High Performance Work Practices and Educational Mismatch: Creation and Destruction of Competencies.*

Riccardo Leoni† and Paola Gritti†

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(preliminary version)

Abstract

With a focus on expressed competencies, the objective of this study is to test the hypotheses of whether a worker's level of competencies is affected by modern work practices, whether owning key competencies affects the acquisition of technical competencies, and finally, whether the presence of educational mismatch has some consequences on expressed competencies. Based on a representative Italian national survey, we separate the overall expressed competencies of a given worker into two categories, namely, key competencies and technical competencies, proving that the former affect the latter and confirming that key competencies constitute a higher-order logic 'class' with respect to technical competencies. In addition, our findings show that i) key competencies increase when adopting new work practices, ii) overeducation has a dissipative effect on both types of expressed competencies and iii) undereducation (which implies having a challenging job) has a strong positive effect. The policy implications of wasting valuable human resource competencies are discussed.

Key words: *work-based learning, educational mismatch, obsolescence of competencies.*
JEL classification*: J21, J24, M53.*

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† Department of Management, Economics and Quantitative Methods, University of Bergamo (Italy). Financial support from the affiliated university is gratefully acknowledged. Corresponding author: leoni@unibg.it

1 Introduction

Over the past few years, Nobel Prize winner J. J. Heckman has repeatedly tackled the economics of learning (e.g., Heckman, 2000; Heckman, Lochner and Taber, 1998; Heckman, Lochner and Todd, 2003). In reviewing the international literature, both theoretical and empirical, he came to the conclusion that 'much learning takes place outside of schools: 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 (this estimate was made in Heckman, Lochner and Taber, 1998)' (Heckman, 2000, p. 5). Although it is not clear which type of competencies can more easily be learnt outside schools (technical or key/soft/transversal competencies) nor the specific organizational characteristics a workplace should have in order to forge individual capabilities, the incisiveness of this authoritative assertion is nevertheless rather relevant. On a theoretical level, a few authors previously argued that work activities constitute a significant, albeit indirect, source of learning: we refer to Arrow's learning-by-doing (1962) Rosenberg's learning-by-using (1982), Lundvall's learning-by-interacting (1988) and, lastly, Cohen-Levinthal's learning-by-searching (1990). More recently, two explanations have been advanced on the issue (i.e., informal learning). The first relates to the concept that the workplace develops collective attitudes or habits that influence employees, regardless and independently of their personality traits. Workplace attitudes may be the result of a management style or of workers sharing common and specific experiences, which set the standards to which new recruits progressively adhere via informal learning (Schneider *et al.*, 1995). Bartel *et al.* (2004) show the existence and persistence of a genuine workplace effect on individual worker perceptions of their role and of the organization, adding to previous studies on the notion that worker attitudes are also strongly correlated to firm performance. The genuine workplace effect has been assumed as such, without investigating its origin.

The second explanation on the origin of informal learning relates to organizational design as an authoritative *source* of stable and socially recognized work practices that employees are *daily* required to perform (Koike, 1994).

One of the objectives of this paper is precisely to investigate the role played by workplace organizational design in *inducing* on one side organizational behaviours and on the other, improvements in the competencies expressed by workers. Leoni (2012) paid particular attention to the so-called «key» competencies, which in the debate on life-long learning are considered applicable to all workplaces, regardless of industry and company size. Their importance is associated with the hypothesis that one of the firm's most valuable assets is not only, or largely, technical knowledge (since this is codified knowledge that can easily be replicated or transferred), but cognitive and cultural knowledge, which is required in external relations (with customers and suppliers), in diagnosing defects, in problem handing and problem solving, and in interacting with colleagues (especially in relation to teamwork), subordinates and hierarchical levels. These competencies constitute the hidden substratum of technical competencies and appear to be able influence the acquisition of the visible part of the iceberg (that is,

techno-specialist competencies) (see *infra*). In this paper, we first extend the analysis to technical competencies, and secondly – based on Montedoro's (2004, p. 49) theoretical suggestions – test whether key competencies really constitute a higher-order logic 'class' with respect to technical competencies that enable learning and activating the latter.

A second aim of the paper is to investigate whether conditions exist – regardless of age advancement - that develop and envelop competencies over the working life. In addition to the role of the aforementioned organizational design, an individual's level of competencies could be affected by training (on/off-the-job) but also by the mismatch between the educational level held and that required by the role. While several studies analyze the effects of overeducation on wages (e.g., Cainarca and Sgobbi, 2012), others focus on career mobility (e.g., Buchel and Mertens, 2004), and others yet on worker satisfaction in relation to the role occupied (e.g., Allen and van der Velden, 2001). De Grip *et al.*'s (2008) is the only study that verifies the effects of job-worker educational mismatch on a set of cognitive skills. In our paper, we go beyond the cognitive skill notion to consider a broader concept, namely, key competencies that include the transversal (or key) and technical components. The cognitive skills considered by De Grip *et al.* (2008) were criticized by McClelland (1973) for being context-free, not involving emotional intelligence (Goleman, 1995) and, as such, capturing and measuring abstracted worker potential. Furthermore, they constitute a subset of all abilities activated in a job, while competencies refer to (and are measured as) overall organizational behaviours actually activated, observed and measured, representing situated and social work practices. As well-known in literature (e.g., Spencer and Spencer, 1993), in the job-competency approach - contrary to the skill approach – the analysis starts with the worker-in-the-job, making no prior assumptions as to what skills are needed to perform the job well, thereafter verifying what type of actions are carried out and then measuring performance (which can range from the threshold to the distinct level). The job-competency approach only at the end allows obtaining the individual's characteristics that enable her or him to carry out appropriate and specific actions.[1] The expressed or demonstrated competencies must then be compared with those the job demands (which we call requested competencies) in order to verify whether a competency gap (or mismatch) exists. According to the iceberg competency model (Spencer and Spencer, 1993, p. 11), competencies that are hidden or beneath the surface are more difficult to learn, while those that are visible are easier to learn. If this were true, we would expect the effects of overeducation to have a negative effect on the competency profile, with a long run effect for key competencies and a short run effect for technical competencies.

[1] In a strict sense, since personal characteristics are responsible for performance, these are called 'competencies'. In other words, an individual's actions can be examined to identify *why* she or he acts in certain ways. In this approach, personal characteristics are considered a good predictor of future performance, becoming a powerful selection tool (see Spencer and Spencer, 1993).

The analysis first reviews the theories of job design (§ 2) and overeducation and obsolescence (§ 3), thereafter testing an econometric model (§ 4) using a recent database constructed by ISFOL[2] (§ 5) following a national survey of a significant sample of workers on the organizational conditions of their workplaces and the learning sources of the enacted or expressed competencies. The relevant findings are discussed in § 6. Our closing remarks are presented in § 7.

2 Job and organizational design, requested competencies and consequential work practices: informal learning.

One of the more microfounded approaches that explicitely acknowledges the impact of organizational design on individual competencies is that of Koike (1994). According to this author, there are two possible strategies (or theories) for the division and organization of labour defined as the «separate system» and the «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 (supervisors and professional staff). Under this organizational design, jobs in the first group require execution capabilities, while those in the second group call for coordination, problem-solving activities, control and command.[3] The company's task is to upgrade, through training, worker competencies according to the requirements of the organizational design, a task that assumes increasing urgency with the technological process and/or product changes implemented by a firm's top management.

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 the flaws, as well as managing the changes arising from variations in quantities demanded, production method modifications and, finally, product innovations. A consequence of repeated and daily problem solving is the development of intellectual (or cognitive) abilities, which are further bolstered by the worker's strategic use of job rotation within and between production islands,[4] precisely because usual and unusual operations tend to differ from one position to another, and from one production island to another, determining actual learning within mobility clusters. Participation in interfunctional improvement groups (quality circles), suggestion systems and consultation on problems that arise are

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

[3] Under this approach, an organizational analysis is called on to set out the procedures (to eliminate useless steps) and to assign to each job the execution of a specific (and limited) number of procedures. In this way, the task is highly narrow and specialized and has no relation with its purpose. The transition from tools to machine tools (numerical control machines) and, lastly, to automated machine tools (computerized numerical control machines) brought with it the need to expand the tasks of individual operators, giving rise to the concept and practice of multiple competencies.

[4] The term *strategic* should be placed against the backdrop of organizational design that favours teamwork, i.e., production islands where upstream workers rotate downstream (thus contributing to correcting any mistakes made by co-workers thanks to the experience gained) and the fact that, ideally, permanence in a given job should not be less than the time necessary to learn the relevant competencies.

additional organizational/management techniques that contribute to increasing the worker's cognitive and relational abilities as well as the quality of products and processes, thanks to constant and diffused problem-solving activities and continuous improvements. These organizational elements are key features of so-called 'high performance work practices' (HPWPs: see Appelbaum *et al.*, 2000; Ichniowski *et al.*, 2000). In addition to organizing their internal activities by processes (instead of by functions) and delegating responsibility (with the resulting flattening of hierarchy levels), HPWPs require extensive information dissemination, both to involve workers and because, according to Nonaka and Takeuchi (1995), information is the key ingredient of knowledge creation.

Koike depicts competency with a matrix (very similar to Spencer and Spencer, 1993), where the rows reflect the breadth, i.e., the competency of a worker in carrying out a series of regular activities (usual operations), while the columns indicate the depth, i.e., the worker's cognitive and relational competencies in dealing with unusual operations.

To produce constantly evolving competencies, an organizational design such as the aforementioned has to follow some basic rules that foresee: (i) the involvement of a wide array of workers (not just the elite or specialists) in the aforementioned practices, possibly with a good basic educational level; (ii) that competencies are more easily acquired from operating within the firm, since these – in most cases – cannot be easily transferred or communicated simply through language; competencies thus acquired are more practical, cheaper and more efficient and effective than would otherwise be the case with traditional off-the-job and formal training; (iii) that classroom learning should involve only short courses with the aim of systematizing knowledge acquired in the field, namely, to provide the *know-why* indicated by Lundvall and Johnson (1994); (iv) that internal competency development must go hand in hand with career growth (in terms of salary and/or position) to motivate workers to give their best and to foster company loyalty.

With regard to the competency concept, the international debate that has developed (see the DeSeCo - *Definition and Selection of Competencies* – project, promoted since 1997 by the OECD: OECD, 2002 and Ryken and Salganik, 2000, 2001, 2003) appears to have reached a consensus around the distinction between technical competencies and key (or transversal) competencies. The former derive from disciplinary knowledge, take the form of codified knowledge and are more easily learnt in a classroom environment; the latter transcend and cross the boundaries of various disciplines, can be influenced by work practices that in turn derive from job and organizational design, can be activated in different positions and supplement technical competencies. The concept of «key» competencies is associated with the epistemological concept of metacompetencies (Montedoro, 2004, p. 49), constituting a higher-order logic 'class' with respect to techno-specialist competencies. According to Alberici (2004, pp. 106-118), metacompetencies relate to the dimension of human action that is associated with the *reflectiveness* of thought, the recursiveness of learning and the autopoietic nature of competencies. These metacompetencies unfold in such dimensions as personal, cognitive, psychological and social resources, social capabilities and, finally, organizational skills.

Leoni (2012) proved that some organizational practices - such as quality circles, suggestion systems, systematic appraisals, being informed and being consulted by managers - develop key competencies. We will analyze whether the same set of organizational practices (HPWPs), which are very compatible with the HPWO (High Performance Work Organization), have a similar effect on technical competencies and whether these are influenced by key competencies.

3 Overeducation, undereducation and their influence on competencies

Literature on overeducation identifies three main measurement methods (Hartog, 2000; Sloane, 2003): (i) the objective method, based on a systematic evaluation of the levels required by the work of a particular occupational group (Rumberger, 1987); (ii) the subjective method, which foresees self-assessment by workers (Sloane *et al.*, 1999); (iii) the empirical method where the state of overeducation is defined, for example, by a higher level of average education plus one standard deviation required by a particular occupation (Groot, 1996). Each of these methods has advantages and disadvantages (Allen and van der Velden, 2005; Hartog, 2000) although Hartog (*ibidem*) argues that the objective method is conceptually superior. However, high measurement costs and limited data availability render the subjective method a viable alternative that can also provide information that would otherwise be inaccessible, while appropriate and thorough data collection reduces the risk of passive manipulation (Allen and van der Velden, 2005). Many studies show that overeducation pertains particularly to young people at the beginning of their career (Hartog, 2000), which would imply a temporary phenomenon. However, some empirical studies have found persistent overeducation (and undereducation) among workers with more experience, which has been interpreted either as providing support for the hypothesis of heterogeneity between individuals with the same educational level but with different capabilities (Green *et al.*, 2002)[5] or as the result of the malfunction of mechanisms to re-balance the labour market. In Italy, Cainarca and Sgobbi (2012) found that overeducation and undereducation affect the under-35 age group to a greater extent, constituting a permanent element of these phenomena.

De Grip *et al.*'s (2008) is the only study that includes as a dependent variable the individual's cognitive abilities, which to some extend – as described above – constitute part of the competencies the worker owns. According to this study, overeducation generates a more rapid decrease of owned cognitive abilities due to lack of use, which triggers a downward adjustment mechanism. However, while psychological literature explains this phenomenon by attributing it to the relationship between cognitive and intellectual stimulation (e.g. Fratiglioni *et al.*, 2004), literature on the obsolescence of skills attributes this to atrophy from lack of use (e.g., De Grip and Van Loo, 2002). The difference between owned and expressed competencies has to be taken into consideration since the effects may not be the

[5] That is, given a distribution of skills around an educational level, people with fewer abilities occupy a lower productivity job, and vice versa (Sloane, 2003).

same; despite not being strictly required by the role, some owned competencies may still be used by the worker and are thus not subject to decline to the extent that they are used. This argument is advanced by those who (e.g., Cainarca and Sgobbi, 2012, for Italy) demonstrate that overeducation, as measured by the subjective method and as an index of the worker's expressed competencies, increases the wage premium compared to a worker in the same position with the requested qualification level. The authors explain this as a premium for the competencies and capabilities accumulated by additional years of study. The value that the employer recognizes to surplus education is only partial; that is to say, the overeducated suffer a wage penalty as each year of education in an overeducated position yields a lower return than that of workers occupying positions that match their education. Conversely, the undereducated benefit from a wage premium because they deal with problems on a daily basis that go beyond their level of education, challenging their competency frontier (e.g., Pazy, 2004; Staff *et al.*, 2004). However, the genuine effect of undereducation, and particularly overeducation, cannot be disentangled from the institutional effect owing to either industry-wide agreements or company-level bargaining that may foresee, amongst other things, clauses for certain positions stipulating a given level of education, which has long been considered a proxy of requested knowledge. If this holds, the overeducation effect captured in the wage regression may not be verified in the competency regression.

4 Empirical Model

The empirical model tested is inspired by the framework of a competency production function whereby an individual's competency level is a function of a series of inputs:

$$ICE_{it} = \Theta' SCH_{it} + \Psi' WBL_{it+} + \Phi' HPWPs_{it} + \Omega' X + u_{it} \qquad \text{for i, t = 1, …….n/m} \quad [1]$$

where ICE is an index of the overall competencies expressed by the individual *i* in a given job at time *t*; SCH is an input vector of an educational nature (schooling), WBL is a vector of work-based learning indices, HPWPs represent high performance work practices and *reflect* the organizational characteristics of the individual's job. According to the literature cited in the preceding section, these are assumed to produce a learning effect since they require the worker to engage in specific reflective work practices. Finally, X is a vector of personal characteristics, while u_{it} is a stochastic term.

Based on the arguments and hypotheses advanced above, the overall index (ICE) must be divided into two components, namely, key competencies (ICE_k) and technical competencies (ICE_{tec}). Moreover, the schooling vector can have three measures relating to the conditions of matching, overeducation and undereducation. Finally, key competencies can affect techno-specialist competencies, thus becoming endogenous variables for the latter. In a cross-sectional context, the time subscript *t* is no longer required and for any given worker *i*, equation [1] becomes a system of two equations (plus an identity):

$$ICE_{tec} = \Theta'_{tec} SCH + \Psi'_{tec} WBL + \Phi'_{tec} HPWPs + \Omega'_{tec} X + \lambda ICE_k + u_{tec} \quad [2a]$$

$$ICE_k = \Theta'_k SCH + \Psi'_k WBL + \Phi'_k HPWPs + \Omega'_k X + u_k \quad [2b]$$

$$ICE_T \equiv ICE_{tec} + ICE_k \quad [2c]$$

where errors across equations are assumed to be correlated (Cov [u_{ts}, u_k] $\neq$ 0). With one or more endogenous variables in the system, the best estimator is constituted by the three-stage least-squares (3SLS), under the constraint of bootstrap estimates to take into account the heteroskedasticity condition traditionally present in cross-sectional data. Weighted estimates allow controlling for potential selection bias.

5 The database and estimate issues

The database[6] used to test the above model was constructed by ISFOL (an Italian governmental institute in charge of the professional training of workers), following a questionnaire survey 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).[7] The questionnaire contains a section intended to determine the frequency of organizational competencies successfully enacted or practiced by respondents, with detailed references of the 'organized context' where the individual operates and distinctions between: (i) the competencies required by the role, (ii) expertise held (i.e., mastery in performing specific activities in given contexts), and (iii) the organizational behaviours activated (expressed competencies).

The sample used (for the target universe) consists of 3578 individuals. This number fell to 3224 due to missing responses to the question on participation in quality circles and systematic appraisals five years prior to the interview; these variables become part of the factorial variable used in some specifications. The t-test on the single variables substantially confirms that the second sample is 'randomly extracted' from the first, except for those variables that refer to a lagged employment relationship not yet in place for youngsters in the sample. See Leoni (2012, Table 2) for these tests.

5.1 Dependent variables

The definition of competencies we use is a subjective measurement of 44 listed activities and, as such, could be called into question since the self-reporting method of assessing competencies entails a

[6] For detailed information on how to retrieve the database and questionnaire, see Leoni (2012, footnote on p. 316).
[7] For the methodological approach of the survey and for an initial assessment of the results, see Tomassini (2006).

potential distortion due to 'social desirability'. To overcome this potential weakness, particular attention from a semantics perspective was paid to the lexicon used. In terms of the survey undertaken here, we refer to Leoni (2012) wherein this issue was analysed. The items were surveyed through a Likert scale from 1 to 7, with frequencies ranging from 'rarely' to 'practically nearly always' to determine whether the organizational behaviours required by the position were effectively and efficiently activated. The items represent various competency dimensions such as (see Ashton *et. al.*, 1999): (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) attitudes/work conditions (organizational effort, autonomy, discretionality, responsibility, variety).

Prior to applying the factor analysis, we followed Ashton *et al.*'s suggestion (*ibidem*, p. 56) of categorizing items into two broad areas, one in relation to key competencies and the other in relation to technical competencies. The factor analysis, as applied to respondent data on the first set of organizational behaviours, enabled extracting – through a scree test - 4 common factors whose underlying constructs allowed identifying the following key competencies:[8] (i) problem solving (through an in-depth analysis of complex problems, the solution to problems, the identification of errors and thinking about solving problems); (ii) communication/social interaction with two different groups: (ii.a) customers (i.e., providing advice and customer care, or selling a product or service) and (ii.b) subordinates (i.e., effectively managing subordinates, giving instructions or training subordinates); finally, (iii) teamwork (joining in a team effort, helping other team members, attentively listening to colleagues). An overall skill index of «key» competencies was compiled (ICE_k) by weighting the single indices through the variances explained by each factors extracted with the factor analysis.

Similarly, with regard to items falling into the technical competencies category, 5 common factors emerged: a) compiling notes and forms, understanding and writing short texts, b) reliably performing specialized services, attention to detail, c) planning and organizing activities d) doing calculations, and e) carrying out even heavy manual work. These were used to compile the overall technical competency index (ICE_T).

5.2 Independent variables

In terms of the schooling vector (SCH), the usual indicator was adopted (number of school years necessary to obtain the diploma held, in accordance with human capital theory). This indicator was subsequently used to verify and construct the matching condition (*education matching*), the overeducation condition (*overeducation*) and the undereducation condition (*undereducation*).

[8] See Leoni (2006) and methodological appendix obtainable from www.isfol.it

For work-based learning, the candidate variables relate to the years of experience in the labour market (*work experience*), to an interactive term combining educational attainment and work experience (*work exp*schooling*), to dummies reflecting learning time (*high and low learning time*) required to perform current job duties,[9] (dummy) variables to capture whether the individual was trained by the current employer (*training with current employer*) or by the previous employer (*training with previous employer*). In addition to these standard variables, control indicators were used such as the size of the business (*establishment size*), type of employment contracts (*temporary contract* and *part-time contract*) and seniority (*tenure*). The information on level of discretion in carrying out tasks (namely, choice/perceived discretion space, influence in determining the time and effort to execute activities and tasks, choice space in decisions on tasks to undertake and in which order, and finally, in decisions on how to perform the tasks to be completed) gave rise to a unique factor (*discretionality*). As foreseeable, the level of discretion is strongly correlated to the job classification level (r= is equal to 0.4).

As concerns the HPWPs vector, capturing the organizational characteristics of the individual's job, we obtained information on innovative work practices such as participating in an improvement group (*quality circle*), submitting suggestions (in the twelve months preceding the interview) to improve the individual's work efficiency (*suggestions system*), formal and systematic performance evaluation by the immediate supervisor (*appraisal*), participating in meetings (at least every four months) where supervisors/management provided information on company operations to verify and fine-tune technical and work-definition problems (*information*), and finally, participating in meetings (at least once every four months) where, upon request, the individual expressed his or her point of view (*consultation*). Through factor analysis, these five elementary variables were collapsed into a unique component (*HPWPs*), which we use in our estimates.

In terms of the personal characteristics vector, with the exception of gender, the neuroscience debate (see Borghans *et al.* 2008; Heckman *et al.*, 2006; Cunha and Heckman, 2008) and the competency approach (Boyatzis, 1982) evince the need and expediency of distinguishing competencies into the harder part, important in the selection process – namely, deep personality traits – and the more flexible part, more easily influenced by the organizational practices adopted by the firm such as HPWPs – specifically, adaptive characteristics (for a review, see Gritti 2013). Hence, four traits captured by the questionnaire (pride in doing the best possible job, resolution/determination in doing the job well, self-updating through books and journals, and finally, self-teaching from books and journals, manuals, video tapes and through correspondence, evening or weekend courses) were processed by factor analysis and provided one unique component (*personality traits*).

5.3 Endogeneity and instruments

[9] The only specification to be added concerns the length of time necessary to learn the competencies expressed by the worker. We arbitrarily selected (albeit 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*).

Due to lacking information, we followed the theory of human capital approach, which holds that education is an exogenous variable. Disregarding schooling, we first investigated endogeneity according to the debate on earnings function such as experience, squared experience and tenure. We then took into account the hypothesis that the bundle of new work practices (HPWPs) are also endogenous, reflecting some other variables. The eligible instruments are constituted by age (and by squared age) for experience (and squared experience) (Dustmann and Meghir 2005; Cingano 2003; Sulis 2009). Altonji and Shakotko (1987) and Sulis (2009) found that the deviation of individual tenure from the sample's average industry tenure is an efficient instrument since it is not correlated, by construction, with the individual fixed effects component or with the matching component. As concerns the potential endogeneity of the HPWPs vector, a functional factorial instrument is constituted by a subset of organizational characteristics that may or may not have affected the individual in place at time *t-n,* specifically, a type of lagged variable with respect to the endogenous regression factor.

Table 1 presents the standard statistics of the variables used in our estimates.

Table 1 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 percentages: for instance, 18% of workers reported a period of more than 24 months to learn their skills compared with 56% reporting a period of less than 6 months (the percentage needed to reach 100 was captured by default by the equation constant).

6 Econometric strategy and findings

A preliminary estimate of Model [2a-2b] was undertaken (see Model-A) using the SUR estimator (excluding the key competencies variable ICE_k from [2a]) in association with the bootstrap method and 'force' command[10] (to account for heteroskedasticity and generate weighted estimates) to verify the independence of the across-equation residuals. The correlation of residuals is 0.613, with the Breush-Pagan test equal to 1126,229 (Prob = 0.000), which implies rejection of the null hypothesis. Due to this correlation and the endogeneity hypothesis of the ICE_k in ICE_{ts} equation [2a], the estimates in Table 2 refer to 3SLS.

Model-B is an exactly identified model where work experience and its squared term, work experience interacted with schooling and tenure, are treated as endogenous; perhaps due to the endogeneity of HPWPs, the first equation appears entirely irrelevant.

[10] The Stata 11.0 package was used.

Model-C is an overidentified model that uses the HPWPs factorial variables at time t-5 as well as changes in autonomy with respect to t-5 as instruments of HPWPs[11] and shows that both HPWPs and personality traits affect key competencies, which in turn increase technical competencies. Overeducation is not statistically significant, while occupying a job requiring a higher level of education induces an expansion of worker competencies, thus giving credence to the challenging hypothesis.

When combining the overeducation and undereducation variable into a single job-worker mismatch continuous variable (Model-D), constraining the coefficient to take a unique value and having a linear relationship with competencies, the mismatch variable becomes highly significant. For an overeducated worker (whose years of overeducation – as we recall − take a negative value), this represents wasting both key and technical competencies, with the further aggravation that the decline of key competencies amplifies the loss of technical competencies. The contrary applies to the undereducation effects: they positively foster key competencies, which in turn influence the development of technical competencies.

The level of education (in the matching condition) safeguards the decline of competencies.

To test for the endogeneity of variables, we manually carried out the robustified Durbin-Wu-Hausman test: the chi^2 (4) is 21.38 with prob> chi^2 = 0.003, which leads to rejecting the null hypothesis that the 4 variables are exogenous. A deeper scrutiny of each single coefficient shows that work experience must be considered exogenous in both equations (technical and key competencies), while the interacted term of work experience with schooling and the HPWPs are endogenous. Instead, work experience squared produced an ambiguous result: in the equations system, where multiple residual variables in relation to the error terms obtained from the reduced-form model were added, the coefficient of residuals is statistically significant (non-significant) with respect to technical (key) competencies and therefore the variable in question must be considered endogenous (exogenous). As commonly known in econometric literature on instrumental variables, when a variable is exogenous but is treated as endogenous, the IV estimator is still consistent although the estimates may be much less efficient. Thus, in the next model we treated work experience squared as an exogenous variable. Unfortunately, the estimator used did not permit carrying out a test on the weakness or robustness of our instruments and this last result must therefore be viewed with some caution.[12]

< Table 2 approximately here >

In Model-E, only HPWPs and the interacted term of work experience with schooling were treated endogenously; the results of interest were even more marked. Montedoro's (2004) hypothesis, according to which key competencies enable learning and activating technical competencies, is strongly confirmed. In turn, key competencies are affected by, amongst others, innovative and performing work

[11] We abandoned the tenure variable since it always had statistically non-significant coefficients.

[12] We attempted to implement the GMM system but the programme (Stata 11.0) did not achieve convergence after the maximum interactions allowed (16 thousand).

practices: this implies that practising reflective actions and social interactions – which form the factorial variable HPWPs – *induces* learning, that is to say, learning is embedded in practises, or more precisely, in *specific* practises that must be recognized and legitimized by the division of labour and organizational design. An analytical side remark is worth adding here: the significant role played by the organizational factorial variable HPWPs provides confirmation of the synergic effect or complementarity role that each single variable exercises on the others and thus forming a system. This implies that the overall impact on the level of key competencies (and on the technical competency cascade) is greater than the sum of single effects (Milgrom and Roberts, 1995, p.181). Two aspects underlie this outcome: first, not all variables considered are equally important in forming the factor; second, each worker does not necessarily apply all work practices simultaneously and with the same intensity.

Discretion to a large extend reflects contractual occupational levels, which in turn are correlated to education. As a consequence, any additional explicative contribution in the technical development direction cannot be expected. Of interest is the statistical significance of discretion in key competencies: this implies that by climbing the professional ladder in terms of job level or grade, workers not only move towards greater autonomy and discretion in accomplishing tasks or goals, from which they may derive satisfaction as well as the 'internal' reinforcement of their locus of control, but also in exercising this discretion - *ceteris paribus* - they benefit from the autopoietic development of key competencies and technical competencies indirectly (via ICE_k on ICE_{ts}).

Given the content of key competencies, it is unsurprising that matching education conditions is not significant for key competencies while it is positively significant for technical competencies. This is coherent with the concept that education provides knowledge, which is *one* ingredient of technical competencies. As for overeducation and undereducation, the results are consistent with respectively obsolescence and the challenging hypothesis, with the peculiarity of a higher rate of return for undereducation compared to educational match, and for key competencies compared to technical competencies. This cannot be considered a short-term problem resulting from a lack of coordination in adjusting schooling requirements and investments among firms and individuals and concerns not only the technical but also the key component. The latter requires prerequisites and longer periods of achievement since it involves tacitness and depth of cognitive processes, and for adults generally involves the deconstruction and reconstruction of mental models (Johnson-Laird, 1983). With regard to Cainarca and Sgobbi's (2012) results and related literature, according to which overeducation is economically recognized by the firm, albeit with a wage penalty for workers, we argue that our results are coherent with the idea that at the wage level, institutional factors intervene that oblige or induce the firm to economically recognize overeducation to some extent.

For the remaining variables, the results largely follow the expected signs: women have a greater ability to acquire technical competencies, a temporary contract negatively affects learning professionalism (even if its significance is only 11%), part-timers face a loss of key competencies,

training with the previous employer – contrary to human capital theory – appears to influence the technical competencies activated in successive firms.

7 Discussion and conclusions

In this paper, we put first forward a distinction between key and technical competencies and provide empirical evidence whereby the former condition the acquisition of the latter. This is in line with the hypothesis of Montedoro (2004), according to whom key competencies constitute a higher-order logic class than technical competencies.

Second, the estimates undertaken show that working in a company that adopts innovative organizational practices induces in workers reflectiveness and stimuli in facing problems and relationships that foster the development of their key and overall competencies. The calculable effect of a 10% increase in the HPWP diffusion index on the overall level of competencies (constituted by the direct effect on both key and technical competencies, and enhanced by the indirect effect via ICE_k on ICE_{tec}) - is equal to around 2.6%. Should private Italian companies adopt the same amount of HPWPs as English companies[13], and the development of competencies were equalized to the growth of labour productivity, the productivity of Italian firms would increase by approximately 53%. The cumulative delay from 1995 to 2007 in the development of productivity of Italian companies compared to English companies was equal to 20%.[14]

Of course, this gap can be attributed to several factors (capital intensity, ICT technologies, etc.,) but the lack of adoption of modern work practices has played a significant role in Italian firms.

The findings highlight the role of job and organizational design in shaping and developing individual worker competencies, associated with other outcomes according to which HPWPs (a) deliver better performance, (b) spur greater radical and incremental product innovation, and (c) are conducive to greater worker satisfaction and commitment[15]. The fact that the underlying learning process is more genuinely 'organizational' than 'individual' should induce scholars, employers and managers, trade unions leaders and policy makers to reconsider the notions of *management by stress* (Parker and Slauther, 1988) and the *intrinsic inevitability* of alienating work fragmentation. After all, the distinction between traditional and new work practices is not far from that proposed by Arendt (1958) in relation to labour and work, according to which the latter (but also HPWPs, in our opinion) establish the identity and meaning of personal lives.

[13] From Ashton and Felstead (1998, p. 22, Table 1) one can estimate that on average British workers are involved in 3.06 of the 5 new work practices; the corresponding figure for Italian workers estimated by Leoni (2006, p. 96, Table 3.4) is equal to 1.01. The questionnaires used in the two surveys were exactly the same (apart from minor aspects) and thus the two averages are highly comparable.

[14] The index of gross value added per hour worked (volume indices, 1995 = 100) for total UK industries reached the level of 125.2 in 2007 while for Italy the level was 105.2 (source: EU_KLEMS, November 2009).

[15] See Leoni (2013a) for a review of this literature.

Third, the estimates indicate that occupying an overeducated position implies - as a result of not using a portion of owned competencies - a sharp decline in both the key and technical competency sphere, compared to an undereducated colleague in a position requiring a higher level of education than that held. Indeed, the latter - as a result of the traditional learning-by-doing/learning-by-using/learning-by-interacting/learning-by-searching/learning-by-solving mechanisms - experience significant growth in their competencies. Occupying a position that requires an additional year of education entails the (informal) development of 1.25% of core competencies and 1.21% of technical competencies, which with the indirect effect (via ICE_k) becomes approximately 1.88%. The weighted average is equal to 1.55%. For a graduate occupying a graduate position, the overall effect is 6.2%.

Unsurprisingly, the equilibrium level of education is not associated with the development of key competencies when recalling that the contents of these competencies are mainly communicative and relational, and these are not traditionally taught in school environments[16] nor do students acquire them unless constructivist pedagogy is applied, which is completely absent in Italian school environments (Leoni, 2013b).

In the debate between those who support the hypothesis of heterogeneity (e.g., Sloane, 2003), according to which, for any given level of education, those with the lowest (highest) competencies are assigned positions that require the lowest (highest) competencies and would thus be artificially overeducated (undereducated), and those supporting the hypothesis that cognitive decline on one side (for the overeducated) and intellectual challenge on the other (for the undereducated) (e.g., De Grip *et al.*, 2008), our results tend towards the second position, supporting the idea that competencies and not individuals adjust (downwards) and, in the event of disequilibrium, seek a position of equilibrium. The variant, with respect to the international debate, is that the construct of cognitive capabilities is replaced, in our case, by key competencies and these are operational behaviours expressed in a given context, unlike De Grip *et al.*'s (*ibidem*) cognitive skills that constitute a context-free construct.

The well-deserved attention of policymakers to education as a potential instrument of social promotion as well as the individual and collective development of productivity should also be accompanied by awareness of the enabling role and scope of organizational design in terms of competency development but also in the dissipation mechanism of skills acquired through education to afford coherence and significance to the concept of lifelong learning.

Future research should distinguish which types of competencies - both key and technical - are involved in worker competency obsolescence as this would help qualify policies to combat such obsolescence and foster competency development in an era of employment crisis and unsettling technological and organizational changes.

[16] Leoni (2012) shows that education is statistically significant only in relation to the problem-solving competency, while it is statistically nil in customer communications, relationships with co-workers and teamwork competencies.

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Table 1 –Descriptive Statistics of the Sample

(Sample of 3,224 workers representative of 7,936,190 private sector employees)

Variables	*Mean (weighted)*	*s. d.*	*Min*	*Max*
Technical competencies (factor)	14.29	6.48	0	30.96
Key competencies (factor)	19.54	9.88	0	46.49
Overeducation (years) (if <0)	-3.52	1.63	-13	-0.5
Education matching (years) (if >0)	11.30	2.85	5	21
Undereducation (years) (if >0)	3.64	2.13	0.5	11
Job-worker educational mismatch (if ≠0)	0.39	4.05	-13	11
Work experience (years)	17.00	9.83	1	50
High learning time (> 24 months)	0.18	0.39	0	1
Low learning time (< 6 months)	0.56	0.50	0	1
Training with current employer	0.31	0.46	0	1
Training with previous employer	0.12	0.32	0	1
Discretionality (factor)	12.79	3.82	3.12	21.84
Establishment size	95.07	543.34	1	18000
Temporary contract	0.06	0.23	0	1
Part time	0.11	0.31	0	1
Tenure	10.56	8.57	0	44
Gender: 1-M (2-F)	1.36	0.48	1	2
Personality traits (factor)	9.42	1.58	1.65	11.57
HPWPs (High Performance Work Practices) (factor)	0.80	0.62	-0.05	1.92
Instrumental variables				
Age	38.70	9.60	17	65
HPWPs at time t-5 (factor)	1.31	0.39	0	1.51
Change autonomy with respect to time t-5: 1-growth (0-unchanged and decrease)	0.23	0.42	0	1

Table 2 –Structural equation model estimates in relation to expressed technical and key competencies

(Bootstrap weighted estimates, reps(400) seed (10101), nodots, force. Levels of confidence: *** ≤ 1%, ** ≤ 5%, * ≤ 10%)

Variables	*Model-A Estimator: SUR*		*Model-B Estimator: 3SLS*		*Model-C Estimator: 3SLS*		*Model-D Estimator: 3SLS*		*Model-E Estimators: 3SLS*	
	coeff. (Boostrap std. err.)	*P>|z|*	*coeff. (Boostrap std. err.)*	*P>|z|*	*coeff. Boostrap sdt. err.*	*P>|z|*	*coeff. Bootstrap sdt. err.*	*P>|z|*	*coeff. Bootstrap std. err.*	*P>|z|*
Dependent variable: Technical competencies										
Overeducation	-0.106 (.142)		0.126 (.816)		0.108 (.130)					
Education matching	0.220 (.040)	***	0.125 (.657)		0.087 (.0.37)	**	0.067 (.026)	***	0.074 (.027)	***
Undereducation	0.710 (.136)	***	0.504 (3.066)		0.247 (.141)	*				
Job-worker educational mismatch							0.185 (.078)	**	0.160 (.082)	**
Work experience	-0.238 (.050)	***	-0.102 (.838)		-0.038 (.106)		-0.405 (.107)		-0.069 (.088)	
Work experience^2	0.196e-3 (.001)		-0.003 (.034)		-0.239e-2 (.002)		-0.240e-2 (.002)		0.847e-3 (.002)	
Work exp*schooling	0.039 (.003)	***	0.041 (.203)		0.022 (.006)	***	0.023 (.007)	***	0.020 (.007)	***
High learning time	-0.127 (.591)		-0.162 (3.778)		-0.364 (.455)		-0.351 (.461)		-0.370 (438)	
Low learning time	-0.578 (.327)	*	-0.258 (3.618)		0.263 (.364)		0.273 (.366)		0.272 (.339)	
Training with current employer	1.706 (.401)	***	1.262 (8.288)		0.560 (.471)		0.553 (.470)		0.620 (.462)	
Training with previous employer	1.766 (.400)	***	1.731 (6.990)		1.711 (.674)	***	1.713 (.679)	**	1.746 (.666)	***
Discretionality (factor)	0.320 (.038)	***	0.189 (2.733)		-0.020 (.077)		-0.023 (.076)		-0.026 (077)	
Establishment size	-0.041e-3 (.000)		-0.049e-3 (.002)		-0.099e-3 (.000)		-0.102e-3 (.000)		0.129e-3 (.000)	
Temporary contract	-0.902 (.516)	*	-1.040 (6.159)		-1.388 (.611)	**	-1.387 (.615)	**	-1.422 (.559)	
Part time	-1.196 (.482)	**	-0.998 (9.831)		-0.248 (.525)		-0.254 (.528)		-0.241 (.528)	***
Gender: 1-M (2-F)	0.420 (.335)		0.555 (4.737)		0.787 (.322)	**	0.797 (0.324)	**	0.853 (.326)	***
HPWPs (factor)	2.182 (.281)	***	1.294 (22.139)							
Personality traits (factor)	0.439 (.095)	***	0.291 (2.429)							
Key competencies (factor)			0.209 (5.092)		0.599 (.082)	***	0.604 (.080)	***	0.607 (.083)	***
Constant	1.401 (1.085)		0.868 (13.406)		0.038 (1.271)		0.194 (.1.350)		0.152 (1.406)	
Dependent variable: Key competencies										
Overeducation	-0.084 (.209)		-0.002 (.232)		-0.091 (.254)					
Education matching	0.153 (.065)	**	0.093 (.074)		0.115 (.077)		0.030 (.050)		0.027 (.052)	

Undereducation	0.685 (.213)	***	0.576 (.228)	***	0.508 (.242)	**				
Job-worker educational mismatch							0.239 (.126)	*	0.244 (.136)	**
Work experience	-0.246 (.101)	**	-0.160 (.190)		-0.116 (.199)		-0.126 (.201)		-0.201 (.155)	
Work experience^2	0.105e-2 (.002)		-0.157e-2 (.004)		-0.069e-2 (.004)		-0.073e-2 (.004)		0.099e-2 (.003)	
Work exp * schooling	0.035 (.008)	***	0.041 (.008)	***	0.035 (.009)	***	0.037 (.010)	***	0.038 (.011)	***
High learning time	0.612 (.982)		0.497 (.893)		0.405 (.925)		0.469 (.934)		0.487 (.890)	
Low learning time	-1.253 (.574)	**	-1-132 (.634)	*	-0.851 (.639)		-0.809 (.643)		-0.831 (.535)	
Training with current employer	1.587 (.675)	**	1.458 (.685)	**	0.735 (.897)		0.694 (.901)		0.699 (.954)	
Training with previous employer	0.512 (.941)		0.144 (1.046)		-0.316 (1.218)		-0.327 (1.227)		-0.298 (1.275)	
Discretionality (factor)	0.516 (.083)	***	0.869 (.682)		0.483 (.109)	***	0.477 (.110)	***	0.475 (.113)	***
Establishment size	0.119e-03 (.000)		0.081e-3 (.000)		0.015e-03 (.000)		0.001e-03 (.000)		-0.013e-3 (.000)	
Temporary contract	0.192 (.898)		1.307 (1.006)		1.355 (1.052)		1.397 (1.053)		1.290 (.1.076)	
Part time	-1.179 (.629)	*	-1.777 (.784)	**	-2.021 (.768)	***	-2.099 (.772)	***	-2.063 (.807)	***
Gender: 1-M (2-F)	-0.665 (.469)		-0.486 (.524)		-0.250 (.550)		-0.196 (.557)		-0.207 (.520)	
HPWPs (factor)	4.239 (.478)	***	4.253 (.558)	***	6.678 (1.464)	***	6.928 (1.504)	***	6.921 (1.726)	***
Personality traits (factor)	0.621 (.170)	***	0.503 (.180)	***	0.434 (.189)	**	0.427 (.192)	**	0.421 (.199)	**
Constant	3.369 (2.130)		2.915 (2.522)	***	2.109 (2.443)		2.868 (.2.521)		3.522 (2.323)	
Number obs	3578		3224		3224		3224		3224	
Technical competencies										
RMSE	4.870		4.122		4.327		4.345		4.352	
R^2	0.431		0.595		0.554		0.550		0.549	
Chi^2	2713.38		3654.11		3159.86		3137.85		3037.06	
P	0.0000		0.0000		0.0000		0.0000		0.0000	
Key competencies										
RMSE	7.898		7.908		8.027		8.060		8.054	
R^2	0.350		0.359		0.339		0.334		0.335	
Chi^2	1924.67		1830.89		1615.21		1602.86		1592.37	
P	0.0000		0.0000		0.0000		0.0000		0.0000	
Work experience										
RMSE			5.232		5.478		5.706			

R^2			0.717		0.689		0.663		
Chi^2			10554.71		8893.07		8415.68		
P			0.0000		0.0000		0.0000		
Work experience^2									
RMSE			426.524		370.340		372.780		
R^2			-0.185		0.106		0.094		
Chi^2			3223.13		3542.29		3457.69		
P			0.0000		0.0000		0.0000		
Work exp*schooling									
RMSE			32.061		37.810		39.756		40.111
R^2			0.773		0.685		0.651		0.645
Chi^2			11015.12		7270.00		6424.69		6293.46
P			0.0000		0.0000		0.0000		0.0000
HPWPs (factor)									
RMSE			1.622		0.492		0.496		0.505
R^2			0.964		0.363		0.351		0.327
Chi^2			86984.80		2065.69		2097.73		2261.76
P			0.0000		0.0000		0.0000		0.0000