Job Complexity and Skill Developments in the workplace[1]

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Abstract

We investigate the relationship of between job complexity and skills development of adult workers in Europe using the Cedefop European Skills and Jobs Survey (ESJS). The results suggests that challenging workplaces, workplaces introducing various types of innovative products, technologies and production processes, support workers' skills developments through their positive impact on the degree of job complexity. Increasing the degree of job complexity has positive and robust effects on the degree of skill development and so does an increase in work experience (tenure). The analysis stresses the importance of on-the-job learning contextual workplace characteristics for adult workers' skills development.

[1] The views expressed in the paper are solely the authors' and do not necessarily represent those of the European Centre for the Development of Vocational Education and Training (Cedefop). Daniel Scheuregger provided useful comments that improved the quality of the paper. The usual disclaimer applies.

1. Introduction

The workplace is not only a place where skills are demanded but it is also a place in which skills formation takes place (Heckman, 2000): this observation introduces the possibility that workplaces putting high demand on workers' skills, through the adoption of complex jobs design, may also be workplaces supporting skills development (Gibbs *et al.*, 2010).

To gain better understanding of the relationship between skills utilization and skills development is important because skills development in the workplace is a real world phenomenon with a real impact on productivity. The learning curve (or experience curve) acknowledges the positive (albeit non-linear) relationship between performance (productivity) and work experience (i.,e., job tenure) arising from learning-by-doing (Arrow, 1962; Anzai and Simon, 1979; Klenow, 1998; Levitt *et al.*, 2013; Besanko *et al.*, 2014).

The scope of learning afforded by the workplace is influenced/mediated by the way jobs are designed. If jobs consist of simple repetitive tasks (a limited amount of) learning arise from repetition; through repetition the skills used to perform a given set of tasks are honed and perfected resulting in a faster and more precise task execution. Complex jobs, on the other hand, put high demand on workers' skills for a variety of reasons (Wood, 1986). Strain may derive from the number of tasks and number of decisions (problem solving) required (Wood, 1986; Jovanovic *et al.*, 1995), from the uncertainty characterizing causal relationship or expected outcomes from choices and often the number or types of alternative courses of action (March and Simon, 1958), from the informational needs linked to problem solving involving finding solutions to complex problems (Payne, 1976; Campbell and Gingrich, 1986; Hunter, 1986; Sweller, 1988; van Merriënboer and Sweller, 2005), or from the need to use and integrate information from many different source (Steinmann, 1976). Learning will take place while workers face these challenges and master them (Anzai and Simon, 1979; Eraut, 2004; Berings *et al.*, 2005; Pankhurst, 2010); through the efforts devoted to find

effective solutions to problems arising from non-routine work situations. Work itself then becomes a source of learning (Jovanovic *et al.*, 1995).

If jobs put strain on workers' skills and afford broad learning opportunities organizations may become learning environments in which human capital can support the product market strategy and can be regarded as a firm-level resource conferring some degree of competitive advantage (Boxall and Purcell, 2011; Ployhart and Moliterno, 2011; Beaudry *et al.*, 2013; Sterling and Boxall, 2013; Sung and Ashton, 2015). The Resource Based View (RBV) posits that the knowledge and the skills accumulated within organisations are rare (specific), valuable, and hard to imitate (Barney, 2001; Hult *et al.*, 2005; Ketchen *et al.*, 2007).[2] They are an intangible asset for the organization (Beaudry *et al.*, 2013),[3] one that contributes to organisational success (Molloy *et al.*, 2011; Smithey Fulmer and Ployhart, 2014).[4] The link between human capital and business success is known to managers; they rank know-how and knowledge as the second most important intangible assets after the reputation of the organisation or of the product (brand asset).[5] Managers are also keenly aware of the time needed to build human capital and that the capital is subjected to depreciation: managers

[2] In addition, to provide competitive advantage human capital should be unique and costly to imitate, but these features will lead to hold-up problems and to tensions between ownership and labour on the division of the economic rent generated by the competitive advantage (Blair, 2011). Consequently, human resource practices supporting workforce motivation and willingness to apply their skills need to be put in place (Kaufman, 2010a; Kaufman, 2010b; Coff and Kryscynski, 2011; Kaufman and Miller, 2011).

[3] Other intangible assets are, for example, organisation and product reputation, patents, design solutions, software and data bases. The management of the supply chain, which is a vital source of competitiveness for lean organisations and modern manufacturing, can also be considered as an intangible asset (Wowak *et al.*, 2013).

[4] Recently the key role of one intangible asset, knowledge capital, in explaining macro phenomena, such as inter-country differences in productivity growth, has been recognized. Efforts to measure the national stock of knowledge capital (patents, design, research and development and human capital) are underway in the US (Corrado *et al.*, 2009), the UK (Awano *et al.*, 2010; Borgo *et al.*, 2013), Europe (van Ark *et al.*, 2009; Jona-Lasinio *et al.*, 2011) and Japan (Fukao *et al.*, 2009; Corrado *et al.*, 2013). Of particular interest for the present discussion is the approach used to measure one sub-component of knowledge capital: human capital. The measure of human capital is derived from data on training provision (Cedefop, 2014) and on expenditures on formal training is likely to underestimate the stock of human capital because it neglects to account for he large amount of knowledge development that takes place during work in informal settings and non-formal training (within and outside organisations).

[5] The assumption that training can be equated to an asset is not without problems. The investment in human capital is not directly controlled by the organisation because it is embodied in workers. Should they leave the company they would take the asset with them (Mortensen and Piekkola, 2011; Wright and McMahan, 2011).

estimate that it takes about 5 years to build a satisfactory knowledge base (Hall, 1992) and consider training (investment in human capital) to remain valid for about 3 years (Awano *et al.*, 2010).[6]

Human capital, however, is embodied in workers and skills do not develop in a vacuum; rather, skills development takes place through workers' engagement in learning activities. Organization that regard human capital as an asset should promote and support learning (Rhoades and Eisenberger, 2002; Fuller and Unwin, 2011; Argote, 2013) through a systems of incentives that support workers' engagement in learning activities (Ardichvili, 2011; Avey *et al.*, 2011), influence workforce attitude and commitment with respect to learning activities (Maurer *et al.*, 2003; Maurer *et al.*, 2008; Pierce and Maurer, 2009; Hager, 2011; Kyndt and Baert, 2013), and ensure that the organization capture an adequate return on the investment (Acemoglu and Pischke, 1999a; Acemoglu and Pischke, 1999b; Acemoglu and Pischke, 2000).[7]

Providing training is a typical example of how firms support the investment in human capital and training provision could complement the learning opportunities afforded by complex job design. On-the-job learning may entail self-reflection on mistakes (Luthans *et al.*, 2006) and if mistakes made in less-complex job are, on average, less costly to the firm than mistakes made in more-complex jobs, organizations may provide career paths whereby individuals will first master less-complex jobs and then will be promoted to more-complex ones (Jovanovic *et al.*, 1995).

[6] Human capital advantage sustains business success when human resources can contribute to quality improvements and in product and process innovation (Ichniowski *et al.*, 2000), it can also sustain organizations' ability to innovate and adopt new technologies (Argote and Miron-Spektor, 2011; Argote, 2013) making organizations resilient to market fluctuations (Pal *et al.*, 2014).

[7] This delicate ecosystem can be threatened by shocks affecting the stability of the employment contract such as downsizing (Lazear, 2009), organizations for which learning is important take appropriate measures to ensure that the retained workforce (those surviving the downsizing) maintain a positive attitude towards learning (Tsai *et al.*, 2007; Datta *et al.*, 2010; Norman *et al.*, 2013).

On-the-job learning conveys information on the quality of the match. Given the degree of choice in the way tasks may be bundled in complex jobs design and given the varying level of autonomy warranted by complex jobs across firms[8] jobs with complex design are a particularly heterogeneous group. Since the number of contingencies that may be arising in complex job is large it is difficult for organization to provide, ex-ante, realistic job previews to job applicants. The problem is compounded by the heterogeneity characterizing workers' skills and abilities.[9] Therefore, an initial misalignment between workers' skills and jobs' requirements may be the expected outcome of job search and recruitment actions (Lazear, 2009). [10] If it is not possible to find individuals possessing all of the desirable attributes some degree of compromise is generally required. When confronted with the choice between subsets of personal attributes in prospect employees the prevailing view among human

[8] Organizations are heterogeneous in the way they adopt management practices, design jobs and make use of workers' skills (Bloom and Van Reenen, 2007; Bloom and Van Reenen, 2010; Bloom and Van Reenen, 2011; Bloom, Genakos, *et al.*, 2012; Bloom, Sadun, *et al.*, 2012; Bloom *et al.*, 2014). Jobs can be designed in various ways and the job design will have an impact on the way workers will have to deploy their skills in order to be effective: some organizations bundle a variety of skills into complex jobs while other break down production into precisely described and rather narrowly defined tasks, which then become jobs (Korpi and Tåhlin, 2009). The way organizations make use of workers' skills is affected by the technology adopted and the way the production process is organized (Bresnahan *et al.*, 2002).[8] Finally job design – tayloristic or high performance work places and all the possible solutions in between these two polar cases – will be influenced by organizations' culture, business and product strategies (Youndt *et al.*, 1996; Kaufman, 2010a; Kaufman, 2010b; Boxall and Purcell, 2011; Kaufman and Miller, 2011; Sung and Ashton, 2015).

[9] Workers knowledge, skills, ability and their proclivity towards engaging in desirable behaviours (from the point of view of the organization) are not directly observable. Recruiters rely on coarse measures of knowledge and ability (educational qualifications) and try to assess the presence of desirable but hard to measure personal characteristics with other techniques. Organisations with modern workplaces spend a lot of time in evaluating the fit between prospective workers and the company culture. The time and resources devoted to personnel selection are testimony of the importance of allocating the right people to the right jobs for the economic success of organizations; the crux of the selection process lies in uncovering workers' skills (knowledge, Competences, ability and skills) so that these can be effectively matched to job's demand (Ployhart and Schneider, 2012). The bundle of competences, attitudes and skills required by their jobs (job design) needs to be embodied in the right worker and not in just any worker (Kristof-Brown *et al.*, 2005).

[10] For example, the recently conducted European Skills and Jobs Survey report the 24% of workers did not possess the full set of skills needed to perform their job when they did join the current organization. Most of these workers, however, developed the necessary skills to be proficient in their jobs (Cedefop, Forthcoming). In addition, the proportion of underskilled workers jumps to 31% among those entering their first job. When new workers are directly hired from education (possibly with an intervening spell of unemployment) they may have the technical and theoretical knowledge but they often lack the mind-set as well as applied knowledge and the soft skills (attitudes) needed to function properly in the workplace (Eurobarometer, 2010; Hettich and Landrum, 2014).School leavers are an important pool of applicants for organizations. Experienced workers are hard to recruit for a variety of reasons: they can command higher wages, and they are less mobile (they often own their house and are more likely to have partners with jobs and family). The way experience work in recruitment is complicated by the positive association with age, work experience tends to be valued less in people older than 50.

resource professionals is to select those with right personality traits (those fitting the job environment) and use training to build the (technical) skills they lack (to meet the job requirements). This practice implicitly acknowledges the key role of workplaces in skills formation when the balance between workers' skills and job demands (in terms of skills) can change over time. [11] Organizations then learn about workers' skills and abilities by observing workers' performance over time (Gibbs, 1995; Farber and Gibbons, 1996; Prendergast, 1999). Workers learn about the quality of their match too. The learning component in complex jobs plays also a fundamental role in the decision to stay as it signals a good match (with increasing productivity). A match is an experience good; its value to the parties will be revealed over time. Good matches will tend to last longer than bad ones (Jovanovic, 1979). These patterns of learning will be re-enacted every time workers experience a change in job (as consequence of vertical mobility – a promotion – or as a consequence of horizontal mobility – job rotation –).

The current paper focuses on the degree of skills development experienced by workers in the workplace and puts it in relation to changes in the perceived complexity of their jobs while controlling for workers' characteristics and organizational features.

The analysis is based on a data set that is cross-sectional nature; as such causality statement can be derived only from supporting theoretical arguments.[12] Yet, the analysis may deliver valuable results because of the rich set of variables influencing skill formation contained by the data set. The study has the following defining characteristics. First, the study can rely on a measure of skills development. In general, human capital development have been measured by proxy, taking participation in various learning activities through which skills can be learnt

[11] Many organisations routinely review the skills need in their workforce, for example 72% of EU companies review internal skill needs (Eurofund, 2010).

[12] The analysis focuses on the relationship between workplace and job complexity changes and skills formation. Consequently, the sample is restricted to employed workers only and the results do not readily generalize to the entire population.

(on-the-job training, interaction with colleagues, formal education, learning on the job etc.) as the measure of the human capital formation (Marsick and Watkins, 2003; Watkins and Marsick, 2003; Yang *et al.*, 2004; Marsick, 2013). Similarly, one Korean study used the self-reported importance of executing own tasks or peer exchange for skill development found in the Korean company survey (Jeon and Kim, 2012). Finally, human capital accumulation has been indirectly measured by wage increases (after training) in one UK study based on the UK skill survey, the study also considers one item tapping weather one's job requires the job holder to learn new things (Felstead *et al.*, 2010).

In comparison with the OECD PIAAC data set, which contains a static, albeit very precise, assessment of skills in the foundation domains of literacy and numeracy, the current study relies on a broad measure of skills development. Since skills are notoriously hard to measure (Green, 2013) the study relies on a subjective measure of perceived overall skill development (knowledge, skills and ability), which encompasses skills formation through all modes of delivery (formal, informal, non-formal, training and on-the-job). The direct measure of skill development used in the present study can be linked to workplace and job complexity change to assess the direction of the relationship. To our knowledge, this is the first time that this is done.

Second, whereby empirical analyses of workplace learning have focused on change in performance on a given tasks or on a narrow set of skills developed through training, [13] the measure of skills development used in the present study provides a comprehensive assessment of how skills have changed (in the current employment spell).[14] For example, a large number of US studies summarized through meta-analysis returned a positive impact of

[13] The OECD-PIAAC data set contains very accurately measured foundation skills in two domains (literacy and numeracy) but it does not contain a measure of the development of these skills over time.
[14] However, our measure will not account for the learning that has had an impact on workers' behaviour (and productivity) through the introjections of workplace norms (accepting diversity) or the outcomes of training aimed at enhancing motivation (Felstead *et al.*, 2010).

training on knowledge (declarative knowledge) and on the acquisition of specific skills (Colquitt *et al.*, 2000). Another meta-analytical study based on about 60 studies that linked specific measures of performance on specific tasks to job design and found a positive relationship between these (Wielenga-Meijer *et al.*, 2010).

Third, the availability of comparable measure of workplace change and skill development across 28 European countries will make it possible to investigate the stability of the relationship across countries.

Fourth, the analysis benefits from the unusually rich set of variables. It contains an expanded list of personal characteristics – including a measure of the attitudes toward learning, and the importance of various aspects (among which the opportunity to use skills) for accepting the current job – influencing skill formation. The data set also contains information on workers' career – promotions, changes in tasks, and horizontal mobility –. Finally, while the bulk of the literature on Human Capital focuses on the individual decision to invest in education and training, the present analysis sheds light on the role of contextual organizational factors – change in job complexity and in workplace practices – that may support human capital formation.

The structure of the paper is the following. Section 2 outlines the empirical model linking changes in job complexity and workplace changes to skills development. Section 3 describes the data. Section 4 presents the estimation results and their robustness to alternative model specifications. Section 5 offers concluding remarks.

2. The empirical model of workplace learning: the importance of job design and workplace characteristics

Organization characteristics can shape the availability of learning opportunities in the workplace through the way work processes are organized, the type of technology adopted and the value given to learning, i.e., socio-cultural importance of learning (Illeris, 2011).

More precisely, the degree of skills development afforded by the workplace is influenced by three broad groups of factors:

1. individual workers characteristics, affecting the motivation to engage in learning activities (formal, informal or non-formal) and learn;
2. job characteristics, jobs can be designed to encourage workers to draw on their skills and to provide them with learning opportunities in the form of complex problems to be solved and to confront workers with non-routine situations pushing workers out of their comfort zone;
3. workplace characteristics, influencing the availability of structured learning opportunities (training, coaching, and opportunities for professional exchanges between peers and colleagues) and support for the workers engaging in learning activities (Hackman and Oldham, 1976; Parker and Ohly, 2008; Fuller and Unwin, 2011; Illeris, 2011).

The learning process takes place when workers engage in learning activities which may also include learning on-the-job especially when learning is regarded an inherent part of workmanship (Hager, 2011).

Though it is known that workplaces characteristics, job design and workers characteristics affect learning, to the best of our knowledge, there is no off-the-shelf model of how these factors interrelate that could be used to support the empirical analysis.

Therefore, we assembled an empirical model with the explicit goal of linking selected background variables, chosen on the basis of a survey of the theoretical and empirical literature, to skills development.[15]

Workplace Changes, workplace dynamism

Organizations must change as they adopt new technologies and respond to competitive pressure, launching new product lines, improving products and production processes, and adopting new technologies or new organizational form characterize dynamic workplaces. The SBTC approach maintains that technological changes lead to increased skill requirements that place increasing demands on workers' skills (Spitz-Oener, 2006; Acemoglu and Autor, 2011) and there is evidence that the same happens in organizations undergoing workplace changes (Caroli and Van Reenen, 2001; Bresnahan *et al.*, 2002; Piva *et al.*, 2005; Antonelli *et al.*, 2010). Given the slow reaction of the education and training system in providing the skills required by technological and organizational changes, organizations will have to invest (at least initially) in the support of workers' skills developments if the aim at remaining at the technological frontier (Goldin and Katz, 2008; Bessen, 2015). Because changing workplaces necessitate the adaption of new routines it follows that workplace change is associated to training provision and on the-job-learning (Chen and Huang, 2009; Antonelli *et al.*, 2010; Neirotti and Paolucci, 2013; Barba Aragón *et al.*, 2014).

[15] The literature review helped also to identify in the lack of measurement of the degree of workplace support for engaging in learning activities a weakness of the empirical model.

learning in the workforce by means of a rich supply of training opportunities and by providing support to workers deciding to take part to training activities (Illeris, 2007).

Changes in Job complexity and skills development

Learning in complex jobs will take place as workers mobilize their knowledge, skills, and competences to master the challenges they meet while working (Anzai and Simon, 1979; Eraut, 2004; Berings *et al.*, 2005; Pankhurst, 2010). Increasing the degree of job complexity may push workers out of their comfort zone, confront workers with new situations and choices and, possibly difficult, problems. Workers will learn and develop their skill set as they seek to find satisfactory solution to these new situations. In contrast, changes in the opposite directions, where jobs are transformed to consist of simple tasks performed routinely and repetitively in a rigidly codified way, where only a limited number of skills are needed for successful performance, will rarely contain a learning stimulus (Pagano, 2014; Parker, 2014). Therefore, the relationship between changes job complexity and skill developments is expected to be positive (Gibbs *et al.*, 2010).

Attitude toward Learning

Personal attitudes influence the likelihood that workers actively seek to gain knowledge. Positive attitudes toward learning will have a positive impact on the amount of the learning outcomes (Maurer *et al.*, 2003; Maurer *et al.*, 2008). We expect that a positive learning attitude will have a positive relationship with the degree of skill development.

Additionally, participation in training and learning will take place more effectively when workers show commitment toward training and learning (Maurer *et al.*, 2003; Maurer *et al.*, 2008; Kyndt and Baert, 2013). [16]

3. Data and Measures

The data used originates from a pan European cross sectional survey on mismatch carried out by Cedefop in 2014, the European Skills and Job Survey (ESJS). The data set consists of about 48,000 observations from 28 EU countries (Cedefop XXXX).

Skill development was captured by a self-rated measure ranging from 0 to 10 (where 0 was anchored to "my skills decreased a lot" and 10 to "my skills increased a lot"). Only 5% of the sample reported deterioration in their skills, 11% answered that their skills remained the same, while 84% of respondent reported some degree of positive skills development. The attitude toward learning was measured by one single item tapping if the respondents enjoy learning for its own sake (higher values implying more positive attitude toward learning). [17] About 80% of the sample reports a positive attitude toward learning (in varying degrees). Workplace dynamism and work complexity changes were measured as latent variables (scales derived from survey questions). Workplace dynamic scale was obtained from items asking if changes in technologies, organisation, product lines and work procedures were introduced.[18] Change of complexity was measured by a scale[19] consisting of three items

[16] We also allowed for the attitude toward learning to affect the strength of the relationship between participation in training, work experience and changes in job complexity and skill development (this is equivalent to a cross-effect between the attitude toward learning and the participation in training, on-the-job learning, and the skills development allowed by changes in job complexity). These relationships are not shown as, to anticipate some of the results, they turned out to be non-significant.

[17] The scale consists of 5 items – item number 1,2,3,9, and 10 – of the scale measuring the disposition towards lifelong learning (Kirby *et al.*, 2010). All 5 items were administered to the survey participants that took the internet version, while participants taking the telephonic interview were asked only one item (item 1). Here, we use on this one item to maximize sample size. Higher scores on the scale and on each item correspond to more favourable attitudes towards learning.

[18] The scale to measure workplace dynamism or workplace change was based on the following four items: In the last five years have changes to the technologies you use (e.g. machinery, ICT systems)/ to your working methods and practices (e.g. how you are managed or how you work)/ to the products/services you help to

capturing changed variety and difficulty of tasks as well as the change of learning needs for the job.[20] In general jobs became more demanding over time, 80% reported an increase in the need to learn new things, 75% an increase in the difficulty of the tasks, and 78% reported an increase in the variety of tasks to be performed. The correlation between the changes in job complexity scale and the degree of skills development is 0.42 providing prima facie evidence of the positive relationship between skills utilization and skills development relationship.

4: Estimation and Robustness Checks

4.1 Estimation

To study the relationship between changes in job complexity and skills development, we have adopted the following regression model:

$$\Delta S_i = \beta_0 + \beta_1 \Delta JC_i + \beta_2 \Delta WP_i + \beta_3 PC_i + \beta_4 X_i + \varepsilon_i$$

Where S is the degree of change in skills, JC is the change in job complexity, WPC denotes workplace change, PC denotes personal characteristics and X is a vector of additional controls (country, industry, occupation dummies, firms size etc etc.). The regressors also included a dummy variable for training participation (if participants did not attended trainings in the last 12 months) and a variable for work experience (tenure, log of years with the current employer) that are clearly related to skills development.

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produce/ to the amount of contact you have with clients or customers (e.g. dealing with customer/client queries or complaints) taken place in your workplace? The answers were Yes or No. High values on the scale mean high degree of workplace dynamism.

[19] The three items used to derive the change in complexity measure where: Have the variety of tasks/ the difficulty of the tasks/ the need to learn new things increased, decreased or remained the same since you started your job with your current employer? The answers were based on a 1 to 10 likert scale, where 0 means the item has decreased a lot, 5 means it has stayed the same and 10 means it has increased a lot. High values on the scale mean increased job complexity (Cronbach alpha = 0.84).

[20] The stability of the scales for workplace dynamism and workplace stability across countries was checked by Confirmatory Factor Analysis (Brown, 2006). The scales were derived by factor analysis. Notice, that the scale on changes in workplace complexity based on factor analysis and the one derived in the text (taking the average of the measures on the three items) have a correlation coefficient of 0.992.

The results of the regression analysis are shown in Table 1. The first model (first column in Table 1), show the expected positive and significant relation between increases in job complexity and skills development.

The regression also shows a positive relationship between the workplace change scale and skill development. The result is not very stable as the size of the coefficient and its significance differ greatly between countries and occupations. It is likely that workplace dynamism has a distal or indirect relationship with skills development. It is not the changes introduced in terms of products, processes and technologies that foster learning but rather the way these changes impact workers' roles and how these changes are reflected in their tasks and on the way tasks are combined into jobs. Ultimately, it is the way jobs are designed that determines the amount of learning afforded in the job and skills development.

The regression also confirms the positive relationship between participation in training activities and skill development, workers not participating in training activities during the previous 12 months experience a significantly lower degree of skills development compared to workers engaging in training.[21]

A positive attitude towards learning is also linked to the perceived degree of skill development. While an attitude toward learning does not directly lead to learning, it is very plausible that workers with a positive attitude towards learning will engage in learning activities (formal informal or non-formal, on-the-job or off-the-job, self-initiated or employers initiated) more frequently than comparable individuals with a less positive attitude towards learning. Similarly, workers choosing a job for skill related (including personal interest) and for career reasons experience a positive degree of skill formation but the skill

[21] Interviewees taking the online version of the survey were also asked if workplace changes were supported by training. Workers receiving training every time the workplace underwent a change has significantly higher skill development compared to workers who received training only for some of the changes, who, in turn, experienced a larger degree of skill formation than workers who did not receive any training. These results are not shown but can be obtained from the authors upon request.

formation experienced by those choosing their job for skill related reasons is 3 times as high than that experienced by those choosing a job for career related reasons.

Table 1: Regression results regarding the degree of skill development (robust standard errors in brackets, EU weighted data)

	Degree of skill development	
	(1)	(2)
change in job complexity	0.400***	0.371***
	[0.016]	[0.015]
index of workplace dynamism	0.126**	0.0969**
	[0.035]	[0.034]
Enjoy Learning for its own sake	0.0641***	0.0745***
	[0.007]	[0.007]
No training past year	-0.292***	-0.260***
	[0.035]	[0.031]
Mismatch Beginning current job		
Overskilled (reference group)	-	0
	-	[.]
Matched	-	0.429***
	-	[0.040]
Underskilled	-	0.774***
	-	[0.063]
Career		
I have been promoted to a higher level position	-	0.197***
	-	[0.020]
I moved to a different unit/department	-	0.0108
	-	[0.033]
I have not been promoted or moved department but the nature of my tasks and responsibilities have changed	-	-0.0420
	-	[0.031]
I now have a lower level position than when I started	-	-0.548***
	-	[0.105]
No changes, my role has remained the same (reference group)	-	0
	-	[.]
Factors influencing decision to accept the job		
Job Security	0.00848	0.0141**
	[0.006]	[0.005]
Career related reasons	0.0224**	0.0139**
	[0.006]	[0.005]
skills related reasons	0.0741***	0.0673***
	[0.006]	[0.005]
work-life balance	-0.00627	-0.0000852
	[0.005]	[0.005]
Tenure with current employer (log)	0.170***	0.132***

	[0.024]	[0.022]
Personal Characteristics	YES	YES
Highest Education Attained	YES	YES
Job characteristics	YES	YES
Industry	YES	YES
Firm Characteristics	YES	YES
Previous Labour Market Position	YES	YES
Mismatch Previous Job	YES	YES
Previous Occupation	YES	YES
Personal Constraints	YES	YES
Geographical Mobility	YES	YES
Job Search and Prevailing Conditions on the Labour Market	YES	YES
Occupation	YES	YES
Country	YES	YES
Constant	4.805***	4.368***
	[0.357]	[0.372]
Number of Observations	46165	46165
R^2	0.223	0.242

Firm's characteristics: type of organization (private or public), establishment size (number of employees). Job characteristics: full-time, type of contract (permanent, temporary or no contract at all), an indicator variable capturing whether the current job is the first job. Personal characteristics: age (in log), gender, born in the country, household composition. Highest educational qualification (3 levels: primary, upper secondary and higher education). Previous labor market position (employed, self-employed, unemployed, long term unemployed , out of the labor force, long term out the labor force or in education), mismatch status in the previous job, an index of the degree of occupational change (if individuals held a job in the same occupation, in a similar occupation, or in a completely different occupation). Geographical Mobility: if the new job involved relocation to a different country, to a different region or no relocation at all. Personal constraints (family obligations): financial difficulties, familial responsibility, owning own house. Job search effort (self-reported measure regarding if many applications were sent and time spent on job search) and prevailing labor market conditions at time of job search (perception of availability of vacancies for people with similar skills, if job offers were turned down and invitations to job interviews). Additional controls include: country (28 dummies), industry (16 dummies), and occupation (10 dummies).

To study the stability of relationship linking changes in job complexity to skills development, we have adopted the following strategy: we monitored changes in the regression coefficient on the construct measuring the change in job complexity to various changes (in the number and type of regressors or in the estimation sample) applied to the regression model. The results of this analysis are shown in Table 2 (second column) and are discussed hereafter.

4.2 Initial Mismatch

The degree of skill development may depend on the initial distance between job's skill requirements and worker's skill endowment: underskilled workers will have a bigger growth potential compared with workers whose skills match or exceed job's skill requirements. The inclusion of the initial match conditions (alongside with variable measuring career progress) in the regression model delivers the expected results: the coefficient on the change in job complexity drops somehow (by about 10%), the underskilled and workers with skills matching their jobs have higher average increase in the degree of skill development than overskilled workers. The reported increment in skills is largest in the group of the underskilled (reference to Verhaest and van der Velden 2015).

4.3 Career development

The positive relationship between job complexity and skill development may be due to career progression: job complexity increases as workers are promoted to higher level positions and this process is associated to a process of skill development. Including the career development variables in the regression does not change the sign and size of the effect of changes in job complexity on the degree of skill development. In addition, the coefficient on the change in job complexity does not change when we restrict the sample to those workers who did not change job title or tasks during the period.

Changes in job design, skills development and changes in the personal work situation (promotions, rotation, skills formation) are measured over the same period of time (tenure with current employer) but it is not possible to assess if the change in one of the dimensions preceded or followed change in any another dimensions. Of course, this renders the direction of causality ambiguous because we might have that change in skills precede change in job design. Recently, the literature in HRM has advanced a more dynamic concept of job design

that sees workers playing an active role in shaping (crafting) the scope of their jobs (Berg *et al.*, 2013; Nielsen, 2013). We do not think that this approach poses a big threat to the validity of our analysis for three reasons: First, even the literature on job crafting acknowledges that job design must be regarded as the starting point of the job crafting process and that the changes are at the margin (Tims and Bakker, 2010; Tims *et al.*, 2012; Berg *et al.*, 2013). Second, some personal characteristics have been associated to an inclination to craft own jobs while skills (proxied by cognitive ability) have been found to have no significant correlation with the likelihood of engaging in the job crafting process and the extent of it (Lyons, 2008). Third, the human resource management literature has characterised workers' inclination towards the personalization of the set of tasks they perform though various constructs: commitment (Green, 2008), Extra Role Behaviour (taking up additional tasks outside the workers' role in the organization) (Van Dyne *et al.*, 1995), Organizational citizenship behaviour - taking up additional tasks to help colleagues - (Organ, 1997; Organ *et al.*, 2006) , and contextual performance (Borman and Motowidlo, 1993; Motowidlo and Van Scotter, 1994); a cursory review of the literature (mainly based on the US labor market) reveal that personality traits are generally linked to these behaviours rather than skills (Morgeson *et al.*, 2005; Bakker *et al.*, 2012) .

To support our claim we tentatively offer an IV approach that relies on the assumption that workplace changes affect skills development through the challenges and the learning opportunities offered by increased job complexity (while controlling for participation in training). Being in a dynamic workplace does not affect workers' skills unless workplace change is reflected in increased opportunities for on-the-job learning (or in training opportunities). When workplace changes induce exogenous changes in job complexity these have a positive impact on skills development of the same order of magnitude of the one in

Table 1): the coefficient on change in job complexity is 0.46 (with a standard error of 0.03).[22] All in all, these analyses suggest that the relationship between changes in job complexity and skill development may not be driven by career progression.

4.4 Attitude toward learning

The effects of changes in job complexity on workers' skills development may arise from workers with a positive attitude toward learning self-selecting into such jobs. To check the empirical content of this contingency we have re-run the models on subsamples split according to whether workers have a strong positive attitude toward learning (a score above 5, and then above 7, on the question "I like to learn for its own sake", a proxy for a positive attitude toward learning) or not. The coefficient on the change in job complexity did not change appreciably in the two sub-samples characterized by a high and low attitude toward learning (the coefficient is 0.37 in the subsample scoring is 5 or less on the attitude toward learning question and 0.38 in the subsample of working scoring 6 or more).[23]

4.5 Tenure

The estimation sample consists of employed workers and this feature may have implications for the strength of the relationship between change and skills development. Workers dissatisfied with the changes in job complexity may have quit the organization (a form of length biased sampling). We have addressed this issue by estimating the regression model (without tenure) on two sub-samples: workers a tenure shorter than 5 years and workers with a longer tenure. The coefficient on the change in job complexity was 0.38 in the first group and 0.39 in the second one. When tenure was included in the two models the coefficient on the job complexity change in the sub-sample with short job tenure changed to

[22] The first step regression confirms the relevance of the instrument: workplace changes have a positive change in job complexity. The coefficient on workplace change is 1.05 (with a standard error of 0.048), a t-statistic of 21.32 and an F-statistic of 454.6.

[23] We also split the sample according to whether the job was chosen because it fitted worker's skills or interests with identical results.

0.37 (while the coefficient in the long job tenure sample remained unchanged). These findings suggest that the effect of changes in job complexity on skills development is not affected very much by tenure. Interestingly, however, the effect of tenure on skills development was much stronger in the short tenure sub-sample (coefficient 0.18 with a standard error of 0.03) than in the long tenure sub-sample (coefficient 0.05 with standard error 0.04). It appears that a large part of learning-by-doing takes place in the first 5 years of employment.

4.6 Other robustness checks: country and occupation

The positive relationship between increases in the job complexity scale and skills development remains is also stable when the model is estimated by country and occupation (separately). Figure 1 shows that, by and large, the coefficient on the change in job complexity in the various countries has the same order of magnitude of the one estimated on the pooled sample. Statistically significant deviations from the coefficient obtained from the pooled sample are observed in Italy and Lithuania only.

FIGURE 1 ABOUT HERE

The relationship between increases in job complexity and skills development appears also to be stable across occupations, see Figure 2. Consequently, the relationship between increased job complexity and skills development can be considered as general, applying throughout diverse institutional setting (imperfectly represented by the national context) and applying to very different occupational groups.

FIGURE 2 ABOUT HERE

5. Conclusions

The paper investigated the importance of the workplace for skills development. Skills develop when workers engage in meaningful learning activities (i.e., training or meaningful on-the-job learning). Changes in job complexity may expose workers to new challenges and thus foster learning and skills development.

At the same time, the empirical model is amenable to improvements along various margins: by increasing the number of individual characteristics, including personality traits, and measure of workplace support to training and other learning activities (Maurer *et al.*, 2008).

The analysis showed a robust and stable relationship between changes in job complexity and workers' skills development across national and occupational contexts. The empirical analysis also stressed the importance of attitudinal and motivational disposition for the development of skills. The results also confirm the significance of training activities for skill formation and the importance of workplace change (as workers in dynamic workplaces may be more likely to be in complex jobs and possibly to engage in training activities).

In general, the analysis supports the notion that workplace dynamism is, on average, skill biased. Workplace changes are accompanied by increased job complexity and through this channel they support skills development. In fact, increases in job complexity are positively and robustly linked skills development. It was well known that job complexity and job design characteristics have clear impact on workers' motivation (Hackman and Oldham, 1976; Oldham and Hackman, 2010), our results suggest that increasing job complexity can also sustain skill formation in the workplace and this has practical implications for organizations. Complex job design tends to put strain to workers' skills but, at the same time, provide scope for skills development; consequently, skills development could be fostered through the promotions of skills utilization in organizations.

Finally, given the importance of workplace for adult workers' skills the study stresses the need for a better understanding of the various ways in which skills are able to support organizational success. We leave this important topic for future research.

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Figure 1: The strength of the relationship between increases in job complexity and skills development in the pooled sample and across individual countries. Coefficients and confidence interval bounds.

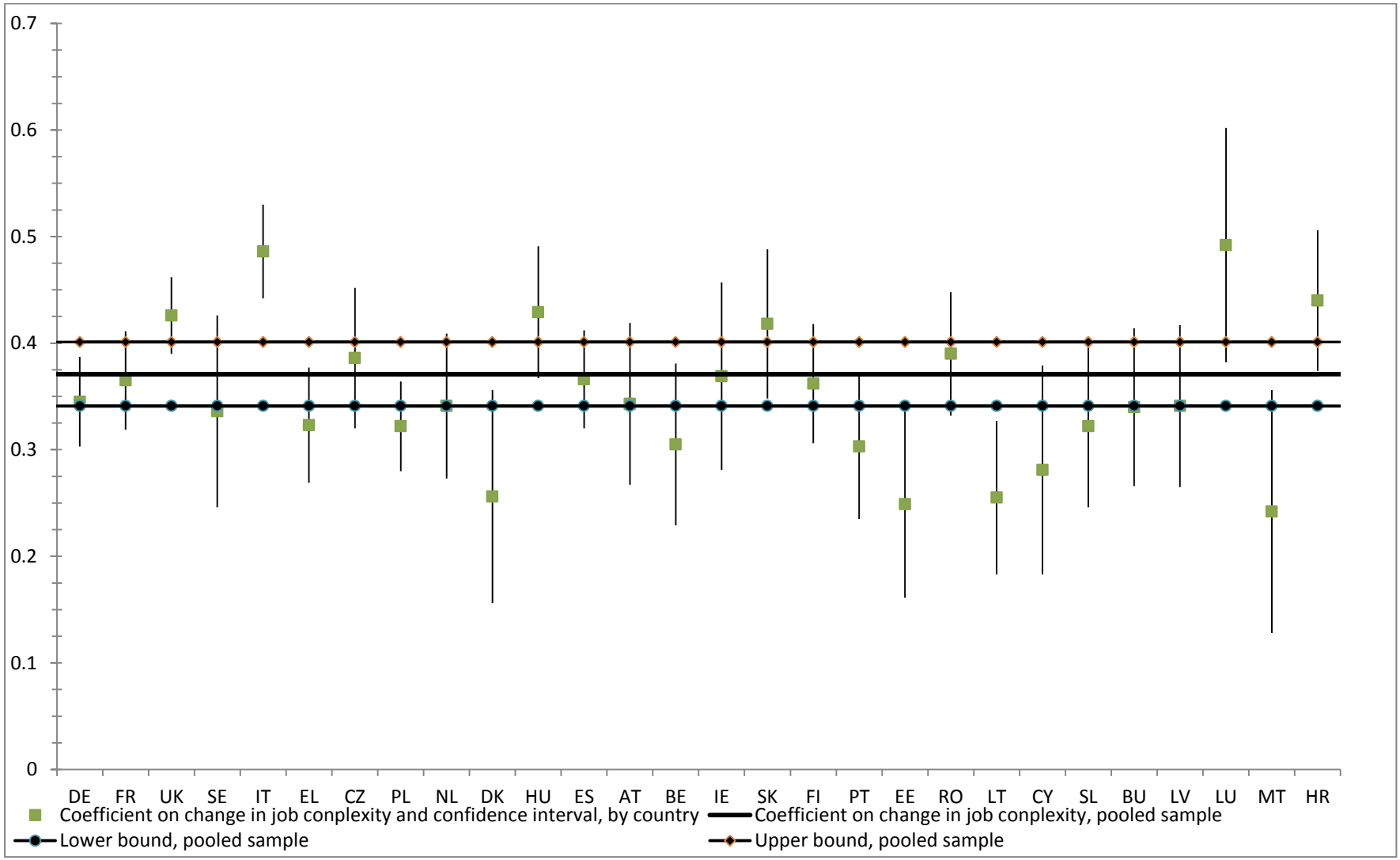

Figure 2: The strength of the relationship between increases in job complexity and skills development in the pooled sample and across occupations (1 digit ISCO codes). Coefficients and confidence interval bounds.