Published in "Industrial & Labor Relations Review", 2, 2012

Workplace design, complementarities among work practices and the formation of competencies. Evidence form Italian employees

Riccardo Leoni[*]

Abstract
By using a large sample survey of Italian employees, we analyze how workplace characteristics affect the growth of a worker's competence level. Our contribution is threefold. First, we disentangle the role of HPWO and HPWPs in determining firm economic results, arguing the mediator role of the latter. Second, we demonstrate the strong statistical significance of a set of work practices on the level of competencies that should affect labor productivity. Third, we deal with key or transversal competencies, considered by literature as both of a higher order and responsible, to a large extent, for the subsequent and continuous learning of other specific competencies of various natures (technical and non-technical knowledge). Having shown that HPWPs appertain to the determinants of key competencies, we individualize one of the sources of dynamic and sustainable growth of both firm performance and worker competencies. The virtuous work practices include: (i) having participated in improvement groups; (ii) having submitted improvement suggestions; (iii) being interviewed for performance evaluation purposes; (iv) receiving constant information flows; (v) being involved and consulted by the organization and (vi) benefiting from an increase in discretionary power.
We also show that these organizational work practices result in more efficient formation when simultaneously adopted as a bundle, confirming the potential exploitation of complementarities or synergies among such practices. The cross-sectional nature of the estimates raises emblematic questions that we address in the paper; however, the set of tests applied not only confirm the results, but also reveal that without controlling for endogeneity the coefficients are downward biased.

Keywords: *job and workplace design, work practices, training, learning*
JEL Code: M53, M54, D23

[*] Department of Economics 'H.P. Minsky', University of Bergamo (Italy). This research was supported by funds from the University of Bergamo. The author thanks Alessandro Gaj for his helpful comments on an earlier draft of this paper, and an anonymous referee and the Editor for their accurate and pertinent remarks and useful suggestions.
The data used in this study were provided under contract with ISFOL (an Italian governmental institution) and cannot be released by the author. Individuals wishing to obtain access to these data and to the questionnaire should contact ISFOL through the website:
http://www.isfol.it/Banche_Dati/Organizzazione_apprendimento_e_competenze_(Oac)/index.scm
Copies of the computer programs used to generate the results presented in the paper are available from the author (leoni@unibg.it).

Over the last ten years, significant international literature has demonstrated the positive relationship between new workplace design, innovative human resource management (HRM), good industrial relations and corporate performance. In particular, it is now widely recognized that the traditional work organization is inadequate to fully exploit the potentials of general-purpose computer-based technology (Appelbaum *et al.*, 2000; MacDuffie 1995; MacDuffie and Kochan, 1995; Huselid and Becker, 1996; Ichniowski *et al.*, 1997; Black and Lynch, 2001 and 2004; Brynjolfsson *et al*., 2002; Breshnan *et al*., 2002; Bauer, 2003; Laursen and Foss, 2003; Cristini *et al*., 2003 and 2008; Zwick, 2004; Mazzanti *et al*., 2006; Colombo *et al*., 2007). The new traits of the modern firm are summarized with the acronym HPWO (High Performance Work Organization) to indicate a firm characterized by an internal design based on processes (rather than functions),[1] a low level of hierarchy, a high level of delegation or discretionary and broad skills, team working, job rotation within and across teams, participation in problem-solving groups (through quality circles and suggestion systems), the existence of multiple incentives to boost motivation such as involvement, information sharing and extensive consultation, performance-related pay and participative industrial relations. All these factors forge a new firm configuration outside of the Taylor-Fordist tradition based on a strong centralization of decision authority and narrowly defined occupations.

A common result of this line of research is «complementarity» amongst several investigated organizational practices. Milgrom and Roberts (1995, p.181) pioneered the renewal of the notion of Edgeworth complementarities, according to whom complementarity between activities obtains if "doing more of one thing increases the returns to doing (more of) the others". Complementarity is such when a function containing the relevant variables as arguments is supermodular (*ibidem*, p. 181). According to literature on HPWO, the complementarity condition also concerns the relationship between organizational change and skills, highlighting that organizational changes have a greater impact on productivity if workplaces can count on high levels of skills.

In order to carry out complete tests of these propositions, detailed information on workers and on the characteristics of the establishments and firms in which they work are required to avoid problems of biases of any order or type: omitted selection bias, sample selection bias, simultaneity bias, unobserved heterogeneity and so forth. In other words, the employer-employee dataset allows modeling outcomes that depend on the characteristics of both sides of the labor market.

[1] An organization based on processes is in turn associated with three important and complementary management innovations, namely, the implementation of activity-based costing (in place of standard costing), activity-based budgeting (which replaces the traditional budgeting and planning process) and activity-based management (instead of management-by-objectives).

Several authors have worked on this theme although largely based on information gathered from surveys on the employer side, while some others have done so from the employee side, searching respectively for the contributions of management practices, market conditions and worker characteristics on the outcome of interest. In both cases, they sought to verify the propositions consistently with the HPWO paradigm, assuming that lack of information causes negligible distortions on the set of estimated coefficients. The above-mentioned acronym has thus been coherently modified into respectively HPWS (High Performance Work System) and HPWPs (High Performance Work Practices).

One of the key propositions of the paradigm is that the modern firm *needs* employee competencies for its functioning, neglecting to raise the question (with only a few exceptions) of whether HPWPs *develop* new competencies, namely, whether they *simultaneously* play a role in the formation of competencies. In economic literature it is well known that work activities (in general) constitute an indirect source of learning, taking the form of learning-by-doing (Arrow, 1962), learning-by-using (Rosenberg 1982), learning-by-interacting (Lundvall, 1988) and learning-by-searching (Cohen-Levinthal, 1990). Heckman (2000, p. 5) argues that much learning takes place outside of schools and documents that "post-school learning is an important source of skill formation that accounts for as much as one third to one half of all skill formation in a modern economy". However, none of the aforementioned scholars specify which kind of competencies can more easily be learned outside schools (technical or key/transversal competencies?), nor the specific organizational characteristics a workplace should have to forge individual capabilities, abilities and skills.

Few studies focus their attention on the relationship between workplace organizational design, as a source of stable and socially recognized *work practices* that employees are required to perform daily, and competency formation. We will review these in some details in the next section. Briefly, the job design theory put forward by Koike (1994) constitutes the first micro-founded integration of organizational features specifically linked to the development of problem solving competencies. Bartel *et al.* (2004) develop the concept further, demonstrating both the existence and persistence of a 'genuine' workplace effect (that is, independent of personal dispositions) on the individual worker's perception of their role and the organization, showing that workers' attitudes are also strongly correlated to firm performance. Finally, Green *et al*. (2001) provide evidence of a strong correlation between the level of a subset of key skills (namely competencies) and some specific work practices.

The debate on life-long learning has highlighted that key competencies are such when: (i) they are of a higher, superior class and ascribable to the epistemological concept of meta-competencies that involve cognitive processes of a higher order; (ii) they are responsible, to a large extent, for the subsequent and continuous learning of other specific competencies of various natures (technical and non-technical knowledge), since they are assimilable to Bateson's deutero-learning (1972); (iii) they are applicable to all workplaces, regardless of industry and company size. Their relevance to the firm is constituted by the fact that the most valuable asset is not only, or largely, technical knowledge (as this can be more easily duplicated or transferred by schooling and by worker mobility) but key competencies such as problem solving, social relations and self-reflexivity, since these are able to reveal the particular and potential capacity for actions incorporated in the human resource. The particularity and potentiality consist in the fact that the key component of competency transforms a potential capacity for action into an actual capacity for action (and thus available to the firm) by a revealing process that - in contrast to specialized technical skills – does not leverage on the application of codified rules for all time, but on the 'inventions and intuitions of reason' within a social game (Cainarca and Zollo, 2001). In the non-ergodic and substantially uncertain context in which the firm in the twenty-first century operates, these inventions and intuitions become significant inasmuch as the most sought-after work activities are cognitive and communicative, relating to interpretation and evocation, activities that reveal their outcomes (namely, competencies) progressively, and outcomes that become known and define themselves in complete form only after the event and only in the context in which they occur. All this takes place in a similar way to that which Heidegger (1954, p. 12-18) sustained in relation to technology.

It follows that key competencies are not easily acquirable, but are constructible by way of activating behaviours linked to reflexive, temporal and locally situated work practices; a broad theoretical consensus has consolidated around this concept, according to which reflexivity is a significant mental prerequisite to developing key competencies (Rychen, 2003, p. 120; Rychen and Salganik, 2003).

Hence, the corresponding HPWPs that forge and develop key individual competencies appear to consist in active participation in improvement groups (or quality circles), the elaboration of information in view of decision taking, being extensively consulted by seniors colleagues, higher level employees and by managers (and consultation may end up with genuine involvement), pro-activity in suggestion systems, continuous and increasing discretionary appraisal (that is well matched with a delayering process).

In the framework outlined, the relationship between HPWO and superior firm performance is seen as mediated by competencies (*ceteris paribus*), which in turn depend on a subset of organizational characteristics (HPWPs), namely those strictly related to the work practices put into action by individual workers.

We have a dataset for Italy at our disposal that actually includes a subset of variables related to information gathered directly from workers, such as daily working practices put into action, which fall within the HPWPs acronym. The aim of this paper is to investigate the role played by these work practices in the competency formation process, also testing the validity that single variables form part of a bundle, which corroborates the idea of complementarity and the resulting synergistic effects associated with it. The analysis reviews both the concept of the firm as an HPWO and the theories of job design with *implicit* work practices required of workers. Thereafter, we build an econometric model that we tested via a recent database constructed by ISFOL[2] based on a national survey of a significant sample of workers, the organizational conditions of their workplaces and the learning sources of the expressed competencies. The relevant findings are then discussed, while the econometric problems of endogeneity, selection bias and heterogeneity in the estimates are addressed in the subsequent section. Our closing remarks are presented in the last section.

The background

Debate on organizational theories has extensively recognized the superior performance of the lean production (Womack, 1990) and HPWO models (Appelbaum *et al*., 1994, 2000; Ichniowski *et al*., 2000) over the Taylor-Fordist models. The profound reason lies in the fact that the former models both stimulate organizational learning in workers and induce the firm to absorb this learning, giving rise to new work practices. The key features of new organizational designs are the implementation of inter-functional activity systems focusing on processes (rather than on functions) and customers (Womack *et al.*, 1990; Coriat, 1991; Davenport, 1993; Hammer and Champy, 1993; Kenney and Florida, 1994). The new system has to be complemented internally by bundles of new work practices (such as those listed in the previous paragraph) in order to be more successful. The new organizational design and the aforementioned complementarities also constitute a prerequisite for the implementation of ICT, specially in Enterprise Resource Planning systems (Ichniowski *et*

[2] ISFOL is an Italian governmental institute for the development of vocational training of workers. The database is labeled with the acronym OAC (Organizzazione, Apprendimento e Competenze, i.e., *Organization, Learning and Competencies*).

al., 1997; Black and Lynch 2001, 2004; Brynjolfsson and Hitt, 2000, 2003; Caroli and Van Reenen, 2001; Brynjolfsson *et al.*, 2002; Bauer, 2003; Greenan, 2003; Cristini *et al*., 2003, 2008; Zwick, 2004; Colombo *et al*., 2007). The literature cited claims that these organizational workplace traits enable individuals to develop the creation of organizational knowledge and firms to control resources that cannot be easily reproduced (Prahalad and Hamel, 1990; Teece, Pisano and Shuen, 1997), thus building competitive advantage.

The job design theory put forward by Koike (1994) is the micro-founded integration of the organizational features specifically linked to the development of problem solving competencies. According to this author, there are two possible strategies for the division and organization of labor, each defined as a separate system and an integrated system. The former breaks down operations into two groups: usual operations for line workers, and unusual operations involving problem solving for more experienced workers. Under this organizational design, jobs in the first group require execution capabilities, while those in the second call for control (of problem solving activities), command and coordination.

In an integrated system, line operators are required (from the start of their employment, with the temporary help of an expert) to deal with flawed products and the causes of these flaws, as well as managing changes arising from variations in quantities demanded, modifications in production methods and, finally, product innovations. The consequence of repeated problem solving on a daily basis is the development of intellectual (or cognitive) abilities, which are further bolstered by the worker's strategic use of job rotation,[3] precisely because usual and unusual operations tend to differ from one position to another, determining actual learning and mobility clusters (Dyboswki, 1998). Participation in inter-functional improvement groups (quality circles), suggestion systems and consultation on problems that arise are additional organizational/management techniques that contribute to raising the worker's cognitive and relational abilities, as well as the quality of products and processes, thanks to constant problem solving. A direct consequence of this informal learning process is that classroom training should concern mainly short courses with the goal of systematizing knowledge acquired in the field, namely, providing Lundvall and Johnson's (1994) *know-why* knowledge.

In the debate on the mechanisms and determinants of competency formation, the hypothesis of learning springing from organizational design lies at the root of the sequences depicted in figure 1.

[3] The term 'strategic' has to be placed on the backdrop of organizational design that favors team work, i.e. production islands where workers rotate, moving downstream along the production flow and thus, thanks to the experience previously gained, contributing to correct any mistakes made by upstream co-workers.

This figure reflects learning as theorized by Argyris and Schön (1996) and Le Boterf (2000), which concerns the first two types of learning (right-hand side). The first type is called single loop learning, since individuals learn by modifying their actions on the basis of their own and their organization's objectives. However, there is no substantial change in the objectives or in the values or 'action theories' that guide this action: the concept and practice of training are part of this cycle. In double loop learning – the second type – individuals question their objectives and assumptions. They are encouraged to take their operational schemes and concepts to higher levels, namely to revise their 'action theory'. Training for 'open' roles takes place against this background. The third type of learning is related to Wenger's community-of-practice (1998) and to practice as a learning process. Learning is not a separate activity but a result that affects practice; it drives practice. Finally, the fourth type relates to the organizational theory whereby organization and job design as well as the methods adopted to motivate workers *translate* into *practices* that autopoietically shape and develop ways to learn competencies that result in better performance.

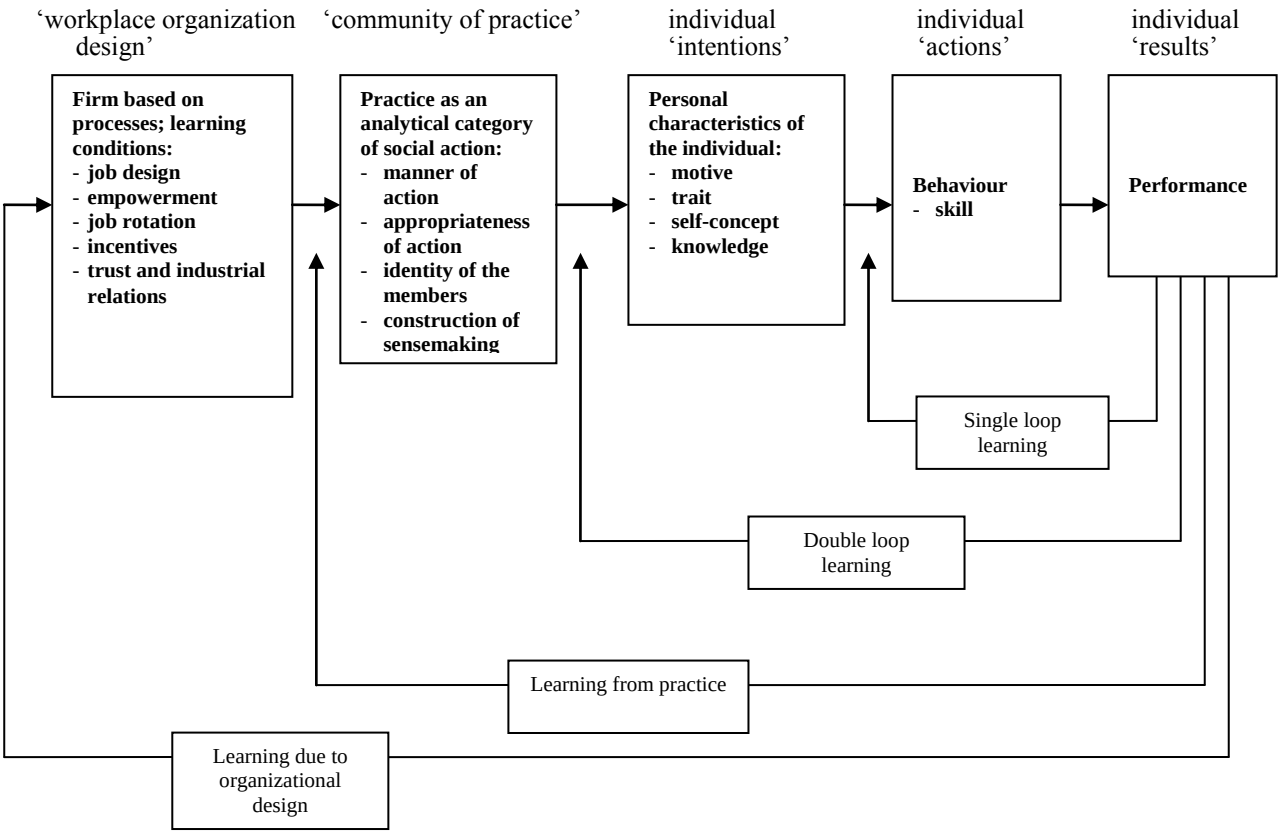
Empirical model

The empirical model to be tested is inspired by the production function framework where an individual's competence level is a function of a series of inputs:

$$ICE_{it} = \alpha_1 SCH_{it} + \alpha_2 WBL_{it} + Z_i + u_{it} \qquad \text{for t = 1, ..n} \qquad [1]$$

where ICE is an index of the competencies expressed (or acted out) by the individual in job i, at time t; SCH is an input vector of an educational nature (schooling); WBL is a vector of work-based learning indices; Z_i is a fixed level of skills acquired independently of education or work, while u_{it} is a stochastic term with E($u_{i1} = u_{i2} = \ldots = u_{in} = 0$).

Figure 1 – The learning chain



For education the usual indicator is adopted, namely educational attainment reflected by the number of school years necessary to obtain the diploma held (SCH: *schooling*), together with the square of this indicator to control for the existence of any decreasing returns, in accordance with the human capital theory.

For work-based learning, the candidate variables are those related to: the years of experience in the labor market (WEXP*: work experience*) (these too supplemented with the square term); an interactive term combining educational attainment and work experience (SCH*WEXP); an index reflecting learning time required to perform current job duties, split between two dummies, one active for periods of over 24 months (HLT: *high learning time*), and the other for periods of less than 6 months (LLT: *low learning time*); two dummy indicators to capture whether the individual has been trained by the current employer (TR_CE: *training with current employer*) or by the previous employer (TR_PE: *training with previous employer*); and, finally, the employee's length of time with the company (TE: *tenure*). In addition to these standard variables, control indicators are used such as: gender (G: *gender*) in order to test the idea (common in literature) that women

develop competencies more easily, especially in the cognitive dimension; the size of the workplace (ES: *establishment size*), whose growth might result in skill improvement thanks to the greater incentives and competition that come with a larger size and/or a more complex organizational design, although the informality of the roles played in smaller organizations might offset this condition; and, lastly, two types of non-standard employment contracts, i.e. a dummy for fixed-term employment (TC: *temporary contract*), and a dummy for part-time employment (PT: part-time contracts) to check whether these types of contracts undermine the learning efforts of workers and the incentive of companies to train workers.

The variable Z_i reflects a vector of organizational aspects characterizing the individual's job since, according to the literature references in the preceding section, they are deemed to have a learning effect prompting the worker to engage in specific work practices. The candidate variables include: participation in an improvement group (QC: *quality circle*); the submission of suggestions (in the twelve months preceding the interview) to improve efficiency in the individual's work (SS: *suggestion system*); a formal and systematic performance evaluation by the immediate supervisor (APP: *appraisal*); participation in meetings (at least every four months) where supervisors/management provide information on company operations to check and fine-tune technical and work-definition problems (INF: *information*); participation in meetings (at least once every four months) where, upon request, the individual expresses his or her point of view (CON: *consultation*) and finally, the level of the worker's discretionary power (DP).

Specifically:

$$\begin{aligned} ICE_{it} &= \alpha_0 + \alpha_1 G_{it} + \alpha_2 ES_{it} + \alpha_3 TC_{it} + \alpha_4 PT_{it} \\ &+ \alpha_5 SCH_{it} + \alpha_6 SCH_{it}^2 + \alpha_7 WEXP_{it} + \alpha_8 WEXP_{it}^2 + \alpha_9 SCH_{it} * WEXP_{it} \\ &+ \alpha_{10} HLT_{it} + \alpha_{11} LLT_{it} + \alpha_{12} TR\_CE_{it} + \alpha_{13} TR\_PE_{it} + \alpha_{14} TE \\ &+ \alpha_{15} QC_{it} + \alpha_{16} SS_{it} + \alpha_{17} APP_{it} + \alpha_{18} INF_{it} + \alpha_{19} CONS_{it} + \alpha_{20} DP \end{aligned} \qquad [2]$$

The above hypotheses are expected to result in the following signs:

$$\begin{aligned} &\alpha_{1,F} > 0,\ \alpha_2 \geq \leq 0,\ \alpha_3 < 0,\ \alpha_4 < 0, \\ &\alpha_5 > 0,\ \alpha_6 < 0,\ \alpha_7 > 0,\ \alpha_8 < 0,\ \alpha_9 > 0 \\ &\alpha_{10} > 0,\ \alpha_{11} < 0,\ \alpha_{12} > 0,\ \alpha_{13} = 0,\ \alpha_{14} > 0 \\ &\alpha_{15} > 0,\ \alpha_{16} > 0,\ \alpha_{17} > 0,\ \alpha_{18} > 0,\ \alpha_{19} > 0,\ \alpha_{20} > 0 \end{aligned}$$

The database and estimate problems

The database that we used to test the above model was constructed by ISFOL, in consequence of a survey carried out in 2004 through a questionnaire administered via CAPI to a stratified sample of approximately 3605 salaried workers representing 9.2 million private sector workers (excluding workers in the construction and agricultural sectors).[4] The questionnaire contains a section intended to determine the frequency of organizational behaviors efficaciously practiced by respondents, with detailed references to the 'organized context' where the individual operates, and a distinction between: (i) competencies required by the role carried out, and (ii) organizational behaviors actually activated (that is, competencies expressed).

Dependent variable

There are 44 listed activities, surveyed through a Likert scale from 1 to 7, with frequencies rising from 'rarely' to 'practically nearly always', to determine whether the competencies required by the position filled are effectively activated. The items represent organizational behaviors that combine to constitute various competency dimensions. Following the "Work Skills in Britain" line of thinking (Ashton *et. al.*, 1999), these dimensions consist of components expressed in such realms as: (i) cognitive/intellectual (writing, reading, calculation, problem solving, control, planning); (ii) interpersonal (communication, teamwork, supervision); (iii) physical (effort, endurance, manual ability); (iv) knowledge (technical, specialized, IT); (v) motivation/self-startedness (reliability, motivation, ability to take independent action); (vi) work conditions (organizational effort, autonomy, discretion, responsibility, variety).

This approach is founded on the idea (as argued by Green *et al.*, 2001) that workers know much more than appears from what they actually do and are required to do on the job. As a result, they are capable of providing a truthful assessment of the activities performed and how they perform them. In a similar vein, workers are capable of self-assessing their own competencies. If there is a self-appraisal error (either overestimation or underestimation), this is simply assumed to be unrelated to the other variables.

The value of a worker's self-appraisal of required and performed activities, as opposed to traditional job descriptions by organizational analysis experts, is supported by international

[4] For the methodological survey approach and for an initial assessment of results, see Tomassini (2006).

literature (Kulik *et al.*, 1987; Fried and Ferris, 1987; Spenner, 1990), documenting instances where it was found that workers' assessments were substantially similar to those made by external observers/specialists. This literature also suggests that the (not easily identifiable and measurable) distortion risk arising from 'social desirability' − which may lead individuals to overestimate their self-assessed skills − can be curbed to a significant extent by paying attention to the language used in questionnaires, by asking respondents not for an assessment of the competencies they possess but the degree of role coverage. This can be measured by the frequency with which respondents effectively fulfill their required duties. The result is a survey of the competencies actually employed (because they are required by the position) and is reflected in the respondent's behaviors and performance. As argued by Ashton *et al*. (1999), one way to proceed with interviews of workers is to inquire about <*problem solving* >: a question can be structured in such a way as to either capture the ability <*to know to solve problems*> or a behavior such as <*I solve problems*>. While the latter tends to determine what the individual does in practice, the former can be interpreted as the potential or ability to know how to do something. The adoption of this principle is not without risk and fault since on the one hand workers may have more competencies than required, activating at the same time organizational behaviors that fulfill required duties in whole or even in part (for a variety of reasons); on the other, they may have insufficient competencies, reporting as a consequence that they fulfill the required duties in part. However, competencies may be possessed but not at all required. Likewise, it cannot be ruled out that negative gaps may be the result of shirking or opportunism. All these problems may be offset by the benefit arising from the respondents' tendency to limit ambiguity and their social desirability.

Factor analysis, as applied to respondent data, made it possible to highlight a number of competencies as common factors, as well as an index of total skills (Leoni, 2006, and methodological appendix downloadable from the website shown in footnote *). Subsequently, based on contributions from economics, sociology and psychology, a series of 'key competencies' were identified as the expression of activities such as: (i) problem solving (carried out through the in-depth analysis of complex problems, the solution of problems, the identification of errors, and thinking about solving problems); (ii) relation/social interaction with two different groups of counterparties: (ii.a) customers (for instance, providing advice and customer care, or by selling a product or service), and (ii.b) subordinates (for instance, effectively managing subordinates or giving instructions to or training subordinates); and finally (iii) team work (joining in a team effort, helping other team members, listening carefully to colleagues). Moreover, an overall skill index was

compiled by weighting the individual indices through the variances explained by the individual factors extracted with the factor analysis.

In this paper, reference is made to the dimensions of competencies expressed by applying equation [2] to the overall index and to each of the key competencies identified. Table 1 shows the average value of each of the competency indices expressed, with reference to the various conditions of the worker. The emerging indications seem to go, in general, in the expected direction. However, for a proper analysis of the data in the table, it should be noted that – by construction – *data are comparable only along the columns*, since the 'common factors' are fed by a number of different items (and coefficients), which affects the level of the calculated index. To illustrate and compare the individual competencies, data standardization procedures could be applied. However, this procedure is redundant since the objective of this paper is to explain the underlying causation factors.

<Table 1 approximately here >

Independent variables

Each respondent was asked several questions, many of which quite accurately cover the specifications of the explanatory variables described in section 3. The only specification to be added concerns the length of time necessary to learn the competencies expressed by the worker. In this paper we arbitrarily selected (although in accordance with Green *et al.*, 2001) three intervals, namely less than 6 months (*low learning time*), between 6 months and 24 months (default variable) and more than 24 months (*high learning time*).

However, respondents were also asked retrospective questions concerning the organizational condition of their job 5 years earlier, i.e., participation in quality circles and formal and periodic performance evaluations. Moreover, respondents were asked to indicate whether their discretionary power on the job had increased or decreased, compared with the previous condition.

Table 2 shows the statistical characteristics of the variables utilized in the estimation processes.

< Table 2 approximately here >

Competencies are expressed by the absolute scores obtained from the factor analysis, while education, work experience and tenure are measured in terms of years. The dichotomic variables reflect the condition measured in percentage terms: for instance, 17 percent of workers reported a

period of more than 24 months to learn their skills, compared with 59 percent of those reporting a period of less than 6 months (the percentage necessary to reach 100 percent was captured by default by the equation constant).

The sample utilized (for the target universe) consisted of 3578 individuals.

First findings

Table 3 shows the estimates, of a cross-section nature, of model [2] related to the overall key competencies expressed by the worker. The variable relating to discretionary power (DP) is for a while excluded as it is measured in terms of an increase or decrease with respect to a previous period, and as such will be included in the dynamic version of the model, dealt with in the next section.

In column 1, the model is restricted to some control variables and schooling, in keeping with the theory of human capital suggestions. The estimate provides an indication in line with this theory, namely, the marginal return on education for the competence level appears to positively decrease. Among control variables, the negative condition for women as well as for fixed-term and part-time employees is strongly emphasized. However, the result is not robust and the return on education appears to rise steadily following the inclusion of years of experience in the labor market (Mod_2), a variable that is not statistically significant.

< *Table 3 approximately here* >

The introduction of the variables related to *work-based learning* (Mod_3) brings their explanatory power into sharp relief. The longer (shorter) the time required to learn them, the higher (lower) the level of competencies acquired and expressed by individuals throughout their career. Training and tenure are two significant factors for the individual's competence development. As far as the first factor is concerned, due to lack of information it is impossible to disentangle whether the positive impact comes from some specific formal training courses, of a cognitive nature, such as problem solving, group dynamics, relational dynamics, etc., or whether it represents a sort of cognitive spillover effect that technical classroom training also generates. This is a question that merits further study but which we leave open for future research.

However, the key variables in the model (Mod_4) are those that reflect the organizational characteristics of the jobs, which are strictly in line with the theory set out in section 2 on HPWOs and Koike's theory of job design, as well as with Green *et al.'s* (2001) results. The particularity of these variables is that they are complementary to those related to work-based learning, simultaneously reducing the role of schooling (whose p-value rises to the limit of acceptability: 9%) and training received from the previous employer. Inclusion of the set of organizational characteristics provokes a leap in the explanatory power of the equation.

< *Table 4 approximately here* >

Table 4 shows the application of Mod_4 to each single competence. Apart from very few exceptions, the positive role of organizational job design is strongly confirmed. Schooling appears to recover the human capital theorization for problem solving competencies. In this regards, it would be very useful to distinguish between different types of schooling in order to understand which could eventually be more suitable for the development of this competence, but the dataset does not allow pursuing this idea.

Prior to concluding this section, it is worthwhile devoting some consideration to a result that might seem contradictory, namely, training received by workers from the previous employer is not significant while training received from the current employer is statistically significant. One way to justify this result is to argue that companies tend to provide firm-specific training, which the worker cannot utilize in a different context. Since the acquired competencies are of cognitive nature, this hypothetical argument seems unlikely; a more plausible explanation is that which takes into account that average tenure is around ten years, and that the previous work experience is historically collocated to the beginning of the 90s when training in Italy was a very marginal, if not entirely neglected, element.[5]

[5] Even today, training is not at all popular in Italy: according to EU statistics, in 2005 only 32% of firms undertook some training compared to an average of 60% in 27 EU countries, placing Italy third from the bottom and just before Bulgaria and Greece.

The impact of work practice persistence and change

The database provides two retrospective pieces of information concerning the respondent's organizational conditions five years earlier, i.e., participation in quality circles or improvement groups and periodic evaluation of work performance. The retrospective questions were asked by first verifying the employment condition at time t-5; in case of a negative reply, the condition was reduced by a year, and then possibly by a further year.

Moreover, compared to the work conditions prevailing at time *t-n*, it is possible to check whether the worker's discretionary power increased or diminished, and whether employment became permanent on a full-time basis. The sample was thus reduced to 3224 observations.

Before proceeding with the evaluation of the role of the new variables, Mod_4 (in table 3) and the equation in table 4 were re-estimated to check whether the difference in the sample number entailed changes in the results obtained. Basically, the estimates confirmed the previous results, except 6 coefficients, which fell to values no longer statistically acceptable.[6] Specifically, Mod_4 applied to the single key competencies shows results in line with those obtained for the larger sample, with few exceptions. For instance, the variable relating to schooling returns to its role linked to competencies related to problem solving and relationships with subordinates, while the variable on information looses (gains) significance in the first (second) of the two competencies in question.

When the lag variables were introduced in the model, the results proved substantially similar to the previous, with two significant qualifications.

< *Table 5 approximately here* >

The first concerns the condition of participation in quality circles, which shows that the rotational involvement of workers is more important than their continued presence in these quality circles. In fact, the econometric results (table 5) show that if an individual has participated in quality circles both at time t and time t-5, the coefficient is not statistically significant (except in one case: Mod_5c), while it is positive and statistically significant when an individual participated in the last 12 months but had not previously participated in quality circles.

[6] The results (not reported due to lack of space) are available on request.

A plausible explanation may lie in the fact that the call to participate strengthens motivation to both contribute to solving problems and to learn from other group members. The mission of these circles is usually short-lived and targeted at solving one or more common problems to develop new ideas/products, or simply to brainstorm. Intensive and engaging personal interactions create new knowledge and competencies, in line with what Nonaka and Takeuchi (1995, p.170) call 'socialization' (transmission of knowledge among members from tacit to tacit) and 'exteriorization' (transmission of knowledge from tacit to explicit or codified) mechanisms. To the contrary, one can argue that those same new solutions help participants acquire new knowledge and new skills, and this should render the continuity or discontinuity of their participation in these groups irrelevant. To this could be added the idea that continued participation tends to grant status to the employee, which ends up demotivating the worker in the learning process. The econometric results confirm the prevalence of the first explanation over the latter.

The second qualification concerns the condition of performance evaluation, where an opposite of the previous result emerges, i.e., confirming the importance of a systematic (that is, not discontinuous) evaluation as a competence development mechanism. Performance evaluations generally concern both competencies and incentives, and their continuity over time helps each individual to direct her/his own efforts towards the attainment of the competencies required by the organization. The positive effect of performance evaluation interviews for competency development purposes was also identified by Diaye *et al.* (2007) in French manufacturing companies with over 50 employees.

With respect to the changing conditions, from time *t-n* and time t, no effects emerged as concern the changing of contracts from temporary to permanent, while contrasting effects emerged with respect to part-time changes. More precisely, a negative effect was determined as far as the client relation competence is concerned and a positive effect for team working.

Increasing discretionary power had a positive and statistically acceptable effect in one case, while in the other two cases the p-value is just above the pre-fixed acceptability threshold of 5%, confirming – to some extent – the relevance of this element among the explanatory variables.

Correlation or a bit more? Endogeneity, selection bias and heterogeneity

There are three problems of an econometric nature that can be raised in connection with the estimates carried out: the endogeneity of some variables, the selection bias and heterogeneity (heteroskedasticity).

In order to operate with certain linearity on these issues, it seems appropriate to try to verify, in a preliminary way, the existence of complementarity between the various work practices. This would offer on one side the advantage of simplifying the information processed and on the other, sustaining one of the most significant theoretical propositions recently advanced in literature on the theory of the firm.

A preliminary step: complementarities between job organizational design and work practices

In our analysis, job design and work practices are two sides of the same coin, since the latter are carried out only if justified by the organizational design. In recent literature, it is often argued that some work practices may be more effective when introduced as a bundle, as a system of mutually reinforcing particles (for references, see sections 1 and 2). For example, it may be far more effective to implement both a suggestion system for mobilizing employee proposals for improvement, to include employees in improvement groups to solve problems, to increase delegation or discretionary power and for managers and/or heads to frequently consult them, than to make either change alone.

Factor analysis can be applied to check whether our six organizational characteristics collapse into a unique complementarity bundle and thus form a system. The estimates of the linear combination of the underlying six elementary variables actually gives rise to a unique factor (which we call HPWPs), under the usual condition that the eigenvalue is greater than one.[7] Two aspects are worth recalling: first, not all six variables are equally important in forging the factor; second, each worker does not necessarily apply all five work practices simultaneously and with the same intensity.

< *Tables 6-10 approximately here* >

In tables 6-10, the columns Mod_6a-Mod_10a show the importance of the bundle concept: the coefficient in all five equations is positive and statistically very strong (p-value < 0.0001). The reduction of four independent variables does not have a significant effect on the explanatory power

[7] The variance explained by the factor is equal to 0.709. The factor was rotated using orthogonal Varimax rotation, before calculating the score to be used in the regression analysis. All the factor loadings are positive and quite high, apart from that relating to the information variable, which is negative but quite negligible (-0.04); the others are of differing sizes: consultation has a loading factor equal to 0.66, the suggestion system is equal to 0.58, appraisal 0.46, quality circle 0.23 and change in worker's discretionary power 0.31.

of the equations, expressed by R-squared. Hence, based on the factor analysis, we can conclude that the bundle of work practices itself matters in developing individual key competencies, even if the cross-section nature of the data does not allow inferring strong causality. The positive and significant result for the system variable can be taken as good evidence of the existence of complementarities between the work practices in our analysis. In fact, the first (and unique) factor extracted suggests that the fraction of total variance explained is higher than any of the six original variables.

Endogeneity and selectivity

Reverse causality is one of the main concerns in somewhat validating the results obtained with the cross-section estimation techniques, namely, some variables could be of an endogenous nature. If disregarding schooling (adopting with this the approach of the theory of human capital, according to which education is an exogenous variable), endogeneity could be advanced in respect of certain variables such as experience, squared experience and tenure, as well as the block of organizational variables. The causes of competency development could be the different capabilities of subjects, which in the final instance could be responsible (in whole or in part) for the longer or shorter stay both in the labor market and in the firm, and being chosen to implement more innovative work practices.

Two econometric approaches are available to deal with the endogeneity themes in question: the first starts with the assumption that competencies are a reflection of personal characteristics, namely personality traits that are specific to subjects and constant over time. Ferrer-i-Carbonell and Frijters (2004) suggest an innovative approach whereby these types of variables (additional) are ideal candidates – in a cross-section context – to capture the *individual fixed effects*, simultaneously allowing monitoring their effects on those variables suspected of endogeneity.

The second more consolidated approach is that of instrumental variables, in the hypothesis of being able to have variables according to needs. In the rest of the paper, we will use the second approach. With the sole purpose of reducing the minimum exposure terms, we develop our arguments only in respect of the employee variable that measures overall key competencies. To identify the elements of distortion on the coefficients of interest and assess the direction of these distortions, it may be useful to simplify [2] in the following way:

$$ICE_{ik} = \beta_0 + \beta_1 WEXP_i + \beta_2 TE_{ik} + \beta_3 Z_{ik} + u_{ik} \quad [3]$$

In [3] the addition of subscript *k* indicates the i-th subject working at time *t* in firm k-th. For simplicity, both the squared experience and other regressors of [2] have been disregarded.

As concerns the nature of the endogeneity and the direction of the distortions, it may also be useful to borrow - with respect to the first two variables - some of the arguments discussed in literature as regards salary (Altonji and Williams, 2005), integrating them appropriately with respect to our third variable (Z). Implicit in this approach is the idea that competencies that are regressing constitute an early symptom of a function of salary.

The error term can be decomposed thus:

$$u_{ik} = \mu_i + \phi_{ik} + \psi_{ik} + \omega_{ik} \quad [4]$$

where the first component refers to the specific individual effects, which are none other than the subject's personality traits; the second to the matching between the employee and firm at the time of recruitment; the third to the organizational characteristics of the positions held, and consequently to work practices implemented by the firm, and the fourth to the error measurement of the employee variable in [2]. Each of the first three components reflect in their own way the influence of the exogenous variables. We proceed by analytically assessing the influences of the exogenous variables on each component in [4], through reference to auxiliary regressions. With reference to the first component, we can write:

$$\mu_i = b_1 WEXP_i + b_2 TE_{ik} + b_3 Z_{ik} + \vartheta_{ik} \quad [5]$$

Concerning the heterogeneity of subjects (in terms of personality traits) Altonji and Williams (2005) demonstrate that the correlation is positive with respect to tenure (b_2>0) and negative with respect to experience (b_1<0). We add that the organizational characteristics, as defined in the text, should be of a forming nature and thus able to shape some of the personality traits (according to Spencer and Spencer's iceberg theory, 1993) underlying the organizational behavior that subjects can activate (b_3>0).

The overall influences of these factors give rise to a sign that is not determinable a priori. With respect to the second component, we can thus have:

$$\phi_{ik} = c_1 WEXP_i + c_2 TE_{ik} + c_3 Z_{ik} + \xi_{ik} \quad [6]$$

Following Altonji and Williams (2005) and Topel's (1991) arguments, experience in the labor market (*WEXP*) could be positively related to the ϕ_{ik} ($c_1>0$) term, due to effect of the best matching that the worker can produce (Burdett, 1978); tenure (*TE*) could instead have two effects: a positive effect, since good matching reduces turnover and therefore tenure increases ($c_2>0$) and a negative effect, since an increase in tenure improves knowledge of internal development prospects with respect to the market and this could lead subjects to abandon the firm in favor of other work opportunities ($c_2<0$).

Topel's (1991) argument moves in the same direction, according to whom the firm may also realize over time (thus to the subject's growing tenure) that the matching was not the best, to the point of implementing a company policy to interrupt the employment relation. As regards organizational characteristics (Z), the development of these might require the involvement of the worker, which in turn improves (also through the rotation of different positions) the worker's matching with the firm and thus potentially abandoning the idea of leaving the firm ($c_3>0$).

The firm's selection process could operate in the same direction, paying attention to those personality traits (for example, learning capacity, involvement, teamwork, etc.) that are suitable to accommodate the particular organizational plan in progress and the firm's core competencies. Also in this case, the overall result of these influences (in terms of the component's sign (φ_{ik})) does not appear to be determinable a priori.

In relation to the third component, we thus can write:

$$\psi_{ik} = d_1 WEXP_i + d_2 TE_{ik} + \nu_{ik} \quad [7]$$

This aspect further aggravates the problems of identification. The correlation could be considered as negative with respect to the experience gained by subjects outside of the firm, due to the effect of previous imprinting that can cause resistance against the new ways of working demanded by modern firms ($d_1<0$); to the contrary, longer tenure could make new ways of working appreciable, since they grant the subject greater autonomy and discretion ($d_2>0$). The total effect remains uncertain.

Generally, it appears difficult to identify a priori the prevalence of the direction of distortions analyzed with the auxiliary equations [5]-[7].

The instruments

Based on literature (in reference to the salary theme), eligible instruments are constituted by age (and by squared age) for experience (and squared experience) (Dustmann-Meghir, 2005; Cingano, 2003; Sulis, 2009), whilst for tenure Antonji and Shakokto (1987), Peter and Perreira (2008) and Sulis (2009) find that the deviation of individual tenure from the sample's average industry tenure is an efficient instrument, since it is not correlated - by construction – both with the individual fixed effects component and with the matching component. A further instrument is constituted by the squared term of the deviation itself.[8]

Due to the endogeneity of the Z vector, the factorial instrument obtained from a set of organizational characteristics that may or may not involve the subject and in place at time *t-n* is used: a type of lagged independent variable compared to the endogenous regression factor.

To strengthen the exogeneity of these conditions with respect to the subject's capabilities, the negative condition is preferable, tantamount to the fact that the subject had not been involved in these organizational practices in the past nor that the organization is certified (with ISO9000/Vision2000), since it could be argued that to obtain this certification the firm could have changed the criteria for staff selection over time in favor of people with pro-active capabilities or traits.[9]

The second set of results

The use of lagged organizational characteristics (*t-n*) as an instrument of organizational characteristics at time t reduces the sample size. The number fell to 3224 due to the absence of the condition of having been employed at time *t-n*.[10]

Naturally, the average values of some of the variables in both samples differ, since the second sample does not include workers (especially younger workers and women who just re-entered the workforce) that at time *t-n* were not employed. Compared to the second, the first sample is

[8] The specification is the following: $\left(\overline{\overline{AA}}_i\right)^2 = AA_i^2 - \left(\overline{AA}_{i,s}\right)^2$ where the second term is the squared tenure of the i-th individual, the third is the average tenure in the s-th industry that the i-th individual belongs to, squared, while the first is the squared deviation.

[9] An alternative strategy would be to deal with the five organizational dummies as endogenous and proceed with the treatment effects model: in this case greater estimation accuracy would be achieved but at the cost of a greater risk of incurring specification errors (Cameron and Trivedi, 2005, p. 95-112).

[10] The retrospectives questions were asked by first verifying the employment condition at time *t-5*; in case of a negative reply, the condition was delayed by a year, and then possibly by another year.

relatively ‘younger’ and, accordingly, variables that reflect seniority (such as: work experience, tenure, but also cumulative competencies or temporary employment contracts, which are more typical at the beginning of a career and, as such, concern younger people) have a higher or lower average value, depending on the case. The t-test performed on the single variables (table 2) substantially confirmed that the second sample was ‘randomly extracted’ from the first, except for those variables discussed above.

The re-estimation of the models on the restricted sample confirms the strong stability of the parameters: see Mod_6b-Mod_10b with respect to the corresponding Mod_6a-Mod_10a in tables 6-10.

The use of instrumental variables instead confirms that – within the just-identified models – in three out of five cases the endogeneity hypothesis should be rejected: Durbin-Hu-Hausman’s test of endogeneity (Cameron and Trivedi, 2009, pp. 182-184) relating to the four instruments, both jointly (F_T) and individually considered (F_i), and respectively for ‘total key competencies’ (Mod_6c), for ‘problem solving’ competencies (Mod_7c) and for ‘team working competencies’ reject the null hypothesis. The tests relating to the weak instruments hypothesis (partial R^2, F test and Shea’s partial R^2) lead to a rejection of the null hypothesis and therefore the instruments are strong. In particular, the F-test is always above the critical value of 10 suggested as a rule of thumb by Staiger and Stocks (1997).

A weak point concerns the F value of the DWH test relating to the third instrument with respect to total key competencies, a point that requires some caution and merits further investigation, which we will deal with shortly.

All this favors acceptance of the value of the parameters estimated with OLS: work experience is not statistically significant, while tenure and organizational characteristics result as statistically significant and positively influence the formation of these three competencies.

As concerns the ‘relation with clients’ and ‘relation with collaborators’ competencies (Mod_8c and Mod-9c), the DWH endogeneity tests reject the null hypothesis, both in the joint form and with respect to the first and third instrument, despite passing the weakness tests of the instruments themselves. It therefore follows that the parameters to accept are those that emerge from the 2SLS estimator, according to which the only statistically significant and positive variable is organizational characteristics. The set of distortions arising from endogeneity led the OLS estimator to underestimate the real influence of organizational characteristics on competency formation in both cases in question.

Econometric literature confirms that as instruments with respect to endogenous variables increase, the efficiency of the estimators also increases. Having a further instrument available, constituted by the squared deviation of tenure with respect to the industry average, we can try to estimate the overidentified models. This estimation technique, with respect to the just-identified models, allows testing the validity of overidentifying instruments. The estimators used are respectively 2SLS and GMM.[11]

The values of the Sargant and Hansen tests, respectively relating to the hypothesis that all the instruments are valid against the hypothesis that at least one of the instruments is not, does not allow rejecting the null hypothesis, indicating that all the instruments applied are valid in all five cases (Mod_6d, c-Mod_10d, c, tables 6-10) and revealing further downward distortions of the estimated coefficients relative to the tenure and organizational characteristics variables.

Discussion and policy implications

In the literature listed in the first section we find claims that flexible production systems (often also called HPWOs) *require* more 'generic skills' (or key competencies, in our words), and consequently *require* both different training content (more generic and fewer technical skills) and a diverse setting (on-the-job training *versus* classroom training). Moreover, the new training has to be 'bundled' with other organizational characteristics and/or HR policies in order to be effective. There is no evidence of the idea that some organizational characteristics may imply work practices that in turn *induce* (or generate) skill formation, independently or in addition to personal traits. Technological changes also claim the same requirement, especially ICT (see, for example, Bresnahan, Brynjolfsson and Hitt, 2002).

Within this line of reasoning, the economic performance that stems from HPWO is ascribed to the particularity of the organizational aspects (just-in-time, TQ, etc.) and/or HR policies. No one has stressed the idea that skills improvement – as a mediator variable between HPWO and work performance – can *emerge*, at least partially, from some specific work practices, better still if they are all performed simultaneously (that is, in a bundled form).

Our findings highlight the functioning of high performance work practices (HPWPs) – seen as a mediator variable between HPWO and economic outcomes – in developing the individual worker's key competencies. The results give evidence of the successful dual role of the re-engineering firm

[11] The GMM estimate is implemented with the use of the Stata10 *wmatrix(robust)* option.

strategy, both on the supply and demand side, in creating and maintaining internal conditions that should allow firms to survive and grow. The dynamic capabilities of a firm cannot in fact be built simply by spending on R&D or making analogous investments (such as ICT), but stem from a strategy that integrates, builds and reconfigures both the workplace and competencies in order to address changing environments, enabling organizations to make the best use of the creative and productive powers of employees. In this respect, it is worthwhile recalling what we mentioned in the introduction: key competencies are considered of a higher order in the hierarchy of competences and have the ability to influence the continuous learning of competencies that are downstream in the hierarchy of these same competencies (e.g. the technical-specialist type). From these properties of key competencies and from our results follows that HPWPs provide a dynamic input to growth, and at the same time raise questions of the legitimate inclusion of the same HPWPs within the set of educational practices (traditionally relegated to schooling and training systems) that are suitable to developing competencies. Theoretical and public debate is still open on this issue, but our findings provide a positive indication in this direction.

When considering the results of other complementary analyses, especially those whereby forms of organization are shaped according to the HPWO paradigm that: (a) deliver better performance, (b) stimulate greater product innovation, (c) pay higher wages and (d) are conducive to greater worker satisfaction and commitment,[12] we retain as very plausible the idea that, within HPWO, virtuous circles develop – with the contribution of HPWPs – as a result of their path dependent nature and their reciprocal interactions, which tend to generate a spiral inscribed (or locked) into trajectories that may well be superior or inferior, according to the «selection» and «intensity» of organizational specificities (Coriat and Dosi, 1998, p.106). All this makes the HPWO a dynamic and continuously evolving enterprise. At the same time, we deem that a much closer look should be taken at the notion of the inevitability of the alienating fragmentation of work. One could argue that the theory whereby individuals are strongly defined by 'what they do' for a living should be rediscovered and emphasized, but also qualified in terms of the meaning of 'work' attributed by Arendt. Namely, as the foundation of personal identity and the meaning of individual lives, provided that workplaces have the appropriate characteristics such as those identified by the strand of research on HPWO and HPWPs to which our findings refer.

Our results are also important in connection with two significant policy issues:

[12] All references of these outcomes have been provided in the first section of the paper.

1. the positive identification of the key characteristics of workplaces that foster competency development well-matched to the needs of the job should prompt employees and employers to introduce – through company agreements – policies designed to reshape workplaces, to achieve objectives in keeping with the findings of our studies;
2. the adoption by firms of workplace reorganization based on those processes necessary to achieve the objectives in line with the above findings is quite expensive and should therefore be encouraged by public incentives policies in order to create the conditions for the effective development and redesign of workplaces in accordance with the firm models investigated in this paper. It is worthwhile recalling that these policies have already been positively implemented in a few North European countries, following publication of the Green Book by the EU in 1997 on 'Partnership for a new organization of work'.

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Table 1 – Key competencies by personal characteristics, occupation, contracts, establishment size, sector and geographical area.

Characteristics	*Level of key competencies**				
	Problem solving	***Relation with clients***	***Relation with collaborators***	***Team working***	***Total key competencies***
Mean	*8.5*	*5.6*	*2.9*	*6.2*	***19.1***
- min-max	*0-16.9*	*0-18.8*	*0-13.3*	*0-13.2*	***0-46.5***
- s.d.	*4.5*	*4.9*	*3.1*	*3.7*	***9.8***
Personal characteristics					
Gender					
Men	*9.1*	*5.5*	*3.1*	*6.6*	***20.1***
Women	*7.7*	*5.8*	*2.5*	*5.6*	***17.6***
Age group					
15-29	*7.9*	*5.4*	*2.2*	*5.9*	***17.8***
30-44	*8.7*	*5.7*	*3.1*	*6.3*	***19.6***
45-64	*8.6*	*5.7*	*3.3*	*6.3*	***19.6***
Schooling					
Compulsory school	*6.6*	*3.7*	*1.9*	*5.8*	***15.3***
Compulsory school + vocational training	*8.2*	*5.3*	*2.9*	*6.0*	***18.4***
High school diploma	*9.6*	*6.7*	*3.3*	*6.5*	***21.2***
Degree	*11.0*	*8.1*	*4.6*	*6.9*	***24.4***
Post-graduate degree	*12.8*	*10.3*	*7.3*	*8.8*	***30.5***
Professional position/professional occupation					
Professional position					
Blue-collar worker	*7.2*	*4.2*	*2.1*	*5.9*	***16.4***
White-collar worker	*9.9*	*7.2*	*3.6*	*6.2*	***21.6***
Manager/ Professional and Managerial Staff	*12.2*	*9.3*	*6.1*	*8.5*	***28.6***
Professional occupation					
Other Occupations	*5.9*	*3.9*	*1.7*	*5.4*	***14.2***
Operative Plants & Machines	*6.7*	*2.8*	*1.6*	*5.8*	***14.7***
Sales Occupations	*7.7*	*10.8*	*3.6*	*5.4*	***20.8***
Personal & Protective Service	*9.4*	*9.5*	*3.8*	*6.2*	***22.6***
Craft & Related Occupations	*9.0*	*9.5*	*3.8*	*6.8*	***19.0***
Clerical &	*9.9*	*7.0*	*3.5*	*6.2*	***21.6***

Secretarial Occupations					
Associated professionals & technicians	*11.2*	*8.6*	*4.9*	*7.3*	***25.4***
Professional	*12.6*	*6.9*	*4.9*	*8.4*	***27.0***
Manager	*12.8*	*10.2*	*7.2*	*9.3*	***30.9***
Type of contract					
Fixed-term	*7.0*	*5.3*	*1.8*	*5.8*	***16.5***
Open-ended	*8.7*	*8.7*	*3.0*	*6.2*	***19.4***
Part-time	*6.7*	*5.5*	*2.2*	*5.2*	***15.9***
Full-time	*8.8*	*5.6*	*3.0*	*6.4*	***19.6***
Size/sectors/area					
Establishment Size					
1-3	*8.2*	*6.6*	*2.5*	*4.7*	***17.6***
4-9	*8.7*	*6.4*	*3.1*	*6.5*	***20.2***
10-15	*8.5*	*5.7*	*3.1*	*5.7*	***18.7***
16-49	*8.5*	*5.0*	*2.9*	*5.7*	***18.7***
50-99	*8.7*	*4.9*	*3.0*	*6.6*	***19.3***
100-499	*8.8*	*4.9*	*2.9*	*7.3*	***20.0***
500-ω	*8.5*	*8.5*	*4.9*	*7.2*	***19.7***
Sectors					
Manufacturing	*8.3*	*3.8*	*2.4*	*6.2*	***17.7***
- traditional	*7.7*	*3.6*	*2.1*	*5.7*	***16.3***
- scale intensive	*8.7*	*3.8*	*2.5*	*6.5*	***18.3***
- science based	*8.4*	*4.0*	*2.7*	*6.8*	***18.6***
Commerce	*8.6*	*8.0*	*3.4*	*6.3*	***20.9***
Hotel + restaurant	*6.3*	*6.0*	*2.2*	*5.0*	***15.6***
Transport + warehousing	*7.9*	*4.7*	*2.3*	*5.5*	***17.0***
Communication +ICT	*10.0*	*6.5*	*3.6*	*6.7*	***21.9***
Banks + Financial Intermediaries	*10.7*	*10.4*	*4.9*	*7.6*	***26.3***
Other activities	*8.7*	*5.6*	*3.2*	*5.9*	***19.1***
Geographical Area					
North-West	*8.7*	*5.2*	*2.8*	*6.3*	***19.2***
North-East	*8.9*	*5.7*	*3.1*	*6.4*	***19.9***
Central	*8.3*	*5.9*	*2.7*	*5.8*	***18.6***
South + Islands	*8.7*	*5.9*	*3.0*	*5.9*	***19.1***

* By construction, level of competencies can be compared only along columns and not along rows.

Table 2 – Descriptive statistics of the two samples

Variables	Full sample of 3578.[+] representative of 9.036.677 employees		Reduced sample of 3224.[++] representative of 7.936.190 employees		Min [+++]	Max [+++]	t-test on mean differences
	Mean (weighted)	s.d.	Mean (weighted)	s.d.			
Total key competencies	19.21	9.79	19.54	9.88	0	46.49	0.167
Competence: problem solving	8.55	4.57	8.64	4.60	0	16.97	0.419
Competence: relation with clients	5.66	4.86	5.75	4.87	0	18.82	0.446
Competence: relation with collaborators	2.94	3.11	3.07	3.15	0	13.31	0.087
Competence: team working	6.22	3.73	6.34	3.75	0	13.17	0.186
Gender: 1-M (2-F)	1.38	0.49	1.36	0.48	1	2	0.089
Establishment size	87.94	512.35	95.07	534.34	1	18000	0.574
Temporary contract	0.084	0.28	0.056	0.23	0	1	0.000 **
Part time contract	0.118	0.32	0.109	0.31	0	1	0.240
Schooling (years)	12.19	3.54	12.16	3.53	5	22	0.727
Work experience (years)	15.44	10.38	17.00	9.83	1	50	0.727
High learning time (> 24 months)	0.17	0.37	0.18	0.39	0	1	0.278
Low learning time (< 6 months)	0.59	0.49	0.56	0.50	0	1	0.012 *
Training with current employer	0.29	0.46	0.31	0.46	0	1	0.073
Training with previous employer	0.12	0.32	0.12	0.32	0	1	0.959
Tenure (years)	9.59	8.55	10.56	8.57	0	44	0.000 **
Quality circle	0.08	0.27	0.08	0.28	0	1	0.967
Suggestion system	0.63	0.48	0.66	0.47	0	1	0.009 **
Appraisal	0.22	0.42	0.23	0.42	0	1	0.327
Information	0.01	0.11	0.01	0.11	0	1	0.984
Consultation	0.43	0.50	0.45	0.50	0	1	0.101
Change in worker's discretionary power	-	-	0.25	0.01	0	1	------

[+] Full sample, equal to 3605 employees, reduced by 27 units due to lack of replies to the variable concerning establishment size.

[++] Sample reduced due to lack of replies to question I.10 on participation in quality circles five years prior to the interview.

[+++] Min and Max values are identical among the two samples.

* Statistically significant at the .05 level; ** at the .01 level.

Table 3 - Dependent variable: Total key competencies

Weighted OLS estimates, with heteroskedasticity-robust standard error.

Independent variables	Mod_1	Mod_2	Mod_3	Mod_4a
	Coeff (s.e.)	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**
Gender: 1-M (2-F)	-2.220 ** (.582)	-1.905 ** (.581)	-1.211 * (.536)	0.601 (.515)
Establishment size	0.00003 (.0002)	-0.0004 (.0002)	-0.00006 (.0003)	-0.0002 (.0003)
Temporary contract	-1.968 * (.920)	-1.059 (.890)	-0.461 (.882)	0.058 (.851)
Part time contract	-1.642 * (.777)	-1.608 * (.772)	-0.905 (.732)	-1.227 (.690)
Schooling	1.673 ** (.409)	1.327 ** (.476)	1.022 * (.463)	0.769 (.450)
$Schooling^2$	-0.029 (.016)	-0.018 (.017)	-0.013 (.017)	-0.011 (.016)
Work experience (WEXP)		0.084 (.114)	-0.057 (.108)	-0.129 (.109)
$WEXP^2$		-0.002 (.002)	0.001 (.002)	0.001 (.002)
Schooling*WEXP		0.014 (.010)	0.007 (.010)	0.011 (.009)
High learning time (> 24 months)			2.121 * (.978)	1.558 (.953)
Low learning time (< 6 months)			-2.693 ** (.602)	-1.629 ** (.601)
Training with current employer			4.222 ** (.678)	1.965 ** (.703)
Training with previous employer			2.547 ** (.865)	1.253 (.852)
Tenure			0.073 (.038)	0.090 ** (.037)
Quality circle				2.690 ** (.933)
Suggestion system				4.275 ** (.548)
Appraisal				2.109 ** (.680)
Information				2.171 * (1.119)
Consultation				2.352 ** (3.116)
Constant	7.691 ** (2.588)	7.519 * (3.166)	10.239 ** (3.182)	8.160 ** (3.116)
Number of obs	3578	3578	3578	3578
F(19, 3558)	32.02	31.09	30.78	38.18
Prob > F	0.000	0.000	0.000	0.000
R-squared	0.123	0.138	0.220	0.309

* Statistically significant at the .05 level; ** at the .01 level.

Table 4 – Model_4. Dependent variables: single key competencies

Weighted OLS estimates, with heteroskedasticity-robust standard error.

Independent variables	Problem Solving	Relation with clients	Relation with collaborators	Team Working
	Mod_4b	Mod_4c	Mod_4d	Mod_4e
	Coeff (s.e.)	Coeff (s.e.)	Coeff (s.e.)	Coeff (s.e.)
Gender: 1-M (2-F)	-0.596 * (.264)	0.776 ** (.253)	-0.060 (.166)	-0.407 * (.209)
Establishment size	-0.001 (.000)	-0.001 * (.000)	-0.001 * (.000)	0.001 ** (.000)
Temporary contract	-0.224 (.419)	0.116 (.455)	-0.405 (.244)	0.527 (.375)
Part time contract	-0.948 ** (.347)	0.130 (.385)	-0.035 (.206)	-0.335 (.335)
Schooling	0.793 ** (.264)	0.264 (.245)	-0.156 (.144)	-0.101 (.196)
$Schooling^2$	-0.018 * (.008)	-0.003 (.009)	0.010 (.005)	0.004 (.007)
Work experience (WEXP)	-0.017 (.059)	-0.141 * (.056)	-0.043 (.032)	-0.014 (.043)
$WEXP^2$	0.001 (.001)	0.002 (.001)	0.001 (.000)	-0.001 (.000)
Schooling*WEXP	-0.001 (.005)	0.011 * (.005)	0.007 * (.003)	0.003 (.004)
High learning time (> 24 months)	0.590 (.444)	0.964 * (.409)	0.538 (.293)	0.194 ** (.324)
Low learning time (< 6 months)	-0.867 ** (.288)	0.169 (.294)	-0.467 * (.202)	-0.646 ** (.241)
Training with current employer	0.816 * (.348)	1.114 ** (.339)	0.722 ** (.213)	0.209 (.267)
Training with previous employer	0.665 (.437)	0.583 (.334)	0.346 (.244)	-0.111 (.361)
Tenure	0.041 * (.017)	0.042 * (.019)	0.026 (.012)	0.014 (.014)
Quality circle	1.359 ** (.404)	-0.547 (.429)	0.620 * (.317)	1.357 ** (.412)
Suggestion system	1.446 ** (.295)	1.428 ** (.260)	0.834 ** (.151)	1.666 ** (.228)
Appraisal	0.107 (.331)	1.211 ** (.322)	0.744 ** (.221)	0.998 ** (.254)
Information	0.250 (.500)	1.576 * (.712)	1.315 ** (.473)	0.460 (.456)
Consultation	0.840 ** (.325)	0.947 ** (.276)	0.752 ** (.178)	0.651 ** (.253)
Constant	1.465 (1.894)	0.050 (1.742)	1.973 (.991)	5.785 ** (1.370)
Number of obs	3578	3578	3578	3578
F(19, 3558)	29.09	21.78	27.14	19.54
Prob > F	0.000	0.000	0.000	0.000

R-squared	0.258	0.194	0.245	0.182

* Statistically significant at the .05 level; ** at the .01 level.

Table 5 – Model with lagged organizational characteristics

Weighted OLS estimates, with heteroskedasticity-robust standard error.

Independent variables	**Total key competencies**	**Problem solving**	**Relation with clients**	**Relation with collaborators**	**Team working**
	Mod_5a	**Mod_5b**	**Mod_5c**	**Mod_5d**	**Mod_5e**
	Coeff (s.e.)	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**	**Coeff (s.e.)**
Gender: 1-M (2-F)	-0.525 (.563)	-0.637 * (.290)	0.882 ** (.272)	-0.009 (.182)	-0.372 (.228)
Establishment size	-0.0003 (.0003)	-0.00015 (.0001)	-0.0005 * (.0002)	-0.0002 ** (.0001)	0.0003 * (.0001)
Temporary contract	0.857 (.994)	0.294 (.520)	0.168 (.516)	-0.477 (.279)	0.684 (.478)
Change contract: from part-time (t-5) to full time (t)	0.446 (.924)	0.435 (.534)	-1.054 * (.472)	-0.273 (.288)	0.716 (.419)
Part time contract	-1.785 * (.766)	-1.082 ** (.392)	-0.200 (.416)	-0.178 (.231)	-0.514 (.378)
Change contract: from temporary (t-5) to permanent (t)	0.318 (1.154)	0.212 (.530)	0.062 (.633)	-0.148 (.397)	0.138 (.640)
Schooling	0.669 (.543)	0.860 ** (.323)	0.169 (.264)	-0.143 (.177)	-0.221 (.225)
$Schooling^2$	-0.005 (.019)	-0.020 * (.010)	0.002 (.009)	0.011 (.006)	0.009 (.008)
Work experience (WEXP)	-0.106 (.135)	0.022 (.077)	-0.161 * (.070)	-0.053 * (.043)	-0.015 (.053)
$WEXP^2$	0.001 (.003)	-0.0008 (.014)	0.002 (.001)	0.0006 (.001)	-0.0002 (.001)
Schooling*WEXP	0.010 (.011)	-0.002 (.006)	0.011 * (.052)	0.006 (.003)	0.003 (.004)
High learning time (> 24 months)	1.520 (.960)	0.627 (.449)	0.903 * (.422)	0.526 (.295)	0.158 ** (.328)
Low learning time (< 6 months)	-1.592 ** (.635)	-0.790 ** (.311)	0.104 (.301)	-0.441 * (.203)	-0.663 (.252)
Training with current employer	1.919 ** (.775)	0.781 * (.382)	1.054 ** (.365)	0.760 ** (.231)	0.216 (.285)
Training with previous employer	0.816 (.914)	0.628 (.480)	0.294 (.351)	0.083 (.234)	-0.012 (.391)
Tenure	0.092 ** (.038)	0.044 ** (.018)	0.034 (.020)	0.023 (.013)	0.018 (.014)
Quality circle (yes, time t & time t-n)	0.946 (1.482)	0.804 (.571)	-1.521 * (.661)	0.209 (.525)	0.889 (.718)
Quality circle (yes time t, no time t-n)	3.916 ** (1.082)	1.919 ** (.521)	0.111 (.558)	0.913 * (.391)	1.528 ** (.441)
Suggestion system	4.480 ** (.587)	1.497 ** (.318)	1.444 ** (.272)	0.871 ** (.164)	1.795 ** (.247)
Appraisal	2.125 *	0.112	1.395 **	0.585 *	0.980 **

(yes, time t & time t-n)	(.890)	(.463)	(.424)	(.267)	(.313)
Appraisal (yes time t, no time t-n)	1.508 (1.131)	0.038 (.461)	0.606 (.534)	0.426 (.383)	0.944 ** (.387)
Information	1.243 (1.186)	-0.013 (.550)	0.907 (.747)	0.981 * (.491)	0.316 (.496)
Consultation	2.326 ** (.710)	0.800 * (.353)	0.965 ** (.297)	0.752 ** (.194)	0.656 * (.276)
Increase in discretionary power (between time t-n to time t)	1.263 (.728)	0.620 (.361)	0.481 (.331)	0.506 * (.219)	0.151 (.276)
Constant	7.824 * (.377)	0.384 (2.358)	0.722 (1.928)	1.788 (1.271)	6.241 ** (1.586)
Number of obs	3224	3224	3224	3224	3224
F(19, 3558)	32.35	21.87	19.55	23.46	17.07
Prob > F	0.000	0.000	0.000	0.000	0.000

* Statistically significant at the .05 level; ** at the .01 level.

Table 6 – Estimates of "Total key competencies" Endogeneity tests. Basic, just-identified and over-identified models

Weighted OLS estimates, with heteroskedasticity-robust standard error.

Dependent variable: ***Total key competencies***	OLS	OLS	2SLS^{+} id. mod.	2SLS^{++} *over*id. mod.	GMM^{++} *over*id. mod.
Independent variables:	Mod_6_a	Mod_6_b	Mod_6_c	Mod_6_d	Mod_6_e
Controls (see Mod_4a - tab.3)	Yes	Yes	yes	Yes	Yes
Experience	-0.117	-0.122	-0.075	-0.071	-0.063
Experience^2	0.001	0.001	0.001	0.002	0.001
Tenure	0.089 *	0.089 *	0.109 **	0.109 **	0.108 *
HPWPs (factor)	5.176 **	5.314 **	6.176 **	6.163 **	6.150 **
N. obs.	*3578*	*3224*	*3224*	*3224*	*3224*
F(15. 3562)(Prob> F)	*46.853(0.000)*	*47.030(0.000)*			
R^2	*0.301*	*0.313*	*0.309*	*0.310*	*0.310*
Wald chi^2 (15) (Prob>Chi^2)			*487.70(0.000)*	*489.75(0.000)*	*492.68(0.000)*
Instruments			$^{+}$ age. age^2. dev.tenure. org.charact.$_{t-n}$	$^{++}$ age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$	$^{++}$ age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$
DWH endogeneity test					
F_1 (1.3203) (Prob>F)			0.05 (0.815)	0.01 (0.932)	0.01 (0.932)
F_2 (1.3203) (Prob>F))			0.01 (0.920)	0.06 (0.805)	0.06 (0.805)
F_3 (1.3203) (Prob>F)			4.55 (0.033)	3.17 (0.075)	3.17 (0.075)
F_4 (1.3203) (Prob>F)			0.32 (0.570)	0.32 (0.569)	0.32 (0.569)
F_T (4.3203) (Prob>F)			1.28 (0.275)	1.01 (0.398)	1.01 (0.398)
Test of overidentifying restrict.					

Sargant Chi^2 (1) (p-value)				0.060 (0.806)	
Hansen's J Chi^2 (1) (p-value)					0.025 (0.874)
Test of weak instruments:					
Experience					
Partial R^2			0.226	0.230	0.230
Robust F (4. 3562) (Prob >F)			28.842 (0.000)	24.353 (0.000)	24.353 (0.000)
Shea's partial R^2			0.336	0.343	0.343
Experience^2					
Partial R^2			0.280	0.315	0.315
Robust F (4. 3562) (Prob >F)			28.057 (0.000)	29.918 (0.000)	29.918 (0.000)
Shea's partial R^2			0.467	0.530	0.530)
Tenure					
Partial R^2			0.938	0.940	0.940
Robust F (4. 3562) (Prob >F)			4910.61 (0.000)	4084.07 (0.000)	4084.07 (0.000)
Shea's partial R^2			0.739	0.739	0.739
Organizational characteristics					
Partial R^2			0.139	0.139	0.139
Robust F (4. 3562) (Prob >F)			47.930 (0.000)	38.213 (0.000)	38.213 (0.000)
Shea's partial R^2			0.136	0.137	0.137

* Statistically significant at the .05 level; ** at the .01 level.

Table 7 – Estimates of "Problem solving competencies" Endogeneity tests. Basic, just-identified and over-identified models

Weighted OLS estimates, with heteroskedasticity-robust standard error.

Dependent variable: ***Problem solving***	OLS	OLS	2SLS$^+$ id. mod.	2SLS^{++} *over*id. mod.	GMM^{++} *over*id. mod.
Independent variables:	Mod_7_a	Mod_7_b	Mod_7_c	Mod_7_d	Mod_7_e
Controls (see Mod_4b. tab.4)	Yes	Yes	Yes	Yes	Yes
Experience	-0.019	-0.004	-0.052	-0.042	-0.027
Experience^2	0.001	0.000	0.001	0.001	0.001
Tenure	0.041 *	0.043 *	0.055 **	0.055 **	0.053 *
HPWPs (factor)	1.612 **	1.678 **	1.648 *	1.662 *	1.679 *
N. obs.	*3578*	*3224*	*3224*	*3224*	*3224*
F(15. 3562)(Prob> F)	*35.374(0.000)*	*31.992(0.000)*			
R^2	*0.250*	*0.256*	*0.256*	*0.255*	*0.256*
Wald chi^2 (15) (Prob>Chi^2)			*405.43(0.000)*	*405.27(0.000)*	*406.81(0.000)*
Instruments			$^+$ age. age^2. dev.tenure. org.charact.$_{t-n}$	$^{++}$ age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$	$^{++}$ age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$
DWH endogeneity test					

F_1 (1.3203) (Prob>F)			0.32 (0.572)	0.43 (0.512)	0.43 (0.512)
F_2 (1.3203) (Prob>F))			0.24 (0.623)	0.33 (0.567)	0.33 (0.567)
F_3 (1.3203) (Prob>F)			2.45 (0.117)	2.48 (0.115)	2.48 (0.115)
F_4 (1.3203) (Prob>F)			0.01 (0.929)	0.01 (0.923)	0.01 (0.923)
F_T (4.3203) (Prob>F)			0.70 (0.594)	0.69 (0.598)	0.69 (0.598)
Test of overidentifying restrict.					
Sargant Chi^2 (1) (p-value)				1.203 (0.272)	
Hansen's J Chi^2 (1) (p-value)					0.473 (0.491)
Test of weak instruments:					
Experience					
Partial R^2			0.226	0.230	0.230
Robust F (4. 3562) (Prob >F)			28.842 (0.000)	24.354 (0.000)	24.354 (0.000)
Shea's partial R^2			0.336	0.343	0.343
Experience^2					
Partial R^2			0.280	0.315	0.315
Robust F (4. 3562) (Prob >F)			28.057 (0.000)	29.918 (0.000)	29.918 (0.000)
Shea's partial R^2			0.467	0.530	0.530)
Tenure					
Partial R^2			0.938	0.940	0.940
Robust F (4. 3562) (Prob >F)			4910.61 (0.000)	4084.07 (0.000)	4084.07 (0.000)
Shea's partial R^2			0.739	0.739	0.739
Organizational characteristics					
Partial R^2			0.139	0.139	0.139
Robust F (4. 3562) (Prob >F)			47.930 (0.000)	38.213 (0.000)	38.213 (0.000)
Shea's partial R^2			0.136	0.137	0.137

* Statistically significant at the .05 level; ** at the .01 level.

Table 8 – Estimates of "Relation with clients competencies". Endogeneity tests. Basic, just-identified and over-identified models

Weighted OLS estimates, with heteroskedasticity-robust standard error.

Dependent variable: ***Relation with clients***	OLS	OLS	2SLS[+] id. mod.	2SLS[++] *over*id. mod.	GMM[++] overid. mod.
Independent variables:	Mod_8_a	Mod_8_b	Mod_8_c	Mod_8_d	Mod_8_e
Controls (see Mod_4b. tab.4)	Yes	yes	yes	yes	Yes
Experience	-0.129 *	-0.142 *	0.112	0.111	0.111
Experience^2	0.001	0.002	-0.000	-0.000	-0.000
Tenure	0.041 *	0.036 *	0.027	0.027	0.027
HPWPs (factor)	1.848 **	1.864 **	2.364 **	2.365 **	2.366 **
N. obs.	*3578*	*3224*	*3224*	*3224*	*3224*
F(15. 3562)(Prob> F)	*25.695(0.000)*	*27.139(0.000)*			
R^2	*0.188*	*0.200*	*0.174*	*0.174*	*0.174*
Wald chi^2 (15) (Prob>Chi^2)			*267.12(0.000)*	*267.12(0.000)*	*269.64(0.000)*
Instruments			[+] age. age^2. dev.tenure. org.charact.$_{t-n}$	[++] age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$	[++] age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$
DWH endogeneity test					
F_1 (1.3203) (Prob>F)			7.70 (0.005)	5.93 (0.014)	5.93 (0.014)
F_2 (1.3203) (Prob>F))			1.54 (0.214)	0.90 (0.344)	0.90 (0.344)
F_3 (1.3203) (Prob>F)			7.80 (0.005)	4.97 (0.0258)	4.97 (0.025)
F_4 (1.3203) (Prob>F)			0.52 (0.472)	0.52 (0.499)	0.52 (0.499)
F_T (4.3203) (Prob>F)			5.16 (0.000)	4.82 (0.000)	4.82 (0.000)
Test of overidentifying restrict.					
Sargant Chi^2 (1) (p-value)				0.001 (0.969)	
Hansen's J Chi^2 (1) (p-value)					0.000 (0.979)
Test of weak instruments:					
Experience					
Partial R^2			0.226	0.230	0.230
Robust F (4. 3562) (Prob >F)			28.842 (0.000)	24.354 (0.000)	24.354 (0.000)
Shea's partial R^2			0.336	0.343	0.343
Experience^2					
Partial R^2			0.280	0.315	0.315
Robust F (4. 3562) (Prob >F)			28.057 (0.000)	29.918 (0.000)	29.918 (0.000)
Shea's partial R^2			0.468	0.530	0.530)
Tenure					
Partial R^2			0.938	0.940	0.940

Robust F (4. 3562) (Prob >F)			4910.61 (0.000)	4084.07 (0.000)	4084.07 (0.000)
Shea's partial R^2			0.739	0.739	0.739
Organizational characteristics					
Partial R^2			0.139	0.139	0.139
Robust F (4. 3562) (Prob >F)			47.930 (0.000)	38.213 (0.000)	38.213 (0.000)
Shea's partial R^2			0.136	0.137	0.137

* Statistically significant at the .05 level; ** at the .01 level.

Table 9 – Estimates of "Relation with collaborators competencies". Endogeneity tests. Basic, just-identified and over-identified models

Weighted OLS estimates, with heteroskedasticity-robust standard error.

Dependent variable: ***Relation with collabor***.	OLS	OLS	2SLS^{+} id. mod.	2SLS^{++} *over*id. mod.	GMM^{++} *over*id. mod.
Independent variables:	Mod_9_a	Mod_9_b	Mod_9_c	Mod_9_d	Mod_9_e
Controls (see Mod_4b. tab.4)	Yes	yes	yes	yes	Yes
Experience	-0.039	-0.050	0.082	0.086	0.089
Experience^2	0.000	0.001	-0.001	-0.001	-0.001
Tenure	0.026 *	0.024	0.020	0.019	0.020
HPWPs (factor)	1.332 **	1.330 **	1.713 **	1.702 **	1.691 **
N. obs.	*3578*	*3224*	*3224*	*3224*	*3224*
F(15. 3562)(Prob> F)	*32.761(0.000)*	*32.885(0.000)*			
R^2	*0.240*	*0.250*	*0.228*	*0.229*	*0.229*
Wald chi^2 (15) (Prob>Chi^2)			*423.51(0.000)*	*424.34(0.000)*	*426.94(0.000)*
Instruments			$^{+}$ age. age^2. dev.tenure. org.charact.$_{t-n}$	$^{++}$ age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$	$^{++}$ age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$
DWH endogeneity test					
F_1 (1.3203) (Prob>F)			6.17 (0.013)	4.14 (0.041)	4.14 (0.041)
F_2 (1.3203) (Prob>F))			0.76 (0.383)	0.28 (0.598)	0.28 (0.598)
F_3 (1.3203) (Prob>F)			7.32 (0.069)	5.57 (0.018)	5.57 (0.018)
F_4 (1.3203) (Prob>F)			0.67 (0.421)	0.67 (0.414)	0.67 (0.414)

F_T (4.3203) (Prob>F)			5.60 (0.000)	5.34 (0.000)	5.34 (0.000)
Test of overidentifying restrict.					
Sargant Chi^2 (1) (p-value)				0.454 (0.500)	
Hansen's J Chi^2 (1) (p-value)					0.204 (0.651)
Test of weak instruments:					
Experience					
Partial R^2			0.226	0.230	0.230
Robust F (4. 3562) (Prob >F)			28.842 (0.000)	24.353 (0.000)	24.353 (0.000)
Shea's partial R^2			0.336	0.343	0.343
Experience^2					
Partial R^2			0.280	0.315	0.315
Robust F (4. 3562) (Prob >F)			28.057 (0.000)	29.918 (0.000)	29.918 (0.000)
Shea's partial R^2			0.467	0.530	0.530)
Tenure					
Partial R^2			0.938	0.940	0.940
Robust F (4. 3562) (Prob >F)			4910.61 (0.000)	4084.07 (0.000)	4084.07 (0.000)
Shea's partial R^2			0.739	0.739	0.739
Organizational characteristics					
Partial R^2			0.139	0.139	0.139
Robust F (4. 3562) (Prob >F)			47.930 (0.000)	38.213 (0.000)	38.213 (0.000)
Shea's partial R^2			0.136	0.137	0.137

* Statistically significant at the .05 level; ** at the .01 level.

Table 10 – Estimates of "Team working competencies". Endogeneity tests. Basic, just-identified and over-identified models

Weighted OLS estimates, with heteroskedasticity-robust standard error.

Dependent variable: ***Team working***	OLS	OLS	$2SLS^+$ id.mod.	$2SLS^{++}$ *over*id.mod.	GMM^{++} *over*id.mod
Independent variables:	Mod_10_a	Mod_10_b	Mod_10_c	Mod_10_d	Mod_10_e
Controls (see Mod_4b. tab.4)	yes	Yes	yes	Yes	Yes
Experience	-0.010	-0.026	-0.122	-0.129	-0.137
Experience^2	0.000	0.000	0.001	0.001	0.001
Tenure	0.014	0.002	0.031	0.030	0.032

HPWPs (factor)	1.946 **	2.013 **	2.455 **	2.473 **	2.542 **
N. obs.	*3578*	*3224*	*3224*	*3224*	*3224*
F(15. 3562)(Prob> F)	*22.303(0.000)*	*21.373(0.000)*			
R^2	*0.169*	*0.176*	*0.167*	*0.167*	*0.165*
Wald chi^2 (15) (Prob>Chi^2)			*184.16(0.000)*	*184.84(0.000)*	*192.22(0.000)*
Instruments			$^{+}$ age. age^2. dev.tenure. org.charact.$_{t-n}$	$^{++}$ age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$	$^{++}$ age. age^2. dev.tenure. dev.tenure^2. org.charact $_{t-n}$
DWH endogeneity test					
F_1 (1.3203) (Prob>F)			1.49 (0.223)	1.24 (0.266)	1.24 (0.266)
F_2 (1.3203) (Prob>F))			0.57 (0.449)	0.49 (0.482)	0.49 (0.482)
F_3 (1.3203) (Prob>F)			0.91 (0.340)	0.27 (0.601)	0.27 (0.601)
F_4 (1.3203) (Prob>F)			0.57 (0.451)	0.59 (0.443)	0.59 (0.443)
F_T (4.3203) (Prob>F)			0.65 (0.627)	0.45 (0.771)	0.45 (0.771)
Test of overidentifying restrict.					
Sargant Chi^2 (1) (p-value)				0.808 (0.368)	
Hansen's J Chi^2 (1) (p-value)					0.354 (0.551)
Test of weak instruments:					
Experience					
Partial R^2			0.226	0.230	0.230
Robust F (4. 3562) (Prob >F)			28.842 (0.000)	24.353 (0.000)	24.353 (0.000)
Shea's partial R^2			0.336	0.343	0.343
Experience^2					
Partial R^2			0.280	0.315	0.315
Robust F (4. 3562) (Prob >F)			28.057 (0.000)	29.918 (0.000)	29.918 (0.000)
Shea's partial R^2			0.467	0.530	0.530)
Tenure					
Partial R^2			0.938	0.940	0.940
Robust F (4. 3562) (Prob >F)			4910.61 (0.000)	4084.07 (0.000)	4084.07 (0.000)
Shea's partial R^2			0.739	0.739	0.739
Organizational characteristics					
Partial R^2			0.139	0.139	0.139
Robust F (4. 3562) (Prob >F)			47.930 (0.000)	38.213 (0.000)	38.213 (0.000)
Shea's partial R^2			0.136	0.137	0.137

* Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Appendix

A) Factor analysis relative to 'key competencies'

Based on Ashton et al.'s (1999) work, key competencies are defined by the items in the following table. The factorial analysis, following the criteria referred to in note 10, gave rise to the load factors below. All variables used support the common factors. Those coefficients that – due to their high value - contribute to defining the construct underlying the factor are shown in bold.

Questionnaire item, section G./ number:	**Job activity**	**Pattern matrix**	
Competency: Problem solving			
3	To analyze complex problems in depth	0.658	
6	To deal with problems or faults (which could be through your own work, someone else's work or equipment)	0.737	
10	To spot problems or defaults (which could be through your own work, someone else's work or equipment)	0.639	
33	To think of solutions to problems (which could be through your own work, someone else's work or equipment)	0.794	
Competency: Professional relations *(impact and influence)*		**toward clients**	**toward collaborators**
2	To deal with people and to interact with them	0.445	
18	To persuade or influence others	0.412	0.564
24	To make public speeches or presentations	0.368	0.362
28	To counsel, advise or care for others	0.394	0.643
30	To sell a product or service	0.792	
43	To instruct, train or teach people, individually or in groups		0.650
44	To counsel, advise or care for customers or clients	0.725	
Competency: Teamwork			
8	To join a group effort	0.767	
11	To help other members of your team	0.864	
36	To listen carefully to colleagues	0.594	

B) Composition of factor relative to organizational characteristics at time *t-n*

Questionnaire item, number:	**Question**	**Reply privileged**	**Pattern matrix**
I.10	Where you a member of a quality circle (or improvement group) five or four or three years ago (according to your previous employment condition)? [admitted reply: 1 = yes; 2 = no]	No	0.6789
I.11	Did you regularly receiving a formal assessment of your performance five or four or three years ago (according to your previous employment condition)? [admitted reply: 1 = yes; 2 = no]	No	0.8310
C.1_2	Do you know if your organization/firm obtained ISO9000 or Vision2000 certifications, or other quality certifications? [admitted reply: 1 = yes, they got it; 2 = no, they didn't get it; 3 = I don't know]	No (2) I don't know (3)	0.0295