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# Defining and Measuring Investment in Organisational Capital: Using US Microdata to Develop a Task-based Approach

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# DEFINING AND MEASURING INVESTMENT IN ORGANISATIONAL CAPITAL: USING US MICRODATA TO DEVELOP A TASK-BASED APPROACH

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# DEFINING AND MEASURING INVESTMENT IN ORGANISATIONAL CAPITAL: USING US MICRODATA TO DEVELOP A TASK-BASED APPROACH

Mariagrazia Squicciarini and Marie Le Mouel*

## ABSTRACT

Research on the role of organisational capital (OC) as a key driver of firm performance, especially as a complementary and enabling asset for other investments, like Information and Communications Technologies (ICT), has burgeoned in recent years and has contributed to making significant progress in the measurement of resources devoted by firms to OC. The expenditure based approach of Corrado, Hulten and Sichel (2005, 2009, hereafter CHS), which estimated investment in organisational capital as 20% of managerial compensation, has been widely adopted across OECD countries. Such an approach relies on the economics and management literature, where organisational capital is defined as a firm-specific knowledge asset embedded in a firm's employees. This literature further suggests that measuring organisational capital requires looking at a number of occupations, including but not limited to managers, who perform activities that shape a firm's organisational capabilities.

The present paper pursues this idea further and seeks to quantify investment in organisational capital by looking at the task content of occupations. It makes a fourfold contribution. Firstly, it offers a definition of OC based on the tasks that shape the long-term functioning of a firm, irrespective of the occupational title of employees. Secondly, it operationalises this definition using Occupational Information Network (O*NET) data from the United States Department of Labor. Relying on both a distribution-based approach and clustering analysis it identifies 84 occupational categories, of which 22 managerial occupations, that perform tasks related to the generation of firms' organisational capital. Thirdly, using employment and earnings data from the 2002 to 2010 US Current Population Surveys, it calculates the investment in organisational capital at both the country and 2-digit sector levels. It does so following CHS (2005) and estimates investment in organisational capital as the 20% of wages paid to all occupations performing OC-related tasks. Finally, relying on the insights of the literature on labour mobility and job separations, the present paper estimates sector-specific depreciation rates for organisational capital. Job tenure and employee turnover data from US Bureau of Labor Statistics over the period 2004-2010 are used for this purpose.

At the aggregate level, the task-based estimates of investment in organisational capital appear on average 90% higher than the estimates of CHS (2005). At the sectoral level, services, especially health, professional and technical services, educational services and finance clearly emerge as large investors in organisational capital, in absolute terms. Once the size of the sector is accounted for, chemicals, petroleum and electronics manufacturing also appear as high investors in organisational capital. Results suggest that organisational capital depreciates at a slower rate than previously thought: between 10% and 25% for most sectors as compared to the 40% suggested in the literature on the capitalisation of intangible assets.

**Keywords:** Organisational capital, embeddedness, tasks, Occupational Network Information (O*NET), US Current Population Survey (CPS), US Job Openings and Labor Turnover Survey.

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# DEFINITION ET MESURE DE L'INVESTISSEMENT EN CAPITAL ORGANISATIONNEL: APPROCHE PAR LES TÂCHES APPLIQUÉE AUX MICRO-DONNÉES AMÉRICAINES

Mariagrazia Squicciarini et Marie Le Mouel*

## RÉSUMÉ

La recherche sur le rôle du capital organisationnel dans la performance des entreprises, en particulier en tant qu'actif catalyseur d'investissements complémentaires tels que les Technologies de l'Information et de la Communication (TIC), a été impulsée par les progrès réalisés dans la mesure du montant des investissements dans cet actif. L'approche par les dépenses de Corrado, Hulten and Sichel (2005, 2009, ci-après CHS), selon laquelle l'investissement en capital organisationnel est équivalent à 20% de la rémunération des managers d'une entreprise, est utilisée à travers l'OCDE. Cette interprétation est en accord avec la littérature en économie et en management, qui défini le capital organisationnel comme une connaissance particulière de l'entreprise, incarnée dans ses employés. Cette définition suggère d'analyser les tâches accomplies par les employés, incluant de manière non exclusive les managers, qui contribuent à former les structures organisationnelles de leur entreprise.

Partant de ce constat, le présent article cherche à quantifier le montant d'investissement en capital organisationnel, à partir d'une analyse des tâches réalisées par différentes occupations. Tout d'abord, nous offrons une définition opérationnelle du capital organisationnel, comme étant constitué d'une série de tâches qui déterminent le fonctionnement à long terme d'une entreprise, accomplies par les employés sans distinction de catégorie occupationnelle. Nous testons ensuite cette définition grâce aux données du *Occupational Information Network* (O*NET) du Ministère du Travail des États-Unis. Utilisant à la fois une approche basée sur la distribution des occupations et une analyse de partitionnement, nous identifions 84 catégories occupationnelles, dont 22 managers, accomplissant les tâches contribuant au capital organisationnel. De plus, nous utilisons des données d'emploi et de rémunération provenant du *Current Population Survey* des États-Unis, pour estimer le montant des investissements en capital organisationnel aux niveaux macroéconomique et sectoriel. Nous suivons l'approche de CHS (2005) et considérons 20% des rémunérations de toutes les occupations ainsi identifiées comme contribuant au capital organisationnel. Enfin, inspirés par la littérature sur la mobilité du travail, nous calculons les taux de dépréciation du capital organisationnel au niveau sectoriel. Pour ce faire, nous utilisons des données sur l'ancienneté et le renouvellement des employés, provenant du Bureau des Statistiques de l'Emploi des États-Unis.

Au niveau macroéconomique, le montant des investissements en capital organisationnel estimé selon l'approche par les tâches est en moyenne 90% plus élevé que celui estimé selon la méthode de CHS (2005). Au niveau sectoriel, les services, dont, la Santé, l'Éducation, les Services Professionnels et Techniques et la Finance apparaissent comme de grands investisseurs en capital organisationnel, en termes absolus. Les Industries Chimique, Pétrolière et Électronique apparaissent aussi comme de grands investisseurs en capital organisationnel une fois la taille du secteur prise en compte. De plus, nos résultats suggèrent que le capital organisationnel se déprécie à un rythme plus lent, entre 10% et 25%, que celui de 40% communément utilisé pour la capitalisation des actifs immatériels.

**Mots clés:** Capital organisationnel, tâches, Occupational Network Information (O*NET), US Current Population Survey (CPS), US Job Openings and Labor Turnover Survey.

* *Nous remercions Carol Corrado, Cecilia Jona-Lasinio, Mary O'Mahony, Kyoji Fukao, Tsutomu Miyagawa, and Matilde Mas pour la pertinence de leurs commentaires lors de l'élaboration de ce document. Nous sommes reconnaissants envers les participants de la réunion d'experts « Mesure des actifs immatériels » et de la réunion OECD-INDICSER « Mesures sectorielles du capital immatériel» pour avoir contribué à la discussion. Le soutien et les conseils d'Alessandra Colecchia, Colin Webb, Andrea de Panizza et Fernando Galindo Rueda ont également été très appréciés. Toute erreur restante découle de notre responsabilité.*

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## Introduction

Organisational capital is an elusive concept whose importance is nevertheless widely acknowledged. Of the many definitions that exist, three emerge as particularly interesting, as they emphasise the information-based systemic nature of organisational capital, and its role in linking tangible and intangible assets. Prescott and Visscher (1980) identify organisation capital as the firm-specific information that affects the production possibility set and is augmented through output-related learning processes. Evenson and Westphal (1995) define organisational capital as the know-how needed to create systems of production combining human skills and physical capital[1]. Black and Lynch's definition (2005) instead centres on firm practices seemingly related to higher productivity, namely workforce training, employee voice and work design.

The importance of organisational capital is apparent from the many studies devoted to quantifying the investments that firms make in this knowledge-based asset and to uncovering the relationship linking organisational capital to entrepreneurial dynamics and productivity. This literature mainly follows an expenditure-based approach and generally relies on selling, general and administrative (SGA) expenses, or on managerial wages-related data to proxy investment in organisational capital. Examples are Papanikolaou and Eisfeldt (2009), who use SGA figures and find that firms with more organisational capital[2] are more productive, have higher Tobin's Q, have higher risk adjusted returns and display higher levels of executive compensation. Lev *et al.*'s (2009) SGA-based figures also suggest organisational capital to be positively related to executive compensation, and to long term operating and stock performance. Corrado, Hulten and Sichel (2005, 2009, henceforth CHS) conversely rely on managers' compensation and on the revenues of the management consulting industry to proxy organisational capital, and assess the role of intangible assets in driving aggregate US productivity growth.

While significantly contributing to a better understanding and measurement of intangible assets, the approaches above may overestimate (in the case of SGA) or underestimate (in the case of CHS 2005, 2009) the levels of investment in organisational capital. On the one hand, SGA expenses encompass a wider category of assets than organisational capital alone. This is reflected by the fact that CHS (2005, 2009) explicitly identify *e.g.* training, advertising and information technology (IT) expenses as distinct asset types other than organisational capital. 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. Tasks-based rather than occupational title-based criteria should hence be followed to identify and measure investment in organisational capital (Prescott and Visscher, 1980; Black and Lynch, 2005).

We pursue this idea further and seek to quantify investment in organisational capital by looking at the task content of occupations. Our contribution is fourfold. We propose an operational definition of organisational capital based on the task content of occupations. US data are then used to test this approach and identify those occupations for which the importance and level of performance of organisational capital-related tasks is highest. We further measure the level of investment in organisational capital at both the aggregate and sectoral level, aware of the systematic differences that exist across industries and motivated by the need to better account for those. Finally, sector-specific organisational-capital depreciation rates are estimated based on employees' tenure data: organisational capital is a firm specific asset embedded in its human capital and the mobility of a firm's workforce is known to affect its accumulation.

We define organisational capital as a set of tasks that we deem likely to affect the medium to long-term functioning of a firm and are involved, to varying degrees, in developing objectives and strategies; organising, planning and prioritising work; building teams, matching employees to tasks, and providing training; supervising and co-ordinating activities; communicating across and within groups. Data from the Occupational Information Network (O*NET)[3] are used to operationalise this definition and to identify which occupations of the US Standard Occupational Classification (SOC)[4] can be considered as contributing to own-account organisational capital. In total, 84 occupations including managerial, business support, and scientific occupations are identified by a distribution-based criterion and clustering analysis. Data on employment and earnings by occupations and industries from the US Current Population Survey (CPS)[5] are used to construct country level and 2-digit sectoral estimates of investment in organisational capital in the United States for the period 2002 to 2010.

With respect to purchased organisational capital, we follow the approach proposed in CHS (2005) and rely on data mirroring the revenues of the management consulting industry[6]. The total turnover of the industry is then allocated across sectors according to the Bureau of Economic Analysis' (BEA)[7] benchmark make and use input-output tables for the year 2002.

Finally, sector-specific organisational capital depreciation rates have been constructed using employees' tenure survey data from the January supplement of the CPS and job turnover data from the Job Openings and Labor Turnover Survey (JOLTS)[8] of US business establishments. This is driven by measurability issues and motivated by the human resource management literature investigating the relationship between turnover of employees and firm performance. This generally suggests that job separations, especially in the form of voluntary quits (alternatively called resignations) are associated with decreased organisational effectiveness and firm performance (see for instance the discussion in Phillips, 1996; Ton and Huckman, 2008; and Glebbeek and Bax, 2004).

Our estimates of own-account organisational capital are on average 90% higher at the aggregated level than the figures obtained using managerial occupations only according to CHS (2005). Moreover, this ratio varies across sectors: large disparities emerge between the level of investment calculated on the basis of managers' income only, versus that obtained from the task-based methodology proposed. Furthermore, sectors rank differently according to the two methodologies used, as the proportion of managers and other occupations contributing to organisational capital varies substantially across sectors. Services sectors, especially health, professional and technical services, educational services and finance clearly emerge as large investors in organisational capital, in absolute terms. Once the size of the sector is controlled for, chemicals, petroleum and electronics manufacturing also exhibits high investment in organisational capital.

The sector-specific depreciation rates of organisational capital calculated on the basis of tenure and turnover data further suggest organisational capital to generally depreciate at a slower pace than assumed in earlier studies, and highlight that differences across sectors do exist. Our figures based on median tenure statistics and on job separations due to voluntary quits vary between 10% (*e.g.* transport and manufacturing) and 25% (*e.g.* arts and entertainment and food services and drinking places). Exceptions are: Agriculture and Utilities, for which a depreciation rate of 5% and 7% is estimated, respectively; and Internet Publishing and Broadcasting, featuring a 33% rate of depreciation of its organisational capital. The proposed depreciation rates for organisational capital appear fairly consistent with some well known stylised facts (*e.g.* less concentrated industries exhibit higher turnover), and have the advantage of accounting for the structural differences that exist among sectors, while grouping sectors into subsets featuring similar turnover and tenure patterns. This should enhance the easiness of use of the proposed depreciation rates, as well as facilitate the production of country aggregated figures.

The rest of this paper is organised as follows. A brief survey of the literature concerned with measuring organisational capital is followed by the empirical analysis, where the data and the analytical

methodologies used to select the relevant organisational capital-related occupations are presented. The estimated investment figures in organisational capital at the sectoral level, and the sector-specific depreciation rates based on job separations and employees' tenure figures are then proposed. The final section discusses how these novel estimates compare with existing ones, and concludes by briefly summarising the main contributions of our paper, its main limitations, and proposing possible alleys for future research.

## Defining, measuring and depreciating organisational capital

### *Defining organisational capital*

The very nature of organisational capital has made it one of the more challenging firm assets to apprehend. This is reflected by the different albeit often complementary definitions and measurement approaches that have emerged in disciplines like economics, management, and accounting.

The economics literature has often modelled organisational capital 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 organisational capital to be a type of business knowledge that affects a firm's production possibility set and is accumulated jointly with output. Its main components are: information on employee and task characteristics, and the quality of their match; information on the quality of the match between employees assigned to teams; and information embodied in employees in the form of firm specific training. This specific knowledge represents the source of a firm's comparative advantage to create and maintain a revenue stream. This definition of organisation capital as a knowledge asset embodied in the firm has been used in a number of models. Examples are the analysis of: the learning process taking place within firms and the creation and accumulation of this knowledge asset (Rosen, 1972); the difficulty of matching employees to jobs and the resulting employee turnover dynamics (Jovanovic, 1979b); the impact of investment in this knowledge asset on firm growth and size distribution (Prescott and Visscher, 1980); and more recently, the rents accruing to firm owners from the return on this knowledge capital (Atkeson and Kehoe, 2005).

From a managerial literature point of view, organisational capital has emerged as an important source of competitive advantage, and as one of the main firm-specific resources. Teece *et al.*'s (1997) survey of the main theories of firm comparative advantages highlights that 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, the substitutability of products, and the bargaining power of buyers and suppliers, or game theoretic approaches modelling the strategic decisions of players (*e.g.* predatory pricing to deter entry). More recent explanations of sustained competitive advantage conversely focus on the ability of firms to exploit scarce and non-imitable firm-specific resources. This has lead to a Resource Based View (RBV) of the firm underlining the need to understand a firm's capabilities in terms of the organisational structure and managerial processes that underpins a firm's productive activity, rather than in terms of balance sheet items (Teece *et al.*, 1997). The authors further argue that in a dynamic context of Schumpeterian creative destruction, the importance of organisational structure and managerial knowledge goes beyond ensuring an efficient combination of inputs into successful products, but determines a firm's ability to react and adapt to ever changing business environments. A firm's dynamic capabilities and its ability to reconfigure its production to enter new markets and to up-grade its activity in global value-chains is key to long-term survival, and rests on superior management qualities and flexible organisational structures.

Recently, sociological approaches to organisation theory have further set aside the standard economic notion of rational profit-seeking individuals and emphasised the interconnectedness of actors and the power struggles involved in their relationships (Lounsbury and Ventresca, 2003). In particular, embeddedness has emerged as a key concept in the analysis of organisations. This notion places the focus

on the network of relationships within which a firm's employees are engaged, or embedded, and that allow for pertinent knowledge to be shared and integrated both in formal organisations as well as in the dispersed practices of individuals (Agterberg *et al.*, 2010). A distinction has been made between structural embeddedness and relational embeddedness. The former holds organisational knowledge to be contained in the network as a whole, whereas relational embeddedness focuses on individuals and their relations. The analytical tool underpinning this paradigm is social network analysis, which has become increasingly popular in many fields and finds a natural application in the context of organisation theories (Borgatti and Foster, 2003). Its use in the context of organisational structures has led to research on management performance and its impact on a number of dynamics, including innovation (Moran, 2005), job turnover (Allen, 2006; Clinton *et al.*, 2012), individual career paths (Ng and Feldman, 2007), and perceived organisational support (Hayton, Carnabuci and Eisenbergerm, 2012).

The concepts of organisational capital and embeddedness proposed by the literature have sometimes been interpreted to include a firm's external network of suppliers and customers and used in the analysis of joint ventures and inter-firm alliances (see Gulati, 1998 for a review; and Gulati, 2007). In particular, the specific operational challenges faced by multinational companies have spurred important research on the interaction of a firm's internal and external networks and the possibility of combining local networks with transnational culture and practices (Meyer, Mudambu and Naryla, 2011 and Agterberg *et al.*, 2010). These notions are likely to be closely linked, as more complex external networks of supplier and customer relations might indeed require a deeper organisational apparatus. Scholars however (*e.g.* Johnson, 1999; Bounfour, 2010) tend to distinguish organisational capital from relational capital, intended as the set of relationships a firm has with its suppliers and customers, and to use different approaches to measuring them.

The concepts and lessons drawn from the various fields above lend support to a view of organisational capital that emphasises its key role in the activity of firms and in their success: organisational capital consists of knowledge, know-how and business practices, and is embedded in a firm's managers and employees. However, while most literature discusses *what* is meant by organisational capital abundantly, attempts to measure *how much* organisational capital is present in firms are less numerous.

***Measuring organisational capital***

Existing organisational capital measurement-related studies can be broadly subdivided into three main groups, each following a different methodological approach. The 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 outputs, and in particular of increased firm performance. Finally a third group of studies measures investment in organisational capital by means of assessing the value of the inputs devoted to the building up of such an asset.

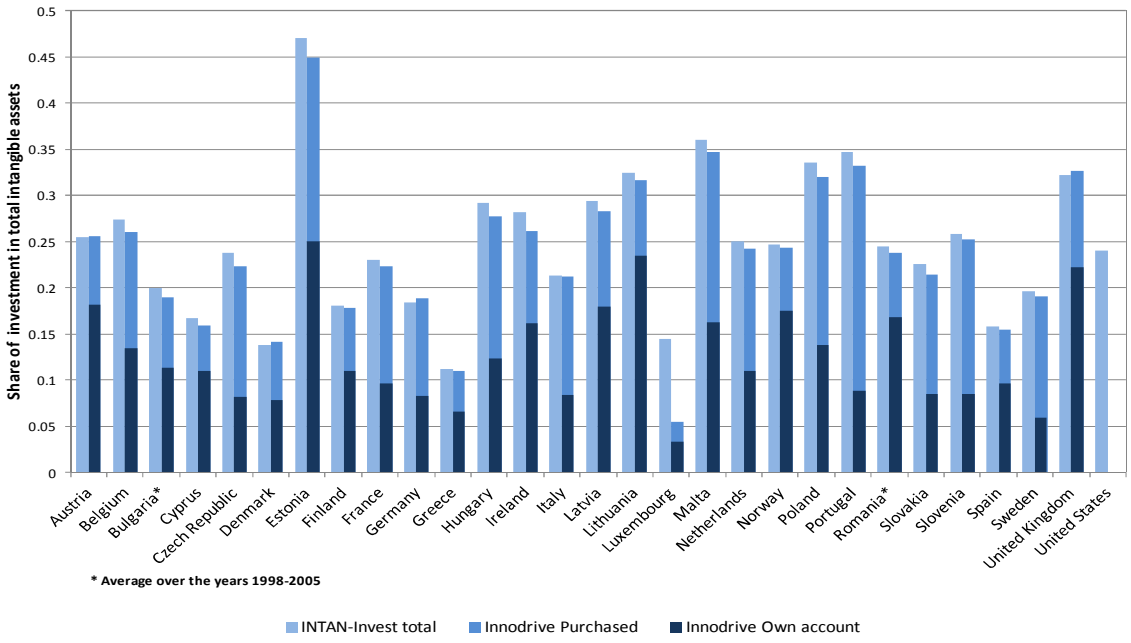
Studies carried out in the early 2000s rely on a somewhat narrow definition of organisational capital, intended mainly as organisational change aimed at introducing such novel work practices as decentralisation (Caroli and Van Reenen, 2001), High Performance Work Systems (HPWS,[9] see Bailey *et al.*, 2001), autonomy over work tasks, and the opportunity to communicate with employees outside the work group. Learning organisations giving firm's employees the opportunity to use and develop their skills and knowledge (*e.g.* Greenan, 2012), as well as "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 are also addressed in this organisational literature (see, *e.g.* van Alstyne, 1997; Birkinshaw and Hagstrom, 2000; and Hales, 2002).

Although narrow, this definition of organisational capital 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 (for a survey, see Black and Lynch, 2005). These measures of organisational capital have been widely used to understand the impact of 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, Lynch and Krivelyova, 2004); and about the determinants of management quality (Bloom and Van Reenen, 2007). Noteworthy in this respect is the recent study of Bloom *et al.* (2012), which relies on a survey of middle level managers in over 10 000 organisations in twenty countries. It investigates the existence of a number of management practices related to processes, monitoring, targets and incentives, and aims to assess overall management quality at the firm level.

The second group of studies defines organisational capital as a firm-specific knowledge asset, and quantifies its effect on firm performance measures as gross output, sales and revenues - in a similar fashion to other assets on a firm's balance sheet. 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' organisational capital 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 a knowledge-based asset. To this end, investment in organisational capital is proxied by firms' spending on sales, general and administrative expenses, whereas predicted profits are derived from industry-level figures. Miyagawa and Kim (2008) conversely estimate organisational capital 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 all types of intangible capital, 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.* the effect of organisational capital, or of intangible assets more broadly, or of other factors like technological progress.

The third approach to measuring organisational capital relies on quantifying the value of the resources used to build it and has been suggested by the CHS work. Own-account organisational capital is assumed to amount to the time that managers spend on developing a firm's business model and its corporate culture, and amounts to 20% of executives' time – managers are assumed to use on average 80% of their time in day-to-day management activities.[10] Purchased organisational capital is conversely estimated to correspond to 80% of the turnover of the management consulting services industry. This methodology has proven very useful in providing a first estimate of organisational capital at the macroeconomic level, and has contributed to highlight the importance of such an intangible asset. Figure 1 shows investment in organisational capital as a percentage of total investment in intangible assets, as estimated by the INNODRIVE project[11] and the related INTAN Invest Database.[12]

**Figure 1: Investment in organisational capital as a percentage of total investment in intangible assets, average over the period 1995-2005**




*Note:* The information in this document with reference to « Cyprus » relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the « Cyprus issue ».

*Source:* OECD calculations based on data from the INTAN Invest Database, June 2012, and INNODRIVE National Intangibles Database, May 2011.

The country level INTAN-Invest figures are shown in the left-hand bar and relate to the overall amount of investment in organisational capital – no breakdown between own-account and purchased organisational capital is provided. The right-hand bars conversely rely on INNODRIVE data and subdivide investment in organisational capital in its own-account and purchased components. The data show investments in organisational capital according to CHS (2005) to represent up to 45% of investments in all intangible assets for Estonia, and at least 25% in 11 other European countries. Own account organisational capital appears to represent more than 10% of total investment in intangible assets for the majority of European countries.

Taken together, the literature mentioned above seems to suggest that a labour cost measure of organisational capital might indeed be appropriate, and that organisational knowledge and capital is embodied in the managers of a firm, as well as in its employees. On the one hand, Black and Lynch's (2005) study about the evolution of managerial and organisational practices highlights that the development of modern work practices, which shift away from traditional forms of task-specific work, has led to greater autonomy and discretion, and to workers having more responsibilities and decisional power. On the other hand, recent evidence from Bloom *et al.* (2012) suggests management quality to be related to both managers' and employees' educational levels, thus showing the link that exists between organisational capital and the broader human capital of a firm. It further argues for the necessity to avoid restricting attention to managerial occupations only, as these represent part of a firm's investment in organisational capital.

We propose a definition of organisational capital that aims to account for the embeddedness of such an intangible asset and allows for its labour cost-based quantification. To this end, organisational capital is modelled as a set of tasks traditionally carried out by managers, but which have been progressively devolved upon non-managerial occupations, due to *e.g.* the decentralisation of authority and the delayering of managerial functions (as underlined in Caroli and Van Reenen, 2001). Doing so it is possible to identify occupations that would *a priori* not be considered as organisational capital by an occupational title-based approach, but that are shown to contribute to the long-term functioning of a firm. In particular, Prescott and Visscher (1980) and Bailey *et al.* (2001) suggest the following sets of tasks to be 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 co-ordinating activities; communicating across and within groups.

Before moving to explain the way we empirically identify those occupations contributing to the organisational capital of a firm, below we discuss how such an asset might depreciate. We do so by looking at the economics literature and human resource management literature investigating the determinants and effects of worker mobility on the long-term functioning and performance of firms.

***The depreciation of organisational capital***

Organisational capital is a firm-specific asset embedded in its human capital, whose accumulation and depreciation is likely shaped by a number of factors. Among them, the extent and frequency of possible organisational changes; the amount, type and frequency of training; the existence and deployment of support and co-ordination infrastructures, especially Information and Communication Technology (ICT); and the mobility of a firm's workforce. Here, we focus only on the latter aspect for two main reasons. On the one hand, the recent literature about organisational change and its drivers, components and possible effects clearly points to the need to better understand and measure the relationship between organisational change and the accumulation of organisational capital.[13] It further highlights the existence of complementarities and substitutabilities with other types of intangible assets – especially training and ICT (see *e.g.* Bresnahan et al., 2002) – and the consequent need to better model and measure them. Aware of the complexity and of the inherent conceptual and measurement difficulties of such an exercise, we however prefer to leave the issue for further research, as the problem would not be tractable in this one study. On the other hand, a widespread agreement seems to exist about the particularly disruptive effect that job separations may have on firms' medium to long-term functioning. Moreover, data about workforce mobility are readily available.

The management literature generally suggests job separations to be negatively correlated with the organisational effectiveness and the performance of a firm, despite the fact that "some" turnover might be beneficial (see for instance the discussion in Phillips, 1996; Ton and Huckman, 2008; and Glebbeek and Bax, 2004). Job separations may in fact represent a disruptive event for firms, especially when they cannot be anticipated or when they concern a part of the workforce accomplishing key functions within the firm. This kind of reasoning was predominant until the 1990s, and led to employees' turnover being considered as a mere cost for firms, motivating a number of studies to investigate its drivers, with the aim to devise mechanisms to retain human capital.[14] More recent organisational change-related research has instead contributed to highlighting potential benefits that may accrue from the turnover of employees, as job separation may facilitate the entry of much needed skills and competencies (see Glebbeek and Bax, 2004, for a discussion). Such studies are also supported by the economic literature trying to explain the industry-specific differences observed in experience and skill premia (*e.g.* Vilalta-Bufi, 2010). This has led to a more balanced view of the possible effects of job separations on firm performance, and to a number of studies empirically investigating the existence of a non-linear – seemingly an inverted U-shaped – relationship between employees' turnover and firm performance (see *e.g.* Shaw *et al.*, 2005, about voluntary turnover and organisational performance).

A number of stylised facts characterising job separations have emerged from the economic literature. In particular, it has been shown that certain categories of workers, including production workers and those with less schooling, are characterised by relatively lower job tenures. It has further been suggested that workers employed in industries with lower concentration or in industries characterised by smaller average firm size tend to turn over more (see Jovanovic, 1979a, for a discussion). Recent studies have also found human capital to be specific to the type of occupation of individuals, and that occupational and industry mobility may contribute to the destruction of (a substantial amount of) human capital. Interesting in this respect are Moscarini and Thomsson's (2007) measurement of long-term US labour market transitions, and in particular of mobility across occupations; and the analysis of Kambourov and Monovskii (2008) about the rising occupational and industry mobility characterising the United States over recent decades.

Taken together, the management and economic literature seems to suggest that human capital in general – including organisational capital – depreciates due to job separations. Evidence further suggests that organisational capital would however tend to depreciate at a relatively lower pace than other types of human capital embodied in comparatively less skilled workers. We therefore turn towards tenure and job turnover related data in order to try and construct evidence-based measures of the service life of organisational capital.

Estimates of both investment and depreciation rates of organisational capital are provided at the sectoral level, and can be combined in order to obtain country-level aggregates. This is motivated by the importance of accounting for the structural differences that exists across industries, as they are known to shape the size of returns on assets, including intangible ones (see *e.g.* Schmalensee, 1985).

**Operationalising the task-based approach to measuring organisational capital**

We implement a three-step approach to estimating sector-specific investment in organisational capital. We first identify which tasks are more likely to correspond to organisational capital-related activities. We then select those occupations with the highest content of organisational capital-related activities, based on the tasks they perform. We finally use occupation-specific average income figures in order to estimate investment in organisational capital at the sectoral level.

***The data: ONET, CPS, SAS and JOLTS datasets***

The data used in this analysis are gathered from the Occupational Information Network (O*Net, or ONET) database, a project on occupational information sponsored by the US Department of Labor. This dataset contains a wealth of survey-based information about workers' main characteristics and requirements, about experience and occupational requirements, about workforce characteristics, and finally occupation-specific information. The ONET dataset has been extensively used in the analysis of the effect of technological change on the task content of occupations, and in particular to determine the tradability and the offshorability of tasks and occupations (*e.g.* Jensen and Kletzer, 2010; Ritter, 2009; Goos, Manning and Salomons, 2010; and Lanz, Miroudot and Nordas, 2011). It has also been used to study the effect of technological change on wages and the demand for skills (*e.g.* Autor and Handel, 2009; and Crinó, 2009) and wage distribution (Firpo, Fortin and Lemieux, 2011), as well as to identify patterns of regional and urban concentration of occupations (Feser, 2003; and Scott and Mantegna, 2009).

The version of the ONET database used for the present study[15] covers 862 US SOC occupations. The possible task content of any occupation is detailed within the "occupational requirements" category, and consists of a total of 41 tasks defined in such a way as to be comparable across all occupations. The list of such tasks can be seen in Table A.1 in the Appendix. Employees in each occupation from randomly selected firms, or occupational experts, are asked to assess the importance, on Likert scales, of the listed 41 tasks and the level at which they perform such tasks. This yields two variables: a first variable, called

"Importance", ranging from 1 to 5, where 1 means that the task is not important and 5 entails that it is extremely important; and a second variable, named "Level", ranging between 1 (lowest level) and 7 (highest level). An example of the way task-related questions are formulated and what is meant by Importance and Level can be seen in Figure A1, in the Appendix. The information contained in the Importance and Level variables is to some extent complementary, as it may sometimes be unclear from the Importance question alone whether a task is actually performed within the occupation – that is, an employee may consider a task very important, but then from the answer to the Level question it may emerge that she does not perform it at all.[16]

In the present study, occupations in the ONET dataset have been aggregated into 479 occupations, to make such occupational groups match the classification of occupations contained in the Current Population Survey (CPS). The CPS is a jointly sponsored initiative of the US Census Bureau and the US Bureau of Labor Statistics, and provides a wide range of statistics relating to employment and earnings. We harmonise the level of aggregation of ONET and CPS data in order to construct occupation-related expenditure-based figures of investment in organisational capital. Our estimates rely in particular on the Annual Social and Economic (ASEC) Supplement of the Current Population Survey (CPS), which provides survey-based estimates of household income received during the previous calendar year. The data pertain to occupations in 52 industries. The armed forces, private households, and membership associations and Organisations are omitted from the results reported in the ASEC supplement. The ASEC Supplement of the CPS is available for the period 2003-2011, with average yearly employment and earnings by industry and occupation that relate to the years 2002 to 2010.[17]

With respect to measuring purchased organisational capital, we follow CHS (2005) and use data from two surveys carried out by the US Census Bureau. The first, the "Services Annual Survey" (SAS) contains data about the revenues of employer firms in the Management Consulting Services sector (NAICS code 54161); the second, known as the "Nonemployer Statistics", provides information about the revenues of non-employers in the NAICS code 5416, that is at a higher level of aggregation. The SAS is available on a quarterly and annual basis for the period 2002-2010; whereas Nonemployer Statistics are available annually from 2002 up to 2009. As Nonemployer Statistics are only available at the 4-digit industry level, with no disaggregation between Management Consulting Services (NAICS 5416-1) and Environmental Consulting Services (NAICS 5416-2), we assume the breakdown of revenues between these two industries to be the same for both employers and non-employers and use the corresponding ratio (on average 85% during the period considered) in order to estimate the corresponding revenues of non-employers. Historical benchmark Input-Output tables published by the US Bureau of Economic Analysis are then used to obtain a sectoral breakdown of the amount of management consulting services purchased by the various industries. As detailed use tables at the 5-digit industry level are only available for the year 2002, we at present propose sector-specific purchased organisational capital figures only for that very year.

Sector-specific depreciation rates for organisational capital have been estimated using employees' tenure survey data from the January supplement of the CPS and job turnover data from the Job Openings and Labor Turnover Survey (JOLTS) of US business establishments. The former is available for four years, namely 2004, 2006, 2008, and 2010 and contains occupation-specific information related to displaced workers, tenure, and occupational mobility. The latter is a programme collecting data on job openings, hires, and separations on the basis of establishment data by size class. It has been produced monthly since December 2000 and makes the distinction between the different types of job separations, namely voluntary quits, layoffs and other separations. Despite their being provided in a regular and timely fashion and at a disaggregated industry level, JOLTS data have the drawback of not being disaggregated by occupations.

***Identifying the organisational capital-related tasks***

The literature presented above identifies five groups of activities closely corresponding to the creation of organisational capital, namely: developing objectives and strategies; organising, planning and prioritising work; building teams, matching employees to tasks, and providing training; supervising and co-ordinating activities; communicating across and within groups. An analysis of the content of the task descriptions suggests that 11 tasks in the ONET data match these activities. They are listed in Table 1 below. The left hand column shows the activities identified by the literature as being related to the generation of organisational capital, whereas the right hand column displays these 11 tasks (both their ONET code and the corresponding definition).

**Table 1: Identification of O*NET tasks that correspond to organisational capital**

| Organisational capital-related activities | ONET Tasks | |
|---|---|---|
| | ONET code | ONET definition |
| Developing objectives and strategies | 224 | Developing objectives and strategies |
| Supervising and co-ordinating activities | 211 | Judging the qualities of things, services or people |
| | 417 | Resolving conflicts and negotiating with others |
| | 421 | Coordinating the work and activities of others |
| Building teams, matching employees to tasks, and providing training | 422 | Developing and building teams |
| | 423 | Training and teaching others |
| | 425 | Coaching and developing others |
| | 432 | Staffing organisational units |
| Organising, planning and prioritising work | 226 | Organising, planning and prioritising work |
| Communication across and within groups | 412 | Communicating with supervisors, peers and subordinates |
| | 414 | Establishing and maintaining interpersonal relationships |

*Source*: OECD compilation based on ONET data, January 2012.

The intuition underlying the framework developed by CHS (2005) implicitly entails that managers would have relatively higher answers to the Importance and Level questions in all the above 11 tasks, as compared to other occupations generally not associated with organisational capital. This is easily verified by means of looking at whether employees in managerial occupations – *i.e*. the 25 occupations denoted by Standard Occupational Classification (SOC) codes beginning by "11-" (*e.g*. 11-1011, chief executives) – answer above average to both the importance and the level questions. Results in Table 2 suggest that at least 22 of the 25 managerial categories considered[18] attribute high importance and level scores to organisational capital-related tasks. Support for the tasks related to training and coaching (ONET codes 423 and 425, respectively) appears slightly weaker than for the other tasks.

Evidently, managers do not only concentrate on building up organisational capital, as also suggested by the assumption made in the CHS's (2005) framework, whereby only 20% of the time of managers corresponds to investment in organisational capital. Data seem to support this, as there are other 18 tasks where at least 17 of the 25 managerial occupations give a high score compared to other non-managerial occupations. Such tasks relate to day-to-day activities (*e.g*. 431, Performing administrative activities) or to the application of general skills (*e.g*. 222, Thinking creatively). Table 2 also puts to light 12 mainly manual tasks, seldom performed by managers (in light shading), which are not related to organisational activities either in the short or the long term.

**Table 2: Importance and level of tasks performed by managers**

| ONET Task code | ONET Task description | Managers answering above average (out of 25 managers) on: Importance | Level |
|---|---|---|---|
| 111 | Getting Information | 23 | 23 |
| 112 | Monitor Processes, Materials, or Surroundings | 15 | 16 |
| 121 | Identifying Objects, Actions, and Events | 14 | 19 |
| 122 | Inspecting Equipment, Structures, or Material | 8 | 9 |
| 123 | Estimating the Quantifiable Characteristics of Products, Events, or Information | 17 | 21 |
| 211 | Judging the Qualities of Things, Services, or People | 22 | 23 |
| 212 | Processing Information | 22 | 22 |
| 213 | Evaluating Information to Determine Compliance with Standards | 21 | 22 |
| 214 | Analyzing Data or Information | 23 | 23 |
| 221 | Making Decisions and Solving Problems | 24 | 24 |
| 222 | Thinking Creatively | 24 | 24 |
| 223 | Updating and Using Relevant Knowledge | 22 | 21 |
| 224 | Developing Objectives and Strategies | 24 | 24 |
| 225 | Scheduling Work and Activities | 25 | 24 |
| 226 | Organizing, Planning, and Prioritizing Work | 25 | 25 |
| 311 | Performing General Physical Activities | 2 | 3 |
| 312 | Handling and Moving Objects | 2 | 2 |
| 313 | Controlling Machines and Processes | 4 | 3 |
| 314 | Operating Vehicles, Mechanized Devices, or Equipment | 3 | 4 |
| 321 | Interacting With Computers | 22 | 24 |
| 322 | Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment | 11 | 10 |
| 324 | Repairing and Maintaining Mechanical Equipment | 6 | 7 |
| 325 | Repairing and Maintaining Electronic Equipment | 5 | 6 |
| 326 | Documenting/Recording Information | 19 | 20 |
| 411 | Interpreting the Meaning of Information for Others | 22 | 21 |
| 412 | Communicating with Supervisors, Peers, or Subordinates | 23 | 23 |
| 413 | Communicating with Persons Outside Organization | 25 | 25 |
| 414 | Establishing and Maintaining Interpersonal Relationships | 25 | 24 |
| 415 | Assisting and Caring for Others | 13 | 15 |
| 416 | Selling or Influencing Others | 23 | 23 |
| 417 | Resolving Conflicts and Negotiating with Others | 23 | 24 |
| 418 | Performing for or Working Directly with the Public | 14 | 18 |
| 421 | Coordinating the Work and Activities of Others | 24 | 24 |
| 422 | Developing and Building Teams | 25 | 23 |
| 423 | Training and Teaching Others | 19 | 21 |
| 424 | Guiding, Directing, and Motivating Subordinates | 24 | 24 |
| 425 | Coaching and Developing Others | 22 | 23 |
| 426 | Provide Consultation and Advice to Others | 23 | 23 |
| 431 | Performing Administrative Activities | 24 | 25 |
| 432 | Staffing Organizational Units | 24 | 25 |
| 433 | Monitoring and Controlling Resources | 25 | 25 |

*Legend:* Organisational capital-related tasks highlighted in dark shading. Manual tasks highlighted in light shading.

*Source:* OECD calculations based on ONET data, January 2012.

Before proceeding further with the analysis a word of caution is needed. The empirical section of this paper is driven by our selection of the 11 tasks identified as being related to the generation of organisational capital. Although the simple evidence in Table 2 seems to broadly support our approach, we cannot be interpreted as proof that the selection of tasks covers all and only that are relevant. Motivated by such a concern, we carried out additional work aimed at both restricting and broadening the scope of our task-based identification of organisational capital-related occupations. Results (not included here, but available upon request) seem to confirm the robustness of our task-based approach to measuring organisational capital.

***From tasks to occupations***

Two methodologies are used to identify those occupations contributing to the building up of organisational capital. The first one relies on an analysis of the distribution of occupations with respect to their answers to the 11 tasks identified as related to organisational capital. The second methodology conversely follows a clustering analysis approach to identify clusters of occupations according to their answers on all the 41 tasks. The final selection of occupations is the overlap between these two methodologies and covers nearly 70% of the occupations selected by either methodology. This selection is conservative in nature, and tries to avoid overestimating investment in organisational capital.

*A distribution-based approach to identifying organisational capital-related occupations*

The first methodology used aims to identify those occupations providing relatively higher importance and level answers to the questions on the 11 tasks identified as organisational capital-related. The criteria used to do so aim to account for the fact that respondents might attribute high importance to a task which they perform at a low level, implying that this task is not a core component of their activities.

- With respect to the Importance question, we rank occupations according to the sum of the answers to the 11 organisational capital-related tasks.

- As for the level questions, occupations are ranked on the basis of the lowest response to any of the 11 organisational capital-related tasks. This aims to ensure that all tasks are performed at a comparatively higher minimum level, and imposes homogeneity in the task profile, as it rules out occupations scoring high with respect to most tasks, but very low to a few.

Occupations in the top quartile of both distributions are identified as being organisational capital-related, as the relevant tasks are on average relatively more important than they are for other jobs and they are consistently performed at a comparatively higher level. It is important to note that occupations are selected according to their *absolute* answers, and not according to the answers to organisational capital-related tasks *relative* to other tasks. While this is likely to be the case for occupations identified as managers, the purpose of the exercise is precisely to look beyond managers, and to uncover occupations carrying out organisational tasks in addition to other tasks. Chefs and Head Cooks (SOC code 35-1011) are an example, as they attribute high importance (3.78/5) to task "312. Handling and Moving Objects" but also to task "432. Staffing organisational units" (3.56/5). Using a selection criterion based on absolute rather than relative answers seems more appropriate to identify such occupations.

These criteria identify 94 occupations as organisational capital-related occupations. The full list of these occupations is provided in the third column of Table A.2 in the Appendix. The task-based criterion identifies 22 out of 25 managerial occupations as organisational capital-related occupations. It excludes "Advertising and Promotions Managers", "Natural Science Managers" and "Property, Real estate and Community Associations managers". The first two are excluded due to their low score on the "432. Staffing organisational units" task, whereas the last due to its low score with respect to the "224. Developing objectives and strategies" task.

Within the SOC 33-0000 to 53-000 categories of occupations, which correspond to more administrative or manual types of occupations, our criteria identify 13 out of 16 occupations called "First-line supervisors/managers". Such results look encouraging, since the criteria used, while agnostic to the content of the title of occupations, has nonetheless picked up occupations whose titles suggest important organisational capital content. The two supervisor occupations excluded by the criteria are "Supervisors of food preparation and service workers" and "Supervisors of landscaping, lawn service and groundskeeping workers". This methodology however also identifies some occupations having no obvious organisational

capital-related role, such as "Commercial divers" or "Hazardous materials removal workers", as they score high on the task "412. Communicating with supervisors, peers and subordinates".

*A clustering analysis approach to identifying organisational capital-related occupations*

We test the robustness of the distribution-based identification criteria above by carrying out a clustering analysis that groups occupations having similar answers for all 41 tasks. Each cluster is then analysed in terms of the importance given to organisational capital tasks by the occupations in that cluster. The methodology draws from both Feser (2003) and Lanz, Miroudot and Nordas (2011), who perform clustering analysis to identify regional clusters of occupation and to identify clusters of tasks performed by similar occupations. In particular, following Lanz, Miroudot and Nordas (2011), the hierarchical clustering analysis performed uses the Euclidian (L2) distance between clusters calculated with the complete-linkage method. An index summarising the information contained in both the importance and the level questions is used as the measure of distance. This is constructed following Feser (2003) and corresponds to the product of the values of the importance and the level variables, previously rescaled between 0 and 1. This method has the advantage of giving a higher index to occupations that score high on both dimensions. Unlike Lanz *et al.* (2011) the importance and level questions are given equal weights. Following the Duda and Hart (1973) criterion occupations get thus grouped into 34 clusters. Clusters are then ranked according to the average index for the 11 organisational capital tasks.

The results of the cluster analysis can be seen in Table 3 below. We here again rely on a distribution based approach to identify the top quartile scoring clusters of occupations and notice the existence of a natural cut-off point between the 13$^{th}$ and the 14$^{th}$ cluster, where the difference between the average indexes of the two clusters is close to 10%. Although applying a distributional approach in a strict way would result in choosing the top 15 clusters – which account for the 25% of occupations – we prefer to behave conservatively, and select only the top 13 clusters, given that the difference between the average indexes of the preceding and following clusters is less than one percent. These 13 clusters group 112 occupations, as shown in Colum 4 of Table A.2 in Appendix. The selection of managerial occupations results identical to that arising out of the task-based methodology discussed above, with the only difference that fewer supervisory occupations are selected here (*e.g.* "Supervisors of housekeeping and janitorial workers", "Supervisor of gaming workers" and "Supervisors of retail sales workers" are not selected by the cluster methodology).

*Combining the two approaches to identify organisational capital-related occupations*

Finally, the set of occupations that according to both methodologies contribute to the generation of organisational capital is chosen. In total, 84 occupations are thus identified, as shown in the fifth column of Table A.2 in the Appendix. The final selection includes 22 of the 25 managerial occupations listed in ONET and 11 of the 16 supervisor occupations, in addition to a number of business support occupations such as purchasing agents, cost estimators, management analysts or actuaries. Less obviously, a number of engineering and scientific occupations, as well as education and health related occupations (post-secondary teachers, dentists, pharmacists, surgeons or nurses) are also identified as organisational capital occupations. Finally, a few more technical occupations are identified as organisational capital-related occupations, such as commercial divers, electrical power-line installers or hazardous materials removal workers.

**Table 3: Results of the clustering analysis**

| Cluster ID | Average Index | Number of managerial occupations | Total number of occupations | Cumulative number of occupations | Relative difference with preceding cluster |
|---|---|---|---|---|---|
| 5 | 0.646 | 2 | 3 | 3 | |
| 34 | 0.595 | 0 | 1 | 4 | 8.0% |
| 4 | 0.575 | 1 | 2 | 6 | 3.4% |
| 1 | 0.513 | 8 | 13 | 19 | 10.7% |
| 6 | 0.504 | 8 | 13 | 32 | 1.8% |
| 3 | 0.439 | 0 | 10 | 42 | 12.9% |
| 2 | 0.430 | 1 | 13 | 55 | 2.1% |
| 32 | 0.419 | 0 | 7 | 62 | 2.6% |
| 9 | 0.417 | 2 | 17 | 79 | 0.5% |
| 29 | 0.415 | 0 | 6 | 85 | 0.4% |
| 7 | 0.413 | 0 | 17 | 102 | 0.5% |
| 19 | 0.388 | 0 | 6 | 108 | 6.0% |
| 28 | 0.388 | 0 | 4 | 112 | 0.2% |
| 12 | 0.350 | 0 | 4 | 116 | 9.7% |
| 30 | 0.348 | 0 | 6 | 122 | 0.7% |
| 8 | 0.347 | 1 | 16 | 138 | 0.0% |
| 27 | 0.338 | 0 | 15 | 153 | 2.8% |
| 11 | 0.338 | 1 | 23 | 176 | 0.1% |
| 33 | 0.331 | 0 | 8 | 184 | 2.0% |
| 18 | 0.313 | 0 | 7 | 191 | 5.5% |
| 16 | 0.303 | 1 | 23 | 214 | 3.3% |
| 31 | 0.291 | 0 | 1 | 215 | 4.0% |
| 10 | 0.280 | 0 | 23 | 238 | 3.5% |
| 17 | 0.277 | 0 | 19 | 257 | 1.2% |
| 23 | 0.269 | 0 | 13 | 270 | 3.0% |
| 13 | 0.268 | 0 | 12 | 282 | 0.3% |
| 24 | 0.263 | 0 | 72 | 354 | 1.9% |
| 25 | 0.228 | 0 | 1 | 355 | 13.3% |
| 14 | 0.220 | 0 | 12 | 367 | 3.5% |
| 22 | 0.206 | 0 | 11 | 378 | 6.3% |
| 26 | 0.202 | 0 | 34 | 412 | 2.3% |
| 21 | 0.201 | 0 | 30 | 442 | 0.5% |
| 20 | 0.172 | 0 | 36 | 478 | 14.3% |
| 15 | 0.152 | 0 | 1 | 479 | 11.6% |

*Source:* OECD calculations based on ONET data, January 2012.

## Estimating investment in organisational capital

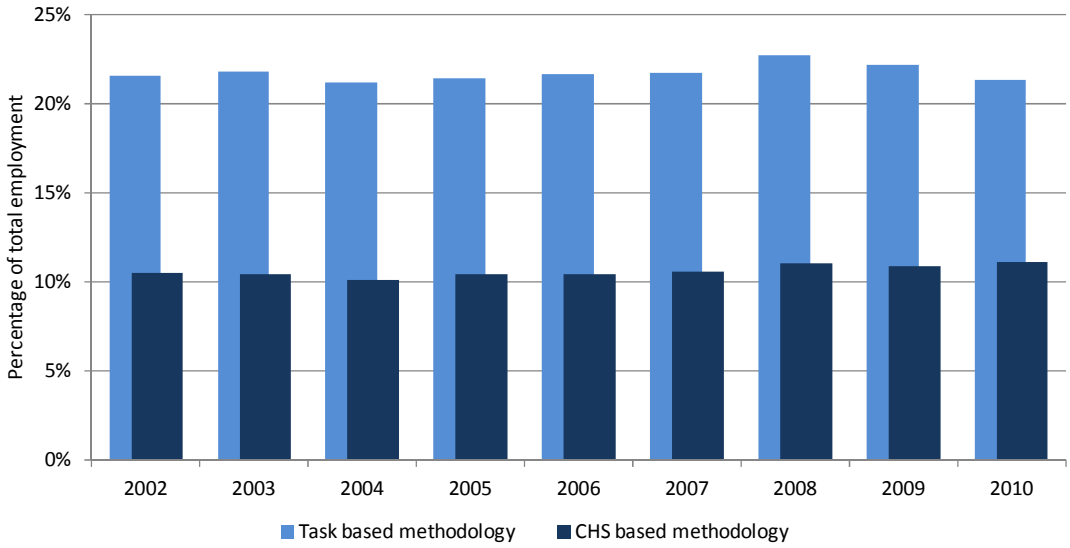
### *Own-account investment in organisational capital*

We rely on sector-specific average yearly earning data from the ASEC supplement of the CPS to estimate investment in organisational capital. To this end, we use information on the occupations identified through our task-based methodology and calculate investment according to CHS (2005), *i.e.* we consider organisational capital to amount to 20% of wages paid to the workforce in the 84 occupations identified. We thus extend the CHS framework over two dimensions: the definition of organisational occupations is broadened beyond managers to include all 84 occupations identified above; and estimates are calculated at

the sectoral level. As the information contained in the ONET data cannot be interpreted as a percentage of time devoted to the various tasks under consideration, a uniform capitalisation factor of 20% is applied to all occupations. In future studies, this assumption could be refined with information from time use surveys to identify occupation specific capitalisation factors. Moreover, the inclusion or exclusion of certain categories of managers might need being reconsidered. This is for example the path followed by Barnes and McClure (2009), who estimate investment in intangible assets for Australia and suggest excluding farm managers and IT managers from the list of organisational capital occupations. In the present paper, the task-based identification methodology proposed leads us to take into account almost all occupations falling under the SOC code 11-0000 and no extra restrictions based on possible overlap concerns are carried out.

At the aggregate country level, including all occupations contributing to organisational capital according to our task-based criterion doubles the number of employees considered: it adds on average 11 percentage points to the average 10.6% of total employment obtained using the CHS (2005) definition based on managers only. These values correspond to the average figures for the years 2002-2010 and can be seen in Figure 2 below.

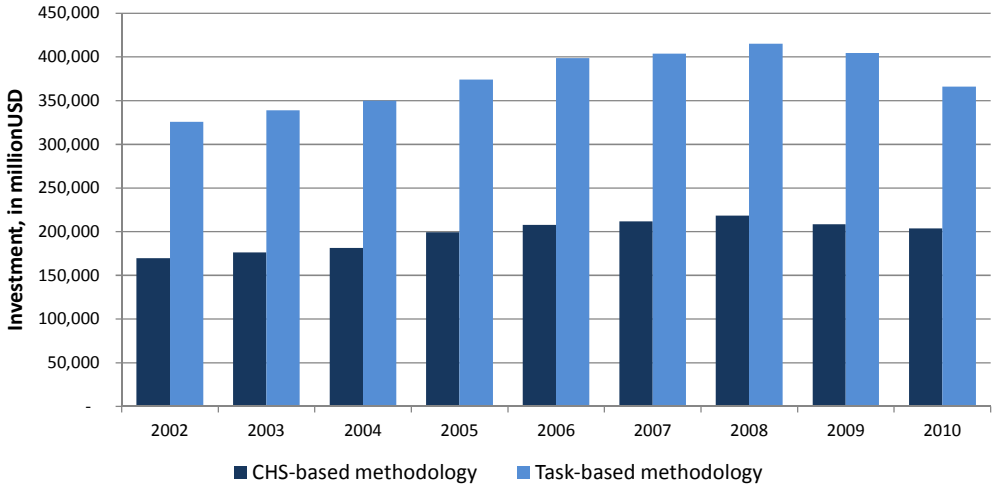
**Figure 2: Organisational capital occupations in the United States, as a percentage of total employment**




*Source:* OECD calculations based on the earnings data by occupation and industry from the Annual Social and Economic (ASEC) Supplement of the Current Population Survey (CPS), US Bureau of Labor Statistics, 2003-2011.

The investment figures resulting from applying our task-based methodology appear on average 90% higher than the investment figures obtained following the CHS (2005) methodology, as shown in Figure 3. The two estimation methodologies yield similar investment trajectories, with an increase in investment from 2004 until a peak in 2008, followed by a decline in 2009 and a levelling off in 2010.

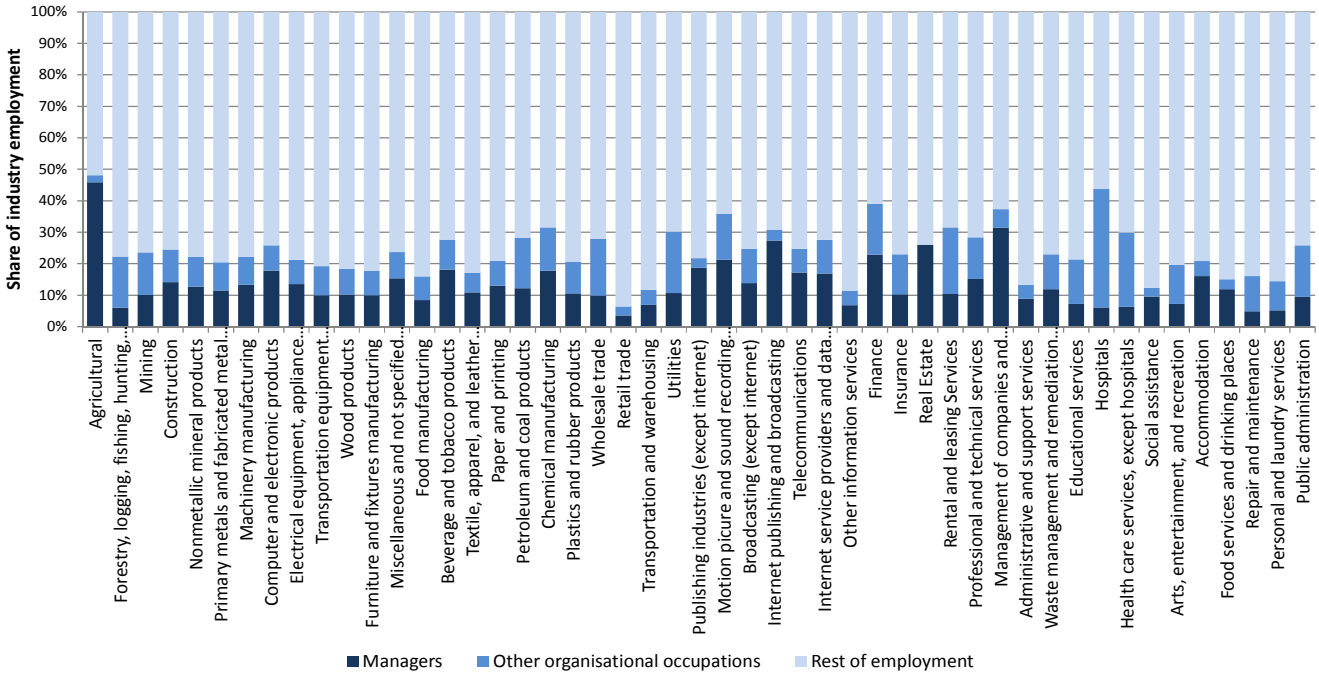
**Figure 3: Investment in organisational capital at the national level for the United States**




*Source:* OECD calculations based on the earnings data by occupation and industry from the Annual Social and Economic (ASEC) Supplement of the Current Population Survey (CPS), US Bureau of Labor Statistics, 2003-2011.

Estimates of investment at the sectoral level reveal which sectors most contribute to aggregate investment in organisational capital, and highlight the differences that emerge when a task-based approach is implemented. In terms of employment, while at the aggregate country level, managerial occupations represent about 10.6% of total employment and non-managerial organisational capital-related occupations represent another 11%, at the sectoral level these proportions vary greatly, as depicted in Figure 4. Managers represent above 20% of sectoral employment for industries such as agriculture, finance, internet publishing, management services, and real estate, and around 5% of sectoral employment for industries such as the health, personal services and retail trade sectors. However, sectors rank very differently when the proportion of non-managerial organisational capital occupations is considered. The health sector exhibits the highest proportion of non-managerial organisational occupations (40% of sectoral employment in the hospital sector and 25% of sectoral employment in the non-hospital sector). Next are the finance, public administration, wholesale trade, utilities and rental services sectors, where the proportion of non-managerial organisational capital-related occupations is around 20%. The food and drinking services, retail trade, agriculture, administrative support, transport, information services, management support and internet services sectors conversely show a corresponding proportion below 5%.

**Figure 4: Organisational capital occupations at the sectoral level as a percentage of sectoral employment in the United States, yearly average, 2002-2010**

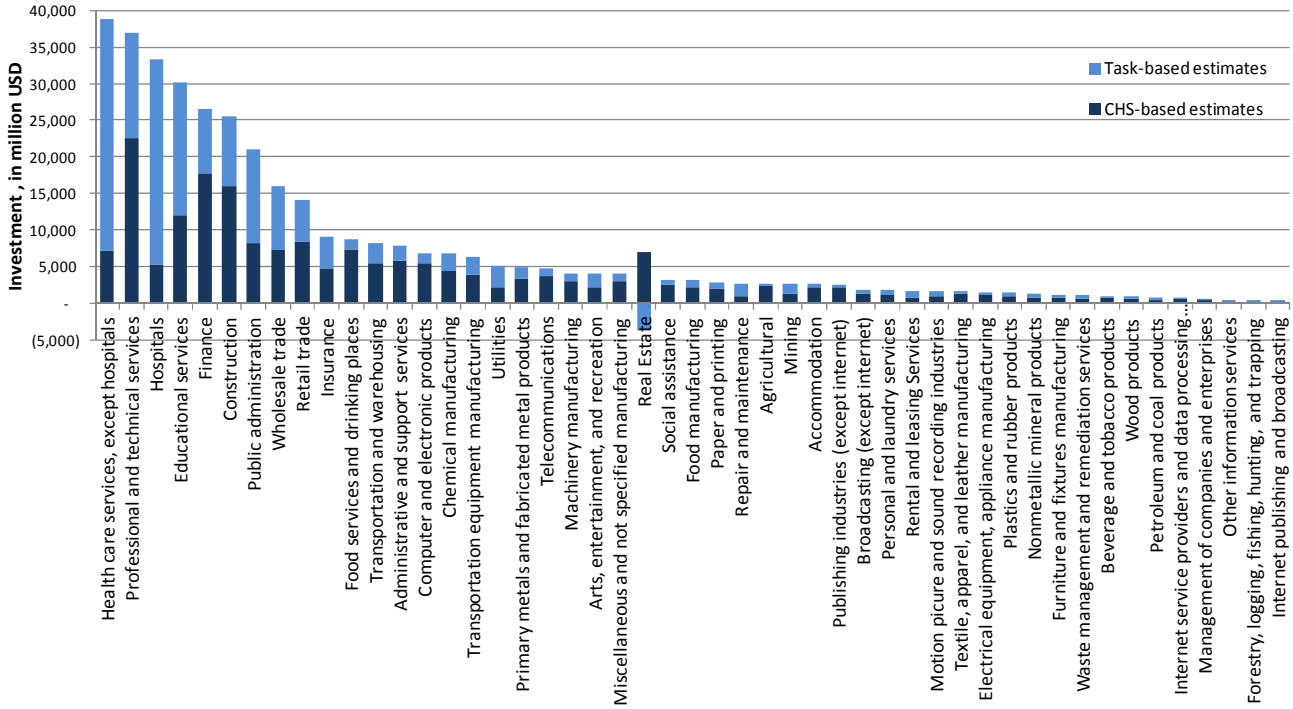



*Source:* OECD calculations based on the earnings data by occupation and industry from the Annual Social and Economic (ASEC) Supplement of the Current Population Survey (CPS), US Bureau of Labor Statistics, 2003-2011.

These sectoral disparities in employment figures related to organisational capital occupations translate into sectoral differences in investment in organisational capital, as shown in Figure 5. The sectors that invest the most in organisational capital, in absolute terms, are the health care services (hospital and non-hospital), professional services, educational services, finance, construction, public administration and wholesale and retail trade sectors, where investment in organisational capital amount to at least USD 14.5 billion per year. Manufacturing (excluding construction) contributes a very small proportion of total investment in organisational capital. In contrast, investment in organisational capital ranges between USD 1 billion in the petroleum and coal products and the wood products sectors and USD 7 billion in the computer electronics and the chemical manufacturing sectors.

While at the aggregated country level, the task-based method yields estimates that are on average 90% higher than the value obtained following CHS (2005). At the sectoral level, this ratio ranges between six times for the health sector and 1.1 and 1.2 for the publishing industries, management services, agriculture, food services and accommodation sectors. The differences that emerge in the distribution of sectors between the task-based employment estimates and the task-based investment estimates stems from the use of sector and occupation specific wage data, thus signalling that differences in wage premia exist. The only sector where the task-based estimates of investment in organisational capital are lower than the CHS's (2005) estimates is the real estate sector, as real estate managers, which represent around 20% of the sector's employment, are not identified as organisational capital-related occupations by the task-based methodology.

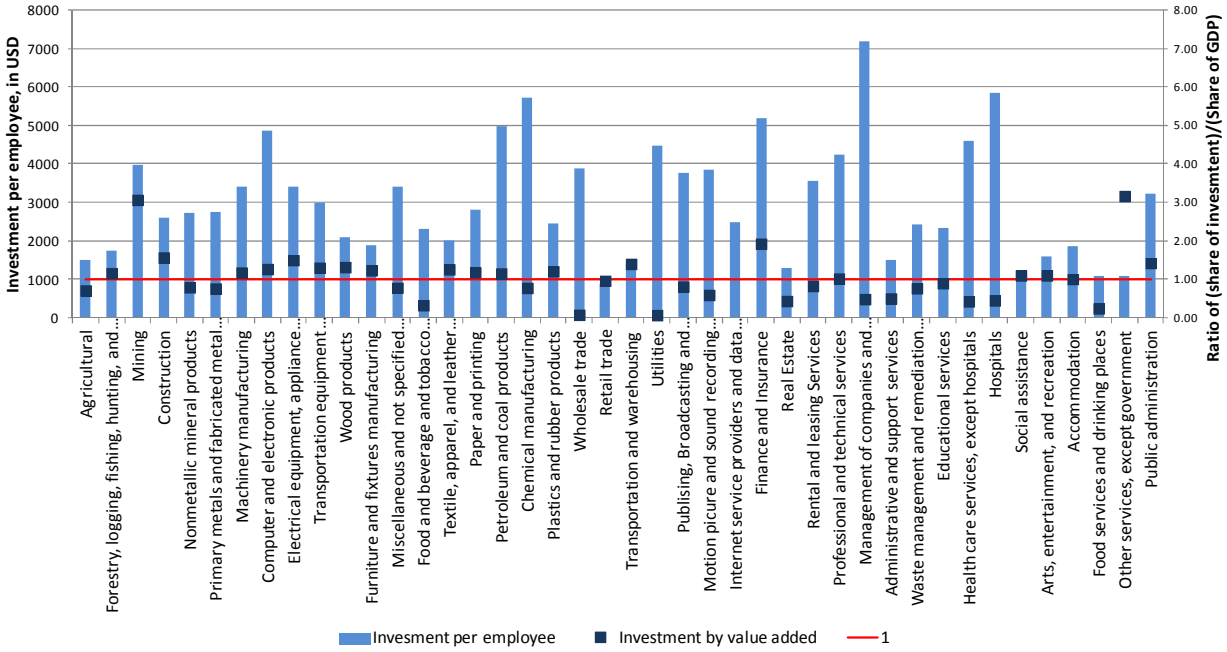
**Figure 5: Sectoral estimates of gross organisational capital investment in the United States, yearly average, 2002-2010**




*Source*: OECD calculations based on the earnings data by occupation and industry from the Annual Social and Economic (ASEC) Supplement of the Current Population Survey (CPS), US Bureau of Labor Statistics, 2003-2011

Obviously, the size of gross investment in organisational capital at the sectoral level is in large part driven by the size of the sectors. When controlling for the size of the sector, the health (hospital and non-hospital), education services and the finance sectors remain large investors in organisational capital per employee, as depicted in Figure 6. However, the construction and retail trade sectors appear to invest much less in organisational capital on a per employee basis. When sectors are compared according to their intensity of investment in relation to value-added, the share of total investment of most manufacturing sectors is larger than their share of value-added, while the reverse is true for most services sectors.[19]

**Figure 6: Sectoral estimates of organisational capital investment per employee and ratio of sector investment share to sector GDP share, yearly average, 2002-2010**




*Note:* The bars represent the level of investment per employee, and relate to the left-hand axis. The squares represent the ratio of the sector's share of investment in OC, over the sector's share in value-added, and relate to the right-hand axis. Sectors that have a ratio above one (horizontal line) invest relatively more in OC than their share of value-added would imply.

*Source:* OECD calculations based on the earnings data by occupation and industry from the Annual Social and Economic (ASEC) Supplement of the Current Population Survey (CPS), US Bureau of Labor Statistics, 2003-2011, and GDP-by-Industry data from the US Bureau of Economic Analysis.

### *Purchased organisational capital*

Estimates of purchased organisational capital are calculated following the CHS (2005) approach, whereby 80% of revenues from the management consulting services sector are considered as investment. Table 4 shows the breakdown of total investment in organisational capital at the aggregate level for the years 2002 to 2010. The ratio of purchased to own-account organisational capital appears pretty stable throughout the period considered, at 1:4, and suggests that the majority of organisational capital continues being produced in-house.

**Table 4: Total nominal investment in organisational capital, 2002 to 2010, in billion dollars**

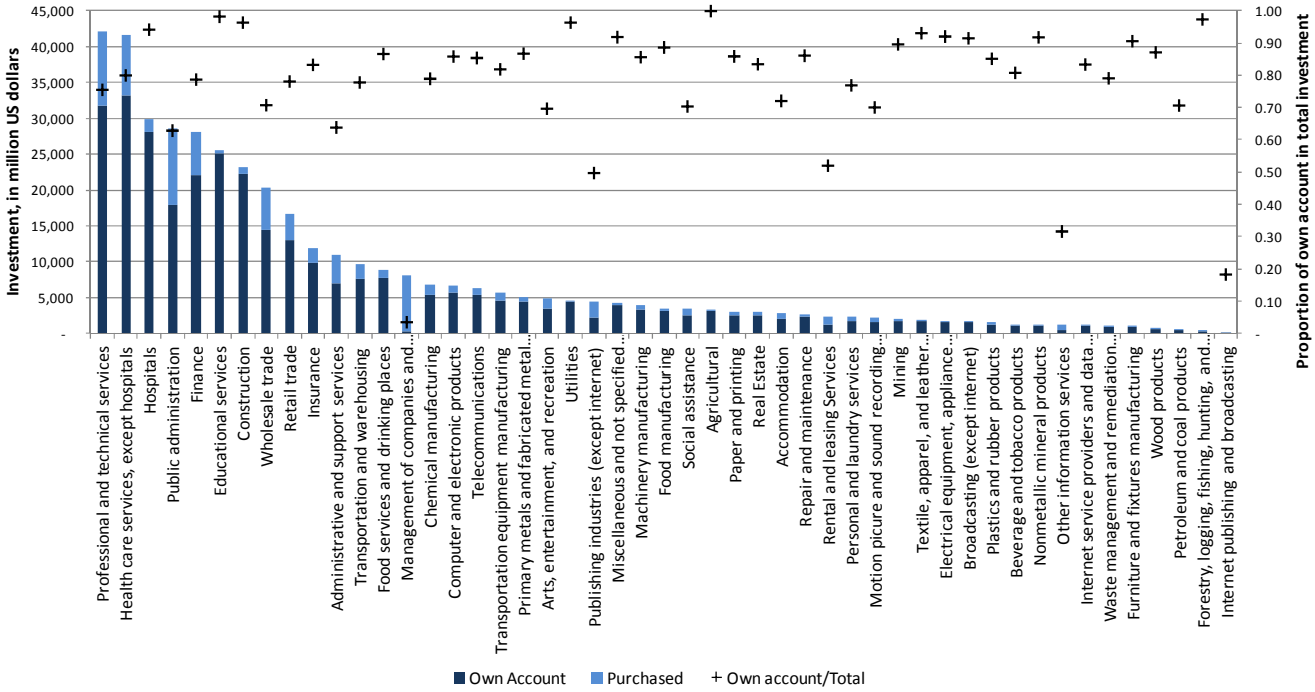
| | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|
| Total organisational capital | 411.5 | 424.4 | 442.8 | 477.9 | 507.7 | 521.2 | 537.5 | 514.6 | 465.4* |
| Own account organisational capital | 325.9 | 339.0 | 350.0 | 374.2 | 398.8 | 403.9 | 415.2 | 404.4 | 365.9 |
| Purchased organisational capital | 85.6 | 85.4 | 92.8 | 103.7 | 108.9 | 117.3 | 122.3 | 110.2 | 99.5 |
| Total revenues of management consulting sector – NAICS 5416-1 | 107.0 | 106.7 | 116.0 | 129.7 | 136.1 | 146.6 | 152.9 | 137.8 | 124.4* |
| *employers* | 90.9 | 90.5 | 99.0 | 109.2 | 114.5 | 122.4 | 128.2 | 115.9 | 124.4 |
| *non-employers* | 16.1 | 16.2 | 17.0 | 20.5 | 21.6 | 24.2 | 24.7 | 21.9 | - |

* Figures related to employers only.
Non-employers (*i.e.* businesses that have no paid employees and are subject to federal income tax) not included

*Source:* OECD calculations based on revenues of the Management Consulting Services (NAICS 5416-1) industry data from the Services Annual Survey and the Non-Employer Statistics, US Census Bureau, 2002-2010.

Investment in purchased organisational capital at the sectoral level is calculated using detailed Input-Output tables, to distribute the revenues of the management consulting services sector across industries. Figure 7 shows purchased and own account investment in organisational capital at the sectoral level for the year 2002, along with the proportion of own account in total investment. Here we propose the 2002 figures only, driven by the availability of detailed I-O tables and wary of imposing the observed 2002 distribution of revenues over the whole period considered. As industries evolve, the 2002 ratios might not be representatives of other years. As Figure 7 suggests, with a few exceptions, own account organisational capital represents above 80% of total sectoral investment in organisational capital. Services are clearly the largest purchasers of management consulting services, while in manufacturing nearly all organisational capital originates within the firm.

**Figure 7: Purchased and own account investment in organisational capital, 2002**




*Source:* OECD calculations based on revenues of the management consulting services (NAICS 5416-1) industry data from the Services Annual Survey and the Non-Employer Statistics, US Census Bureau, 2002-2010 and from historical benchmark Input-Output tables from the US Bureau of Economic Analysis, 2002.

### The service life of organisational capital: calculating tenure based depreciation rates

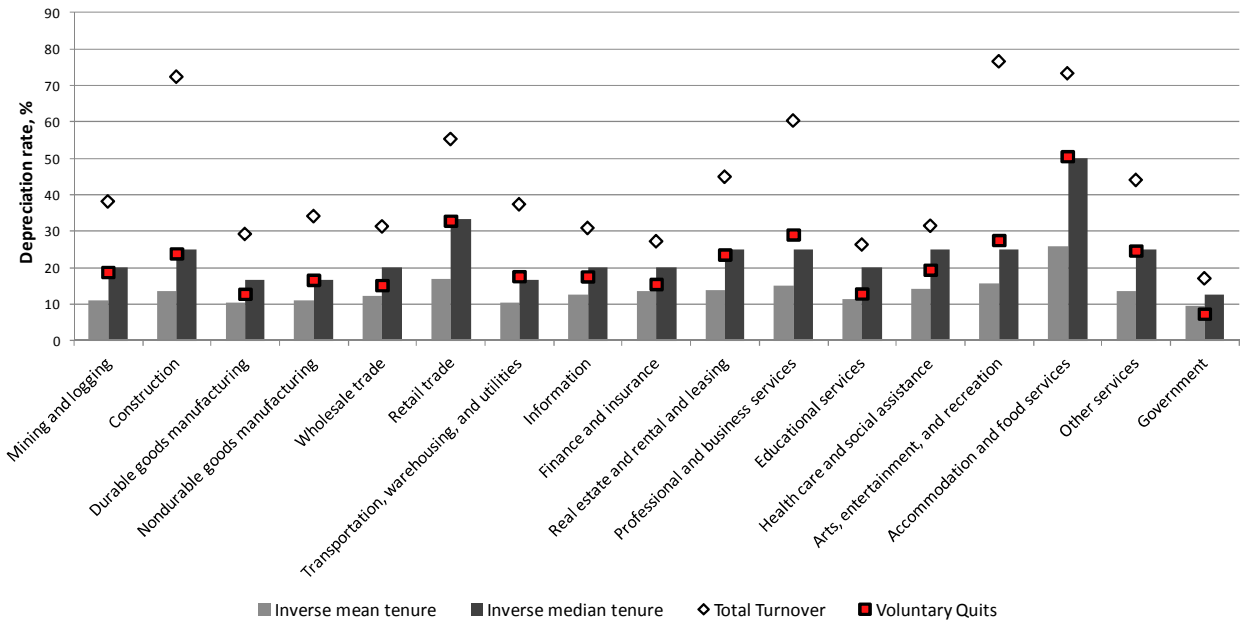
CHS (2009) assume a 40% depreciation rate for organisational capital, obtained as a combination of the rates for brand equity and R&D. They do so motivated by the fact that such a firm-specific resource seemingly features two contrasting components: a long-lasting learning-by-doing element which depreciates like R&D; and a short-lived organisational "forgetting" dynamic, similar to advertising. Recent survey-based estimates for the United Kingdom (Awano et al., 2010) and preliminary results from the ISTAT-Isfol Survey in Italy (Perani and Guerrazzi, 2012) however suggest that the average life length of business process improvements is much longer than is implied by CHS (2009). Depending on the sector considered and on features like firm size, the average estimated life of a bundle of business-related firm specific resources – including organisational capital – ranges between 4 and 5.4 years. This would lead to linear depreciation rates of 18% to 25%.

Such types of survey based data are unfortunately not available for the United States, and other indirect ways of estimating the sector-specific service life of organisational capital have to be devised. Supported by the literature on job tenure and turnover, and to its findings about the way job separations affect the accumulation of firm-specific human capital, we thus rely on job separations and employee tenure data to estimate the rates at which organisational capital depreciates.

We look at both tenure and turnover data for two main reasons. On the one hand, most relevant studies are concerned with the effect of job separations on firm performance, and in particular with the disruptive effect of voluntary quits. On the other hand, organisational capital, defined as a set of tasks that affect the medium to long-term functioning of a firm, is embedded in human capital and its accumulation is therefore likely to depend on the tenure of the workforce, and in particular on the tenure of occupations contributing to the generation of organisational capital. Moreover, job tenure and turnover are to some extent two sides of the same coin and there are no *ex ante* criteria supporting one over the other.

The depreciation rates constructed on the basis of tenure and turnover data are shown in Figure 8. In the case of job separations, organisational capital-related depreciation figures are calculated in a standard way, *i.e*. using the ratio of the number of separations over average total number of workers, per year (see *e.g*. Glebbeek and Bax, 2004). Figure 8 in particular displays the estimated depreciation rates related to total turnover (white diamonds) and voluntary quits (squares). With respect to tenure data, Figure 8 shows the depreciation rates obtained by means of taking the inverse of the mean and median sectoral tenures. It is worth noticing that the level of sectoral aggregation used is driven by the availability of turnover data, whereas the choice of the years considered is dictated by the availability of tenure data. Moreover, tenure data are available by occupation, whereas turnover ones are not. To enhance the comparability of results, the rates in Figure 8 rely on all occupations.

**Figure 8: Rate of turnover, voluntary quits and inverse of average and median tenure for the United States, yearly rate average, 2002, 2004, 2008, 2010**




*Source*: OECD calculations based on tenure data by occupation and industry from the January supplement of the Current Population Survey for the years 2004-06-08-10 and turnover data from the Job Openings and Labor Turnover survey, Bureau of Labor Statistics.

Figure 7 clearly highlights that sector-specific tenure related data are always positively skewed, with median tenure that are consistently lower than mean ones. It also shows that important cross-sector differences exist with respect to job separation rates, and in particular the proportion of total separations due to voluntary quits as opposed to layoffs and other types of separations (*e.g.* retirement). We believe voluntary quits deserve attention because they arguably represent a more disruptive event for firms than other types of separations. Retirements and layoffs can to some extent be foreseen and planned for, and it seems reasonable to expect that firms would ensure the smoothest possible transitions, and minimise the possible disruptive effect of such events over the accumulation of organisational capital.

The distributional properties of the data, as well as the reasoning above suggest relying on median tenure and voluntary quits-related data in order to estimate the desired sector-specific depreciation rates of organisational capital. As Figure 8 shows, depreciation rates calculated on the basis of median tenure and voluntary quits related data are similar. Table 5 presents the sector-specific service lives of organisational capital, corresponding to the median tenure of organisational capital-related occupations; and the related depreciation rates obtained assuming linear depreciation.

As can be seen, depreciation rates range from 5% and 7% in agriculture and utilities respectively, to 25% in arts and entertainment, food services and drinking places, motion picture and sound recording industries, and rental and leasing services. Median tenure in the internet publishing and broadcasting industry is particularly low – 3 years – and leads to a depreciation rate of 33%. In general, organisational capital seems to depreciate slower in the manufacturing sector than in the services sector.

The tenure and turnover based depreciation rates proposed in the present work appear significantly lower than those assumed by CHS (2009), but in line – although somewhat lower in some cases – with those suggested by survey results.

Our analysis in any case overlooks completely the way within-firm and within-sector occupational mobility and organisational change affect the tasks performed by employees and their occupational profiles, and thus the accumulation and the depreciation of organisational capital. We look forward to future studies addressing these issues in detail, and to a better understanding of whether such phenomena are likely to foster or hinder the accumulation of organisational capital.

**Table 5. Sector-specific organisational capital depreciation rates**

| NAICS code | Industry | Median tenure | Depreciation rate |
|---|---|---|---|
| 111-112 | Agricultural | 20 | 5% |
| 22 | Utilities | 15 | 7% |
| 113-115<br>92 | Forestry, logging, fishing, hunting, and trapping<br>Public administration | 11 | 9% |
| 337<br>322-323<br>331-332<br>336 | Furniture and fixtures manufacturing<br>Paper and Printing<br>Primary Metals and Fabricated metal products<br>Transportation equipment manufacturing | 10 | 10% |
| 321<br>326<br>333<br>48-49 | Wood products<br>Plastics and Rubber products<br>Machinery manufacturing<br>Transportation and Warehousing | 9 | 11% |
| 23<br>311<br>313-316<br>327<br>334<br>42<br>511<br>5191 exc. 51913<br>524<br>811 | Construction<br>Food manufacturing<br>Textile, apparel and leather manufacturing<br>Non-metallic mineral products<br>Computer and electronic products<br>Wholesale trade<br>Publishing industries<br>Other information services<br>Insurance<br>Repair and Maintenance | 8 | 13% |
| 21<br>312<br>325<br>335<br>517<br>55 | Mining<br>Beverages and tobacco products<br>Chemical manufacturing<br>Electrical equipment, appliances manufacturing<br>Telecommunications<br>Management of companies and enterprises | 7 | 14% |
| 324<br>399<br>44-45<br>515<br>518<br>531<br>622<br>812 | Petroleum and coal products<br>Miscellaneous and not specified manufacturing<br>Retail trade<br>Broadcasting<br>Internet service providers and data processing services<br>Real Estate<br>Hospitals<br>Personal and laundry services | 6 | 17% |
| 562<br>61<br>621, 623 | Waste management and remediation services<br>Educational services<br>Health care services, except hospitals | 5.5 | 18% |
| 54<br>521-523, 525<br>56, exc. 562<br>624<br>721<br>813 | Professional and technical services<br>Finance<br>Administrative and support services<br>Social assistance<br>Accommodation<br>Membership associations and organisations | 5 | 20% |
| 512<br>532-533<br>71<br>722 | Motion picture and sound recording industries<br>Rental and leasing services<br>Arts, entertainment and recreation<br>Food services and drinking places | 4 | 25% |
| 51913 | Internet publishing and broadcasting | 3 | 33% |

*Source:* OECD calculations based on tenure data by occupation and industry from the January supplement of the Current Population Survey for the years 2004-06-08-10, US Bureau of Labor Statistics.

**Advancing the intangible assets measurement agenda**

This paper proposes a novel approach to the measurement of investment in organisational capital and to the depreciation of such an important knowledge-based asset. A careful analysis of the task content of occupations highlights the importance of non-managerial occupations for the generation and accumulation of organisational capital, and suggests accounting for such occupations when estimating investment in organisational capital. Doing so suggests that previous figures may underestimate investment in organisational capital, and that sectors vary greatly in the extent to which they invest in such an asset. Services sectors generally exhibit higher absolute gross investment in organisational capital and seem to rely more on purchased organisational capital than manufacturing sectors. Manufacturing industries emerge as large investors in organisational capital in relative terms, with nearly all such investment being produced in-house. We also propose a novel approach to estimating the rates at which organisational capital depreciates that relies on job turnover and tenure data. The sector-specific estimates obtained underline the differences that exist across sectors and suggest that organisational capital is an asset that depreciates at a slower pace than previously supposed, with rates that vary mainly between 10% and 25% a year.

While attempting to improve the measurement of the intangible assets over several dimensions, our work is subject to a number of limitations, which we hope future research will address. Firstly, the results of our task-based approach are driven by the organisational capital-related tasks selected in the first step of the analysis. The selection is performed on a semantic basis, and the description of tasks is relatively succinct, which might lead to overlooking certain tasks that would indeed affect the medium to long term functioning of a firm but are not described as such. To test for the robustness of our results to the initial selection of tasks, factor analysis over the 41 ONET tasks has been performed. This allows us to identify how tasks relate to each other, and how similar the (unobserved) underlying functions accomplished may be. The result of such a robustness test (not included here, but available upon request) suggest that the tasks initially identified as contributing to organisational capital belong to two factors: a first factor, where the tasks related to organising and planning work are shown to be complementary to tasks related to gathering and interpreting information; and a second factor, where the tasks related to building teams and providing training appear complementary to tasks involving social and communication skills more generally, *e.g.* working directly with the public, or caring for others. While the tasks relating to the treatment of information are performed by most managers, those relating to social and communication skills appear to be performed much less by those in managerial occupations.

The selection of occupations based on the tasks identified through the factor analysis entails 77 occupations and looks broadly similar to that resulting from the tasks identified through the simple semantic analysis we carried out. Eighteen of the 25 managerial categories emerge as being related to organisational capital.[20] Of the other business support functions previously identified, cost estimators, financial analysts and actuaries are no longer selected. The factor analysis-based selection further leads to identifying a total of nine scientific and engineering occupations (as compared to the 14 occupations previously selected), and to add five health-related occupations to the group of organisational capital related ones. The number of supervisory occupations identified following the factor analysis conversely remains the same as before. The selection of education and miscellaneous occupations (clergy, fire-fighters, commercial divers, hazardous material removal workers, etc) picked up by the first methodology also remains unchanged in the factor analysis-based selection.

Secondly, the ONET database is the result of a long-term project and the wealth of data contained in it has been collected over a number of years. The survey of different occupational profiles is not updated through time, leading to the impossibility of accounting for likely changes in the task content of occupations, while research suggests that the adoption of certain work and organisational practices is likely to affect the importance and level of the tasks performed within occupations.

Thirdly, our estimates follow US-based studies and use US data only. It assumes that 20% of total wages paid to the relevant occupations correspond to investment in organisational capital, while estimates for other countries (*e.g*. Fukao *et al.*, 2009) however suggest that different – especially lower – capitalisation factors might be more appropriate. In addition, differences in the proportion of time spent on organisational capital-related tasks are likely to emerge across occupations, sectors and countries. Future research might help shed light on these issues and identify suitable capitalisation factors, possibly through time use surveys.

Fourthly, we are aware that the industry-specific distribution of firms and their size is likely to shape job separation dynamics and hence the depreciation rate of organisational capital. For example, industries composed mainly of small firms, where there is high staff turnover, will have a higher rate of depreciation of organisational capital. Although measures related to *e.g*. industry concentration like the Herfindal Index can be easily constructed, it is not straightforward to decide how to best use them to calculate the desired industry-specific depreciation rates of organisational capital. We therefore leave it to further research to investigate whether and to what extent industry structure and the distribution of firms affect job turnover rates and hence the depreciation of organisational capital. The way business cycles and technological paradigms might affect the accumulation and destruction of organisational capital would also deserve further investigation in future studies.

Finally, and possibly more importantly, our analysis completely overlooks the possible complementarities and substitutability that may exist between different types of intangible assets, and the effects of investment in one asset type on investment in other assets. The existence of complementarities between organisational change, adoption of ICT and technological change in general has been well documented, with respect to both investment and impact on performance (Caroli and Van Reenen, 2001; Breshnahan, Brynjolffson and Hitt, 2002; Greenan and Mairesse, 2006). Polder *et al.* (2010) further highlight the importance of ICT adoption to enable organisational innovation. However, the CHS (2005, 2009) framework is based on a complete taxonomy of intangible assets, where investments in ICTs, in R&D and in training are considered separately. In addition, many intangible assets are estimated using a labour cost approach. This implies that the value of investment in such assets is calculated as a proportion of the compensation received by the employees in the relevant IT, design or financial occupations. We therefore believe that special attention should be paid to the issue of double counting. In the case of organisational capital, this would entail restricting the definition of investment in organisational capital to the wages received by managers and employees not elsewhere accounted for. Moreover, the complementarities and possible substitutability of investment in different types of intangible assets would need to be suitably modelled and measured, possibly by extending the task-based approach to other intangible asset types,[21] to better appreciate the contribution of knowledge-based assets to productivity growth.

## ENDNOTES

1. Their definition of organisational capital relates to the way production, investment and invention capabilities translate into operations, and is shaped by experience and knowledge differentiation.

2. Firms are ranked at the industry level based on the ratio of organisational capital to book assets.

3. The O*Net database is a project on occupational information sponsored by the US Department of Labor. For more information visit *www.onetonline.org*.

4. See *www.bls.gov/SOC* for more details. The year 2000 SOC classification is used here.

5. The Current Population Survey (CPS) is sponsored jointly by the US Census Bureau and the US Bureau of Labor Statistics (BLS). For more information visit *www.census.gov/cps/*.

6. Corresponding to the North American Industry Classification System (NAICS) code 54161.

7. See *www.bea.gov/industry/io_benchmark.htm* .

8. Administered by the Bureau of Labor Statistics, see *www.bls.gov/jlt/* .

9. High Performance Work Systems are about creating opportunities for participation through the introduction of self-directing and offline teams.

10. IT and farm managers are excluded from the count.

11. INNODRIVE is a project funded by the European Commission. See *www.innodrive.org* for more details.

12. INTAN-Invest estimates are based on work conducted under the COINVEST and INNODRIVE projects and an ongoing effort of The Conference Board. See *www.intan-invest.net*.

13. Caroli and Van Reenen (2001) for instance highlight the possible discrete nature of "this form of 'capital' where marginal changes may not be possible" (p. 1457).

14. Part of the literature has even suggested the existence of a firm-specific optimal turnover rate, balancing out the costs of turnover with those costs firms would have to incur in order to minimise job separations. See Abelson and Baysinger (1984) about optimal and dysfunctional turnover.

15. Data extracted in January 2012. ONET data are updated on a rolling basis.

16. As an example, Figure A.2. in the Appendix, shows the task profiles of four occupations: food service managers, food preparation workers, construction managers and construction labourers.

17. Data extracted using the Bureau of Labor Statistics online tool Data Ferrett.

18. The managerial occupations that often answer below average on the organisational tasks are Advertising and Promotion managers and Real Estate managers.

19. The results obtained for the sector "Management of companies" in Table 6, namely a level of investment in organisational capital per employee much higher than other industries, and in Table 7, namely a very low ratio of own account organisational to total organisational capital, relates to a specificity of the North American Industry Classification System (NAICS). The NAICS classification groups the management of

companies into a single sector, with no information as to the sector to which the management is applied. This is not the case, for example in the Japan Standard Industry Classification (JSIC) where Management of companies is a sub-category of each industry.

20. In addition to the three managerial occupations excluded in the main analysis – namely advertising and promotion managers, natural science manager and property, real estate and community association managers, the additional managerial categories that fail to pass the task-based test are administrative services managers, transportation and distribution managers, engineering managers, and other managers.

21. See Corrado *et al.* (2012) for a discussion of the use of O*NET data in the context of investment in new product development in financial services.

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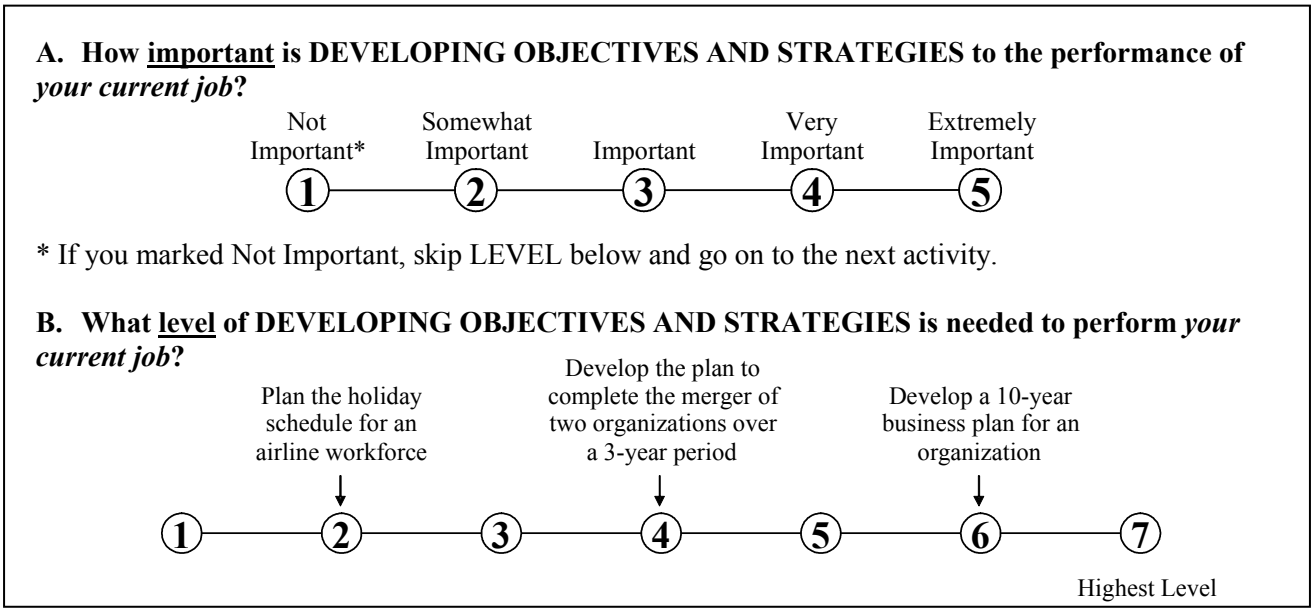
# APPENDIX

**Table A. 1: List of 41 tasks analysed in the O*Net database**

| Task Code | Task description |
|---|---|
| 111 | Getting Information |
| 112 | Monitor Processes, Materials, or Surroundings |
| 121 | Identifying Objects, Actions, and Events |
| 122 | Inspecting Equipment, Structures, or Material |
| 123 | Estimating the Quantifiable Characteristics of Products, Events, or Information |
| 211 | Judging the Qualities of Things, Services, or People |
| 212 | Processing Information |
| 213 | Evaluating Information to Determine Compliance with Standards |
| 214 | Analyzing Data or Information |
| 221 | Making Decisions and Solving Problems |
| 222 | Thinking Creatively |
| 223 | Updating and Using Relevant Knowledge |
| 224 | Developing Objectives and Strategies |
| 225 | Scheduling Work and Activities |
| 226 | Organizing, Planning, and Prioritizing Work |
| 311 | Performing General Physical Activities |
| 312 | Handling and Moving Objects |
| 313 | Controlling Machines and Processes |
| 314 | Operating Vehicles, Mechanized Devices, or Equipment |
| 321 | Interacting With Computers |
| 322 | Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment |
| 324 | Repairing and Maintaining Mechanical Equipment |
| 325 | Repairing and Maintaining Electronic Equipment |
| 326 | Documenting/Recording Information |
| 411 | Interpreting the Meaning of Information for Others |
| 412 | Communicating with Supervisors, Peers, or Subordinates |
| 413 | Communicating with Persons Outside Organization |
| 414 | Establishing and Maintaining Interpersonal Relationships |
| 415 | Assisting and Caring for Others |
| 416 | Selling or Influencing Others |
| 417 | Resolving Conflicts and Negotiating with Others |
| 418 | Performing for or Working Directly with the Public |
| 421 | Coordinating the Work and Activities of Others |
| 422 | Developing and Building Teams |
| 423 | Training and Teaching Others |
| 424 | Guiding, Directing, and Motivating Subordinates |
| 425 | Coaching and Developing Others |
| 426 | Provide Consultation and Advice to Others |
| 431 | Performing Administrative Activities |
| 432 | Staffing Organizational Units |
| 433 | Monitoring and Controlling Resources |

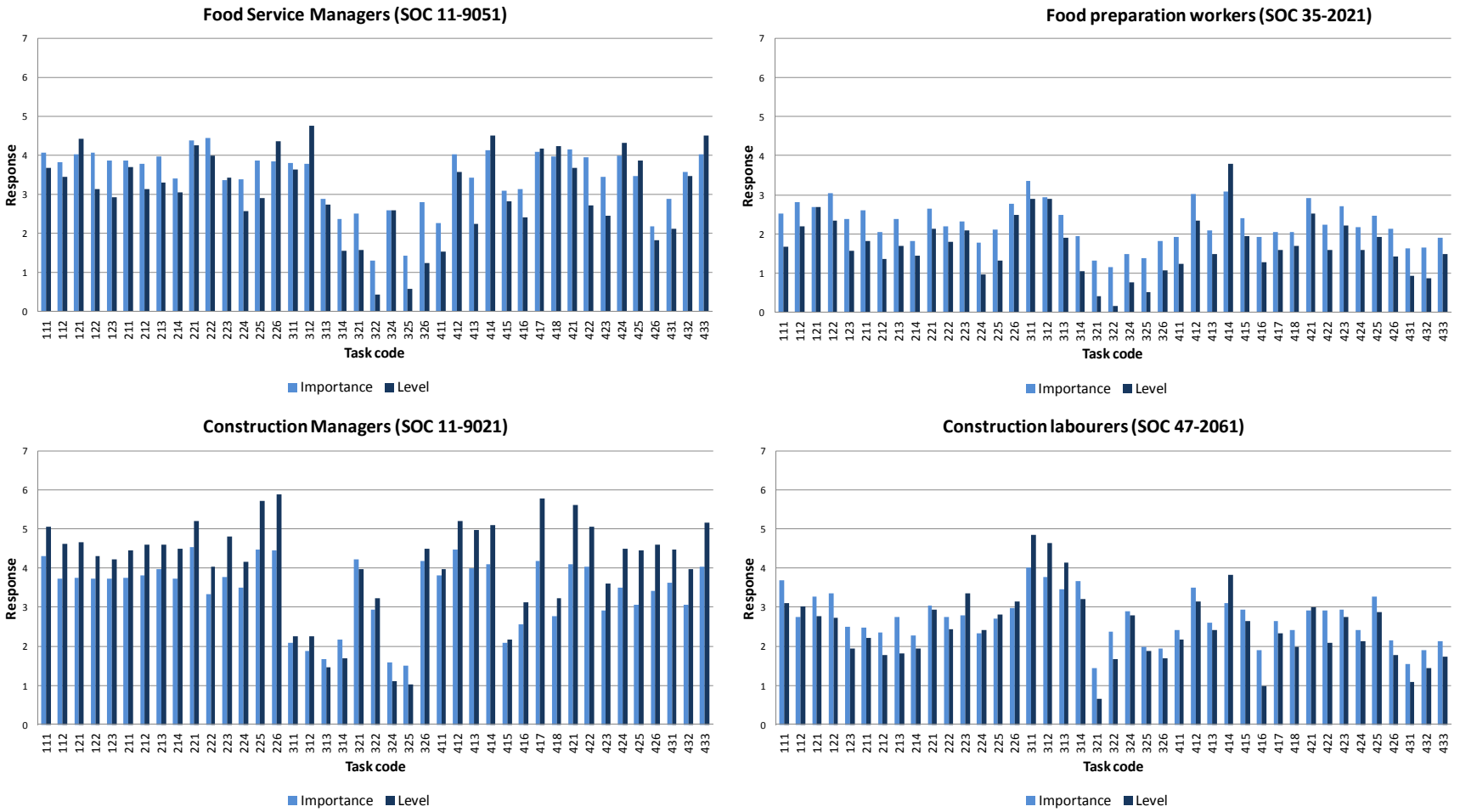
*Source:* US Department of Labour's Occupational Information Network database, extracted January 2012.

**Figure A.1: Example of Importance and Level question asked in the O*NET questionnaire**




Source: ONET Generalised Work Activities Questionnaire, www.onetcenter.org/questionnaires.html (last accessed January 2012).

**Figure A.2. Task profiles of Food Service Managers, Food Preparation Workers, Construction Managers and Construction labourers**




Source: OECD calculations based on US Department of Labour's Occupational Information Network database, extracted January 2012.

**Table A.2. Occupations identified the distribution-based approach and cluster analysis**

| Title | SOC code | Distribution Approach | Cluster Analysis | Both |
|---|---|---|---|---|
| chief executives | 111011 | 1 | 1 | 1 |
| general and operations managers | 111021 | 1 | 1 | 1 |
| marketing and sales managers | 112020 | 1 | 1 | 1 |
| public relations managers | 112031 | 1 | 1 | 1 |
| administrative services managers | 113011 | 1 | 1 | 1 |
| computer and information systems managers | 113021 | 1 | 1 | 1 |
| financial managers | 113031 | 1 | 1 | 1 |
| human resources managers | 113040 | 1 | 1 | 1 |
| industrial production managers | 113051 | 1 | 1 | 1 |
| purchasing managers | 113061 | 1 | 1 | 1 |
| transportation, storage, and distribution managers | 113071 | 1 | 1 | 1 |
| farm, ranch, and other agricultural managers | 119011 | 1 | 1 | 1 |
| farmers and ranchers | 119012 | 1 | 1 | 1 |
| construction managers | 119021 | 1 | 1 | 1 |
| education administrators | 119030 | 1 | 1 | 1 |
| engineering managers | 119041 | 1 | 1 | 1 |
| food service managers | 119051 | 1 | 1 | 1 |
| gaming managers | 119071 | 1 | 1 | 1 |
| lodging managers | 119081 | 1 | 1 | 1 |
| medical and health services managers | 119111 | 1 | 1 | 1 |
| social and community service managers | 119151 | 1 | 1 | 1 |
| managers, all other | 119199 | 1 | 1 | 1 |
| purchasing agents, except wholesale, retail, and farm products | 131023 | 1 | 1 | 1 |
| compliance officers, except agriculture, construction, health and safety, and transportation | 131041 | 1 | 1 | 1 |
| cost estimators | 131051 | 1 | 1 | 1 |
| logisticians | 131081 | 0 | 1 | 0 |
| management analysts | 131111 | 1 | 1 | 1 |
| other business operations specialists | 131199 | 1 | 1 | 1 |
| financial analysts | 132051 | 1 | 1 | 1 |
| financial examiners | 132061 | 1 | 1 | 1 |
| loan counselors and officers | 132070 | 1 | 1 | 1 |
| financial specialists, all other | 132099 | 1 | 1 | 1 |
| computer scientists and systems analysts | 151120 | 1 | 0 | 0 |
| actuaries | 152011 | 1 | 1 | 1 |
| architects, except naval | 171010 | 1 | 1 | 1 |
| surveyors, cartographers, and photogrammetrists | 171020 | 1 | 0 | 0 |
| agricultural engineers | 172021 | 0 | 1 | 0 |
| biomedical engineers | 172031 | 1 | 1 | 1 |
| chemical engineers | 172041 | 1 | 1 | 1 |
| civil engineers | 172051 | 1 | 1 | 1 |
| environmental engineers | 172081 | 0 | 1 | 0 |
| industrial engineers, including health and safety | 172110 | 1 | 1 | 1 |
| marine engineers and naval architects | 172121 | 0 | 1 | 0 |
| mining and geological engineers, including mining safety engineers | 172151 | 0 | 1 | 0 |
| nuclear engineers | 172161 | 1 | 1 | 1 |

| Title | SOC code | Distribution Approach | Cluster Analysis | Both |
|---|---|---|---|---|
| petroleum engineers | 172171 | 1 | 1 | 1 |
| engineers, all other | 172199 | 0 | 1 | 0 |
| agricultural and food scientists | 191010 | 1 | 1 | 1 |
| biological scientists | 191020 | 1 | 1 | 1 |
| medical scientists | 191040 | 1 | 1 | 1 |
| environmental scientists and geoscientists | 192040 | 0 | 1 | 0 |
| market and survey researchers | 193020 | 1 | 1 | 1 |
| psychologists | 193030 | 1 | 1 | 1 |
| sociologists | 193041 | 1 | 1 | 1 |
| miscellaneous social scientists and related workers | 193090 | 1 | 1 | 1 |
| counselors | 211010 | 0 | 1 | 0 |
| social workers | 211020 | 0 | 1 | 0 |
| miscellaneous community and social service specialists | 211090 | 0 | 1 | 0 |
| clergy | 212011 | 1 | 1 | 1 |
| directors, religious activities and education | 212021 | 1 | 0 | 0 |
| postsecondary teachers | 251000 | 1 | 1 | 1 |
| elementary and middle school teachers | 252020 | 0 | 1 | 0 |
| secondary school teachers | 252030 | 0 | 1 | 0 |
| special education teachers | 252040 | 0 | 1 | 0 |
| other teachers and instructors | 253000 | 0 | 1 | 0 |
| archivists, curators, and museum technicians | 254010 | 0 | 1 | 0 |
| other education, training, and library workers | 259010 | 1 | 1 | 1 |
| producers and directors | 272012 | 1 | 1 | 1 |
| athletes, coaches, umpires, and related workers | 272020 | 0 | 1 | 0 |
| dancers and choreographers | 272030 | 1 | 1 | 1 |
| chiropractors | 291011 | 1 | 1 | 1 |
| dentists | 291020 | 1 | 1 | 1 |
| dietitians and nutritionists | 291031 | 1 | 1 | 1 |
| optometrists | 291041 | 0 | 1 | 0 |
| pharmacists | 291051 | 1 | 1 | 1 |
| physicians and surgeons | 291060 | 1 | 1 | 1 |
| physician assistants | 291071 | 0 | 1 | 0 |
| podiatrists | 291081 | 0 | 1 | 0 |
| registered nurses | 291111 | 1 | 1 | 1 |
| audiologists | 291121 | 0 | 1 | 0 |
| occupational therapists | 291122 | 1 | 1 | 1 |
| physical therapists | 291123 | 1 | 1 | 1 |
| radiation therapists | 291124 | 0 | 1 | 0 |
| recreational therapists | 291125 | 1 | 1 | 1 |
| respiratory therapists | 291126 | 1 | 1 | 1 |
| speech-language pathologists | 291127 | 0 | 1 | 0 |
| veterinarians | 291131 | 0 | 1 | 0 |
| licensed practical and licensed vocational nurses | 292061 | 0 | 1 | 0 |
| other healthcare practitioners and technical occupations | 299000 | 1 | 1 | 1 |
| first-line supervisors/managers of correctional officers | 331011 | 1 | 1 | 1 |
| first-line supervisors/managers of police and detectives | 331012 | 1 | 1 | 1 |
| first-line supervisors/managers of fire fighting and prevention workers | 331021 | 1 | 1 | 1 |
| fire fighters | 332011 | 1 | 1 | 1 |
| chefs and head cooks | 351011 | 1 | 1 | 1 |

| Title | SOC code | Distribution Approach | Cluster Analysis | Both |
|---|---|---|---|---|
| first-line supervisors/managers of housekeeping and janitorial workers | 371011 | 1 | 0 | 0 |
| first-line supervisors/managers of landscaping, lawn service, and groundskeeping workers | 371012 | 0 | 1 | 0 |
| pest control workers | 372021 | 1 | 0 | 0 |
| first-line supervisors/managers of gaming workers | 391010 | 1 | 0 | 0 |
| first-line supervisors/managers of personal service workers | 391021 | 1 | 1 | 1 |
| animal trainers | 392011 | 0 | 1 | 0 |
| recreation and fitness workers | 399030 | 1 | 1 | 1 |
| residential advisors | 399041 | 1 | 1 | 1 |
| first-line supervisors/managers of retail sales workers | 411011 | 1 | 0 | 0 |
| first-line supervisors/managers of non-retail sales workers | 411012 | 1 | 1 | 1 |
| sales engineers | 419031 | 1 | 1 | 1 |
| first-line supervisors/managers of office and administrative support workers | 431011 | 1 | 1 | 1 |
| dispatchers | 435030 | 0 | 1 | 0 |
| desktop publishers | 439031 | 1 | 0 | 0 |
| first-line supervisors/managers of farming, fishing, and forestry workers | 451010 | 1 | 1 | 1 |
| agricultural inspectors | 452011 | 1 | 0 | 0 |
| forest and conservation workers | 454011 | 1 | 1 | 1 |
| first-line supervisors/managers of construction trades and extraction workers | 471011 | 1 | 1 | 1 |
| boilermakers | 472011 | 0 | 1 | 0 |
| brickmasons, blockmasons, and stonemasons | 472020 | 1 | 0 | 0 |
| hazardous materials removal workers | 474041 | 1 | 1 | 1 |
| explosives workers, ordnance handling experts, and blasters | 475031 | 1 | 1 | 1 |
| first-line supervisors/managers of mechanics, installers, and repairers | 491011 | 1 | 1 | 1 |
| electrical power-line installers and repairers | 499051 | 1 | 1 | 1 |
| commercial divers | 499092 | 1 | 1 | 1 |
| manufactured building and mobile home installers | 499095 | 1 | 1 | 1 |
| first-line supervisors/managers of production and operating workers | 511011 | 1 | 1 | 1 |
| supervisors, transportation and material moving workers | 531000 | 1 | 1 | 1 |
| Total | | 94 | 112 | 84 |