Employees are clearly aware of how the firm's innovation activities should be performed	*Q196 I am confident that the data within my organization is up to date*
5	We are constantly reviewing how to better exploit external knowledge	*Q194 When it comes to data, my organization has the means and opportunities to implement new developments quickly*
6	Employees share a common language to refer to our products and services	*Q212 Within my organization everybody uses the same software (Office, Salesforce, Dynamics, etc.)*

Table 2 Potential and Realized absorptive capacity

2.1 Country overview

Looking at the data across the North Sea region, we see a great variation in realized and potential absorptive capacity ranging from 1, 'strongly disagree', to 5 'strongly agree', where 3 is 'neutral'. On average, realized absorptive capacity appears to outperform potential absorptive capacity, i.e., most companies believe they are performing better in the transformation and exploitation of data technology, deriving new insights and consequences from the combination of existing and newly acquired knowledge, and incorporating transformed knowledge into operations (Zahra and George, 2002). Despite critical knowledge not always being easily

available through external sources (Argote, 2011), SMEs do relatively well in identifying and acquiring new external knowledge and in assimilating knowledge obtained from external sources. Nevertheless, few SMEs have made full use of the power of digital technology in businesses. It is likely that the reduced rate of digital technology exploitation is caused by the barriers SMEs encounter, including limited internal resources and awareness, high financial vulnerability, and skill gaps. As such, SMEs continue to lag behind in digital transformation. Among the North Sea region, Sweden is leading in the digitalization of SMEs, followed by England, Belgium, Netherlands, and Germany (Figure 3). The results suggest that due to their limited resources, SMEs focus on making the most of data technology however, there seems to be unrealised potential to further explore and assimilate external knowledge. Therefore, policy interventions can support SMEs to firstly identify, acquire and internalise external knowledge (increase PAC) and secondly, to develop their digital capabilities and increase their RAC.

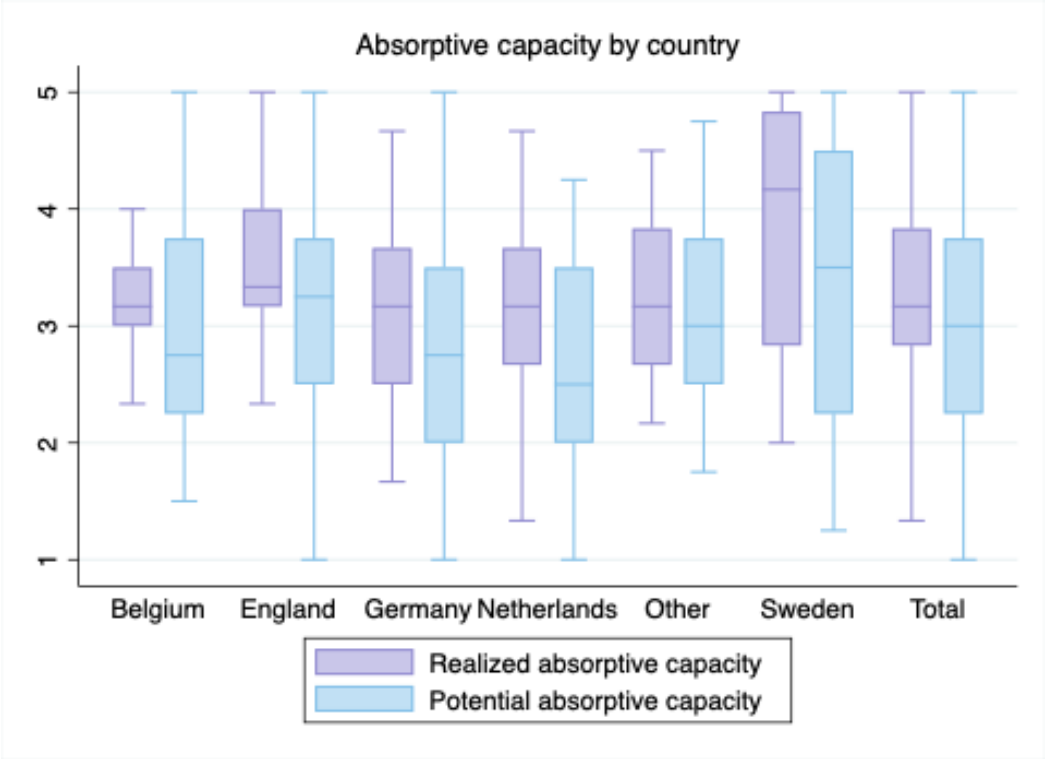

Figure 3 Absorptive capacity by country

2.2 Sectoral analysis

When looking at our data on a sector level, at first glance, there are striking differences between the sectors in terms of digital skills. IT sector followed by Education and Energy sectors reported a higher RAC. Given the nature of businesses and radical changes in business environments, these sectors proactively transform and exploit the knowledge for profit generation. Meanwhile, agriculture, forestry, and fishing sectors have the urgency to increase productivity, however, farmers face constant changes caused by technological advances, manifested by low potential and realized absorptive capacity (dos Santos et al., 2021). A general overview of the absorptive capacity of digitalization by sector can be found in Figure 4. It is also remarkable the level of variability within each sector. For example, in the energy sector PAC fluctuates between very low levels (score of 2) to companies reporting the highest levels of both PAC and RAC (5). These results suggest there is no consistency in data practices at sector level with each company doing their best to maximise their resources

and capabilities. Furthermore, the variability would suggest that the best practices are not shared across companies in the same industries suggesting there is potential for networks and hubs to facilitate knowledge exchange. These results support the findings of Dubouloz et al. (2021) who find that both high-tech and low-tech sectors encounter the same innovation barriers. Therefore, targeted policy interventions could support SMEs across sectors overcome these barriers and develop their digital capabilities.

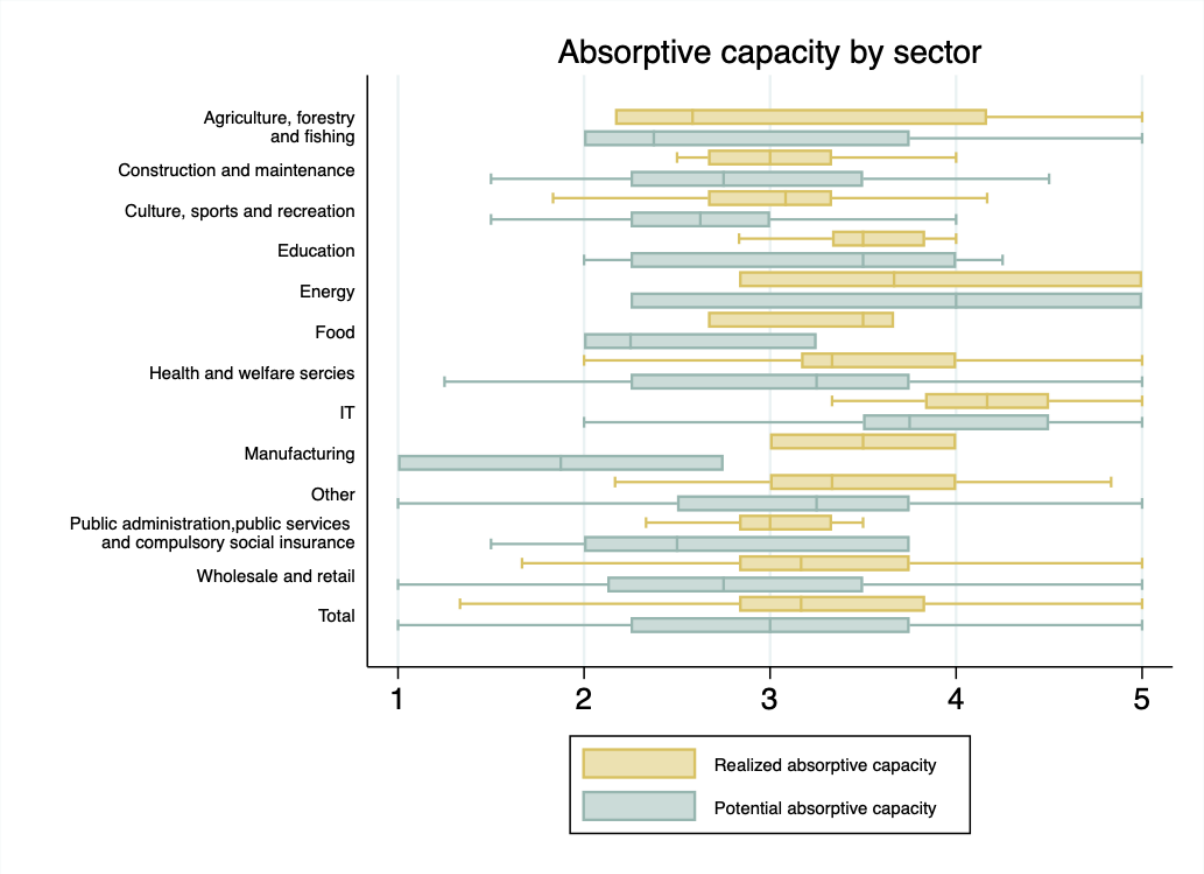

Figure 4 Absorptive capacity by sector

3. Determinants of digital skills

While digitalization has been shown to contribute to performance (Li et al., 2021), it is important to study a firm's absorptive capacity to recognize, assimilate and apply the value of new information to commercial ends (Cohen and Levinthal, 1990; Jansen et al., 2005; Zahra and George, 2002). More importantly, determining a firm's realized absorptive capacity, that is, the capability to develop and transform the combined existing knowledge and the newly acquired in real applications helps identify the innovative capabilities that influence financial performance (Cohen and Levinthal, 1990; Zahra and George, 2002). In this report we offer some insights on how organizational parameters affect the acquisition and assimilation (PAC), and transformation and exploitation (RAC) of external knowledge. Specifically, this report focuses on six aspects of organizational characteristics, i.e., target market, awareness of digital tools, availability of data (data per business segments), time allocation across data processes, security and compliance, and data quality. The statistical results are presented in Appendix 1, and visualized in Figure 5. In the following discussion section, we summarize the key

takeaways from the results, focusing on the significant effects only.

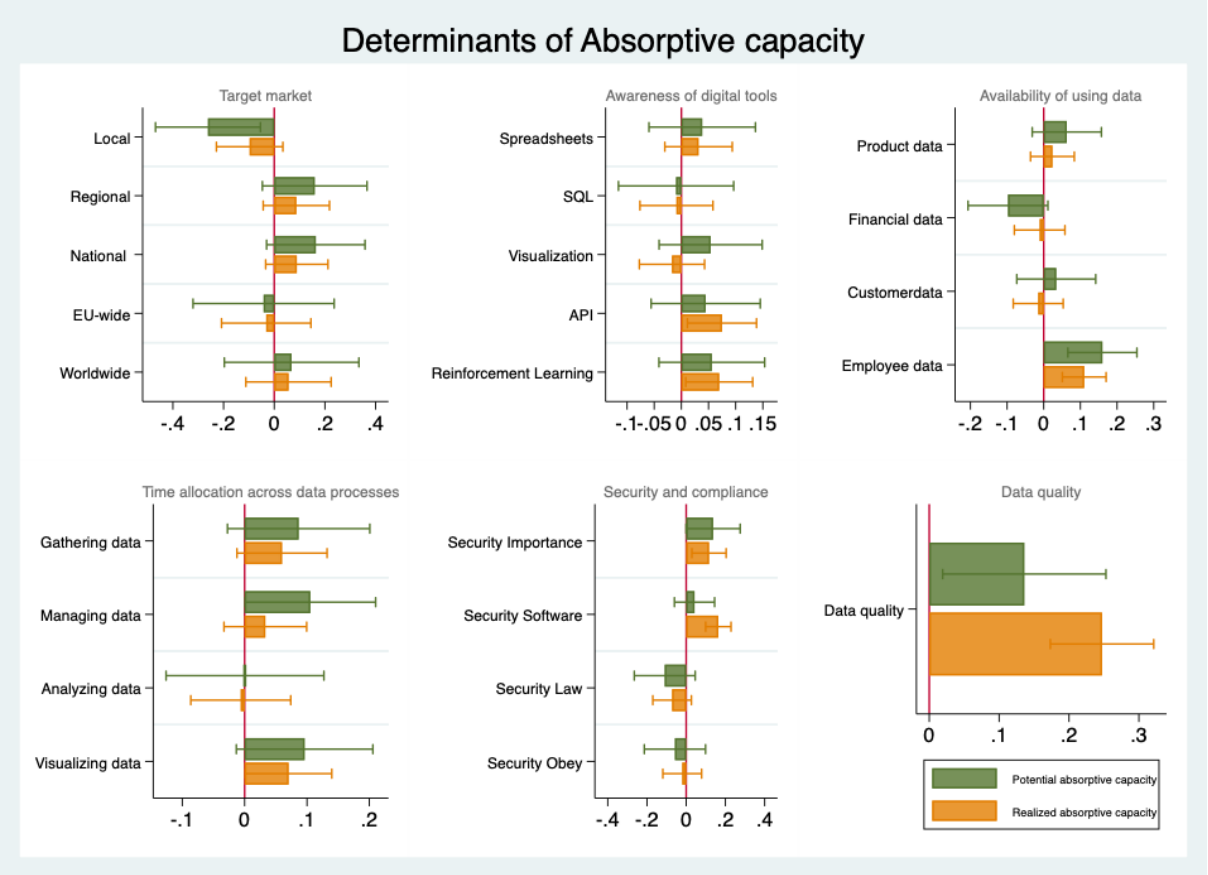

Figure 5 Determinants of absorptive capacity[1]

- *The lack of market knowledge implies difficulties in collaborating with other firms, access to various sources of information thus constrains the opportunities to learn and innovate.* Most SMEs trade within their local market with few businesses operating at a EU-wide or worldwide market level. Due to their low exposure to external resources and markets, firms rely heavily on the knowledge within the firm. It limits their ability to use prior knowledge and diversified background to identify the value of new information and to transform it into product, service or process innovation. To increase SMEs' absorptive capacity one should facilitate both their exposure to experiences from diverse markets on how to internationalise, and the extensive knowledge of a specific market's unique features (Eriksson, Johanson, Majkgård and Sharma, 1997, Eriksson, Johanson, Majkgård and Sharma, 2000). Our results suggest that if companies expand their trading from local to the national level, the impact on PAC changes from negative to positive, i.e., if companies are supported to expand their areas of trade, it actually can help them develop their abilities to identify and make better use of external knowledge in the future. Thus, policy support in increasing their PAC could have long-term impact on improving the company's learning ability and long-term prospects.

- *Data usage efficiency and data quality lay a foundation for technological innovation.* SMEs in general have a poor efficiency of data usage. SMEs often have limited usage of big data, mostly using financial and employee data, whilst lacking insights into product and customer data as these are often driven by

1 Add comment on confidence interval – significance.

the market and/or larger businesses. There is a size-related gap with only 12% of SMEs using big data compared to 33% of large firms (Vodafone, 2020). SMEs are still at the early stage of acquisition and assimilation of data and knowledge and tend to be limited to managing and visualizing data. SMEs are vulnerable to market dynamics and competition due to their lack of big data analysis skills which would allow SMEs to have insights into their business environment. To progress digitalization, SMEs need to expand their data usage. Besides, in this process, data quality also plays a key role in increasing the value of big data. Interestingly, results show that focusing on financial data has a negative impact on both potential and realised absorptive capacity. SME managers believe they must focus on their financial performance even though, our findings show that this might lead to companies missing external opportunities. Conversely, our results suggest that focusing on employee data can result in an increase in PAC and RAC. These findings support past studies on tacit knowledge in SMEs which state that knowledge in SMEs is rarely explicit or formalised (Dosi, 1988; Polanyi, 1967; Nelson and Winter, 1982). Therefore, policy interventions should focus on supporting SMEs in increasing their RAC by making better use of data on different segments of the business as well as having clearer processes around managing and analyzing data. The interventions would aim to decrease the gap between PAC and RAC for data usage and increase the overall RAC to decrease the gap in digital skills and data use between SMEs and large businesses.

- *A proper digital transformation is based on sensing and learning capabilities, whilst digital awareness is key to developing the resilience of digitalization within an organization.* Awareness of digital tools is the first step in the adoption of new technologies (Garzoni, De Turi, Secundo, and Del Vecchio, 2020). SMEs that are aware of the benefits of digital tools, e.g., API and reinforcement learning, often value more technology integration and place the adoption of new technologies among their priorities. These companies, thus develop the necessary skills to quickly and efficiently adapt to market changes and achieve sustainable growth of their businesses. Thus, a policy aimed at increasing and facilitating exposure SME managers to these digital tools can have a positive impact on company's abilities to recognise and make use of external knowledge. Specifically, the focus should be on API and reinforcement learning tools as these have a significant positive impact on RAC. Findings are consistent with OECD's (2019) report on SME and Entrepreneurship Outlook which finds access to skills as a key dimension that could unleash SMEs potential to drive innovation, productivity, and growth.

4. Conclusion

In this report, we investigated the impact of six SME characteristics with a specific focus on data usage and digital skills and their impact on absorptive capacity, i.e. a company's ability to recognise, assimilate and exploit external knowledge with the ultimate goal to improve their performance (increase productivity, growth and innovate). Our results show that SMEs' digital skills and use of data are generally underdeveloped which results in a limited PAC and RAC. Therefore, the knowledge and skills gap represent opportunities for policy interventions that could unleash SME growth potential.

Firstly, we found that companies that trade at a larger scale (regional, national, or worldwide) report higher

PAC and RAC. Furthermore, we found that there is little consistency in terms of the level of absorptive capacity across sectors. Therefore, a first recommendation would be to increase knowledge exchange across companies to increase their exposure to external resources. This could be achieved through the creation of networks and hubs that would facilitate collaboration between companies. Our findings support past research on the role of networking in driving innovation suggesting that exchanging knowledge with suppliers, customers, and intermediaries (professional and trade associations) can contribute to firms obtaining access to new markets and technologies and speeding products to market (Pittaway's et al., 2004; Brunswicker and Vanhaverbeke, 2014; Dubouloz et al., 2021). Thus, governments could support SMEs' competitiveness and innovativeness by investing in the development of knowledge exchange hubs and trade associations to foster business collaborations.

Secondly, we find that SMEs that have a higher awareness of digital tools report significantly higher RAC. Therefore, access to (external) knowledge helps SMEs benefit from open innovation as they can adapt quickly to market changes and adopt new technology (Dubouloz et al., 2021). Our findings support OECD (2021) SME policy recommendations, specifically that governments should provide direct support through targeted policies that would improve digitalisation. However, the reported variability in PAC and RAC across all industries suggests that the policy interventions should not only focus on innovative new ventures or high growth firms but should be broader to support SMEs across the spectrum to increase their productivity and absorptive capacity. Such interventions would also support to bridge the skills gap reported by SMEs and enable them to increase their digital capabilities by making better use of data within their organisation.

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Appendix 1 Determinants of digital skills (Potential & Realized AC)

	(1)			(2)			
VARIABLES	Potential AC			Realized AC			
2.countrynum	0.144	0.056		2.countrynum	0.045	Q155Tools ReinforcementLe	0.070**
	(0.186)	(0.049)			(0.118)		(0.031)
3.countrynum	0.136	0.063		3.countrynum	-0.147	Q161AnalyzesProduct-data	0.024
	(0.191)	(0.048)			(0.121)		(0.030)
5.countrynum	0.016	-0.098*		5.countrynum	-0.057	Q162AnalyzesFinan-cialdat	-0.011
	(0.182)	(0.055)			(0.115)		(0.035)
6.countrynum	0.076	0.034		6.countrynum	-0.214	Q163Customerdata	-0.015
	(0.207)	(0.055)			(0.131)		(0.035)
7.countrynum	-0.010	0.160***		7.countrynum	0.073	Q164Employeedata	0.110***
	(0.214)	(0.048)			(0.136)		(0.030)
Q7GeographicLocal	-0.262**	0.087		Q7GeographicLocal	-0.097	Q181TimeGatheringdata	0.060
	(0.105)	(0.058)			(0.066)		(0.037)
Q7GeographicRe-gional	0.160	0.105**		Q7GeographicRe-gional	0.087	Q182TimeManagingdata	0.033
	(0.105)	(0.053)			(0.066)		(0.034)
Q7GeographicNa-tional	0.164*	0.001		Q7GeographicNational	0.089	Q183TimeAnalyzingdata	-0.006
	(0.098)	(0.064)			(0.062)		(0.041)
Q7GeographicEUwide	-0.042	0.096*		Q7GeographicEUwide	-0.032	Q184TimeVisualizing-data	0.070**
	(0.141)	(0.055)			(0.089)		(0.035)
Q7Geographic Worldwide	0.068	0.137*		Q7Geographic Worldwide	0.056	Q211SecurityImportance	0.116***
	(0.135)	(0.070)			(0.085)		(0.044)
Q151Tools Spreadsheets	0.038	0.042		Q151Tools Spreadsheets	0.032	Q212SecuritySoftware	0.164***
	(0.050)	(0.052)			(0.031)		(0.033)
Q152ToolsSQL	-0.010	-0.109		Q152ToolsSQL	-0.009	Q213SecurityLaw	-0.072
	(0.054)	(0.079)			(0.034)		(0.050)
Q153Tools Visualization	0.054	-0.057		Q153ToolsVisualiza-tion	-0.017	Q214SecurityObey	-0.020
	(0.048)	(0.079)			(0.030)		(0.050)
Q154ToolsAPI	0.045	0.136**		Q154ToolsAPI	0.075**	DataqualityJADS	0.247***
	(0.051)	(0.059)			(0.032)		(0.037)
Constant		0.521		Constant		0.461**	
		(0.320)				(0.203)	
Observa-tions	204	Observa-tions	204				
R-squared	0.619		0.769				
Adj. R-squared	0.56	Adj.	0.73				