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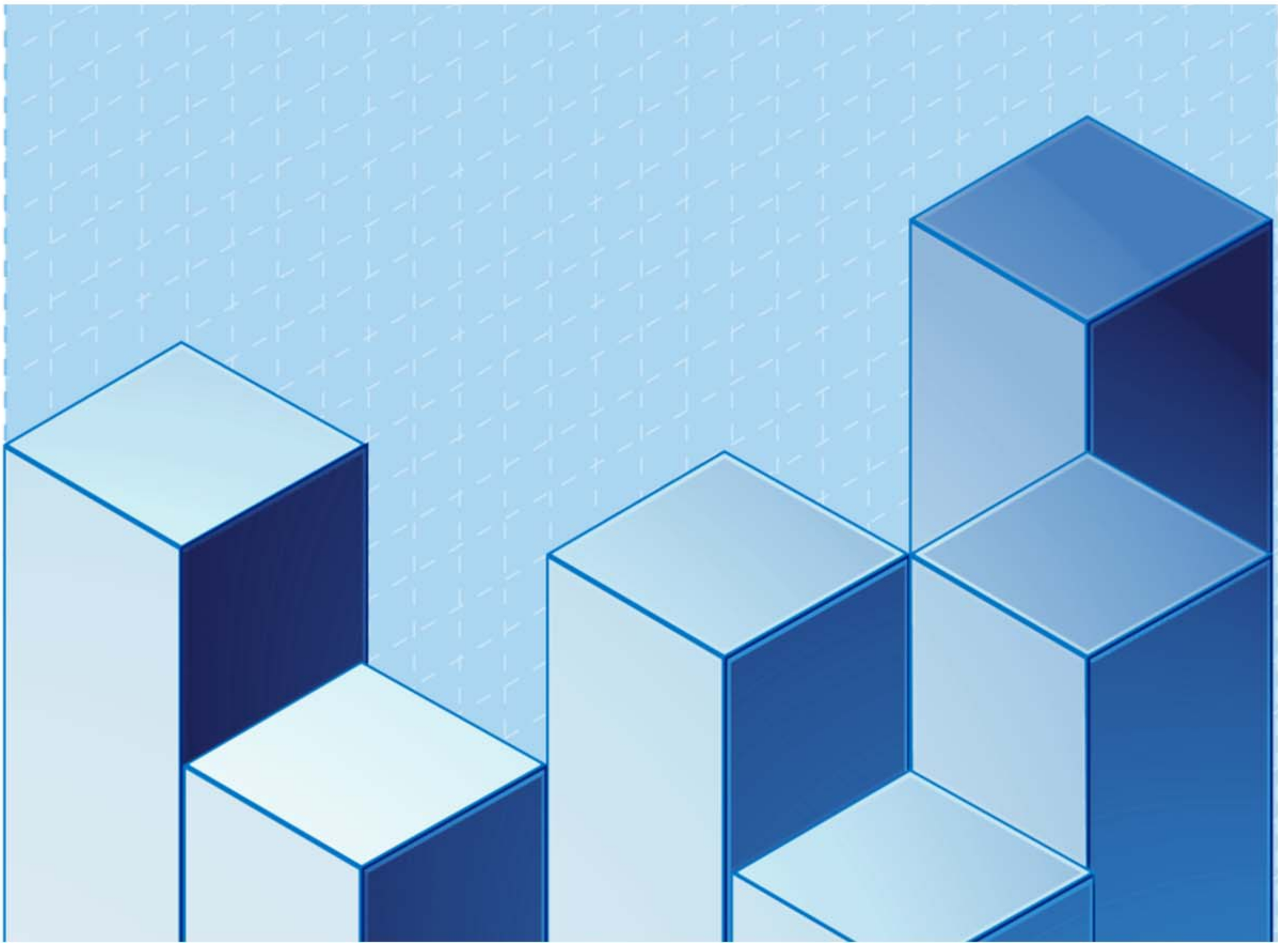

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INVESTMENT IN ORGANISATIONAL CAPITAL: METHODOLOGY AND PANEL ESTIMATES*

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Abstract

This work proposes a task-based methodology for the measurement of employment and investment in organisational capital (OC) in OECD countries. OC is defined as firm-specific organisational knowledge resulting from the performance of tasks affecting the long-term functioning of firms. Country-specific occupations accruing to the generation of OC are identified on cross-country worker data reported in the OECD Programme for the International Assessment of Adult Competencies (PIAAC). In-house investment in OC is then estimated à la Corrado, Hulten and Sichel (2009) as 20% of wages paid to OC-related occupations. Total investment in OC for 2012 is found to range from 1.4% of value added in the Czech Republic to 3.7% in the United Kingdom, with an average 2.2% across all countries. Managers appear to account for less than half of total employment and investment in OC, with total investment in OC is higher in services than in manufacturing. Extending the methodology to estimate a panel of industry-level investment for 20 EU countries and the U.S. yields similar patterns. Experimental figures of OC investment for the public sector suggest that intensity in investment in OC appears to be higher in the public sector than in the private sector.

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** M. Le Mouel: DIW Berlin, German Institute for Economic Research and OECD, Economic Analysis and Statistics Division (EAS); L. Marcolin: OECD, Economic Analysis and Statistics Division (EAS); M. Squicciarini: OECD, Economic Analysis and Statistics Division (EAS).

Note: The "Organisational capital database" is available at SPINTAN Project website (www.spintan.net)

1. Introduction

Organisational capital (OC) is an elusive concept whose importance is nevertheless widely acknowledged, as it is found to correlate positively with firm performance and productivity (e.g. Hansen and Wernerfelt, 1989; Brynjolfsson et al., 2002). The numerous definitions that exist generally emphasise the knowledge and information-based systemic nature of organisational capital, its role in linking tangible and intangible assets, and its strategic importance (e.g. Prescott and Visscher, 1980; Black and Lynch, 2005).

Several studies have engaged in quantifying firms' investments in this important type of knowledge-based capital (KBC), in uncovering the relationship linking investment in OC and in other types of KBC to differences in firms' performance (e.g. Aral and Weill, 2007), and in assessing the extent to which investment in KBC shapes entrepreneurial dynamics and productivity. These studies often follow an expenditure-based approach and rely on selling, general and administrative (SGA) expenses, or on managerial wages data to proxy investment in OC. Corrado, Hulten and Sichel (2005, 2009, henceforth CHS) rely on managers' compensation and on the revenues of the management consulting industry to proxy own account and purchased OC respectively, and investigate the role of KBC in driving aggregate US productivity growth.

While significantly contributing to a better understanding and measurement of KBC in general, and of OC in particular, these approaches nevertheless do not provide a clear definition of what organisational capital is or does, and may overestimate (in the case of SGA) or underestimate (in the case of CHS 2005, 2009) such investment. On the one hand, SGA expenses encompass a wider category of assets than OC alone. On the other hand, the literature has long suggested that firms' organisational capabilities reside in a number of occupations including but not limited to managers. The increasing prevalence of distributed leadership (von Krogh et al. 2012), coupled with jobs being interpreted as organisational building blocks arising out of the bundles of tasks performed under different administrative job titles (Cohen, 2013) call for the use of task-based rather than occupational title-based criteria when identifying and measuring investment in OC (Prescott and Visscher, 1980; Black and Lynch, 2005).

The present work capitalises on the task-based approach first presented in Squicciarini and Le Mouel (2012) and proposes a definition of organisational capital and a measurement approach that builds on the organisational, management and economics literatures. It defines organisational capital as the firm-specific organisational knowledge resulting from the performance of tasks affecting the medium and long-term functioning of firms. The tasks considered involve, to varying degrees: developing objectives and strategies; organising, planning and prioritising work; building teams, matching employees to tasks, and providing training; supervising and coordinating activities; and communicating across and within groups to provide guidance and motivation.

The task-based methodology of Squicciarini and Le Mouel (2012) is here implemented on novel cross-country data available in the OECD Programme for the International Assessment of Adult Competencies (PIAAC) survey. This is done to validate the results first obtained using O*NET data and to gain further insights on the extent to which organisational knowledge is generated by managers and other occupations and about the possible differences that may exist across countries.

To this end information relating to tasks performed at work by different occupations, available in the PIAAC survey for 20 countries, is exploited to identify those occupations carrying out OC-related tasks to the highest extent. In total, around 20 broad occupational classes of the International Standard Classification of Occupations (ISCO 2008), including managerial, professional and associate professional occupations in business administration, science and engineering, health, and education, are identified as contributing to the generation and accumulation of own-account OC.

Secondly, exploiting the cross-country nature of the PIAAC dataset, this analysis tests the ‘homogeneity’ assumption implicitly made by the OC measurement literature whereby cross-country estimates, when they exist, are based on methodologies devised for and tested on one country only – typically the United States – and then replicated on other countries (e.g. INTAN-Invest estimates). Doing so entails implicitly assuming that countries are broadly similar in their industrial structures and framework conditions, and that organisational practices and investment are to a great extent homogeneous across countries. However, recent literature, including a number of studies led by Bloom and Van Reenen (e.g. Bloom and Van Reenen, 2007, 2010; Bloom et al., 2012), provides compelling evidence on the existence of cross-country differences in management practices and organisational arrangements. The OECD PIAAC data offer a unique opportunity to explore the country-specific nature of OC.

Thirdly, OC-related employment and investment figures for the year 2012 are estimated using the labour force participation and earnings information contained in the PIAAC survey. This is done following existing definitions of own-account or in-house investment in OC (especially from CHS), whereby 20% of the earnings of OC-related occupations is considered own-account investment in OC. The resulting estimates suggest that at the aggregate level, employment in all OC-related occupations and total OC investment figures are on average 2.5 times higher than those resulting from considering managerial occupations only. This implies that estimates based on managers might underestimate OC. Also, thanks to the wealth of information contained in the PIAAC database, OC employment and investment figures have been estimated at levels which had not been hitherto considered due to data limitations: by industry, by firm size (micro firms; small and medium enterprises; and large firms), and by the public or private nature of the firm.

Finally, the proposed task-based methodology is used to estimate investment in OC over 2000-11 for 26 industry and 21 EU countries and the U.S.. To this end, data about wages and employment in OC occupations from the European Labour Force Survey (EULFS), the European Structure of Earnings Survey (SES) and the U.S. Current Population Survey (USCPS) are used. Also, figures related to the intensity of OC investment by macro sectors of the economy are obtained for the considered years, in a similar fashion to what done in the cross-sectional part of the analysis. The declination of OC investment by firm size over the panel, however, is left to future work.

When compared with INTAN-Invest investment information these new estimates of organisational capital are found to be highly correlated, with OECD estimates evidently being higher in levels than INTAN-Invest's ones. Also, and to compare the proposed estimates with recent cross-country analysis, this work further investigates the extent to which they align with the management practices-related estimates stemming from the World Management Survey (2004-2010). No strong correlation between the two measures emerges. This likely mirrors not only the different approaches taken - one focusing on management only, the other on organisational capital more broadly - but also possible differences in the sampling and estimation strategies implemented.

The remainder of this paper gives a brief survey of the literature related to measuring OC, followed by a discussion of the proposed definition of organisational capital and of the way in which it is operationalised – discussion that builds importantly on Squicciarini and Le Mouel (2012). The data and the analytical methodology used to select the relevant OC-related occupations using PIAAC data are then presented, followed by the estimates of economy-wide and sectoral level investment figures for the 2012, based on PIAAC information solely. The next section further extends the estimates to the years 2000-11 and presents further descriptive information at the country-industry-year level. The final section summarises the main contributions of the paper and highlights some limitations of this work as well as possible avenues of future research.

2. Defining organisational capital

The very nature of OC has made it one of the more challenging KBC assets to quantify convincingly. This is reflected by the different, albeit often complementary, definitions and measurement approaches that have emerged in economics, organisation science, management, and accounting.

OC has been defined as the firm-specific information that affects the production possibility set and is augmented through output-related learning processes (Prescott and Visscher, 1980); the know-how needed to create systems of production combining human skills and physical capital (Evenson and Westphal, 1995); and the ability to integrate individual members' specialised knowledge, which serves as the basis upon which firms establish their long-term strategies (Grant, 1996). Black and Lynch (2005) further highlight the importance of OC-related firm practices like workforce training, 'employee voice' and work design, and their relation with higher productivity.

The economics literature has often modelled OC as a firm specific information asset, whose conceptualisation rests on a notion of the firm that goes beyond the representative production function. Prescott and Visscher (1980) argue that OC is a type of business knowledge which is able to affect a firm's production possibility set and that gets accumulated jointly with output. OC's main information-related components concern employee and task characteristics; the quality of their match, and the quality of the match of employees to teams; and the knowledge embodied in employees in the form of firm-specific training. Such knowledge, they argue, represents the source of a firm's comparative advantage to create and maintain revenue streams. Prescott and Visscher (1980) and Bailey et al. (2001) further suggest that the following sets of tasks are essential in generating a firm's organisational knowledge: developing objectives and strategies; organising, planning and prioritising work; building teams, matching employees to tasks, and providing training; supervising and coordinating activities; communicating across and within groups to provide guidance and motivation.

The approach to OC proposed by Prescott and Visscher (1980) can be found in a number of models, including: firms' internal learning processes and the creation and accumulation of this KBC (Rosen, 1972); the difficulty of matching employees to jobs and the resulting employee turnover dynamics (Jovanovic, 1979); the impact of investment in this KBC on firm growth and size distribution (Prescott and Visscher, 1980); and more recently, the rents accruing to firm owners from the returns on OC (Atkeson and Kehoe, 2005).

The managerial and organisational science literature has conversely tended to emphasise the role of OC and of organisational capabilities as sources of competitive advantage, and as key firm-specific resources. As Teece et al. (1997) highlight, earlier explanations of firm-specific rents were mainly based on industrial organisation theories related to market dynamics like the ease of entry into a market and bargaining power, or on game theoretic approaches modelling the strategic decisions of players (e.g. predatory pricing to deter entry).

Conversely, more recent explanations of sustained competitive advantage focus on the ability of firms to exploit scarce and non-imitable firm-specific resources. This Resource Based View (RBV) of the firm underlines the need to understand a firm's capabilities in terms of the organisational structure and managerial processes that underpin its productive activity, rather than in terms of balance sheet items. Teece et al. (1997) further argue that in a dynamic context of Schumpeterian creative destruction, a firm's ability to react and adapt to an ever changing business environment and to up-grade its activity in a global value-chain context rests mainly on its flexible organisational structure and its superior managerial knowledge and qualities. This organisational knowledge emerges from interactions between individuals within the firm and is formalised and articulated into routines by specific functions within the organisation (Nonaka, 1994). Looking beyond the role of central, upper-echelon leadership, von Krogh et al. (2012)

propose a model of organisational knowledge creation that emphasises the distributed nature of organisational knowledge within a firm.

In this respect, Aral and Weill's (2007) study of IT assets and organisational capability shows that differences in performance emerge when firms invest in both assets jointly. Kapoor and Adner (2011) highlight the importance of a firm's organisational structure for its ability to manage technological change, while Nocke and Yeaple (2014) argue that OC can affect firms' export status and product diversification through its effect on marginal costs.

Finally, a broad literature – from psychology to finance – underlines the positive relationship between performance on the job and workforce endowments in terms of skills and competencies that are relevant to the tasks to be accomplished (e.g. Kaplan et al., 2012; Ng and Feldman, 2009). Consensus seems to exist about the fact that employee skills and abilities, as well as other characteristics, are related to outcomes at both the level of the individual employee and of the firm (see Ployhart and Moliterno, 2011, for a discussion). Also, recent survey-based evidence from Bloom et al. (2012) and Bender et al. (2016) further confirms management quality to be related to both managers' and employees' educational levels.

The concepts and lessons drawn from the various fields above lend support to a view of OC that emphasises its key role in the activity of firms and in their success: OC consists of knowledge, know-how and business practices, and is embedded in a firm's workforce. However, while much literature discusses what is meant by OC, attempts to measure how much OC is generated and accumulated are less apparent.

3. Measuring organisational capital

3.1 Existing approaches to measuring organisational capital

Existing OC measurement-related studies have broadly taken three main approaches.

A first group relies on non-monetary survey-based measures and attempts to capture the adoption, presence and quality of organisational and managerial practices. The second group is concerned with obtaining monetary estimates of the value of organisational practices in terms of output, and in particular of increased firm performance. Finally, a third group of studies measures investment in OC by means of assessing the value of the inputs devoted to building up such KBC.

Studies carried out in the early 2000s rely on a somewhat narrow definition of OC, intended mainly as organisational change aimed at introducing novel work practices such as decentralisation (Caroli and Van Reenen, 2001), High Performance Work Systems (HPWS, see Bailey et al., 2001), autonomy over work tasks, and the opportunity to communicate with employees outside the work group. Analysis relying on such a definition has focused on learning organisations giving firm's employees the opportunity to use and develop their skills and knowledge (e.g. Greenan, 2012); and on "new" organisation features, such as flat hierarchy, empowered workers, self-governing teams, use of temporary structures and lateral communications enabled by the adoption of ICTs (see, e.g. van Alstyne, 1997; Birkinshaw and Hagstrom, 2000; and Hales, 2002). Bloom et al. (2012) designed and carried out a survey of middle level managers in over 10000 organisations in twenty countries to investigate management practices related to processes, monitoring, targets and incentives, with the aim of assessing overall management quality at the firm level.

Although narrow, the above definition of OC makes measurement of organisational practices tractable, and significant efforts have been made in designing business surveys aiming to assess the implementation and quality of organisational practices (see e.g. Black and Lynch, 2005, for a survey). These measures of OC have been widely used to understand the impact of organisational practices and organisational change on firm performance (Black and Lynch 2001, Miyagawa et al. 2010); on the demand for skills (Caroli and

Van Reenen, 2001); on wage levels, wage inequalities and employment dynamics (Bailey et al. 2001; and Black et al., 2004); and about the determinants of management quality (Bloom and Van Reenen, 2007).

In a second group of studies, OC is defined as a firm-specific knowledge asset, and its effect on measures of firm performance such as gross output, sales and revenues is quantified, in a similar fashion to other balance sheet assets. Such literature generally relies on the estimation of firm level production functions, as in Lev and Radhakrishnan (2005) and Lev et al. (2009) for the United States, Miyagawa and Kim (2008) for Japan, and Ludwig and Sadowski (2009) for Germany. Lev et al. (2009), for instance, estimate firms' OC in terms of profit surplus accruing from increased revenue and decreased costs, as compared to the predicted profits that would be obtained in the absence of such KBC. To this end, investment in OC is proxied by firms' spending on SGA expenses, whereas predicted profits are derived from industry-level figures.

Miyagawa and Kim (2008) conversely estimate OC in terms of excess returns to investment in complementary assets such as R&D and advertising. This methodology is generally followed to estimate the value – at both the firm and the aggregate level – of bundles of intangibles. SGA expenses can in fact be used as firm-level proxies for investment in many types of KBCs, as they include R&D, marketing and software expenditures, as well as management fees (Che, 2009). However, relying on a production function-based approach to estimate Total Factor Productivity (TFP) makes it difficult to determine the mechanism picked up in the residual, i.e. whether TFP dynamics is affected by OC, KBC more broadly, or other factors such as technological progress.

A third approach to measuring OC relies on quantifying the value of the resources used to build it and has been suggested by CHS. The authors assume own-account OC to amount to the time that managers spend on developing a firm's business model and its corporate culture. They estimate it to correspond to 20% of executives' time, as managers are assumed to use on average 80% of their time in day-to-day management activities. Purchased OC is conversely estimated to correspond to 80% of the turnover of the management consulting services industry. This produces country- and industry estimates for the United States and for some European countries.

3.2 A task-based approach

Linking the findings of the literature above, it can be concluded that OC is embodied in a firm's employees – including but not limited to managers – accomplishing a set of tasks related to the long term functioning of a firm, and that labour cost measures of OC may be used to quantify investment in OC at both the micro and macro levels. The set of tasks that existing studies suggest to be essential for the generation and accumulation of organisational knowledge and capital relate to:

- developing objectives and strategies;
- organising, planning and prioritising work;
- building teams, matching employees to tasks, and providing training;
- supervising and coordinating activities;
- communicating across and within groups to provide guidance and motivation.

Most of these tasks, traditionally carried out by managers, have been progressively devolved upon non-managerial occupations, due to the decentralisation of authority and the delayering of managerial functions (as underlined in Caroli and Van Reenen, 2001 and von Krogh et al., 2012). Focusing on a task-based approach rather than a priori selecting employees based on their occupational titles, it should thus be possible to more precisely identify that part of the workforce that contributes to the long-term functioning of firms.

4. Operationalising the task-based approach

The task-based approach proposed in Squicciarini and Le Mouel (2012) is implemented here to estimate investment in OC. In a first step, the tasks that are more likely to correspond to OC-related activities are identified. In a second step information on the frequency with which workers perform OC-relevant tasks is used to identify those occupations performing OC-related activities to the highest extent. Finally, individual level employment and earnings data are exploited to estimate OC-related employment and investment in organisational capital. This is done at the national and sectoral level, for different firm sizes, and for the private and the public sectors. An important objective of this work is also to assess the extent of cross-country differences in the performance of OC-related tasks and to compare results with those derived from the US-based survey O*NET.

4.1 Data: the PIAAC background questionnaire

This analysis uses data from the Programme for the International Assessment of Adult Competencies developed by the OECD, a household survey seeking to assess the skill level of the working-age population in the areas of literacy, numeracy and problem-solving. In addition to performing these tests, survey respondents provide detailed information on their educational, professional and family background in a complementary questionnaire. The first round of PIAAC, collected in 2011-2012, covers average samples of 5,000 adults aged between 16 and 65, in 24 participating OECD member and partner countries.

The PIAAC questionnaire contains information on 15 general tasks, such as “sharing information with colleagues” or “working physically”, as well as 25 tasks related to skill use in literacy, numeracy and ICT, such as “reading letters, memos or emails” or “calculating prices, costs or budgets”. The full list of tasks relevant to the present study is provided in Table A1 in the Appendix 1. While the interpretation might to some extent differ between general tasks and tasks related to skill use, these 40 items are all included in the analysis as they provide additional information and improve the precision of the clustering analysis. They are treated homogenously since the tasks needed to identify OC-related activities all fall into the first category and results are thus unlikely to be biased. For each of these 40 items, respondents are asked how often they perform these tasks or use these skills, on a scale of 1 (“Never”) to 5 (“Every day”).

We restrict our analysis to countries where occupational information is available at the 3 digit level of the ISCO classification. This occupational breakdown is comparable to, albeit slightly less detailed, than that of the O*NET data used in previous analysis focusing on the United States (see Squicciarini and Le Mouel, 2012). Given this restriction, our dataset covers 20 countries and 112 occupational categories.

For every country and occupation, an average answer for each of the 40 tasks is constructed, based on the assumption that workers are homogenous within occupations in terms of the tasks they perform, and that task performance differs across occupations. This index represents the main building block of the analysis.

A first look at this index reveals a feature of the PIAAC questionnaire of relevance to the present analysis. For occupations at the top of the ISCO classification, corresponding to managers, professionals and associate professionals, the average response over all 40 tasks is persistently above 3 (at least once a month). On the other hand, for occupations listed towards the end of the classification, such as clerical workers, crafts and trades workers and plant and machine operators, the average response is below 2. This implies that they report never performing many of the tasks listed in the questionnaire. In turn this warns about the fact that the daily activities of these occupations are not fully captured in the PIAAC data, while those of managers and professionals seem to be better captured. However, this should not affect the robustness of the present analysis, considering that the proposed methodology relies not only on cluster analysis but also on a distribution-based approach, whereby only the top quartile of the distribution is taken into account when identifying OC-related occupation. Also, in so far as OC-related tasks can be identified in the list of tasks detailed in PIAAC, this should not bias our results.

4.2 Identifying the tasks related to OC

The selection of tasks that will serve to discriminate OC-relevant occupations is identified on the basis of a semantic analysis of their description. Three overlapping sets of tasks are thus determined according to the closeness with which they align to the theoretical definition of OC as stated in the previous section. The smallest and core set of tasks encompasses the 3 tasks that explicitly mention organisational activities plus a fourth task relating to teaching and instructing. This list is presented in the third column of Appendix 1 Table A1. It corresponds to a restrictive definition of OC, and ignores the team-building, communication and problem-solving dimensions of organisational activities, which the literature suggests are key components of OC. A broader list of 9 tasks, encompassing these latter activities, is presented in the fourth column of Appendix 1 Table A1. Finally, a more exhaustive list, consisting of 11 tasks, adds a further set of activities that can be associated with communication and instruction and is presented in the final column of Appendix 1 Table A1.

The main analysis in this paper uses the list of 9 tasks, because it captures enough dimensions of OC while remaining parsimonious. The alternative selections of tasks discussed above are used for robustness analysis. Table 1 compares the list of 9 OC-related tasks based on the PIAAC data, in the first 2 columns, with the list of 14 OC-related tasks based the O*NET data[1], in the last 2 columns. Both datasets capture the concept of organisational capital in its broader sense as they contain information on tasks relating to organisation and planning, but also to team-building, communication and problem solving. Subsequent results on the selection of occupation suggest that the list of 9 tasks performs strongly when it comes to capturing occupations which can be a priori associated with OC, such as managers and supervisors.

Table 1. Selection of OC related tasks, comparison of PIAAC and O*NET databases

PIAAC		O*NET	
Task Code	Task Name	Task Code	Task Name
10	Cooperating and collaborating		
11	Sharing information with co-workers	412	Communicating with people inside the organisation
12	Instructing, training, teaching people	422	Developing and Building Teams
20	Negotiating with people	423	Training and Teaching Others
		424	Guiding, Directing, and Motivating Subordinates
		425	Coaching and Developing Others
		426	Provide Consultation and Advice
16	Planning your own activities	224	Developing Objectives and Strategies
17	Planning the activities of others	225	Scheduling Work and Activities
18	Organising your own time	226	Organizing and Prioritizing Work
		421	Coordinating Work and Activities
21	Faced with simple problems	221	Making Decisions and Solving Problems
22	Faced with complex problems		
		211	Judging the Qualities of Things, Services, or People
		432	Staffing Organizational Units
		433	Monitoring and Controlling Resources

Source: Authors' own calculations based on PIAAC data, extracted June 2015, and O*NET data (version 16.0), extracted April 2012

1. In the O*NET database, "tasks" refer to occupation-specific activities, while activities comparable across occupations are labelled "work activities". It is the latter, in addition to14 skills and 3 knowledge areas that are used in previous analysis to identify organisational capital. While part of the tasks described in PIAAC are implicitly related to skill use, there is no information concerning knowledge areas.

4.3 From tasks to occupations: a distribution-based and cluster approach

The selection of occupations is based on the overlap between two distinct criteria. The first relies on information contained only in the 9 tasks identified above, while the second uses information from the full set of tasks to cluster occupations into groups. The analysis is performed for each country separately, and the results suggest that while there is a core group of occupations (mainly managers) which can be associated with the formation of OC in all countries, differences across countries exist with respect to the other occupations contributing to the generation and accumulation of organisational capital.

4.3.1 A distribution-based approach

In a first step, a distribution-based approach relying only on the answers to the 9 OC-related tasks identified above is applied. For each occupation in each country, the average and the minimum responses for the 9 OC tasks are calculated. Occupations are then ranked by country according to these two measures, and the country-specific cut-off values are defined as the first quartile of occupations that show the highest scores in the answers related to the OC tasks. The cut-off values for the average response range from 3.37 in Germany to 3.99 in Ireland, with an average of 3.62 across the countries considered, which corresponds to performing these tasks between every month (answer 3) and every week (answer 4). The cut-off values for the minimum response range from 1.92 for the Czech Republic to 2.87 for the United Kingdom, with an average of 2.36 across all countries. This corresponds to performing OC-related tasks between less than once a month (answer 2) and at least once a month (answer 3).

The final selection of occupations is restricted to the overlap between both criteria. An occupation is considered as contributing to the generation of firm-specific OC if workers in that occupation perform all the 9 OC tasks on average almost every week and there is no single task that they perform with a regularity of less than once a month. By definition, the average and the minimum criteria pick up the top quartile of occupations (around 28 occupations). For most countries, the overlap selects one fifth of occupations (around 22 occupations). A notable exception is Korea, where the overlap between the average and the minimum criteria is lower than for the other countries, and only 16 occupations are thus selected.

4.3.2 Clustering analysis

The distribution-based approach is complemented with country-specific hierarchical clustering analyses of the occupations. This second approach retains the information on all the tasks to allocate occupations into groups and uses the complete linkage (i.e. farthest neighbour) method and the Euclidian measure of distance. The country-specific optimal number of clusters is obtained from the Duda-Hart (1973) criterion. For each cluster, the average response on the 9 OC tasks is then calculated, and the cut-off point defined as the value corresponding to the top quartile. The cut-off values range between 3.39 in Germany and 4.06 in the United Kingdom, with an average of 3.64, and are very similar to the cut-off values that emerge from the distribution-based analysis.

4.3.3 Combining the two for a final selection

Table 2 presents the final list of OC-related occupations for each country, resulting from the overlap of the selections using the two criteria described above. On average, 19 occupations are identified in each country, with country-specific sets of OC-related occupations that range from 14 occupations in Korea to 24 occupations in Poland. The results confirm the importance of managers in contributing to the formation and accumulation of OC in firms, as they consistently appear in the selection across countries. In addition, a number of other occupational categories, especially professionals and associate professionals in science and engineering, health, education, and business administration, are identified as being OC-related in many countries.

These results are in line with those obtained using the O*NET database (Squicciarini and Le Mouel, 2012), and this suggests that the methodology proposed is robust and results are not sensitive to using information from different sources. Appendix 1 Table A2 presents the detailed comparison, and lists the occupations selected using the O*NET and the PIAAC databases for the United States, in the third and fourth columns respectively. The results for the managerial and health occupations are identical, while they differ in the detail for the other professional occupations.

The importance of professional and associate professional occupations, especially in the field of science and engineering, suggests that the creation and accumulation of OC is likely to overlap with the building up of other knowledge-based assets, such as R&D, design and computerised information. This is likely to be a source of spillovers with respect to the generation and accumulation of other KBC types, but also of double-counting, when the estimates of the resources devoted to the creation of these different assets uses a labour cost approach à la CHS. Unfortunately though, and differently from the O*NET data, the tasks contained in the PIAAC data do not allow for the identification of tasks relating to these other KBC assets, thus preventing any further evidence to be provided on the extent of this overlap.

Comparing the results obtained across countries suggests that the main hypothesis concerning the importance of non-managerial occupations for the construction of OC holds, as does the one about the difference in the importance of particular categories across countries. These differences can in part be driven by cross-country heterogeneity in the sectoral composition of the economies considered, in the organisation of firms and in the understanding of what occupations do and how job titles are consequently classified, in line with what found by Bloom et al (2012). Our estimates of employment and investment at the sectoral level will shed more light on this issue. The sensitivity of the results to the choice of tasks is tested by both restricting and broadening the definition of OC. The results of these robustness checks are reported in Appendix 2.

5. Employment and Investment in OC: cross-sectional estimates

Once identified those occupations that contribute to the generation and accumulation of organisational knowledge, it is possible to quantify the importance of this asset in the economy. Using employment and earnings-related information provided at the individual level in the PIAAC survey, survey respondents are classified according to whether they are employed in an OC-related occupation or not. Aggregating such figures across these individuals yields OC employment and investment for each of the 20 countries. To this end, survey weights are recalibrated to be representative of the aggregate and industry employment structure, according to external labour force surveys and following a methodology described in Squicciarini et al. (2015). Given these adjusted sample weights, total employment, including both employees and the self-employed, is calculated for each country. OC-related employment figures by industry, in both the public and private sectors, as well as by firm size can be also obtained by aggregating across the relevant survey respondents according to the appropriate dimension.

Table 2. Selection of OC-related occupations by country

ISCO	ISCO Title	AUT	BEL	CAN	CZE	DEU	DNK	ESP	EST	FRA	GBR	IRL	ITA	JPN	KOR	NLD	NOR	POL	SVK	SWE	USA	TOT
1	**Managers**																					
110	Chief executives and legislators	√	√	√	√	√	√	√	√			√	√	√		√	√	√	√	√	√	**17**
121	Business services and administration	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	**20**
122	Sales, marketing and development	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	**20**
131	Production managers in agriculture				√		√		√	√	√							√			√	**7**
132	Manufacturing, mining, construction, and distribution	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	**20**
133	ICT services	√	√	√	√	√	√	√	√	√		√		√		√	√	√	√	√	√	**17**
134	Professional services	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	**20**
141	Hotel and restaurant	√		√		√	√		√	√				√				√		√	√	**10**
142	Retail and wholesale trade	√	√	√	√	√	√	√	√	√	√			√	√	√	√	√	√	√	√	**18**
143	Other services	√	√	√	√	√	√	√	√	√	√	√	√	√		√		√	√		√	**17**
2	**Professionals**																					
211	Physical and earth science	√		√									√		√		√	√				**6**
212	Mathematicians, actuaries and statisticians		√		√																	**2**
213	Life sciences	√				√																**2**
214	Engineers	√	√	√		√	√	√	√	√	√		√		√	√	√	√				**14**
215	Electrotechnology engineers	√	√	√					√				√		√	√		√				**8**
216	Architects, planners and designers				√				√													**2**
220	Health professionals, except doctors			√				√		√	√						√				√	**6**
221	Medical doctors	√	√	√	√	√	√		√		√	√	√	√	√	√	√	√		√	√	**17**
231	Higher education teachers	√	√			√	√	√		√	√			√		√			√			**10**
232	Vocational education teachers			√		√	√			√			√						√		√	**7**
233	Secondary education teachers	√		√	√			√		√	√	√		√				√	√		√	**11**
234	Pre- and primary school teachers					√			√	√	√	√					√	√	√	√	√	**10**
235	Other teaching professionals			√		√					√								√	√		**5**
241	Finance	√			√			√					√			√	√					**6**
242	Administration	√	√	√	√	√	√	√		√		√	√	√		√		√				**13**
243	Sales, marketing and PR	√			√	√	√		√			√					√	√				**8**
251	Software and applications developers and analysts											√	√		√	√						**4**
252	Database and network				√		√					√				√			√			**5**
261	Legal professionals			√							√	√		√				√	√	√	√	**8**
262	Librarians, archivists and curators											√										**1**
263	Social and religious professionals			√		√		√			√				√						√	**6**

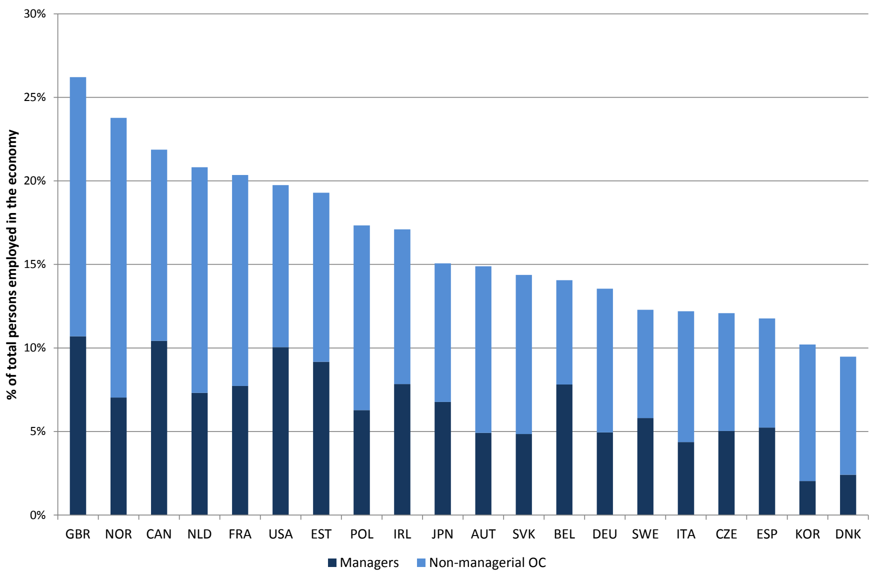
3	**Technicians and associate professionals**																					
312	Mining, manufacturing and construction supervisors	√	√	√	√	√	√		√				√	√		√		√	√		√	**13**
313	Process control technicians					√													√			**2**
314	Life science																	√	√	√		**3**
315	Ship and aircraft controllers	√							√				√					√				**4**
322	Nursing and midwifery			√						√	√						√				√	**5**
331	Finance and mathematical sciences											√			√							**2**
332	Sales agents and brokers				√								√	√		√						**4**
333	Business services agents	√							√			√	√			√	√	√				**7**
334	Administrative secretaries							√		√	√			√								**4**
341	Legal, social and religious		√						√		√											**3**
342	Sports and fitness workers								√													**1**
351	ICT operations and user support technicians		√																			**1**
352	Telecommunications and broadcasting technicians							√										√	√			**3**
4	**Clerical support workers**																					
421	Tellers, money collectors and clerks	√																				**1**
441	Other clerical support workers														√							**1**
5	**Services and sales workers**																					
516	Other personal services workers												√									**1**
531	Child care workers and teachers' aides																		√			**1**
7	**Craft and trades workers**																					
732	Printing trades workers												√									**1**
741	Electrical equipment installers and repairers																√					**1**
753	Garment and related trades workers																			√		**1**
754	Other craft and related workers																			√		**1**
8	**Plant and machine operators**																					
811	Mining and mineral processing																			√		**1**
817	Wood processing and papermaking														√							**1**
835	Ships' deck crews and related workers											√										**1**
	TOTAL	**23**	**17**	**22**	**19**	**21**	**18**	**17**	**21**	**18**	**19**	**18**	**20**	**17**	**14**	**19**	**17**	**24**	**20**	**16**	**19**	

Source: Authors' calculations based on the PIAAC database, extracted June 2015.

Investment in OC is calculated applying the methodology of CHS whereby investment in OC consists of 20% of the wages paid to the relevant occupations. For comparability, investment figures are presented as a ratio of value-added, obtained from the OECD STAN database or the OECD System of National Accounts. The assumption that 20% of wages represents investment in OC is derived from the management literature where it is suggested that managers spend around one fifth of their time of activities that affect the long-term functioning of firms (CHS, 2009). This assumption, which is not tested in the context of the present paper due to the lack of relevant information, would deserve further investigation in the future, as it is reasonable to hypothesise that different occupational profiles may be involved to a different extent in the generation of organisational capital. The breakdown of investment into the various categories is obtained in a similar fashion.

Figure 1 plots the proportion of total OC-related and of managerial employment in the economy for the year 2012. The latter figures reflect the results that would be obtained by following the CHS methodology, which looks exclusively at managerial occupations. While the share of managers in total employment ranges from 2% in Korea to 10% in the United Kingdom, the United States and Canada, the share of all OC-related employees ranges from 9.5% in Denmark to 26% in the United Kingdom. Across countries, the share of managers in total employment averages 6.5% while the share of non-managerial OC occupations averages 10%. The proposed measure of OC-related employment is on average 2.7 times higher than the number of managerial workers only. These figures suggest that in all countries, non-managerial workers account for the majority of OC related activities and that overlooking them entails substantially underestimating investment in organisational capital.

Figure 1. OC-related workers, 2012

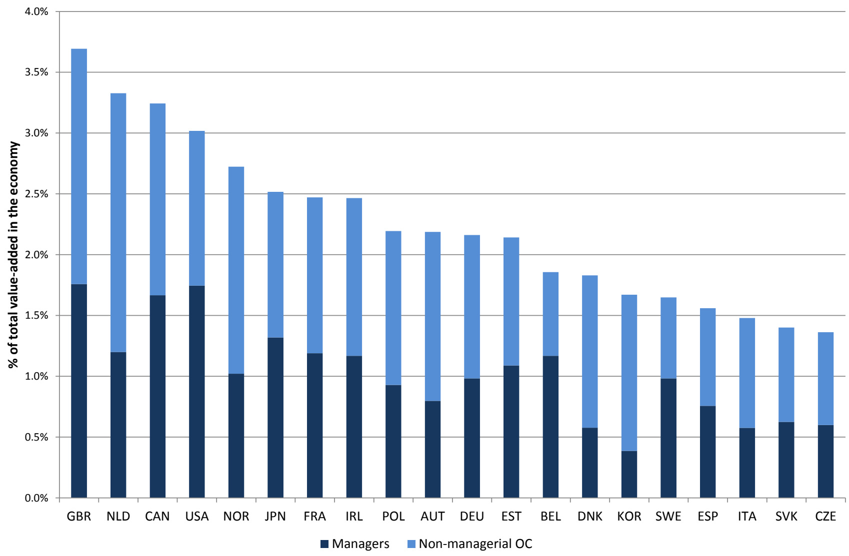


Source: Authors' own calculations based on publicly available PIAAC data, extracted June 2015.

Figure 2 depicts investment in OC, as a share of total value-added, for the year 2012, again separating out the fraction attributable to managerial occupations from that attributable to non-managerial occupations. Investment in OC as a share of value-added attributable to managerial occupations ranges from 0.4% in Korea to 1.8% in the United Kingdom, while total investment in OC as a share of value-added ranges from 1.4% in the Czech Republic to 3.7% in the United Kingdom. Across countries, these values are 1% and 2.2% respectively. Hence, including non-managerial occupations results in estimates of investment in OC that are on average 2.3 times higher than those obtained considering only managerial occupations.

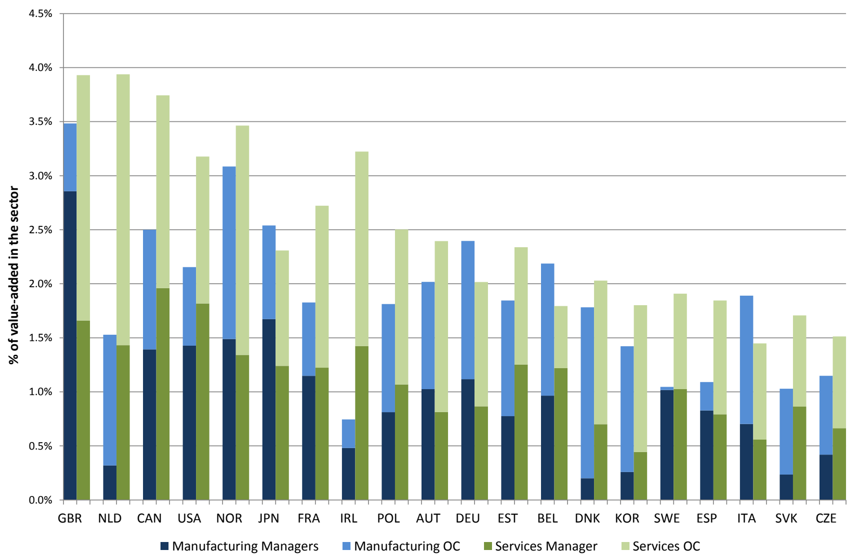
Figure 3 shows the breakdown between the manufacturing sector (ISIC Revision 3, sectors 15 to 37) and the services sector (ISIC Revision 3, sectors 50 to 93) separately. For many countries, the share of managers in manufacturing and in services is similar, while the share of non-managerial OC occupations differs greatly. With the exception of Japan, Germany, Belgium and Italy, investment in OC is higher in services than in manufacturing. This is in line with what could be expected given the industrial structure of these countries. A breakdown in more narrowly defined industries is reported in Figure C1 in Appendix 3. The same appendix contains further evidence of OC investment and employment when broken down by firm size where the worker is active (Figure C2) and by taking into account the difference between employees and self-employed workers (Figure C3).

Figure 2. Investment in OC, as a percentage of total value-added in the economy, 2012



Source: Authors' own calculations based on publicly available PIAAC data and OECD STAN database, extracted June 2015.

Figure 3. OC investment in manufacturing and services, 2012



Source: Authors' own calculations based on publicly available PIAAC data and OECD STAN database, extracted June 2015.

5.1 Organisational capital in the public sector

Research undertaken in the context of the SPINTAN project aims to estimate KBC investments for a specific part of the economy (see Corrado et al. 2014) and by addressing the differences that may exist in the nature of intangible assets, depending on whether they are produced by the private or the public sector.

In the case of organisational capital, while its purpose might differ according to whether sustained competitive advantage is an objective or not, the more general nature of organisational knowledge remains comparable in both the public and the private sectors. Indeed, the continued ability of workers to work together to produce output, be it sold at market prices or not, requires organisational know-how, team-building and communication. Hence, the task-based definition of OC can be applied in the context of the public sector without further modification, and OC-related occupations can be identified as those who perform organisational tasks at a comparatively high level, as done in the case of the private sector. OC investment in the public and private sectors is thus estimated using the same methodology detailed above.[2]

Given the list of OC occupations, investment in the public sector can be estimated as the sum of investment in the following "SPINTAN" sectors: scientific research and development (ISIC Rev.4 sector 72); public administration and defence (84); education (85); health and social work (86-88); and arts, entertainment and recreation (90-93).

While in many countries these sectors see a heavy participation of public institution in the production process, some investment may nevertheless be generated by private entities operating in the same sectors. It is reasonably be expect, for instance, a comparatively greater presence of private actors in public sectors like education and health in countries like the United Kingdom and the United States, as compared to e.g. Nordic countries like Sweden and Finland, where schools, universities and hospitals are mainly publicly held and managed.

To account for such differences, the present methodology information available in PIAAC about the private, public or non-profit nature of the institution in which surveyed individuals work. Entities are classified as publicly owned if public institutions are (at least) majority shareholders. Estimates of investment for each sub-section of the economy are thus obtained restricting the population of interest according to the institutional nature of the workplace. This approach makes it possible to account for the private or public nature of firms in all industries, including e.g. public firms in industries not usually classified as public-services, like transportation and electricity production (two investment-intensive ones). This appears especially important since both non-market and market entities are operating in four out of the five "SPINTAN" industries mentioned above.[3]

The results of this exercise are shown in Figure 4. With the exception of Belgium and the Netherlands, investment in OC, as a share of value-added, is higher in public entities in the public sector than in private entities in the private sector. This is largely driven by non-managerial occupations, such as health and education professionals, that form a large share of employment in the public sector.

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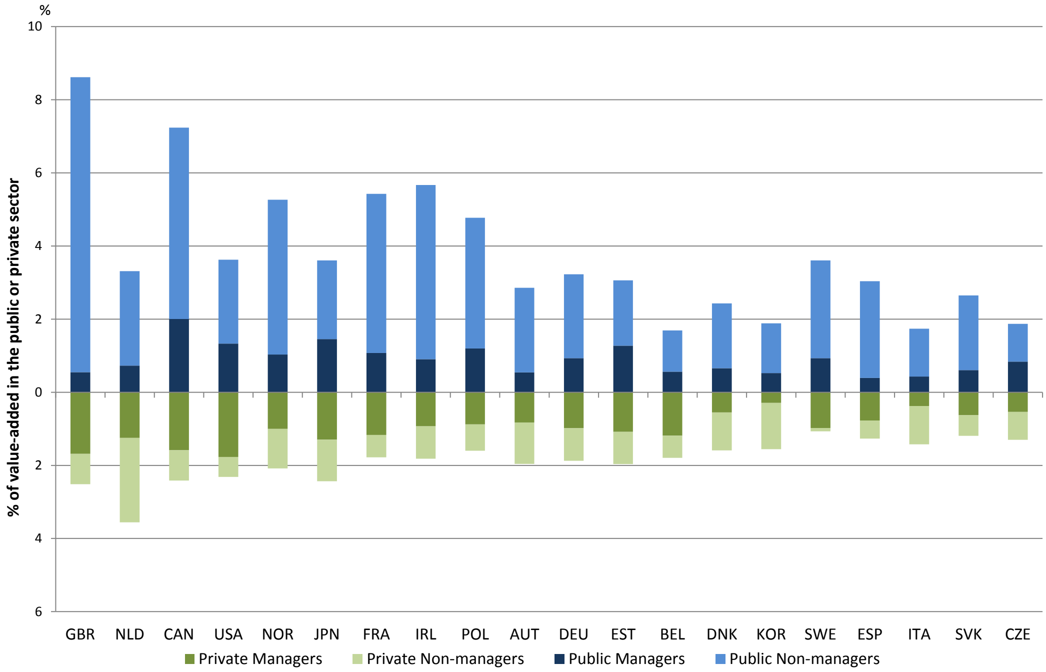
2 A further constraint limiting our ability to produce public sector estimates of investment in OC stems from the scarce availability of data on wages at the occupational and sector level, which account for the institutional nature (i.e. public vs private) of an individual's workplace.

3 The implemented definition of public ownership in PIAAC, however, does not distinguish between public owned firms and other public institutions. If this allows a more encompassing assessment of the role of public investment in the economy, it also reduces comparability with the already scant literature and the SNA, which excludes publicly-owned firms from the boundaries of the non-market economy.

Figure 4. OC investment in the public and private sectors, 2012



Source: OECD (2015).
Legend: Countries are sorted in descending order of OC investment intensity for the total economy, as in Figure 2.

6. Employment and Investment in OC over time

The estimates presented so far refer to the year 2012 only and are based on wage and employment data as reported in the PIAAC database. In order to estimate a panel of OC investment for the years 2000-11 this paper relies on information gathered in country specific surveys of employment (Labour Force Surveys – LFS) and wages (Earning Surveys) by 3 digit ISCO2008 occupations and 2 digit ISIC3 industries. Assuming that the within-occupation intensity in OC tasks does not vary significantly over time in the decade considered, it is possible to quantify employment in OC occupations within each 2-digit sector. Expenditure in OC-related labour by industry is then computed as the product between the number of OC employees and their average wage in the respective occupation and sector. Finally, investment in OC is estimated as 20% of the salaries of the workers contributing to the generation of OC, similarly to what done when estimating the cross-section figures. For Finland, Greece, Hungary, Luxembourg and Portugal the list of OC occupations have been imputed using the selection of OC occupations from their closest neighbours, as done the cluster analysis detailed in Squicciarini et al., 2015.

Employment figures, which exclude self-employed individuals, are sourced from the European Labour Force Survey (EULFS) for EU27 countries, and from the U.S. Department of Labor's Current Population Survey (CPS) for the United States.[4] Average wage information at the occupation-sector level is sourced from the European Structure of Earning Survey (SES) for EU27 countries, and from the CPS for the United States. Average earnings have been imputed for Austria, Germany, Denmark and Ireland since they are not included in the SES. As the SES provides information every four years (for 2002, 2006 and 2010), European data for the remaining years have been interpolated and extrapolated. Table D1 in Appendix 4

4 Self-employed are excluded, in reason of their likely employment in one-person firms, where organisational challenges are of different nature than those analysed in the present paper.

summarises these steps. Gross annual earnings are used, as opposed to net earnings, as they reflect how much firms spend on their OC-related employees (rather than the amount that employees effectively bring home). The obtained estimates of OC are winsorised at the 1% level, to limit the effect of outliers.

To ensure comparability across time and between the different sources of data, changes in both industry and occupation classifications have been taken into account. The industry classifications have been all converted from ISIC revision 3 (pre 2008) and revision 4 (2008-2014) into the 34 industry breakdown of the TiVA database. All occupations have been converted to the ISCO 1988 classification. Given the mixture of 2-digit and 3-digit level information across countries and over time, employment and earnings are calculated at the 2-digit occupational level when data granularity could not support working at the 3-digit level.

6.1 New estimates of investment in Organisational Capital for the years 2000-11

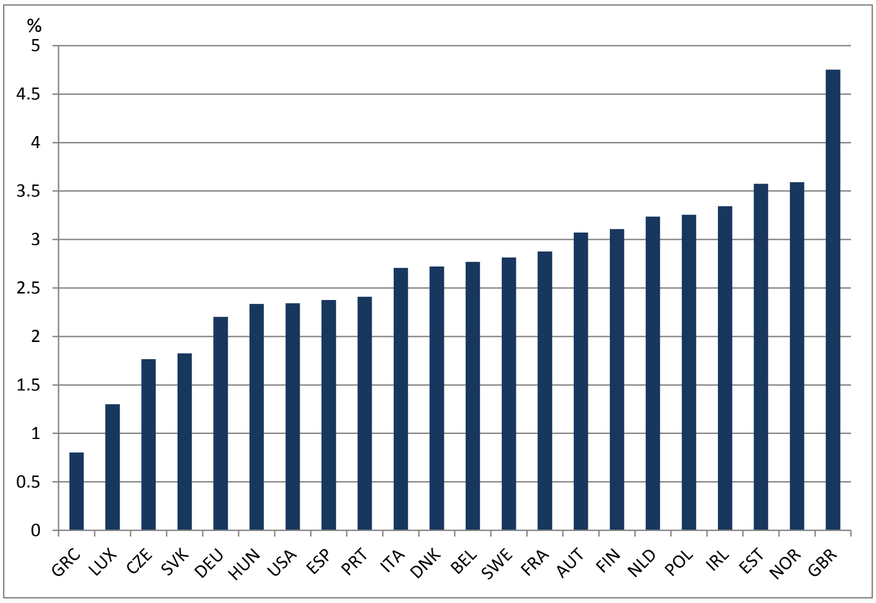
Following the methodology outlined above, estimates of investment in OC are proposed for the years 2000-11. In this period, OC investment has seen a 33% and 73% cross-country average increase in total manufacturing and total services, respectively, with growth rates that are more heterogeneous in manufacturing than in services.

Figure 5 presents the cross-industry mean of the ratio between investment and value added, for each country in the dataset. Value added is adjusted to take into account investment in organisational capital, as suggested by Corrado et al. (2009). Intensities range from 4.5% (United Kingdom) to 0.8% (Greece). The observed cross-country variation can stem from a number of factors, including differences in management practices and in the intensity of overall KBC investment across countries, as well as differences in the sectoral composition of the economy, as it becomes clear by looking at Figure 6.

Figure 6 shows that, in all countries except Greece and Norway, “SPINTAN” sectors (ref. previous sections) are on average more intensive in OC investment than non-SPINTAN industries (approximately corresponding to the definition of market sectors). Across the countries considered, investment in the education, health and government sectors on average reaches 8.1%, 4% and 2.9% of (adjusted) industry value added, respectively. Also, estimates suggest that investment in OC represents a bigger proportion of value added in business services than manufacturing. The most OC-intensive sector in the business section of the economy is financial services (ISIC rev.3 codes 65 to 67), where investment in organisational capital represents on average 3.6% of value added.

Figure 5. Investment in Organisational Capital over Value Added, 2000-2011

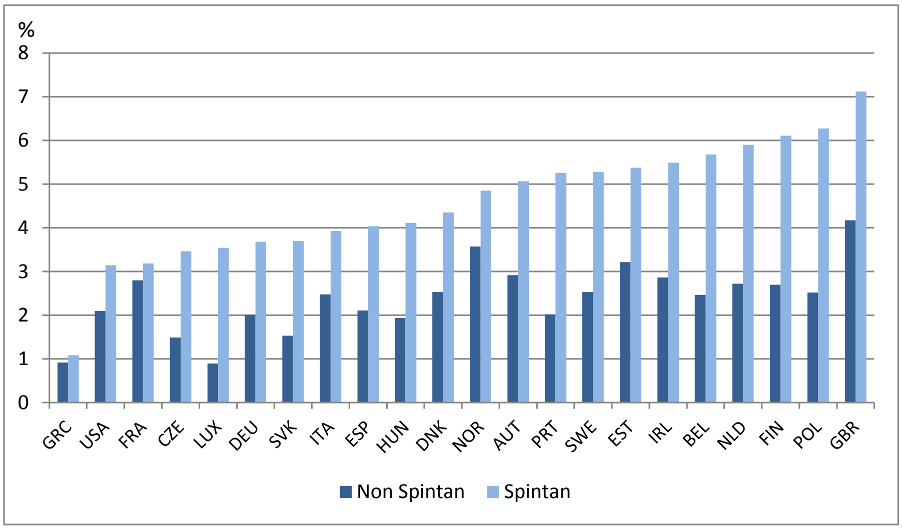
Average across all considered industries-years



Note*:* Value added and investment in current prices and local currencies. Value added adjusted to take into account investment in organisational capital.

Figure 6. Investment in Organisational Capital over Value Added by macro industry, 2000-2011

Average across all considered year-industries in the SPINTAN vs Non-SPINTAN section of the economy



Note: Value added adjusted to take into account investment in organisational capital. The “SPINTAN” sectors here considered are scientific research and development (ISIC Rev.4 sector 72); public administration and defence (84); education (85); health and social work (86-88); and arts, entertainment and recreation (90-93). The non-SPINTAN sectors include all other sectors except for agriculture (ISIC Rev. 4 sectors 01-03).

Source: authors’ calculations based on PIAAC, EU LFS, SES, and CPS data.

6.2 Comparing INTAN-Invest and OECD organisational capital-related figures

This section compares the estimated OC figures with the series provided in the 2012 release of the INTAN-Invest database. To the best of the authors' knowledge, this is the only database where country-sectoral information of investment in OC is available, with OC being estimated using a comparable methodology (based on Corrado et al., 2009). The estimates provided in the two data sources appear highly correlated. With respect to the currently accessible INTAN-Invest dataset, the OECD estimates have the advantage of being more granular in nature, i.e. they are provided at a more disaggregated industry level; cover both the private and the public part of the economy, and encompass a larger set of European countries.

The comparison provided here refers to year 2010 for the 14 European countries included in both data sources, namely: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, United Kingdom. Sectoral coverage is restricted to the total business sector excluding agriculture, and industries are defined according to the INTAN-Invest grouping. Quantities are compared in local currency and current prices. Table A2 shows that the industry-specific estimates proposed in the two sources considered are highly and significantly correlated, for all industries except for the construction sector. The resulting ranking of countries is also highly correlated, no matter the industry of focus.

Table 3. Correlations for OECD and INTAN-Invest OC country-industry estimates, 2010

	Pairwise	Spearman
Construction	0.1605	0.8154*
Finance	0.6412*	0.5956*
Manufacturing	0.8756*	0.9297*
Mining	0.9785*	0.8374*
Other services	0.9001*	0.9692*
Trade	0.8666*	0.9121*
Utilities	0.6408*	0.8286*

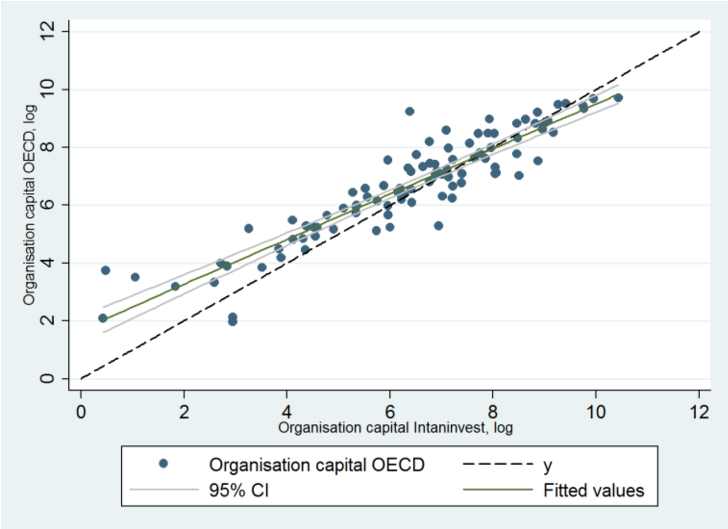
Note*:* Authors' calculations based on PIAAC, EU LFS, SES, CPS, SNA and INTAN-Invest data. Series are expressed in local currency and current prices for the business sector excluding agriculture, for 14 EU countries as reported above. * identifies significance at the 5% confidence level.

Figures 7 (a) and (b) corroborates the similarity between the two datasets by providing a graphical representation of the pairwise correlations. The data points mostly lie closely to the diagonal. While (a) simply plots the available data, panel (b) aggregates investment over all industries in each country.

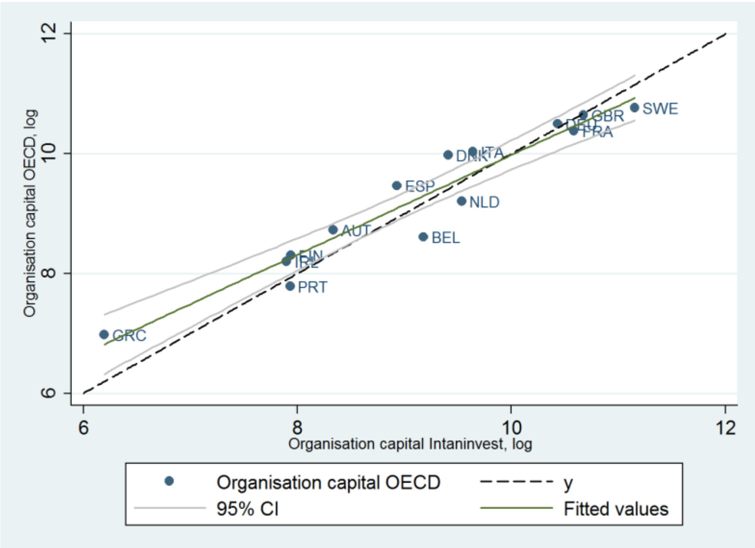
A second benchmark exercise is carried out comparing the present data with information on the managerial practices of firms, as reported in the World Manufacturing Survey (WMS) for the years 2004-2010 and a subset of countries which are available in both datasets. The WMS is a widely used source of information on management across countries. Appendix 4 contains more information on the survey and the way correlations are estimated. The two dataset do not seem to yield similar rankings of countries and, when a statistically significant correlation between OC investment as a proportion of value added and management scores can be established, it is not especially sizeable. Pending further explorations of the WMS dataset, it can be tentatively concluded that the OECD task-based approach and WMS do not measure the same dimensions of managerial capabilities in an economy.

Figure 7. Comparison current vs INTAN-Invest (log) estimates of OC, 2010

(a) Industry-country correlation



(b) Country-wide (sum) correlations.



Note*:* authors' calculations based on PIAAC, EU LFS, SES, CPS, SNA and INTAN-Invest data. Series are expressed in local currency and current prices for the business sector excluding agriculture, for 14 EU countries as reported above.

7. Conclusions

The present work proposes a definition of organisational capital and a measurement approach that builds on the organisational, management and economics literatures and is operationalised using novel cross-country data collected by the OECD PIAAC survey. It capitalises on the task-based approach first proposed in Squicciarini and Le Mouel (2012), who use data from O*NET to calculate investment in OC at macro and 2-digit sectoral levels for the United States.

Organisational capital is defined as the firm-specific human capital performing a set of tasks affecting the medium and long-term functioning of firms, including developing objectives and strategies; organising, planning and prioritising work; building teams, matching employees to tasks, and providing training; supervising and coordinating activities; and communicating across and within groups to provide guidance and motivation.

The task-based methodology is implemented on PIAAC data covering 20 countries and consists in combining the ranking of occupations according to the frequency with which workers perform OC-related tasks, with a clustering analysis of occupations based on all tasks / activities carried out at work. Results suggest that on average 20 broad occupational classes of the International Standard Classification of Occupations (ISCO 2008) are identified as being OC-related in each country. Despite cross-country differences, a core group of managerial occupations are consistently identified as OC occupations across countries. Differences arise in the selection of professionals and associate professionals in science and engineering, health, education, and business administration.

OC-related employment and investment figures for the year 2012 are estimated using labour force participation and earnings information contained in PIAAC. This is done following existing definitions of own-account investment in OC (especially from CHS), whereby 20% of the earnings of OC-related occupations is considered as own-account investment in OC. At the aggregate level, the share of all OC occupations in total employment represents between 9.5% in Denmark to 26% in the United Kingdom, with an average of 16%. Estimates suggest that total investment in OC, as a share of value-added, ranges from 1.4% in the Czech Republic to 3.7% in the United Kingdom, with an average 2.2% across all countries.

The wealth of information contained in the PIAAC database allows for a detailed breakdown of OC employment and investment. For most countries considered, it is found that total investment in OC is higher in services than in manufacturing, and higher in the public sector than in the private sector.

The same patterns are confirmed when examining first-time estimates the period 2000-11. Such estimates are obtained by using the OC-related list of occupations obtained for the 2012 in conjunction with information on employment and average wages from data sources other than PIAAC. Data on employment and average wage by occupation and sector are sourced from the EU Labour Force Survey, EU Structure of Earnings Survey, and the U.S. Current Population Survey. Estimates of investment in OC by country and sector are obtained as a function of employment and wages in organisational-related occupations, based on the methodology in Corrado et al. (2009). The obtained estimates are compared and found substantially consistent with INTAN-Invest information, whenever the two sample overlap.

Further improvements in the produced estimates could be achieved by relaxing some of the assumptions implied by the present methodology. Firstly, detailed time use surveys would provide important evidence to support the CHS assumption used to convert OC employment into investment. Indeed, it is likely that the amount of time spent on activities contributing to the long-term functioning of firms differs between occupations and that the 20% capitalisation factor does not apply homogenously. Secondly, information on the occupational category of survey respondents is provided at a relatively aggregated level. A more detailed breakdown of this information would allow for a finer identification of who contributes to the generation and accumulation of OC. Both of these limitations are likely to result in an overestimation of the amount of own-account investment in organisational capital.

As investment in other KBC assets can also be estimated on the basis of labour cost information, special attention should be paid to avoid double-counting the time (and hence the cost) of employees working on tasks related to several KBC assets at the same time. The existence of clear complementarities between assets has been confirmed by several studies in the past, in particular between organisational capital and ICT or computerised information (e.g. Bresnahan et al., 2002). Overlaps in employment and complementarities between R&D, OC, design and computerised information have also been explored in Squicciarini and Le Mouel (2013). Future work will therefore need to address complementarities and double counting issues, especially when expenditure-based approaches are pursued.

In addition to the above caveats, it shall be noted that the estimates presented in this paper offer only a partial picture of OC investment, as firms dedicate important resources to purchasing organisational knowledge from external sources, especially the management consulting industry. CHS (2005) find that in the United States, the purchased component of OC investment represented around 25% of total OC investment for the period 1998-2000. Adding this purchased component to the own account estimates provided here might, if anything, lead to even higher figures of investment in organisational capital.

Finally, while the definition used throughout this work is one of capital, the present work remains silent about the extent to which OC accumulates over the years and the extent to which it depreciates. Similarly, the relationship between organisational capital and organisational change is left unaddressed. As both these issues are neither easy nor straightforward to address, they are left to future research.

Taken altogether, the results proposed in the present paper shed new light on the importance of OC in the economy. Large country and sector-specific differences emerge in the intensity of OC investment, which had not yet been documented. In addition, the role of OC in economic growth, as evidenced in previous growth accounting exercises, would need to be revised to take into account the size of OC investment once non-managerial OC-related occupations are included. Finally, the new estimates of OC investment proposed can be used to analyse the role or such KBC type with respect to e.g. skill use and mismatch, its impact on the routinisation of tasks and the resulting polarisation of wage distribution, and its role in integrating and upgrading in global value chains (GVC).

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APPENDIX 1

Table A1. List of tasks present in PIAAC database

Task code	Task description	Robustness check 1 *4 tasks*	Main analysis *9 tasks*	Robustness check 2 *11 tasks*
	General tasks			
10	Cooperating and collaborating with co-workers		√	
11	Sharing work-related information with co-workers		√	√
12	Instructing, training or teaching people, individually or in groups	√	√	√
13	Making speeches or giving presentations in front of 5 or more people			
14	Selling a product or a service			
15	Advising people			√
16	Planning your own activities	√	√	√
17	Planning the activities of others	√	√	√
18	Organising your own time	√	√	√
19	Persuading or influencing people			√
20	Negotiating with people either inside or outside your firm or organisation		√	√
21	Faced with simple problems that take no more than 5 minutes to find a good solution		√	√
22	Faced with complex problems that take at least 30 minutes to find a good solution		√	√
23	Working physically for a long period			
24	Using skill or accuracy with your hands or fingers			
	Literacy, numeracy and ICT skill use at work			
25	Read directions or instructions			
26	Read letters, memos or emails			
27	Read articles in newspapers, magazines, or newsletters			
28	Read articles in professional journals or scholarly publications			
29	Read books			
30	Read manuals or reference materials			√
31	Read bills, invoices, bank statements or other financial statements			
32	Read diagrams maps or schematics			
33	Write letters memos or emails			
34	Write articles for newspapers, magazines or newsletters			
35	Write reports			
36	Fill in forms			
37	Calculating prices, costs or budgets			
38	Using or calculating fractions, decimals or percentages			
39	Use a calculator, either hand-held or computer based			
40	Prepare charts, graphs or tables			
41	Use simple algebra or formulas			
42	Use advanced math or statistics such as calculus, complex algebra, trigonometry or use of regression techniques			
43	Use a computer for email			
44	Use the internet to better understand issues related to your work			
45	Conduct transactions on the internet			
46	Use spreadsheet software			
47	Use a word processor			
48	Use a programming language to program or write computer code			
49	Participate in real-time discussions on the internet			

Source: Authors' own calculations based on PIAAC data, extracted June 2015.

Table A2. Selection of OC-related occupations according to the PIAAC and to the ONET databases

ISCO 3 digit	ISCO Title	ONET	PIAAC
110	Chief executives and legislators	√	√
121	Business services and administration managers	√	√
122	Sales, marketing and development managers	√	√
131	Production managers in agriculture		√
132	Manufacturing, mining, construction, and distribution managers	√	√
133	Information and communications technology service managers	√	√
134	Professional services managers	√	√
141	Hotel and restaurant managers	√	√
142	Retail and wholesale trade managers	√	√
143	Other services managers	√	√
213	Life science professionals	√	
214	Engineering professionals (excluding electrotechnology)	√	
216	Architects, planners, surveyors and designers	√	
220	Health professionals, except doctors	√	√
221	Medical doctors	√	√
232	Vocational education teachers		√
233	Secondary education teachers		√
234	Pre- and primary school teachers		√
242	Administration professionals	√	
243	Sales, marketing and public relations professionals	√	
252	Database and network professionals	√	
261	Legal professionals		√
262	Librarians, archivists and curators	√	
263	Social and religious professionals	√	√
312	Mining, manufacturing and construction supervisors	√	√
322	Nursing and midwifery		√
331	Financial and mathematical associate professionals	√	
334	Administrative and specialised secretaries	√	
343	Artistic, cultural and culinary associate professionals	√	
522	Shop salespersons	√	

Source: Authors' own calculations based on PIAAC data, extracted June 2015, and O*NET data (version 16.0), extracted April 2012

APPENDIX 2

Robustness checks using stricter and broader definitions of OC

The sensitivity of the results to the choice of tasks is tested by both restricting and broadening the definition of OC. Firstly, using the narrow definition mentioned above, we keep only 4 tasks (see the fourth column of Table A1 in Appendix 1), and replicate the analysis spelled out above. Table B1 summarises the results of this robustness test. In the second column, we show the total number of occupations selected with the 9 tasks, and in the third column the results of using only 4 tasks. The fourth column shows the number of occupations that are the same with both methodologies, and the final column shows the total number of occupations in each country. The overlap between using 9 and 4 tasks is very high in most countries. Korea and the Netherlands are notable exceptions, as there are only 6 and 12 occupations, respectively, that are identified by both criteria. In terms of occupations, there seems to be a bias concerning the ISCO category 230 "Teaching professionals", as many more are selected when using only 4 tasks than when using 9 tasks. This is to be expected as in the restricted definition of OC, the task "instructing and teaching others" has a more important weight than in the broader definition. This confirms that the broader definition of OC is more appropriate, as it is manages to better discriminate between occupations.

Secondly, we broaden the definition of OC, to include 11 tasks: we drop task 10 "Cooperating and collaborating", and add three communication tasks (see the fifth column of Table A1 in Appendix 1). The results are summarised in Table B2, and show very little difference with those obtained with the main analysis. Looking at the occupations, there seems to be no occupational category that is favoured by one or the other criteria. This suggests that including the communication related tasks does not add substantial information to the analysis. Hence, since the inclusion of such additional tasks, while justifiable on the basis of the definition of OC, does not add anything to the analysis, it is preferable to remain parsimonious and limit the number of tasks used for the analysis to 9.

Table B1. Robustness analysis using 4 OC-tasks

Country	Selection using 9 tasks	Selection using 4 tasks	Overlap	Total number of occupations
AUT	23	19	17	110
BEL	17	19	14	109
CAN	22	22	18	112
CZE	19	23	18	110
DEU	19	21	19	101
DNK	18	20	15	112
ESP	17	19	14	111
EST	21	24	20	112
FRA	18	19	16	108
GBR	19	21	17	101
IRL	18	20	14	106
ITA	20	18	15	112
JPN	17	18	15	111
KOR	14	15	6	109
NLD	19	21	12	109
NOR	17	21	14	101
POL	24	24	20	111
SVK	20	21	20	111
SWE	16	20	15	108
USA	19	21	17	110

Source: Authors' calculations based on the PIAAC database, extracted June 2015.

Table B2. Robustness analysis using 11 OC-tasks

Country	Selection using 9 tasks	Selection using 11 tasks	Overlap	Total number of occupations
AUT	23	24	22	110
BEL	17	16	14	109
CAN	22	21	21	112
CZE	19	22	19	110
DEU	19	20	19	101
DNK	18	15	12	112
ESP	17	18	17	111
EST	21	25	19	112
FRA	18	16	12	108
GBR	19	19	18	101
IRL	18	19	17	106
ITA	20	20	20	112
JPN	17	17	17	111
KOR	14	20	12	109
NLD	19	21	18	109
NOR	17	18	14	101
POL	24	20	16	111
SVK	20	19	17	111
SWE	16	14	10	108
USA	19	20	19	110

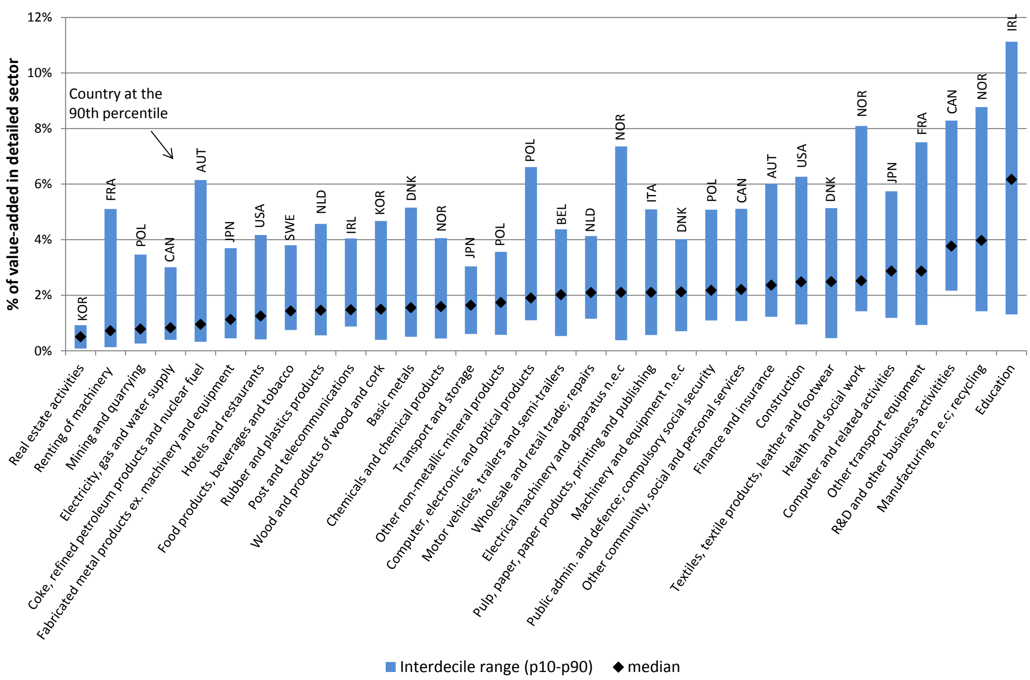
Source: Authors' calculations based on the PIAAC database, extracted June 2015.

APPENDIX 3

Further evidence from the cross-sectional analysis

Figure C1 offers a more detailed view of the industry level and shows the distribution of OC investment across countries for each sector. Median investment in OC ranges from 0.5% of value-added for real estate activities, to 6% in education. Some sectors display very high dispersion across countries. This is true especially in renting of machinery; coke, refined petroleum products and nuclear fuel; and electrical machinery and apparatus, where the ratio of the top 10% of OC investors to the bottom 10% of OC investors is higher than 15. The sectors with the smallest dispersion, where this ratio is smaller than 3, are wholesale and retail trade, and R&D and business activities.

Figure C1. OC investment by industry, 2012



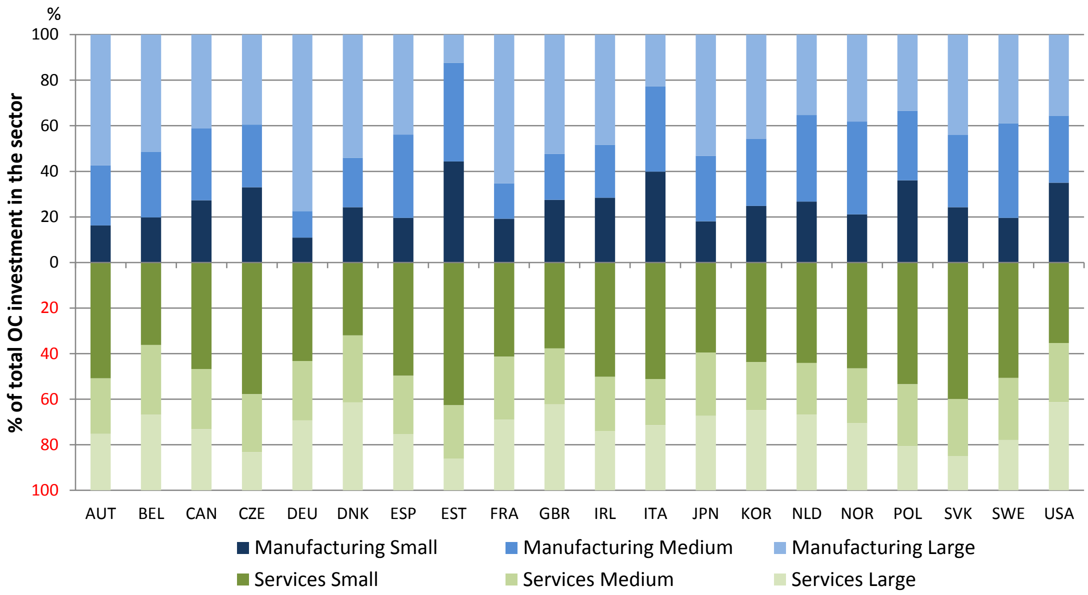
Source: OECD (2015).

Figure C2 shows the breakdown of OC investment for small (1 to 50 employees), medium (51 to 250 employees) and large (more than 251 employees) firms. In the services sector, small firms account for on average half of OC investment in that sector, while in manufacturing, 45% of OC investment comes from large firms.

Figure C3 shows the role of the self-employed in OC. The dark blue line shows their share in OC employment, and the light blue line in OC investment. The black diamonds represent the benchmark share of self-employed in total employment. In seven out of twenty countries, the share of the self-employed in OC employment is smaller than their share in total employment. Norway is the country where self-employed workers account for the smallest share of total employment and investment in OC, at only 7%.

While Korea has the highest share of self-employed in total employment (24%), it is in Italy that they account for the largest share of OC investment (34%).

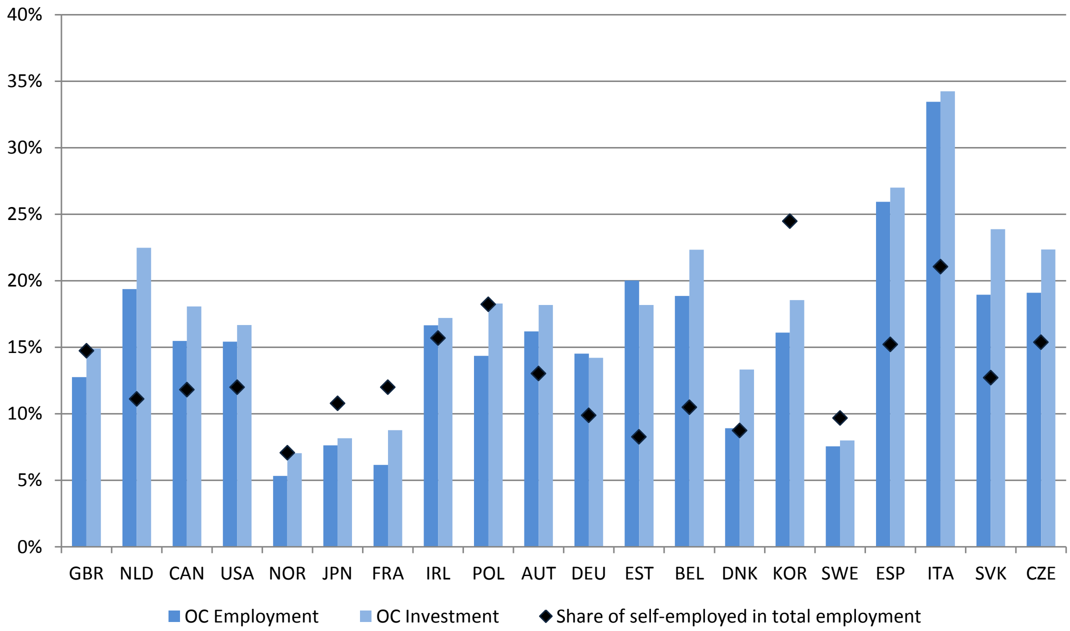
Figure C2. OC investment by firm size, 2012



Source: OECD (2015).

Legend: "Manufacturing OC" and "Services OC" refer to those occupations contributing to the generation of Organisational Capital other than managers, in manufacturing and services, respectively. Countries are sorted in descending order of OC investment intensity for the total economy, as in Figure 2.

Figure C3. Share of the self-employed in OC employment, OC investment and total employment, 2012



Source: Authors' own calculations based on publicly available PIAAC data and OECD STAN database, extracted June 2015.

APPENDIX 4

Constructing a time series of investment in OC

Table D1. Availability of information in each dataset, by country

Country	PIAAC	SES	LFS
Austria	√	Imputed from Finland, Netherlands	√
Belgium	√	√	√
Czech Republic	√	√	√
Germany	√	Imputed from France, Belgium	√
Denmark	√	Imputed from Sweden	√
Estonia	√	√	√
Spain	√	√	√
Finland	Imputed from Sweden, Denmark, Norway	√	√
France	√	√	√
Greece	Imputed from Italy, Spain	√	√
Hungary	Imputed from Czech Republic, Poland, Slovakia	√	√
Ireland	√	Imputed from Finland, Netherlands	√
Italy	√	√	√
Luxembourg	Imputed from Belgium, Netherlands	√	√
Netherlands	√	√	√
Norway	√	√	√
Poland	√	√	√
Portugal	Imputed from Spain	√	√
Sweden	√	√	√
Slovak Republic	√	√	√
United Kingdom	√	√	√

Comparison with World Management Survey data

This section describes the first attempt to compare the estimated OC investment with the information reported in the World Management Survey (WMS). The WMS is a survey of 18 managerial and human resources practices implemented in medium-sized firms worldwide. The information collected through the questionnaire is evaluates in scores ranging between 1 (identifying bad practices) and 5 (identifying good practices). Such information is then summarised into three indexes with equal boundaries, capturing the extent to which firms set their targets and follow up on them (“target”), are monitoring production processes (“monitoring”), or provide incentive to their employees (“people”). An extra summary index is also calculated (“management”). More information on its objectives, coverage and methodology can be found in Bloom and Van Reenen (2007), and Bloom et al. (2014).

For the purposes of this analysis, the comparison between the WMS and the present estimates of OC is based on the publicly available aggregate-level information and on the firm-level survey data[5] for the manufacturing sector only. Only 10 countries are present in both datasets: France, Germany, Greece, Ireland, Italy, Poland, Portugal, Sweden, the United Kingdom and the United States.

In principle, both data sources should draw a similar picture of managerial capabilities in the considered countries. However, the nature of the data (ad-hoc phone survey vs national surveys), their coverage (a sample of representative firms vs the entire industry), and the scope of the analysed phenomenon (selected managerial practices vs a number of organisational and managerial tasks as described in Le Mouel and Squicciarini, 2015) suggest that differences may exist and be justifiable. The last distinction seems especially important: organising, planning and prioritising work; building teams, matching employees to tasks, and providing training; supervising and co-ordinating activities; communicating across and within groups need not perfectly overlap with the managerial practices recorded in the WMS.

Such misalignment can be observed, for instance, when ranking the countries according to different WMS indicators and the intensity of organisational capital investment in value added for the overall manufacturing sector (ref. Table D2).[6] Firm level scores are summarised at the country/year level by computing the frequency of firms displaying score 3 or higher (out of 5), and countries ranked according to such frequencies.[7] The higher the ranking, the better the organisational and managerial capabilities in the country. Data refer to 2005, a year for which the number of countries available in both datasets is maximised. The ranking of countries substantially differs across measure of the WMS, and the organisational capital investment intensity. Statistically insignificant Spearman correlations (not reported) confirm the difficulty in ranking countries in a similar way according to the different proposed indicators, independently on whether the correlations are computed year by year or pooling data over all years.

Nevertheless, a firm-level Ordinary Least Square (OLS) regression is able to retrieve a small but significant correlation between WMS average scores and manufacturing OC investment intensity (ref. Table D3).[8] A higher score in managerial practices is positively correlated with intensity in OC investment, although not as far as monitoring is concerned. Even discarding endogeneity concerns which may affect the validity of the estimates, the magnitude of these correlations is very small: a standard deviation increase in "Management", for instance is correlated to a 0.03 standard deviations increase in the ratio of OC investment to value added, i.e. an about 0.009 increase on average across country. The small size of this economic relationship suggests that managerial practices, as recorded in the WMS, may not be first order drivers of the OC investment intensity in the manufacturing sector in the considered countries.

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5. We are extremely grateful to Prof. D. Scur and the World Management Survey team for granting access to such microdata for the purposes of the present research.

6. In the follow up of this paper, comparison can be carried out at the industry level (within manufacturing), information which is present in the accessed micro-data.

7. Differences in rankings between WMS-based and investment-based indicators persist if WMS-based rankings are computed on the basis of the average score across firms in the country/year in consideration.

8. Each firm-level observation in the regression is weighted by the inverse of the number of firms in the country.

Table D2. Ranking of countries based on different proxies of managerial capabilities

Manufacturing sector (2005)

Country	OC intensity	Management ratio	Monitor ratio	Target ratio	People ratio
GRC	1	3	4	4	3
DEU	2	7	9	8	7
USA	3	9	10	9	2
IRL	4	8	8	10	6
PRT	5	1	1	1	1
ITA	6	2	3	2	10
FRA	7	6	2	7	8
SWE	8	10	7	6	9
POL	9	5	4	5	5
GBR	10	4	6	2	4

Source: Authors' calculations based on PIAAC, EU LFS, SES, CPS, SNA and the World Management Survey.

Table D3 Correlation between WMS firm scores and manufacturing-level OC intensity in investment, 2004-10

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Management	0.0334**	0.0416***						
Monitor			0.0099	0.0194				
Target					0.0494***	0.0538***		
People							0.0242*	0.0344**
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
N	5,509	5,509	5,509	5,509	5,509	5,509	5,509	5,509

Source: Authors' calculations based on PIAAC, EU LFS, SES, CPS, SNA and the World Management Survey. Both dependent (OC investment over VA) and independent variables (WMS indicators) are standardised. Pooled ordinary least square regressions with robust standard errors.