Organizations in the knowledge economy. An investigation of knowledge-intensive work practices across 28 European countries

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Abstract

Purpose – This paper aims to investigate whether the shift towards the knowledge economy (e.g. an increasing reliance in knowledge in the production of goods and services) is related to the work practices of organizations (aimed at the provision of autonomy, investments in training and the use of technology).

Design/methodology/approach – The analyses are based on data about over 20,000 companies in 28 European countries. National level indicators of knowledge intensity are related to the work practices of these organizations. Multilevel analysis is applied to test hypotheses.

Findings – The results show that there is a strong and positive relationship between the knowledge intensity of the economy and the use of knowledge intense work practices.

Originality/value – To the best of our knowledge, this is one of the first papers to test whether knowledge intensity at the national level is related to the work practices of organizations.

Keywords Organizational design, Knowledge management, Diffusion of innovation, Knowledge economy

Paper type Research paper

Introduction

The shift toward the knowledge economy is believed to move organizations toward more flexibility, decentralization and autonomy (Alvesson, 2004; Powell and Snellman, 2004; Foss, 2005; Makani and Marche, 2010; Khadir-Poggi and Keating, 2013; Lee, 2015; Ullah and Narain, 2020; Valeri, 2021). A basic assumption in these studies is that structures and practices of organizations are affected by the environment in which they operate (Neef, 1999; Ferreira *et al.*, 2018). While prior studies generated important insights, there are several ways to improve our understanding of the link between the knowledge economy and organizational practices. The present article aims to close three gaps in the current literature.

First, much of the research provides indirect evidence by focusing on the connection between the knowledge economy and work, rather than on the practices of organizations. For example, previous studies investigating how factors such as globalization and technological change affect labor demand (Wood, 1987; Burris, 1998; Cerny, 1999; Martinaitis *et al.*, 2020) focus on tasks and jobs of workers (Aoyama and Castells, 2002; Fernández-Macías, 2012; Sakamoto *et al.*, 2018; Kalleberg and Mouw, 2018). Other studies do center on organizations and the role of decentralization, adaptation and innovation in knowledge intense economies (Switzer, 2008; Hodgson, 2016), but they remain largely theoretical. The present study fills this void by analyzing three knowledge-intensive work practices (KIWPs), namely

(1) decentralized decision making (producing knowledge), (2) organizational learning practices (developing and distributing knowledge) and (3) the use of technology (applying knowledge). These work practices are derived from three approaches to organizations, namely the dynamic capabilities approach, organizational learning theories and models of technology adoption and diffusion.

Secondly, it is necessary to think about the knowledge economy in the sense of *the degree of knowledge intensity* of the economy, instead of stating that modern organizations operate in a knowledge economy (Powell and Snellman, 2004; Manville and Ober, 2003; Nurunnabi, 2017). In this study, innovation is the independent rather than the dependent variable, which is common in innovation research (e.g. Crossan and Apaydin, 2010; Koster, 2021). In the present study, innovations serve as the starting point and the question is whether this creates an environment to which organizations adapt. Hence, the analyses relate to organizational mechanisms, such as learning and dynamic capabilities, emphasizing how organizations change their structures and processes to remain competitive (Felin and Powell, 2016; Kapoor and Aggarwal, 2020). This leads to a more fine-grained understanding of how the knowledge economy affects organizations.

Finally, investigating how knowledge intensification of the economy relates to the work practices of organizations requires comparative research of organizations operating in different environments. Since knowledge intensification of the economy is a macro level factor, cross national research is required. Therefore, empirical research is conducted connecting the economy and the practices of organizations operating in *different countries*. Hence, this study answers to the call in the literature for more organizational research across countries (Greenwood *et al.*, 2014).

To date, these three conditions are not met in a single study. Instead, there are studies of knowledge-intensive organizations and about the knowledge economy. But there is very little connection between them, while this is needed to show how the knowledge economy relates to the management of organizations. Gaining insights in the relationship between knowledge intensification of the economy and the work practices of organizations also has practical value for managers and consultants. Most and for all, this research helps organizations identifying which practices matter if they aim to increase their knowledge intensity. Furthermore, considering that economies vary in their level of knowledge intensity, research showing that knowledge intensification relates to organizational practices enables learning across organizations. For organizations in less knowledge intense economies, this information can help them to prepare them for the future (considering that economies move in the direction of increased knowledge intensity) and for organizations in the more knowledge intense economies it provides a benchmark to assess whether their current practices fit their environment.

Data of 20,672 companies in 28 countries gathered through the fourth European Company Survey (ECS), which was held in 2019, are combined with country level data about the knowledge intensity of the economy. These national level data (the European Innovation Scoreboard: EIS) are constructed by the European Commission (2020). This article is structured as follows. In the next section, the link between knowledge intensity of the economy and knowledge intense work practices is further theorized and explored. The theoretical section results in the general hypothesis that organizations use more knowledge intense work practices if they operate in a knowledge economy, which is then tested using a multilevel regression analysis. Theoretical and practical implications are discussed in the closing section.

Work practices in the knowledge economy
The term knowledge economy is often used, but not always clearly defined. Powell and Snellman (2004) are an exception as their overview of studies into the knowledge economy

starts with a clear definition, namely: the production of services and goods based on "knowledge-intensive activities" and a "greater reliance on intellectual capabilities" (p. 201). Technological changes and innovations underlie this shift in production processes. Although it is generally accepted that economies tend to move in the direction of a knowledge economy, there is some debate about the way in which it proceeds. The two sides of this debate focus on different aspects of the relationship between technology and economy. There are those believing that economies are entering a completely new phase that can be termed a "new economy". These authors tend to argue that there is an abrupt break with the old economy because of technological change (see for example Schwab, 2016). Such conceptualizations of the economy view it as a series of distinguishable periods. However, historically it has happened too often that such breaks were announced, while afterward they turned out to be gradual changes and much of the economy stayed the same. This change-within-stability position is therefore taken by many researchers (Boyd and Holton, 2018). A different position is taken by those arguing that one should look at the outcomes of these changes to conclude whether economies are entering a new era. This position is for example reflected by the well-known "productivity paradox" as well as by the theoretical argument that technological change is far less deterministic than is often assumed (Burris, 1998; Swedberg, 2005; Boyd and Holton, 2018; Brynjolfsson *et al.*, 2018).

In other words, several researchers point out that technological change is not automatically visible in organizations, work practices, or productivity. Nevertheless, that technological change takes place is not disputed. In other words, while we are not entering a completely new economic reality disrupting the old economy, it is acknowledged that changes occur. For these changes to be visible, technologies need to be applied and used by workers and organizations to be effective (Foster and Rosenzweig, 2010; Wensing and Krol, 2019). Conceptualizing the knowledge economy in terms of varying levels of knowledge intensity rather than dichotomously (stating that an economy is either a knowledge economy or not) is more accurate. It is a matter of degree.

The more knowledge intense the economy, the stronger the emphasis is on the producing, diffusing and applying knowledge (Adler, 2001; Powell and Snellman, 2004). These knowledge-intensive activities are sometimes termed "knowledge work". Nevertheless, the term needs further clarification as it refers to different aspects. Different conceptualizations can be found across the literature (Kelloway and Barling, 2000). A large share of research regards knowledge work as work that is performed by a specific group and focuses on professions and occupations (e.g. Adler *et al.*, 2008; Paton, 2013). Other researchers emphasize the importance of personal characteristics and activities, such as creativity and individual learning, that enable workers to thrive in the knowledge economy. And still others argue that knowledge works implies specific behaviors like creating and sharing knowledge and information (Kelloway and Barling, 2000). Without a doubt, occupations, persons, activities and organizational behavior are important aspects of knowledge work. Nevertheless, it overlooks the *organizational side* of the knowledge economy. That is, it does not include the mechanisms that are necessary for an organization to function in a knowledge-intensive environment. At the same time, it is through these organizational mechanisms that the knowledge economy affects the content of work, which then in turn leads to changes in the occupational structure and demand different kinds of activities and behavior in the workplace. The literature on knowledge-intensive organizations provides insights in some of the mechanisms and work practices that are central to such organizations stimulating and enabling the production, diffusion and use of knowledge (Pyöriä, 2005).

Due to technological changes, the economic landscape reflects a system of economic opportunities based on connections and information (Carlsson, 2004). This economic landscape is characterized by increasing knowledge intensity, a stronger focus on the adaptability of organizations as they operate in an economic system that is more dynamic due

to the use of technology and the need to process information inside and outside organizations. The next question is what the implications are for the organization of work.

While there is some debate how to analyze knowledge work (and whether it refers to work in specific sectors or occupation or should be viewed as a kind of work behavior), when focusing on the characteristics of this work, the following stand out. Pyöriä (2005) distinguishes two ideal types of work, namely "traditional" and "knowledge" work. Knowledge work (1) puts more emphasis on professionalism, self-management and job and task circulation compared to traditional work; (2) is less standardized than traditional work; and (3) requires more learning (both in terms of formal education and on-the-job learning) compared to traditional work. Instead of focusing on the extremes of these types, it is also possible to interpret them as relative positions on a continuum from traditional to knowledge work. Again, it is not an either/or situations, but a matter of degree whether an organization has these knowledge work characteristics. In the next section, it is hypothesized how organizational practices relate to knowledge intensification.

Explaining KIWPs
Several organizational theories explain why organizations would apply certain practices in more knowledge intense economies. The main explanations are provided by theories concerning dynamic capabilities, organizational learning and the use of technology. Each of these set of theories focuses on different aspects of knowledge processes that are central to the knowledge economy.

The *dynamic capabilities approach* offers insights into how organizations achieve fit with their environment (Teece, 2014). The dynamic capabilities approach distinguishes dynamic capabilities from ordinary capabilities that enable organizations to manage their day-to-day operations. Having dynamic capabilities enables organizations to change, adapt and innovate by sensing opportunities and threats, seizing opportunities and reconfiguring resources remain competitive since they are also more innovative (Teece, 2007). Research into these capabilities shows that they relate to the structure and governance of organizations. Regarding the knowledge intensity of organizations, several studies show that these organizational tend to rely more on self-organization, autonomy and decentralized decision making (Wu, 2015; Felin and Powell, 2016; Grandori, 2016; Young-Hyman, 2017). This is mainly the case because knowledge work requires decision making and finding solutions to unfamiliar (instead of routine) problems (Jacobs, 2017). Therefore, if the economy is more knowledge intense, work practice will be adopted in line with these organizational mechanisms.

H1. From this it follows that it is expected that the more knowledge intense the economic environment is, the more organizations rely on decentralization.

Organizational learning takes place through social processes facilitating the creation of new knowledge and its application in organizations (Levitt and March, 1988; Argote and Miron-Spektor, 2011). As such, it is directly related to the knowledge intensity of the environment. Organizational enablers of learning work in formal (procedures and policies) as well as in informal ways (related to norms and organizational culture) (Berta *et al.*, 2015). These learning mechanisms range from the abstract (e.g. organizational routines) to the practical (Argote, 2011). The latter includes the practices of organizations to increase their stock of human capital (Antonacopoulou, 2006; Argote and Miron-Spektor, 2011). This usually involves investments in the formal training of workers (Koster and Benda, 2020). Beyond these formal practices are the informal practices through which people in organizations learn, such as learning-on-the-job (Bishop, 1996; Berg and Chyung, 2008). The formal and informal learning practices help organizations to develop unique resources enabling them

to be competitive (Barney, 1991; Calantone *et al.*, 2002; Jiménez-Jiménez and Sanz-Valle, 2011). As increased competition is a characteristic of the knowledge economy, having learning practices increases the fit between organizations and their environment. Furthermore, it is a means to respond to the knowledge intensity of work that is central to the knowledge economy (Obeso *et al.*, 2020).

H2. From this it follows that it is expected that the more knowledge intense the economic environment is, the more organizations rely on formal and informal learning.

A third stream of organizational theories that help understanding KIWPs focuses on the application of knowledge in organizations *using technology*. Knowledge application can be distinguished from the production and development of knowledge (Zack, 1999; Baskerville and Dulipovici, 2006) and this distinction is for example found in studies concerning the availability of technologies that are new to organizations and the actual application and use of them (Davis, 1986; Struik *et al.*, 2014). In the conceptualization of knowledge work, Pyöriä (2005) emphasizes the role of using information technology as an integral part of that kind of work. While acknowledging that there are also cases in which these technologies do not coincide with knowledge work, it can be argued that it works the other way around: people doing work that is more knowledge-intensive are more likely the work with IT. In that sense, information technologies support knowledge workers in their jobs (Jacobs, 2017).

H3. From this it follows that it is expected that the more knowledge intense the economic environment is, the more organizations have technology-related work practices.

Whereas these three theoretical arguments lead to predictions about the relationship between knowledge intensity of the economy and the application of knowledge intensive work practices about organizations, they should not be regarded as exclusive theories and predictions. Instead, it is much more likely that these work practices are combined and bundled into a package as is also predicted by theories of knowledge work, as they state that knowledge needs to be created, developed and applied to be effective (Pyöriä, 2005; Bahar, 2019; Obeso *et al.*, 2020).

H4. Hence, the overall prediction is that it is expected that the more knowledge intense the economic environment is, the more organizations have KIWPs.

Figure 1 presents the research model that was developed in the previous sections. On top, there are the national level factors that are hypothesized to be related to the knowledge-intensive work practices that reside at the organizational level. Besides that, the figure acknowledges that knowledge intensity is not the only explanation of KIWPs and that there may be other factors at the organizational and the national level that also explain them.

Data and methods
Data
Data from different sources are combined to conduct the analyses. Data at the organizational level are available through the ECS 2019 (ECS; Van Houten and Russo, 2020). The data for this survey are collected by the European Foundation for the Improvement of Living and Working Conditions (Eurofound) and the European Center for the Development of Vocational Training (Cedefop). This fourth edition of the ECS contains information about 21,869 establishments in 28 European countries (27 EU (European Union) member states and the UK). These company level data are combined with data at the national level. These national
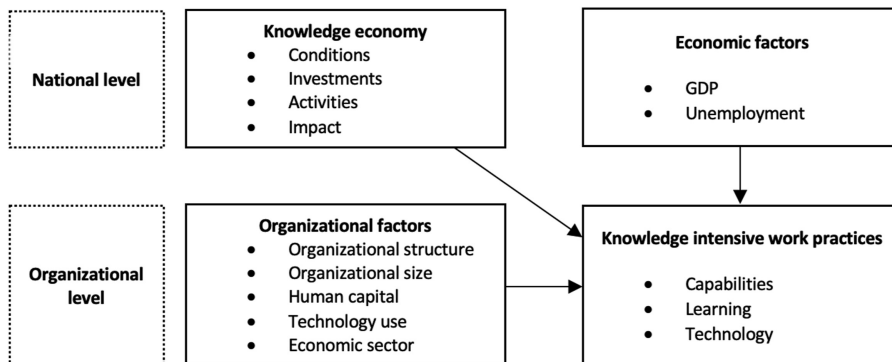
level data provide the possibility to investigate the impact of the knowledge intensity of the economy on KIWPs. Besides that, several control variables at the national level are included in the analyses. These national level data are accessed through Eurostat. The national level data are available for all 28 countries. There are, however, some missing values in the ECS; a total of 1,197 companies did not provide responses to the dependent variable in this study. These companies are excluded, and the analyses are carried out on the remaining 20,672 companies.

Measures
Knowledge-intensive work practices (KIWPs). The dependent variable – KIWPs – is constructed as follows. Based on the theoretical frameworks outlined above, it was argued that organizations generate three practices under conditions of knowledge intensification, namely practices enabling them to adapt to changing circumstances, to enhance learning and to use technology. The ECS includes measures capturing these practices. The ability to deal with changing circumstances is indicated with two questions about the unpredictability of the work and leeway of workers to adjust their work. Learning in the organizations is captured with three questions about the need to train workers, their participation in training and whether their work involved learning on the job. The use of technology is measured with a question indicating to what extend workers use PCs or laptops. The exact wording of the items is provided below.

(1) For how many employees in this establishment does their job include finding solutions to unfamiliar problems they are confronted with? Your best estimate is good enough. [*Unfamiliair problems*].

(2) For how many employees in this establishment do their job include independently organizing their own time and scheduling their own tasks? Your best estimate is good enough. [*Scheduling*].

(3) How many employees in this establishment are in jobs that require continuous training? Your best estimate is good enough. [*Continuous training*].

(4) In 2018, how many employees in this establishment participated in training sessions on the establishment premises or at other locations during paid working time? Your best estimate is good enough. [*Participation in training*].

(5) In 2018, how many employees in this establishment have received on-the-job training or other forms of direct instruction in the workplace from more experienced colleagues? Your best estimate is good enough. [*On-the-job training*].

(6) How many employees in this establishment use personal computers or laptops to carry out their daily tasks? Your best estimate is good enough. [*Computers*].

Respondent are asked to indicate on a seven-point scale for each of these questions to how many of the employees it applies. The categories of these items are as follows: none at all, less than 20%, 20–39%, 40–59%, 60–79%, 80–99% and all.

Since these are separate items in the questionnaire, there is the possibility that they measure aspects of organizations that are unrelated. To assess whether the items measure a construct that can be labeled KIWPs, a reliability analysis is performed. This analysis shows that the items have a Cronbach's alpha of 0.71. Therefore, it is concluded that the items can be combined into a single scale. This scale is created by adding the scores on the items. These scores are divided by six. Hence the final scale also runs from 1 to 7.

Knowledge intensity economy. To measure the knowledge intensity of the economy, data from the European Innovation Scoreboard (EIS; European Commission, 2020). The EIS is an index consisting of scores on 4 sub-dimensions (consisting of 10 innovation dimensions), namely (p. 8):

(1) Framework conditions

    a. Human resources (educational level)

    b. Attractive research systems (international competitiveness)

    c. Innovation-friendly environment (opportunities)

(2) Investments

    a. Finance and support (financial resources)

    b. Firm investments (knowledge investments)

(3) Innovation activities

    a. Innovators (number of innovators)

    b. Linkages (collaboration)

    c. Intellectual assets (property rights)

(4) Impacts

    a. Employments impacts (knowledge intense employment)

    b. Sales impacts (exports and sales)

For detailed information about the dimensions and the underlying indicators, see the EIS 2020 methodology report (European Commission, 2020). The indicators are measured with Eurostat data. Following an extensive procedure, these data are transformed to calculate an index: The Innovation Index that runs from 0–1 in theory. The Innovation Index is used as an indicator for measuring the knowledge economy. Powell and Snellman (2004, p. 202) mention different approaches to measuring the knowledge economy, such as a focus on "stock of knowledge" (e.g. human, organizational and intellectual capital) or "activities" (e.g. R&D efforts, investments in information and communication technology). The advantage of the Innovation Index is that it does not have a narrow focus and integrates these approaches into

a single measure. Hence, it includes several dimensions that are generally assumed to be central to the knowledge economy.

Control variables
At the national level, the analyses of knowledge-intensive work practices are controlled for GDP per capita in purchasing power standards (GDP pps) and the level of unemployment. Both statistics are taken from the Eurostat database. GDP pps expressed in relative terms, with a score of 100 as the EU average. The variable has a minimum of 53 and a maximum of 260 (the values are divided by 10). The level of unemployment is indicated with the percentage of the labor force without work and lies between 2 and 19%.

At the level of the establishments, several control variables are included. Three variables measure the use of technology by these establishments by asking whether they use it or not. Hence, these variables are dummy variables, with a 0 indicating that these technologies are not present and a 1 that they are. The variable *robots* are measured with the question "Robots are programmable machines that are capable of carrying out a complex series of actions automatically, which may include the interaction with people. Does this establishment use robots?", the variable *IT production* is measured with the question "Does this establishment use data analytics (Data analytics refers to the use of digital tools for analysing data collected at this establishment or from other sources) to improve the processes of production or service delivery, and the variable *IT monitoring* is measured with the question "Does this establishment use data analytics to monitor employee performance?". The variable *hierarchical levels* is measured with the question "... how many hierarchical levels do you have in this establishment?". Then there are three questions measured on a 7-point scale (none at all, less than 20%, 20–39%, 40–59%, 60–79%, 80–99%, and all) about the employees in the establishment. The variable *% managers* is measured with the question "How many people that work in this establishment are managers? Your best estimate is good enough", the variable *% permanent employees* is measured with the question "How many employees in this establishment have an open-ended contract? Your best estimate is good enough", and the variable *% part-time* is measured with the question "How many employees in this establishment work part-time (part time refers to working less than 35 h per week)? Your best estimate is good enough". The final variable *organizational size* is measured by asking the question "Approximately how many people work in this establishment?". The variable organizational size has three categories, namely: 10–49, 50–249 and 250 and more.

Table 1 provides the summary statistics for all variables included in this study. As this table shows, the most common of the six KIWPs relates to the use of PCs and laptops and on-the-job-training. Secondly, there is considerable variation in the measure of knowledge intensity of the economy. Robots are used in 12% of the companies and IT systems for production and monitoring are applied more often (49 and 32% respectively). Finally, it is worth noting that organizations of different sizes and from all economic sectors are represented. Regarding organizational size, Table 1 shows that most organizations are small (with 10–49 workers).

Method
The dataset has a hierarchical structure: companies are nested in countries. The overall expectation is that the knowledge economy at the country level is related to the knowledge intensity of the work practices that these companies apply. To get an accurate estimation it is necessary to take account of this nested structure of the data. Therefore, multilevel models (Snijders and Bosker, 2011; Bickel, 2007) are estimated. Such models enable to distinguish variance at different levels, in this case the country level and the company level. To assess these models, several statistics are computed. The intraclass correlation

	Min/Max	Median	Mean	S.D.	Percentage
Knowledge-intensive work practices	1/7	3.5	3.60	1.16	
Unfamiliar problems	1/7	3	3.19	1.61	
Scheduling	1/7	3	3.44	1.77	
Continuous learning	1/7	3	3.23	1.78	
Participation in training	1/7	3	3.78	1.91	
On-the-job training	1/7	4	3.88	1.77	
Computers	1/7	3	4.01	2.02	
Innovation Index (EIS)	0.16/0.71		0.48	0.49	
Framework conditions	0.17/0.86		0.51	0.20	
Investments	0.14/0.75		0.47	0.17	
Innovation activities	0.10/0.76		0.51	0.18	
Impacts	0.30/0.86		0.50	0.12	
GDP pps	53/260		98.64	29.94	
Unemployment	2/19		6.78	2.66	
Robots	0/1				11.62
IT production	0/1				49.45
IT monitoring	0/1				31.54
Hierarchical levels	1/10		3.10	0.90	
% managers	1/7		2.11	0.52	
% permanent	1/7		5.87	1.51	
% part-time	1/7		2.23	1.32	
Organizational size	1/3		1.48	0.68	
10–49	0/1				62.40
50–249	0/1				27.30
250+	0/1				10.30
Mining and quarrying	0/1				0.43
Manufacturing	0/1				24.56
Electricity	0/1				0.09
Water supply	0/1				1.59
Construction	0/1				10.38
Wholesale	0/1				19.99
Transportation and storage	0/1				6.02
Accommodation and food service activities	0/1				6.02
Information and communication	0/1				3.81
Financial and insurance activities	0/1				2.00
Real estate activities	0/1				1.36
Professional. scientific and technical activities	0/1				6.41
Administrative and support service activities	0/1				3.06
Arts. entertainment and recreation	0/1				3.11
Other service activities	0/1				10.41

Table 1.
Descriptive statistics

Source(s): European Company Survey (ECS) 2019 and European Innovation Scoreboard (EIS) 2020 20,672 establishments in 28 countries

coefficients (ICC) indicate how much of the variance resides at these two levels. The ICC provides information about the extent to which there is country level variance that can be explained by adding variables at that level. The next step in multilevel modeling is to investigate what happens to these variances after adding these variables. By adding company and country level variables, the ICC becomes smaller if they explain national level variation in KIWPs. Furthermore, by focusing on the variances at the two levels and by examining how they change after the additional variables are included, it is possible to assess how much of that variance is explained at the country level as well as at the company level. The fit of the multilevel models is investigated with likelihood ratio tests (Peugh, 2010;

Snijders and Bosker, 2011; Hox *et al.*, 2017). This test does not provide enough information to assess the fit of the model. However, by comparing the likelihood tests between the models, allows to test whether the difference between the models is statistically significant. The difference is called the deviance and is tested with a chi-squared test (with the number of parameters that are tested as the degrees of freedom) (Snijders and Bosker, 2011).

For the present analyses, several steps are taken to test the hypotheses. First, the focus is on the composite measure of KIWPs (based on the results of the scale analysis). To get a baseline against which the consecutive models are compares, a so-called empty model is estimated. This empty model does not include explanatory variables and provides that variances at the country and the company level. Then a model is estimated with the control variables at the country level and the company level. The third model also includes the indicator for the knowledge economy (the Innovation Index). Besides testing the significance of these explanatory variables, it is also investigated whether it leads to an improvement of the model if these variables are added. Furthermore, it is assessed how much of the variance at the two levels is explained. Next to that, several other models are estimated, namely models with the separate KIWPs (six in total) and models in which the sub-dimensions of the Innovation Index are investigated separately. The models are structured using the same procedure as the models with the composite measure as the dependent variable. These additional tests serve as sensitivity analyses to see how robust the initial models are if other specifications are chosen.

Results

Based on the country averages of the KIWPs (presented in Table 2), it can be concluded that the use of these practices is more common in Sweden, the UK and Finland and that companies in Romania, Bulgaria and Lithuania make less use of these practices. On a scale from 1–7, the average use in Sweden is 4.6 and 2.6 in Romania. Focusing on their scores on the Innovation Index, Sweden and Romania also have the highest and the lowest scores (0.71 and 0.16, respectively). To get a first impression of how the knowledge economy relates to the use of KIWPs, the correlation between the Innovation Index and the country level mean of the use of KIWPs is calculated. This analysis shows that there is a positive and statistically significant associated between them ($r = 0.78$). Figure 2 shows this relationship. Clearly, there is a positive association between the innovation index and the use of KIWPs at the aggregate level. The next question is whether this association also holds in a multilevel framework controlling for factors at the national level and the level of the companies. To investigate this, several multilevel regression models are calculated.

Table 3 presents the results of the multilevel analysis with the composite measure of KIWPs as the dependent variable. Starting with the control variables, the following insights are gained. At the national level, GDP pps is positively related to the use of KIWPs. Furthermore, several characteristics at the company level explain the use of KIWPs. Notably, companies relying on robots and the two kinds of data analytics positively relate to the use of KIWPs. These practices are also more often applied in companies with more managers, more permanent workers, more fulltime workers and in smaller companies. Finally, it turns out that there are sectoral differences. The results show that KIWPs are particularly used by companies in three sectors: financial and insurance activities, professional, scientific and technical activities, and information and communication. Overall, these results emphasize the role of knowledge intensity at the organizational level in explaining KIWPs.

The final model presented in Table 3 also includes the knowledge economy indicator (the Innovation Index). Regarding the control variables, adding this indicator does not change the results for the company level variables, whereas the effect of GDP disappears. The latter finding suggests that higher GDP results in more knowledge intensity of the economy.

Country	N	KIWPs	Innovation index
Austria	977	3.82	0.60
Belgium	963	3.66	0.62
Bulgaria	957	3.04	0.23
Croatia	521	3.27	0.30
Cyprus	115	3.45	0.45
Czechia	835	3.64	0.43
Denmark	987	4.03	0.68
Estonia	468	3.61	0.50
Finland	1,008	4.14	0.71
France	1,288	3.67	0.53
Germany	682	3.76	0.61
Greece	472	3.17	0.39
Hungary	1,026	3.18	0.34
Ireland	286	3.81	0.57
Italy	1,404	3.54	0.42
Latvia	490	3.17	0.32
Lithuania	458	2.95	0.40
Luxembourg	219	3.84	0.64
Malta	135	3.78	0.43
Netherlands	1,011	3.69	0.65
Poland	768	3.10	0.30
Portugal	913	3.59	0.49
Romania	721	2.86	0.16
Slovakia	334	3.42	0.34
Slovenia	526	3.46	0.43
Spain	1,383	3.59	0.43
Sweden	1,058	4.56	0.71
The United Kingdom	667	4.19	0.61
Total	20,672	3.60	0.48

Source(s): European Company Survey (ECS) 2019

Table 2.
Number of
establishments, mean
level of KIWPs and
Innovation Index per
country
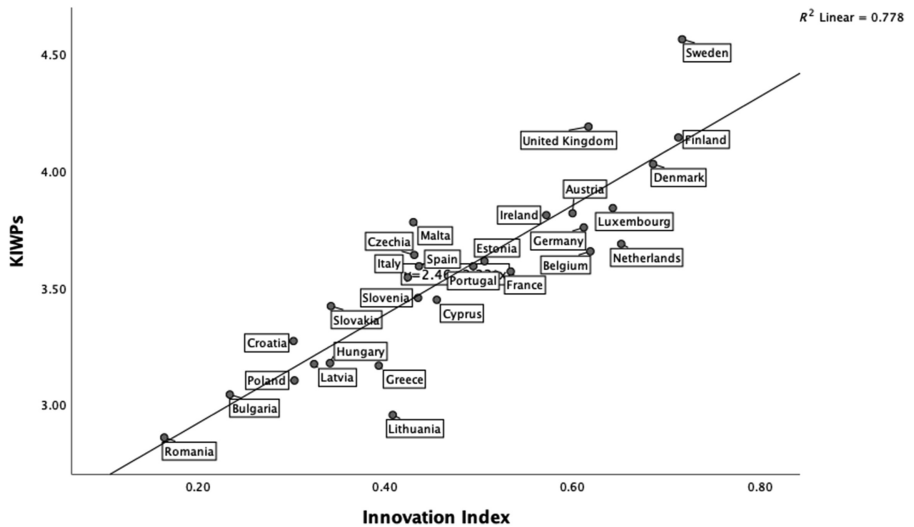
Figure 2.
Correlation between
Innovation Index and
national mean
of KIWPs

		(0)			(1)			(2)	
	b	se	p	b	se	p	b	se	p
Intercept	3.62	0.08	0.00	1.83	0.25	0.00	1.35	0.15	0.00
Country level									
Innovation Index							2.43	0.30	0.00
GDP pps (/10)				0.04	0.02	0.01	0.00	0.02	0.88
Unemployment				−0.02	0.02	0.39	−0.01	0.01	0.24
Company level									
Robots				0.12	0.02	0.00	0.12	0.02	0.00
Data analytics – process				0.34	0.02	0.00	0.34	0.02	0.00
Data analytics – employee performance				0.14	0.02	0.00	0.14	0.02	0.00
Hierarchical levels				0.01	0.01	0.14	0.01	0.01	0.13
% managers				0.26	0.01	0.00	0.26	0.01	0.00
% permanent employees				0.06	0.00	0.00	0.06	0.00	0.00
% part-time employees				−0.03	0.01	0.00	−0.03	0.01	0.00
Organizational size				−0.12	0.01	0.00	−0.12	0.01	0.00
Mining and quarrying (reference)									
Manufacturing				0.09	0.11	0.39	0.09	0.11	0.39
Electricity				0.66	0.13	0.00	0.66	0.13	0.00
Water supply				0.30	0.12	0.01	0.30	0.12	0.01
Construction				0.30	0.11	0.01	0.30	0.11	0.01
Wholesale				0.59	0.11	0.00	0.59	0.11	0.00
Transportation and storage				0.38	0.11	0.00	0.38	0.11	0.00
Accommodation and food service activities				0.17	0.11	0.14	0.17	0.11	0.14
Information and communication				1.40	0.11	0.00	1.40	0.11	0.00
Financial and insurance activities				1.52	0.12	0.00	1.52	0.12	0.00
Real estate activities				0.83	0.12	0.00	0.83	0.12	0.00
Professional. scientific and technical activities				1.45	0.11	0.00	1.44	0.11	0.00
Administrative and support service activities				0.79	0.11	0.00	0.79	0.11	0.00
Arts. entertainment and recreation				0.57	0.11	0.00	0.57	0.11	0.00
Other service activities				0.74	0.11	0.00	0.74	0.11	0.00
Variance country level	0.16	0.04	0.00	0.11	0.03	0.00	0.03	0.01	0.00
Variance company level	1.15	0.01	0.00	0.88	0.01	0.00	0.88	0.01	0.00
Intraclass Correlation (ICC)	0.12			0.11			0.03		
% company variance explained				0.30			0.71[a]	0.80[b]	
−2 Log likelihood		55101,33			50215,25			50183,16	
Deviance					4886,08			32,09	

Note(s): [a] Compared to model with control variables; [b] Compared to the empty model
Source(s): European Company Survey (ECS) 2019, Eurostat, and European Innovation Scoreboard (EIS) 2020 20,672 establishments in 28 countries

Table 3.
Multilevel regression analysis of knowledge-intensive work practices

Furthermore, there is a significant and positive relationship between the Innovation Index at the national level and the use of KIWPs, thus supporting the overall hypothesis that the knowledge economy is positively related with the knowledge intense work practices of organizations.

Looking at the explanatory contribution of the different models, the following is concluded. First, based on the empty model (the model without explanatory variables), Table 3 shows that 12% of the variance in KIWPs can be attributed to the national level. The other 88% is due to variance at the company level. Secondly, adding the control variables at the company and the country level reduces the variance at both levels. At the company level

the reduction is 23% and at the country level the reduction is 31%. Finally, in the third model shown in Table 3 which includes the knowledge economy, the share of country level variances drops to 3% (implying a change of 75% in the intraclass correlation coefficient). Then, comparing the variance at the national level in the final model with that of the empty model, the Innovation Index reduces it with 80%. Put differently, besides having a positive and statistically significant impact, the Innovation Index explains a large share of the country level variance in KIWPs.

Before stating the overall hypothesis (Hypothesis 4), three sub-hypotheses about the knowledge economy were formulated, namely that the knowledge economy would be related to decentralization, (formal and informal) learning and the use of technology. The models presented in Tables 4 and 5, test these hypotheses, using information about unfamiliar problems and scheduling to indicate decentralization, variables measuring continuous learning, participation in training and on-the-job training as indicators for training, and the use of computers to indicator technology-use. The results of these models are in line with the three separate hypotheses: The Innovation Index is positively related with each of these indicators. Hence it is concluded that Hypothesis 1–3 also find empirical support.

Regarding the extent to which these indicators are explained by the knowledge economy, it turns out that the reduction in country level variance is the strongest in the use of work practices related to decentralization (71 and 53% for scheduling and unfamiliar problems, respectively) and that the reduction in continuous learning is the lowest (21%). All in all, the empirical results are in line with the four research hypotheses formulated in the theoretical section.

Finally, models are estimated with the four sub-dimensions of the Innovation Index (framework conditions, investments, innovation activities and impacts), as the explanatory variables (these models are not reported to save space, but they are available upon request). These variables are investigated separately. The analyses show that each of these dimensions positively relates to KIWPs, with the indicator measuring framework conditions, which include human resources, attractiveness of the research system and innovation-friendliness of the environment, leading to the largest reduction of variance at the country level (compared to the empty model, the country level variance is reduced with 75%) and impacts, in terms of employment and sales, having the lowest reduction in country level variance (a reduction of 56%). Hence, while there is some variation in the impact across the different indicators of KIWPs on the one hand and the sub-dimensions of the Innovation Index, these additional analyses indicate the outcomes remain if the focus is on these separate indicators. It should also be noted that the strongest results if composite indicators are used: an overall indicator of the knowledge economy with a summary score for KIWPs leads to the strongest (in terms of explained variance) models.

Discussion and conclusion

This paper focuses on how the knowledge management practices of organizations relate to the structure of the economy in which they operate. The analysis of a representative sample of companies in 28 European countries leads to the overall conclusion that the more knowledge intense an economy is, the more likely it is that organizations apply knowledge intense work practices. This insight has several implications. First, it shows that developments external to organizations has consequences for the way they are structured, in this case: that the economic conditions that organizations deal with are transferred into the way they manage their knowledge. Whereas this is often assumed, researching organizational structures in a cross-national comparative perspective is not a common practice in organizational studies. Hence, empirically, this link is not often established. Secondly, the implication of this finding is that the knowledge intensity of the economy is associated with the knowledge intensity of

	Unfamiliar problems			Scheduling			Continuous learning		
	b	se	p	b	se	p	b	se	p
Intercept	2.19	0.28	0.00	1.47	0.28	0.00	2.76	0.34	0.00
Country level									
Innovation Index	2.39	0.43	0.00	2.96	0.40	0.00	1.50	0.56	0.01
GDP growth	−0.01	0.02	0.49	−0.02	0.01	0.30	−0.01	0.02	0.75
Unemployment	−0.01	0.01	0.63	−0.03	0.01	0.05	0.00	0.02	0.92
Company level									
Robots	−0.14	0.04	0.00	−0.01	0.04	0.77	−0.17	0.04	0.00
Data analytics – process	−0.29	0.02	0.00	−0.26	0.03	0.00	−0.32	0.03	0.00
Data analytics – employee performance	−0.07	0.03	0.00	0.02	0.03	0.57	−0.28	0.03	0.00
Hierarchical levels	−0.06	0.01	0.00	−0.09	0.01	0.00	0.03	0.02	0.03
% managers	0.30	0.02	0.00	0.37	0.02	0.00	0.10	0.02	0.00
% permanent employees	0.05	0.01	0.00	0.08	0.01	0.00	0.04	0.01	0.00
% part-time employees	−0.04	0.01	0.00	−0.05	0.01	0.00	−0.01	0.01	0.21
Organizational size	−0.22	0.02	0.00	−0.21	0.02	0.00	0.03	0.02	0.12
Mining and quarrying (reference)									
Manufacturing	0.20	0.16	0.23	0.21	0.17	0.23	−0.02	0.18	0.91
Electricity	0.59	0.20	0.00	0.68	0.21	0.00	0.91	0.22	0.00
Water supply	0.27	0.18	0.14	0.32	0.19	0.10	0.47	0.20	0.02
Construction	0.41	0.17	0.01	0.49	0.18	0.01	0.41	0.18	0.03
Wholesale	0.44	0.16	0.01	0.71	0.17	0.00	0.49	0.18	0.01
Transportation and storage	0.27	0.17	0.11	0.48	0.18	0.01	0.82	0.19	0.00
Accommodation and food service activities	0.24	0.17	0.16	0.17	0.18	0.34	0.25	0.19	0.18
Information and communication	1.30	0.17	0.00	1.78	0.18	0.00	1.30	0.19	0.00
Financial and insurance activities	0.73	0.18	0.00	1.63	0.19	0.00	1.87	0.20	0.00
Real estate activities	0.63	0.19	0.00	1.46	0.20	0.00	0.64	0.21	0.00
Professional. scientific and technical activities	1.22	0.17	0.00	1.85	0.18	0.00	1.42	0.19	0.00
Administrative and support service activities	0.53	0.17	0.00	1.07	0.18	0.00	0.80	0.19	0.00
Arts. entertainment and recreation	0.63	0.17	0.00	0.90	0.18	0.00	0.42	0.19	0.03
Other service activities	0.67	0.17	0.00	0.95	0.18	0.00	0.73	0.18	0.00
Country level variance	0.06	0.02		0.05	0.01		0.10	0.03	
Company level variance	2.14	0.02		2.40	0.02		2.69	0.03	
Intraclass Correlation (ICC)	0.03			0.02			0.04		
Statistics control model									
Country level variance	0.13	0.04		0.17	0.05		0.13	0.04	
Company level variance	2.14	0.02		2.40	0.02		2.69	0.03	
Intraclass Correlation (ICC)	0.07			0.06			0.05		
% company variance explained [a]	0.53			0.71			0.21		
Deviance	20.65			29.52			7.13		

Note(s): [a] Compared to the empty model
Source(s): European Company Survey (ECS) 2019, Eurostat, and European Innovation Scoreboard (EIS) 2020 20,672 establishments in 28 countries

the work practices for all organizations in an economy. This in turn provides evidence for the discussion about how to understand the knowledge intensification of the economy and whether this concentrated in certain sector of the economy or whether it means that it affects all organizations. Based on the empirical results of this paper, the conclusion is in favor of the latter; the knowledge economy impacts all organizations.

	On-the-job learning			Participation in training			Computers		
	b	Se	p	b	se	p	b	se	p
Intercept	3.62	0.37	0.00	2.80	0.49	0.00	1.92	0.35	0.00
Country level									
Innovation Index	2.14	0.64	0.00	3.08	0.95	0.00	2.48	0.63	0.00
GDP growth	−0.03	0.02	0.21	−0.02	0.03	0.65	−0.02	0.02	0.42
Unemployment	−0.01	0.02	0.22	−0.01	0.03	0.86	−0.02	0.02	0.31
Company level									
Robots	−0.27	0.04	0.00	−0.15	0.04	0.00	0.03	0.04	0.47
Data analytics – process	−0.34	0.03	0.00	−0.34	0.03	0.00	−0.49	0.03	0.00
Data analytics – employee performance	−0.26	0.03	0.00	−0.24	0.03	0.00	0.03	0.03	0.28
Hierarchical levels	0.09	0.02	0.00	0.10	0.02	0.00	0.02	0.01	0.24
% managers	0.17	0.02	0.00	0.14	0.03	0.00	0.48	0.02	0.00
% permanent employees	0.02	0.01	0.02	0.06	0.01	0.00	0.10	0.01	0.00
% part-time employees	0.03	0.01	0.00	−0.01	0.01	0.53	−0.09	0.01	0.00
Organizational size	−0.09	0.02	0.00	0.01	0.02	0.57	−0.26	0.02	0.00
Mining and quarrying (reference)									
Manufacturing	0.27	0.19	0.14	−0.39	0.19	0.04	0.21	0.17	0.20
Electricity	0.17	0.22	0.43	0.11	0.23	0.63	1.34	0.20	0.00
Water supply	0.19	0.21	0.35	0.05	0.21	0.82	0.40	0.19	0.03
Construction	0.45	0.19	0.02	−0.09	0.19	0.62	0.06	0.17	0.74
Wholesale	0.51	0.19	0.01	−0.11	0.19	0.56	1.43	0.17	0.00
Transportation and storage	0.28	0.19	0.15	−0.03	0.20	0.90	0.37	0.17	0.03
Accommodation and food service activities	0.76	0.19	0.00	−0.39	0.20	0.05	−0.09	0.17	0.59
Information and communication	0.99	0.19	0.00	−0.05	0.20	0.79	3.02	0.17	0.00
Financial and insurance activities	0.95	0.20	0.00	0.93	0.21	0.00	2.89	0.18	0.00
Real estate activities	0.27	0.21	0.20	0.23	0.22	0.28	1.69	0.19	0.00
Professional. scientific and technical activities	1.01	0.19	0.00	0.41	0.19	0.04	2.71	0.17	0.00
Administrative and support service activities	0.85	0.20	0.00	0.02	0.20	0.91	1.41	0.18	0.00
Arts. entertainment and recreation	0.42	0.20	0.03	−0.12	0.20	0.56	1.06	0.18	0.00
Other service activities	0.63	0.19	0.00	0.05	0.19	0.79	1.31	0.17	0.00
Country level variance	0.13	0.04		0.30	0.09		0.13	0.04	
Company level variance	2.72	0.03		2.96	0.03		2.28	0.02	
Intraclass Correlation (ICC)	0.05			0.09			0.05		
Statistics control model									
Country level variance	0.19	0.06		0.42	0.13		0.21	0.04	
Company level variance	2.72	0.03		2.96	0.03		2.28	0.02	
Intraclass Correlation (ICC)	0.07			0.13			0.08		
% company variance explained	0.31			0.29			0.38		
Deviance	10.51			10.82			13.31		

Table 5.
Multilevel regression analysis of knowledge-intensive work practices

Note(s): [a] Compared to the empty model
Source(s): European Company Survey (ECS) 2019, Eurostat, and European Innovation Scoreboard (EIS) 2020 20,672 establishments in 28 countries

Regarding the application of knowledge-intensive work practices, the following is concluded. Most and for all, the analyses show that organizations apply these practices in unison rather than as separate and isolated means of governing knowledge. This finding was mainly corroborated with the empirical result that these practices are positively related with each other and form a sufficiently reliable scale. Besides that, the finding that the knowledge

intensity of the economy equally affects the underlying indicators, further strengthens the idea that organizations apply these practices as a bundle rather than focusing on each of these practices individually. This, then has implication for theories concerning the knowledge management of organizations. As was explained in the theory section, there are at least three theoretical approaches the enable to link the knowledge economy with the knowledge management practices of organizations, namely the dynamic capabilities approach, organizational learning theory and theories concerning the use of technology in organizations. Since each of these theories focuses on a specific part of these practices and establishing that these practices are applied in unison, it can be argued that integrating them is necessary to get a full theoretical account of organizations and their management in the knowledge economy. In other words, dynamic capabilities, organizational learning and the use of technology are all part of it. The present analysis provides the step toward an integrated model based on these three theoretical approaches. It should be noted, it was possible to link the chosen practices to these approaches, but that this is not to say that these are the only practices or theoretical notions that matter for understanding organizations in the knowledge economy. Nevertheless, since other practices could not be satisfactory covered in this analysis, this asks for additional research.

Additional research is needed in the following directions to overcome the empirical shortcomings of this paper (e.g. a reliance on cross-sectional data and analyzing secondary data). This first route to be explored relates to a move toward the knowledge economy. An underlying assumption in the literature is that economies are moving in the direction of increasing knowledge intensity. That this is the case is not disputed here. However, even though the current analysis points in the direction of changes in the structure and governance of organizations due to the spread to the knowledge economy, the cross-sectional data do not allow causal statements. Hence, longitudinal data are needed for future research to assess whether changes in the economy also translates into changes in organizations and their knowledge management. What is crucial in this respect is that the indicators for the knowledge economy as well as indicators for the knowledge intensity of the work practices are available for a sufficiently long period of time. One of the drawbacks may be that the focus will be somewhat narrower as this relaxes the possibility of constructing a longitudinal dataset. The second direction for future research means taking a different approach, namely a further advancement of the measurement of KIWPs. In this paper, it was possible to construct a scale based on secondary data enabling the assessment of the work practices. The next step is to strengthen this measurement. There are two points that need attention to achieve that. To begin, the indicators used here can be taken as the starting point to create an improved scale measuring KIWPs that are derived from the three theoretical approaches (dynamic capabilities, organizational learning and the use of technology). To develop these indicators, it is additionally required to assess whether the three theoretical approaches suffice for that purpose or that other theoretical approaches are necessary to include as well. The resulting measure should be richer in terms of content (covering KIWPs more broadly) as well as its theoretical base (and the possibility to generate an integrated model of these work practices). A third direction for future research concerns the fit between the environment and organizational practices. Whereas literature suggests that external fit should enhance organizational performance, it is still an open question whether this holds in the case of knowledge intensity of the economy.

Finally, some practical implications can be distilled from this paper. The first is that knowledge-intensive organizations and organizations in which knowledge intensity is increasing, are advised to look at the way in which they structure and govern their organization. Since autonomy, learning and technology are central feature of knowledge intense organizations, they could consider whether their practices are in place. In addition to that, it makes sense to have these work practices in bundles. Therefore, it makes sense to see

whether autonomy, learning and technology are governed consistently in the organization. And, finally, as the results show that the economic environment matters for these practices, it is advised to have mechanisms to scan external development that are relevant for their KIWPs. The present study provides concrete ideas how to do that. Managers and consultants can use the measures of knowledge intensity and KIWPs to assess organizations. For example, they can ask the question whether the organization provides sufficient training to their workers, given the knowledge intensity of the environment in which it operates.

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