

Innovation adoption and training activities in SMEs

Davide Antonioli

Department of Economics and Management (DEM)

University of Ferrara

Via Voltapaletto 11

44100 Ferrara (FE)

Italy

ntndvd@unife.it

phone number: +39 0532 455093

Edoardo Della Torre

Department of Management, Economics and Quantitative Methods

University of Bergamo

via dei Caniana 2

241127 Bergamo (BG)

Italy

edoardo.dellatorre@unibg.it

phone number: +39 035 2052818

(corresponding author)

Innovation adoption and training activities in SMEs

Abstract. This article adopts the resource-based view and the complementarities approach to examine how SMEs combine the adoption of organisational and technological innovation with investments in training activities. The results of econometric analysis on a panel dataset of about 118 Italian manufacturing SMEs furnish a quite complex picture of the effects of innovation on training. On the one hand, organisational innovation seems to be related to higher investments in (formal and informal) internal training; specifically, it is the adoption of autonomous teams and multiskilling practices that is associated with the coverage and the intensity of internal training, while job rotation is negatively associated with the coverage of external training. On the other hand, the general index of technological innovation does not show any significant relationship with training activities, while the individual technological innovation variables are associated with internal training. Specifically, the coverage of internal training is positively affected by ICT innovation and negatively affected by process innovation. These results demonstrate that SMEs have limited awareness of the risks associated with underinvesting in training during the implementation phase of the innovation process. The implication of such findings for research and practice are discussed.

Keywords: organisational innovation, technological innovation, training, SMEs, Italy.

Introduction

There is a broad consensus among scholars that training investments by SMEs are significantly lower than those of larger firms. There are several reasons for this difference, including the price and opportunity costs (i.e. the lost output) of training, financial constraints, and the risk that training may increase the outflow of trained employees (Storey and Westhead 1997; Sadler-Smith et al. 1998; de Kok 2002; Hoque and Bacon 2006).

Despite the higher constraints experienced by SMEs, their needs for training activities do not differ from those of larger firms. In modern and competitive firms, training investments are necessary because of the increasingly strategic role of knowledge and human capital in building and sustaining competitive advantages (Lado and Wilson 1994; Nonaka 1991; Nonaka and Takeuchi 1995; Boxall 1996; Wright et al. 2001; Nyberg et al. 2014). Moreover, training investments become particularly important in firms striving for competitive advantages through the adoption of organisational and technological innovation (Milgrom and Roberts 1990, 1995; Black and Lynch 2001, 2004). These innovation activities, in their turn, increase firms' needs to provide employees with the adequate skills, change their attitudes, and increase their acceptance of innovation (Klein and Sorra 1996; Klein et al. 2001; Tidd et al. 2001; Choi and Price 2005). Moreover, training contributes to creating an organisational environment that, through knowledge dissemination, enables innovation to be continuously and effectively regenerated in a 'cumulative' change process (Milgrom and Roberts 1995; Laursen and Mahnke 2001; Laursen and Foss 2003)

Despite this great theoretical emphasis, the issue of up-skilling the workforce following the adoption of innovation has remained largely unexplored, especially in regard to SMEs. Whilst for large firms it has been shown that technological and organisational innovation acts as a driver of greater training investments (e.g. Lynch and Black 1998; Antonelli et al. 2010), the SME literature has mainly focused on the barriers to training investments and on the effects of

training on firms' economic performance (e.g. Antonioli et al., 2010; Bryan, 2006; Storey and Westhead, 1997; de Kok, 2002; Storey, 2004). Better knowledge about investments in training initiatives following the adoption of innovation in SMEs is needed not only to advance the academic debate but also to provide institutional and company policy-makers with useful information. Indeed, it has been argued that innovation failures are often the consequences of an ineffective implementation process, rather than being due to the ineffectiveness of the innovation *per se* (Klein and Knight 2001). Knowing the extent to which SMEs combine the adoption of innovation with investments in training enables scholars to advocate more effective public policies and training initiatives at firm-level.

In this paper we contribute to filling this gap in the literature by analyzing the role of innovation in explaining training activities in SMEs. We consider organisational and technological innovations as factors that (should) drive firms' decisions to invest in training activities. The empirical analysis, which draws on a panel dataset of 118 Italian manufacturing SMEs, allows us to verify whether SMEs' innovation strategies are consistent with the predictions of the resources-/knowledge-based view, as well as their level of awareness about the existence of complementarities between innovation activities and human capital development. Differently from the previous SME literature, our focus is not on the effects of innovation and training on firm performance, but rather on the effects of innovation on training activities. Different types of training activities (external, internal and on-the-job), their intensity, and their coverage of the workforce are considered in order to determine whether and how SMEs support innovation through human capital investments.

The rest of the article is structured as follows. The next section illustrates the theoretical framework of the study. We then review the existing literature on the relationship between training and innovation in SMEs in order to develop the hypotheses tested in the empirical analysis. The empirical part of the paper first describes the key methodological issues and the

instruments employed for the econometric analysis, and then presents the main results. The final part of the paper discusses the results obtained, their limitations, and their implications for practice and future research in this area.

Theoretical framework

Several theories acknowledge the strategic role of training in modern (competitive) organisations. In the strategic management literature, the resource-based view of the firms has received increasing attention from HRM scholars, also when the focus of analysis has been on SMEs (e.g. Sheehan 2013; Martinez-Costa and Jimènez-Jimènez 2009). Its basic formulation consists in consideration of internal resources (including human resources) as the main means with which firms can achieve the ultimate goal of sustainable competitive advantage (Barney 1991, 1995; Lado and Wilson 1994). As well known, according to its leading theoretician, this approach maintains that “creating sustained competitive advantage depends on the unique resources and capabilities that a firm brings to competition in its environment. To discover these resources and capabilities, managers must look inside their firms for valuable, rare, costly-to-imitate resources, and then exploit these resources through their organisation” (Barney, 1995: 60).

In this sense, individual HRM practices are easy-to-imitate and are therefore not direct sources of competitive advantage (Wright et al. 1994). Rather, it is the adoption of a system of complementary and interdependent HR practices that is able to generate and develop inimitable human and social capital within the firm (Lado and Wilson 1994; Boselie et al. 2005). In this regard, Boxall (1996) theorizes that ‘human resource advantage’ consists of *human capital advantage* and *human process advantage*: the former concerns the recruitment of human resources in order to capture talents (outstanding people), and it is imitable by other firms; the latter “may be understood as a function of causally ambiguous, socially complex,

historically evolved processes such as learning, co-operation and innovation [...] which are thus very difficult to imitate” (Boxall 1996: 67).

Moreover, within the resource-based view, the knowledge-based conception of the firm maintains that knowledge creation is a dynamic process in which subjective and objective factors interact in shaping and being shaped by the business environment (Nonaka and Toyama 2007). On this view, the knowledge most critical for the success of a firm is “tacit”, in the sense that it is implicit, subjective, codified and therefore difficult to transfer and to imitate by competitors (Nonaka 1991; Nonaka and Takeuchi 1995; Nonaka and Toyama 2007): “creating new knowledge is not simply a matter of ‘processing’ objective information. Rather, it depends on tapping the tacit and often highly subjective insights, intuitions, and hunches of individual employees and making those insights available for testing and use by the company as a whole” (Nonaka 1991: 97). Training provision plays an important role in these complex knowledge-creation/management processes, because “training creates the human skills that, taken together, are the repository in which the tacit knowledge of an organization resides” (Johnson et al. 1996: 113) and “exposure to diverse training programs [...] would stimulate employees to share their expertise and experience, acquire new knowledge, and utilize what they learn subsequently in the work” (Chen and Hang 2009: 107).

Overall, the resource-/knowledge-based approach stresses the complementarity relationships among training, organisational innovation (teamwork and other work practices) and technological innovation in supporting organisational success. Empirically, the so-called “complementarity thesis” has been largely supported, also for SME contexts. Way (2002), on studying the US small business sector, found that the adoption of a high-performance work system (which includes, together with other HRM practices, autonomous teams, job rotation and formal training) is associated with higher levels of perceived productivity and with lower

levels of voluntary employee turnover. Della Torre and Solari (2013), by analyzing Italian SMEs over the period 2002-2007, showed that combining investments in high-performance HRM practices (including training and the new forms of work organization) with advanced technologies enables firms to achieve higher increases in productivity and economic performance.

The aim of this study is not to test for the existence of a complementarity effect between innovation and training in SMEs; rather, in light of the existing evidence, we assume its existence and we analyze the extent to which SMEs combine the adoption of organisational and technological innovation with investments in training activities. In the next section we review the main studies that have analysed the relationship between innovation and training, and we try to extend it to the SME context by formulating some hypotheses to be tested in the empirical analysis.

First, however, it should be clarified that innovation can assume different forms and that several definitions and classifications have been adopted in the literature (see Damanpour and Aravind 2012 for a review). Damanpour (1991), in his influential study, identified three typologies of innovation advanced by the literature, each centred on a pair of types: technological (i.e. innovations related to basic work activities and concerned with products and processes) and administrative (i.e. innovation related to the management of basic work activities); product (i.e. new products or services) and process (i.e. new elements for the production or services operations); radical (i.e. reorientation and non-routine innovation that produces fundamental changes in the activities) and incremental (i.e. routine and instrumental innovation that produces little change in the activities). The bulk of the literature on innovation has focused on the second typology (product and process), mainly by adopting a technology perspective (Damanpour and Aravind 2012). In this paper we adopt the distinction made by Edquist and colleagues (2001) between technological and organisational process

innovations. Technological innovations are defined as “new goods that are used in process of production [...] Examples include paper and pulp processing machines, industrial robots and IT equipment”. Organisational innovations are instead “new ways to organise business activities [...] and have no technological elements as such. They have to do with coordination of human resources. Examples [...] are just-in-time production, TQM, and lean production” (Edquist et al. 2001: 15-16).¹

Innovation and training in SMEs

The strategic HRM literature typically considers innovation as the output variable of HRM investments (e.g. Laursen and Foss 2003; Cheng and Huang 2009; Lopez Cabrales et al. 2009). For example, Shipton and colleagues (2006) found support for the existence of an interaction effect between HR practices promoting an exploratory learning focus, i.e. practices that promote the generation of new ideas through an active search for alternative viewpoints and perspectives (e.g. on-the-job development), and HR practices that give the employees the knowledge, skills and attitudes necessary to perform effectively (e.g. formal training) in predicting the level of innovation in work organisation of firms, while product innovation seems to be influenced more by solely exploratory learning practices. With respect to SMEs, Sheehan (2013) analysed the HRM/performance causal linkage on a sample of UK SMEs, showing, amongst other things, that the more SMEs invest in formal HRM systems (in terms of number of practices adopted, including training and development), the better their innovation performance becomes (in terms of product, process, organisation and marketing). In regard to individual practices, training and development, together with strategic people management practices, are the only practices to be significantly correlated with all three performance indicators considered (innovation, financial results and labour turnover) (Sheehan 2013).

Despite its great importance for the success of the innovation process (Klein and Sorra 1996, Klein et al. 2001, Marler et al. 2006, Sawang and Unsworth 2011; see also Ballot and Taymaz, 1997 for an evolutionary perspective on the relation between innovation and training), the relationship between the adoption of technological and organisational innovation and investments in training activities has instead remained largely unexplored in the HRM literature. One interesting exception is the study developed by Neirotti and Paolucci (2013) on a sample of large Italian firms. The authors explore the role of training in either determining organisational and technological changes or supporting firms in the assimilation of such changes. They found evidence that firms in which training activities are part of a system of HRM practices (i.e. the so-called high-performance work systems) are more likely to develop organisational and technological changes. More interestingly, they also found that technological and organisational changes favour firms' involvement in training activities: specifically, technological changes favour training in technical and operational skills, while organisational changes favour training in cognitive and interpersonal skills.

The positive effects of organisational innovation on training investments are also supported by other empirical findings. For instance, Osterman (1995) analyzed a representative sample of US firms and found that those which made use of so-called 'high performance work systems' (i.e. firms adopting self-directed work teams, job rotation, problem solving groups, Statistical Process Control, Total Quality Management) provided their employees with higher levels of training than firms which did not make use of such work practices. Similarly Lynch and Black (1998), again on US firms, showed that the new work practices such as job rotation, self-managed teams, the use of benchmarks and Total Quality Management are associated with higher training investments.

Although the literature outlined above mainly concerns large firms, we can expect the positive relationship between organisational innovation (e.g. teamwork, multitasking, delegation of

responsibility) and training activities to be independent from the firm's size. This should therefore also hold for SMEs, because if innovations of this kind are to be successful, the employees need to have new knowledge, skills and attitudes to be properly involved in the new work system. Empirical support for this view is provided by Sawang and Unsworth's (2011) study on a sample of Australian SMEs, which shows that the model of innovation implementation effectiveness developed by Klein and colleagues (2001) –which considers training as a key practice for the success of the implementation process– also holds for smaller enterprises. The authors conclude their analyses by affirming that skilful and capable employees increase the level of implementation effectiveness (Sawang and Unsworth 2011) . Accordingly, introducing organisational innovations such as autonomous work teams, decentralization of decision-making power, job rotation and multi-skilling without supporting them with adequate training investments may be highly detrimental to innovation outcomes. Hence, we expect that firms which have adopted organisational innovations of this kind have also increased their training activities.

H1: The adoption of organisational innovation increases firms' training activities

The same reasoning may be developed with regard to technological innovation. As stated by Johnson and colleagues, "Technology use affects the nature of work. As firms adopt new technologies, their skill requirements change. Workers require a different set of skills in order to work with the new technologies" (Johnson et al. 1996: 111). These needs – which also characterize the adoption of organisational innovation (Caroli et al. 2001) – may be satisfied by resorting to the external market (new hirings) or by providing training to the internal workforce. Johnson and colleagues' multivariate analysis on Canadian firms suggests that "technology adoption is the most important factor explaining which firms engage in training.

Use of each of the labour-enhancing and labour-saving technologies stimulates greater training” (Johnson et al. 1996: 117). Similar findings have been reported by the economic literature, which refers to this point as “skill-biased organisational/technological change” (e.g. Caroli and Van Reenen 2001; Caroli et al. 2001; Bresnahan et al. 2002). Behaghel and colleagues (2012), for example, showed that when French firms introduce new technologies, they “massively rely on training in order to upgrade the skill level of their workforce, whereas the use of excess turnover as a provider of new skills remains very limited” (Behaghel et al. 2012: 509). This appears to be particularly the case of SMEs, which normally encounter greater difficulties than large firms in finding the skills they need on the external labour market (EC 2007). We may therefore expect that, particularly when technological innovations are introduced, their choices will turn to the upskilling of their workforces through training investments.

H2: The adoption of technological innovation increases firms’ training activities

The above discussion also requires us to consider the interaction between organisational and technological innovation in fostering SMEs’ training activities. Indeed, the complexity of a systemic approach to innovation, i.e. the choice of jointly introducing organisational and technological innovations in order fully to exploit complementarities between them (Michie and Sheehan, 1999; Laursen and Foss, 2003; Li et al., 2006), should increase the firm’s needs for training to a greater extent than the single spheres of innovation do, so that we can expect the relationship between techno-organisational innovation and training to be closer than the relationship between the individual spheres of innovation and training.

H3: When organisational and technological innovation are jointly introduced and are jointly high in intensity, the effects on investments in training are high as well

Besides the generic effects of innovations on training activities, there are several specific aspects that should be addressed to gain deeper understanding of this relationship in the SME context. Among them is, for example, the firm's decision to provide training internally through formal or informal and on-the-job programs, or by outsourcing the function to external providers. Moreover, firms also have to define the target of the training programs, i.e. which employees should be involved. In the next two subsections, the expected effects of organisational and technological innovations on these two decisions are discussed, and some specific hypotheses are developed.

Types of training

According to the knowledge-based view of the firm, both internal and external training contributes to the process of knowledge creation, but some differences exist in regard to the emphasis that they place on the various phases of the process: external training contributes mainly by internalizing explicit knowledge (internalisation), while internal training places more stress on the articulation and interaction of prior tacit knowledge (externalization and socialization phase) (Nonaka and Takeuchi 1995; Laursen and Mahnke 2001).

With respect to SMEs, the decision to outsource training is closely influenced by financial costs (Black et al. 1999). In this regard, on the one hand SMEs may experience higher transaction costs because of their lower negotiation power with respect to training providers; but on the other hand, they may also benefit from the economies of scale achieved by large and specialized providers and that are not achievable internally (Galanki et. al. 2008). However, economies of scale are only achievable by external training specialists when the

training provided is definable as off-the-shelf, i.e. when they can design the training program and deliver it to a large number of customers. When the program is tailored to the particular needs of the client, the economies of scale are not achievable by external specialists and the costs of outsourcing the training function increase (Gainey and Klaas, 2005). Moreover, evidence suggests that external training providers should not consider the training needs of smaller firms as equal to those of larger firms (which constitute their traditional market), because “learning styles, attitudes and preferences of owner/managers may be quite different from their traditional audiences” (Sadler-Smith et al. 1998: 92).

Consequently, since SMEs are subject to severe financial constraints, external training is only accessible to them for standard training programs that can be easily imitated by their competitors. If we consider the decision by SMEs to invest in innovation and training as a strategy to increase their competitive advantages through internal resources that add value and are rare and difficult to imitate or replace – i.e. if we adopt the resource-based view of the firm – then SMEs should not outsource training functions. This seems to be particularly the case when organisational innovations are introduced, because innovations of this kind typically require firm-specific new skills and competencies. By contrast, when technological innovations are adopted in SMEs (especially in the case of radical technological innovation), the knowledge needed is mainly external to the firm and can be easily acquired from training specialists. As an example, we may imagine that when firms adopt an ICT innovation (e.g. a new PC application), they acquire the skills and knowledge relative to the new technology from the software house that supplies it. Thus, external training provides employees with the general knowledge that is typically needed by firms when they change their technology, while internal (formal and on-the-job) training provides specific human capital that can be useful for organisational innovation processes, which are typically firm-specific (Laursen and Mahnke, 2001).

To summarize the foregoing discussion: when technological innovations are introduced, we expect external training activities to increase (since new technologies typically require new technical skills), while when organisational innovations are adopted (for example job rotation, multitasking, decentralization), we expect an increase in internal training activities. .

H4: The adoption of organisational innovation increases firms' internal training activities (formal and on-the-job)

H5: The adoption of technological innovation increases firms' external training activities

Intensity and coverage of training

Despite the claims by the international institutions that it is necessary to increase the skills levels of all participants in the labour market (e.g. EC 2010), current theories and evidence suggest that training programs are mainly addressed to the “core” segment of the workforce employed in the firm, i.e. employees that are already high-skilled, both because they occupy strategic roles in the organisation (Wright et al. 2001) and because they are better learners than low-skilled employees (Osterman 1995; Barrett and O’Connel 2001). This view is taken by the architectural approach to strategic HRM proposed and tested by Lepak and Snell (2002). These authors describe the possible configurations of different ways to manage people, and they comment on their empirical analysis by concluding that: “it appears that the most likely form of HR investment varies for different types of human capital” (Lepak and Snell 2002: 539).

This pattern may intensify when training activities are the consequence of the adoption of technological innovations, because these changes require great absorptive and adaptive capabilities that high-skilled workers are more likely to possess (Mainga et al. 2009). With

respect to organisational innovation, Lynch and Black (1998) found that establishments which have introduced high-performance work practices (such as, for example, self-managing teams and total quality management) are more likely than other firms to train a large proportion of their workforce.

These patterns seem also applicable to SMEs, not least for the reasons relative to costs discussed above. For example, in the presence of an organisational innovation such as a new job rotation program, on-the-job training initiatives may be easily extended to large part of the workforce, and therefore the coverage of training activities (i.e. the share of employees involved) should increase. Instead, when technological innovation requires external training investment, in order to contain costs the firm may decide to intensify the training initiative by focusing only on the core segment of its workforce, thus registering an increase in the intensity (i.e. the number of hours per employee) of training activities.

Hp6: The adoption of organisational innovation increases the coverage of firms' training activities among employees .

Hp7: The adoption of technological innovation increases the intensity of firms' training initiatives for selected employees.

Method and sample

Our empirical analysis was conducted using a single data set, which resulted from the match of two survey waves on manufacturing firms located in the area of Milan (in the Lombardy region of Italy). Milan is one of the top-ranked OECD metropolitan regions and the first contributor to national GDP among the Italian cities, accounting for more than 10% (OECD 2006).

The sample on which the analysis was conducted consisted of 118 manufacturing enterprises enrolled with the Lombardy Industrial Association (Assolombarda), the largest territorial association of the General Confederation of Italian Industry (Confindustria).

The Research Department of Assolombarda carries out an annual survey on the characteristics of employment in its affiliated firms. The questionnaire comprises a section relative to the characteristics of the firm (e.g. number of employees, industry, market, level of innovation, relationship with other firms), one devoted to contractual and socio-demographic characteristics of the labour force (e.g. types of contract, sex, qualifications, education, origin, hiring, terminations), one concerning the work organisation and HRM practices used (e.g. autonomous and semiautonomous teamwork, job rotation, multi-tasking, training), one relative to time and absences from work, distinguishing among the causes of absence, and one relative to the levels and composition of pay.

Both in 2005 and in 2008, the questionnaire was sent to the HR managers of around three thousand firms, and the replies amounted to 334 in 2005 and to 416 in 2008. Given the small number of services firms (less than 10% of the sample in the two years), we decided to analyze only the manufacturing firms. Careful selection of the quality of the replies and matching between the respondents of two years generated a sample of 140 firms for the development of our analysis. The subsequent refinement of our focus towards SMEs (Small and Medium Enterprises), which represented 85% of the sample, left us with a working sample of 118 firms over each year.

Data

The data at our disposal were clustered into three main sets useful for our econometric analysis described in the next section: controls, innovation and training variables (see Table 1; see also Table A1 in Appendix A for descriptive statistics and Appendix B for a questionnaire

extract that includes the questions on innovation and training from which we constructed our main variables). The three sets were used within the following general estimation model:

$$(1) \text{TRAIN}_{t,i} = \beta_0 + \beta_{1,i}\text{Controls}_{t,i} + \beta_{2,i}\text{INNO}_{t,i} + \varepsilon_{t,i}$$

The first set of variables on the right-hand side of equation (1) comprises firm-specific characteristics, and they are mainly used to capture potential factors influencing training activities, the purpose being to isolate, as far as possible, the effect of our main variables of interest, i.e. innovation indicators.

Table 1 about here

Dependent variables. The dependent variables in our model are training variables. We count six dependent variables and they capture three main training instruments: on-the-job training, internal courses, and external courses. As discussed above, all three types of training are expected to be related to organisational and/or technological innovation. Consistently with the measures of training volumes adopted by Neirotti and Paolucci (2013), for each of the three types of training activities we can compute both the share of employees involved (coverage) and the hours per capita (intensity), as set out in Table 1.

Independent variables. The main regressors of interest consist of organisational and technological innovation variables (Table 1). Organisational innovation variables, which are synthesised into a composite index, provide information on the intensity of innovation

activities in the organisational sphere. Technological innovation variables, which include two dummies, are also synthesised into a composite index. Our measures of technological innovation are similar to those used in other studies on the training/innovation relationship (e.g. Guidetti and Mazzanti 2007; Añón Higón 2011). However, it should be pointed out that innovation variables, especially organisational ones, have been frequently measured as simple dummies (e.g. Janod and Saint-Martin 2004; Chi et al. 2011), while here we capture the intensity of adoption of the single organisational practices in terms of the percentage of employees involved. In our case, the richness of micro-level data not only reduces, to some extent, the likelihood of relevant variables being omitted, as also pointed out below, but gives an original and essential value added to this study, because it enables us to construct indexes of ‘innovation intensity’ that can also be interacted (Organisational innovation * Technological innovation).

Controls. The set of controls included several variables that may influence training activities (Table 1). Belonging to a specific sector or to a group may drive the probability of implementing training activities, but it may also determine the type of such activities (Black et al. 1999). Tenure, in our case proxied by the share of short-term employees, can be treated as a factor related to training as well; indeed, some recent evidence suggests that training is mostly provided to permanent workers with long tenure (Waddoups 2012). An index of competition pressure was also included among the controls because of the likely linkage between competition and the need for a highly-skilled workforce. Moreover, we also used very specific shares of white-collar workers that identify high-skilled and low-skilled white-collar workers. We also had at our disposal the share of employees with a bachelor degree. This enabled us to test the potential relation between highly-educated workers and training, which may be especially important in the case of the upskilling required by technological

change (Mainga et al. 2009). Furthermore, since several studies account for the positive effect of employee unionism and firm-level collective bargaining on the provision of training by firms (e.g. Osterman 1995; Cedefop 2010; Waddoups 2012), we also controlled for the presence of union representatives in the workplace. Finally, the number of employees (size) is another control that we could use in the first step of the estimation procedure, as explained below.

Methodology

The panel structure of our working sample, although limited to a two-year dimension ($T=2$), allowed us to deal with some econometric issues by exploiting panel data econometrics. It reflected the need, stressed by several authors (Klein and Sorra 1996; Lopez-Cabrales et al. 2009; Mainga et al. 2009), to use panel data when dealing with the relation between innovation and training.

In our estimation procedure, we had to cope with both non-random sample selection (firms that implement training programmes self-select according to specific characteristics) and unobserved heterogeneity (in the equation of interest we may have individual specific effects that are not observed but are correlated with the error term). A straightforward estimation procedure, even if in a panel data context (random effects or fixed effects), could not solve these problems (Dustmann and Rochina-Barrachina 2007).

In order to solve the selection issue we implemented a version of the Mundlak-Chamberlain procedure (Mundlak 1978; Chamberlain 1984) proposed by Wooldridge (1995). We estimated the variables of interest through a two-step procedure (Wooldridge 2002) which allowed us to deal with selection bias in a context of panel data also in the presence of a very short T (see Appendix C).

In order to take account of endogeneity (Bryan 2006; de Kok 2002) due to unobserved heterogeneity, we exploited the rich set of controls, which, coupled with the main variables of interest (organizational innovation and technological innovation), contributed to capturing the largest part of unobserved heterogeneity due to management attitude (Huselid and Becker 1996).²

Finally, because our dependent variables were related and, most importantly, because managerial decisions about training types are not independently taken (the decision to implement one training program is not unrelated with the decision to implement the others) we considered it appropriate to adopt a *seemingly unrelated regressions* (SUR) methodology (Zellner 1969). The basic idea is that errors of the equations are correlated for a given firm, since the choices related to training activities are not mutually independent for the single firm, but the errors are not correlated across firms: as an example, the decision to invest in on-the-job training for firm A is not related to the same decision for firm B. Given this assumption, we could exploit the cross-equations correlations among errors in order to increase the efficiency of our estimators (Cameron and Trivedi, 2010). Although we applied this approach, the gains in efficiency were only modest and the results were unchanged with respect to a simple pooled OLS in the second step of the analysis. We then decided to stick to the presentation of OLS pooled results, since it also allowed us to proceed by adopting a stepwise procedure that refined each of our specifications going from a general model, with all of our covariates included, to a more parsimonious one that retained only the ‘most relevant’ covariates after an iteration process.³

Results

In the following tables we report the results by alternatively using innovation composite indexes (Table 2) and single innovation dummies (Table 3) as the main regressors of interest.

We also conducted regressions with the inclusion of interacted innovation composite indexes (i.e., $\text{InnTech} * \text{InnOrg}$), which are not reported because there was no evidence of an interaction effect between technological and organisational innovation on training⁴ (hypothesis 3 not supported).

Considering the control variables first, the sectors do not emerge as being of primary significance for training activities. The two sectors with significant and persistent coefficients across specifications are rubber-plastic and textiles. The former is related positively to the intensity of internal training, but negatively to the coverage of external training; the latter is positively linked with the intensity of on-the-job training, but negatively with the coverage of internal training. With regard to the other control variables, the share of workers with temporary contracts is not surprisingly related with on-the-job training activities; the larger the share of temporary workers, the larger the intensity and coverage of training through the on-the-job mechanism. Finally, the last two control variables related to training, as emerged from our data, are the share of low-skilled and high-skilled white-collars: the former has a negative coefficient when significant, while the latter has a positive coefficient when significant.

Before turning to discussion of our main regressors, it should be stressed that all the regressions were corrected for sample selection bias using the IMRs retrieved from the probit regressions of the first step of the analysis. Indeed, the correction was necessary because the estimations were conducted on the subsample of firms doing training as indicated by Wooldridge (1995), which reduced the number of observations to 147. In our case the *Wald tests* that jointly test the significance of the IMRs rejected the null hypothesis of IMRs equal to zero only in two estimations, which actually needed a correction for selection. The same applies to the specifications in Table 3, where different kinds of main regressors are used.

As regards innovation variables, as far as the composite indexes of innovation are concerned (Table 2), technological innovation does not seem to be related to training activities; hypotheses 2, 5 and 7 are therefore not supported by our analyses. The changes in organisational innovation are instead related to two specific training types: the coverage of on-the-job activities and the intensity of internal courses provided to the workers. For the latter specific types of training activities, therefore, hypotheses 1, 4 and 6 are supported.

Table 2 about here

Table 3 shows the linkages among the single technological and organisational innovations which were used to construct the composite indexes. The single innovation dummies make it possible to capture the role of specific types of technological and organisational change that are related to training activities within the firm. Firstly, we can see how technological innovations are related to the intensity of internal training. However, the coefficients have opposite signs: negative for process innovation and positive for ICT innovation.

As regards the organisational variables, the introduction of autonomous teams is positively related with the intensity and coverage of on-the-job training as well as (although less robustly) with the coverage of external training activities, and negatively related with the coverage of internal training. By contrast, polyvalence across several tasks induces more formal internal training, but it is neutral with respect to on-the-job training and only marginally attached to external forms of training. Finally, rotation among several tasks shows a negative relation with the share of employees covered by external courses. It is worth recalling that the results concerning organisational innovations should be read in light of the discrete nature of the organisational variables. A positive (negative) linkage with training

activities means that the larger the share of employees involved in a specific type of organisational innovation, the higher (lower) the training activities. We shall return to these findings in the following discussion section.

Table 3 about here

Discussion and implications

Findings

The findings illustrated in the previous section show that the nexus between innovation and training activities in SMEs is considerably more complex than is often supposed in both the academic and policy debate. To summarize, the econometric analysis shows that the organisational innovation index is associated with higher investments in training activities, but not the technological innovation index. However, the effects generated by organisational innovation are not particularly strong, given that only two out of six of our measures of training activities (i.e. the coverage of on-the-job training and the intensity of internal courses) are positively affected by the introduction of innovations of this type. Moreover, the picture becomes even more complex when we consider the single innovation variables (i.e. the innovation variables composing the two general indexes), suggesting that general indexes may hide very different patterns between single innovations and training practices. In the following discussion, therefore, we consider the general relationships between the adoption of ‘bundles’ of innovation and training activities, as well as the specific relationships that characterize the adoption of single innovation and training activities.

Bundles of innovation. The general innovation indexes employed in our analysis may be considered as ‘bundles’ of innovation according to the complementarities approach (MacDuffie, 1995). When we consider such bundles of innovation (Table 2), it is mainly the adoption of organisational innovation that acts as ‘a driver’ of higher training investments, while technological innovation does not have a significant relation with firms’ training strategies.

Specifically, organisational innovation seems to increase the coverage (i.e. the share of employees involved) of informal on-the-job training activities as well as the intensity (i.e. the number of hours per employee) of formal internal training. These results support previous findings on the greater use of internal training made by innovative firms (Laursen and Mankhe 2001) and, consistently with the resource-based view that not all employees have strategic value (Wright et al., 2001), they show that more costly (in terms of time, resources, logistics) training activities (i.e. formal activities) are addressed only to the ‘core’ employees that occupy a strategic role in the organisation and who were involved in training programs also before (and independently from) the innovation adoption. This interpretation is also supported by the finding that the greater the share of high-skilled employees, the higher the coverage of formal (internal and external) training activities provided by the firm. For ‘non-core’ employees who need upskilling in order to adopt the innovation properly, SMEs’ training strategies consist of informal on-the-job training practices because they are easier to manage, more flexible, and less costly than formal activities (de Kok, 2002).

Our results contrast with some recent findings on large firms which show that both technological and organisational changes have positive effects on firms’ training investments (e.g. Neirotti and Paolucci 2013). Therefore, also considering that the effects of organisational innovation are rather weak and that the interaction between the two bundles has proved to have no relationships with training activities, it may be the case that there are fewer

complementarities in SMEs than in large firms among inputs that can be coordinated (Guidetti and Mazzanti, 2007). This may reduce the value to employers of investment in training to complement innovation, particularly when technological innovation is adopted. However, empirical evidence on SMEs seems to contrast with this view by showing that the potential of complementarities within and between innovation bundles also holds in non-large contexts (e.g. Way, 2002; Della Torre and Solari, 2011). Hence, such results may be better explained by the scant awareness among SMEs managers about the opportunities that they miss by under-exploiting the complementarities between the bundles of innovation and skill upgrading in their firms. Moreover, the extant literature shows that missing the advantages connected to the complementarities increases the risk of innovation failure (Klein and Sorra 1996; Klein et al. 2001; Klein and Knight 2005), also in SME contexts (Sawang and Unsworth 2011). SME managers should therefore pay greater attention to the development of an organisational environment that (through training investments) enables employees to adopt the changes introduced adequately, and that permits the exploitation of the complementarities connected to the adoption of innovation.

It should also be noted that, according to the innovation management literature, training is not the only high-quality implementation practice impacting on the effectiveness of the innovation process. Other factors, such as rewards, communication, organisational support and time availability, are of key importance as well (Klein et al. 2001). According to Klein and Sorra (1996), the influence of such factors can be considered compensatory, meaning that the presence of one of them compensates for the absence of another. Therefore, because the cost of training is relatively higher for smaller than for larger firms, in SMEs the policies and practices adopted by managers to support the adoption of innovation could be those requiring lower financial efforts than training, like for example the effectiveness of communication and the provision of organisational support to the change-recipients. Futures studies could usefully

address the issue of the alternative strategies followed by SMEs to support the adoption of innovation; despite the importance of the topic for the competitiveness of SMEs, to our knowledge this is the first study that tries to analyse such patterns.

Single innovations. As far as single innovation variables are concerned, we have a reappraisal of the significance of technological innovation. Indeed, we find that also technological innovation has a role in influencing SMEs' internal training activities: specifically, process innovation has a negative relation, while ICT innovation has a positive one (Table 3). Since ICT has recently been shown to have strong effects on the product innovation performance of SMEs (Añón Higón, 2011), our result concerning firms' investments in training activities in order to successfully implement the new ICT adopted is indicative of the high level of SME awareness about the strategic role performed by such factors. The result on process innovation is quite surprising, although it is similar to Bryan's (2006) finding of a non-significant relationship between the two variables. According to the rationale of our second hypothesis, we can say that the adoption of innovation relative to the production process is the only type of innovation that induces SMEs to recruit skilled employees from the external labour market to satisfy their needs. By hiring new employees that possess the new skills required by innovation adoption, firms reduce their need to invest in training. Of course, this is a speculative interpretation, and future research in the field should more thoroughly analyse why SMEs decide to search for the skills that they need on the external market rather than upskill the internal workforce according to the different types of innovation adopted.

With regard to organisational innovation, the two work practices with strong linkages to training activities are autonomous work-teams and multitasking. Autonomous work-teams increase both the coverage and the intensity of on-the-job training. One reason why SMEs provide informal training may be that they want to avert the risk of trained employees moving

to another employer; indeed, the skills provided by on-the-job training are typically highly firm-specific (Lynch, 1991). Since the poaching problem is particularly serious for SMEs, such firms may prefer to invest in this type of training rather than in formal and external programs. Storey and Westhead (1997), as well as Black and colleagues (1999), have shown that, for virtually all types of employees, the probability of being involved in formal training activities increases with firm size. This confirms the importance of the informality of the HR practices in SMEs (Wilkinson, 1999; Ram et al., 2001) and suggests that future research on training in SMEs should make greater efforts to understand how and why informal training practices take shape in highly innovative contexts.

By contrast, the adoption of multitasking work practices increases the intensity and coverage of formal internal activities, with more experienced employees acting as formal trainers for other employees involved in the multitasking program. Therefore, the skills needed to construct polyvalence in the workforce are internally generated, but they require formal courses; on-the-job training does not seem to be sufficient.

Finally, the inverse relationship between the adoption of job rotation programs and external training suggests that this kind of organisational innovation may be adopted by SMEs mainly as a substitute for training. By having employees rotate among jobs/departments, firms can increase their levels of skills and knowledge, thereby reducing their training needs. This view is supported by the finding that it is not only external training that is inversely related to job rotation; the other training variables have negative relationships as well, with the sole exception of formal internal training. This suggests that future studies in the field should also investigate which innovations act as substitutes for training activities in SMEs.

Implications for International Human Resource Management

Since our results come from the Italian context, a context where SMEs and informality are highly present, some interesting implication for the international HRM field (which is mainly focused on large forms) can also be drawn. Particularly, the current study could be usefully replicated adopting a comparative perspective, thus allowing a better understanding about how SMEs training strategies related to the adoption of organizational and technological innovation differ according to the cultural and institutional context in which SMEs are embedded. For instance, we may expect that in countries where public funding for training (related to the adoption of innovation) are available to SMEs, the relevance of informality and the duality between core and non-core employees (the first receiving formal training, the latter informal training) are weaker.

Another issue that comparative human resource management studies could usefully address relates to the missing innovation complementarities on training that emerged from our study. Given that firms training investments in Italy are generally lower than in other advanced countries (Cedefop 2010), it could also be the case that our findings reflect this pattern rather than a scant awareness among SMEs managers about the existence of complementarities between innovation and training. Hence, a comparative analysis that includes countries where firms training investments are higher would offer a clearer picture of the peculiarities of the SMEs with regard to the exploitation of the complementarities founded by the literature on large firms.

Apart from the comparative evidence, the understanding of the relationship between innovation and training in SMEs could be increased by not considering SMEs as a single category, but rather differentiating them according to their organizational characteristics. Particularly, distinguishing SMEs that are internationalized and operate on the global market from those operating only on the domestic (or local) market and which are therefore not inserted in international networks could result in very different finding for the two groups. For

example, we can expect that SMEs which are exposed to the international context are less likely to adopt informal training than SMEs which are not exposed to international influences. Overall, given the relevance of SMEs in the world economic context, research in the international HRM field should pay greater attention to the exploration of innovation and training strategies in smaller firms.

Limitations

Although the richness of the dataset employed for this analysis has made it possible to identify the relationships between innovation and training activities from a causal perspective, the analysis also has some limitations that may hopefully be overcome by future research.

Firstly, we have not been able to address the well-known ‘single-respondent’ problem that characterizes large part of the HRM literature (Sheenan, 2013). This limitation, combined with the use of ‘self-reported’ measures, acquires particular importance if the variables considered for the analysis may suffer from the subjectivity of respondents. While this may be a minor problem for formal training activities (which are normally registered in internal reports and documents), it may acquire more importance for informal training and innovation variables. For example, a recent qualitative study on Italian SMEs has shown that the meaning of the term ‘innovation’ is socially constructed, with each actor having its own perspective on what innovation is (Massa and Testa, 2008). Therefore, ‘self-reported’ measures and ‘single-respondent’ datasets may suffer from the differences among individuals’ perceptions, and future studies should take such aspects into greater account. The starting point would be to develop research designs that, according to the so-called ‘mixed-methods approach’ (Creswell, 2004), combine quantitative and qualitative methods of inquiry.

A second limitation of the study stems from its lack of information regarding the contents of training activities. Indeed, although this paper may help to increase understanding of the

relationships between innovation and training in SMEs, its analysis of the types of training activities (on-the-job, internal or external) would have benefited from being able to consider also the contents and the skills transferred to employees by training activities. In this regard, our study draws on the findings of previous research, and the availability of original information would have considerably increased its contribution.

Finally, a third limitation of the paper is its treatment of SMEs as a single category ranging from 1 to 250 employees. It is particularly the importance of informality in smaller firms (Wilkinson, 1999) which suggests that researchers should strive for larger samples that enable them to compare how the training-innovation relationships take shape in firms belonging to different size classes. Black and colleagues (1999), for example, estimated that a 10% increase in firm size increases the hours per week of formal off-site training by 0.6% and the hours per week of formal on-site training by 1.3%. Our findings show that, at least to some extent, both formal and informal internal training activities are driven by the adoption of organisational innovation; this suggests that deeper understanding about how such relationships vary according to firm size is a prominent line of inquiry for the advancement of knowledge.

Final remarks

By adopting the resource-based view of the firm and the complementarities approach, the main aim of this paper has been to analyse whether and how SMEs support the adoption of organisational and technological innovations with training activities. The results of the econometric analysis furnish a quite complex picture of the effects of innovation on training. On the one hand, organisational innovation seems to be related to higher investments in (formal and informal) internal training; specifically, it is the adoption of autonomous teams and multiskilling practices that is associated with the coverage and the intensity of internal

training. On the other hand, when the general index of technological innovation is considered, it does not show any significant relationships with training activities, while when the single technological innovation variables are considered, ICT innovation proves to be significantly associated with the coverage of internal training, and process innovation is negatively related to the same training variable.

These results demonstrate that SMEs have limited awareness of the risks associated with underinvesting in training during the implementation phase of the innovation process. Methodologically, our analysis suggests that if scholars focus only on the general innovation indexes, i.e. on “bundles” of innovations, they may obtain misleading evidence due to the very different patterns that characterise the relationships between the individual types of innovation and training activities adopted by SMEs.

Overall, better understanding of the reasons why SMEs seem not to fully combine the adoption of innovation with adequate investments in training activities – i.e. whether or not it is a matter of ‘ignorance’ (Storey and Westhead, 1997) – is essential for scholars to give managers and policy-makers sound evidence that enables them to design effective evidence-based programs.

APPENDIX A – Descriptive statistics

Table A1. Descriptive statistics of the variables used in the econometric analysis

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Training (Dependents)</i>					
On the job (OJT) - coverage	236	0.036	0.119	0	1
On the job (OJT) - intensity	236	0.179	0.357	0	1
Internal courses - coverage	236	0.147	0.253	0	1
Internal courses - intensity	236	0.323	0.429	0	1
External courses - coverage	236	0.125	0.208	0	1
External courses - intensity	236	0.416	0.456	0	1
<i>Innovation (Independents)</i>					
Technological innovation	236	0.307	0.393	0	1
Organisational innovation	236	0.251	0.184	0	1
Process innovation	236	0.328	0.460	0	1
ICT innovation	236	0.287	0.444	0	1
Decentralization	236	0.245	0.264	0	1
Autonomous teams	236	0.195	0.286	0	1
Semi-autonomous teams	236	0.220	0.276	0	1
Multitasking	236	0.361	0.317	0	1
Job rotation	236	0.234	0.291	0	1
<i>Controls</i>					
Food	236	0.034	0.181	0	1
Chemicals	236	0.208	0.406	0	1
Rubber	236	0.076	0.266	0	1
Metal-machinery	236	0.547	0.499	0	1
Textiles	236	0.042	0.202	0	1
Other manufacturing	236	0.093	0.291	0	1
Temporary	236	0.032	0.052	0	0.300
Group	236	0.589	0.853	0	2
Competition	236	0.775	0.215	0	1
High-skilled WC	236	0.143	0.158	0	0.760
Low-skilled WC	236	0.455	0.239	0	1
Union*	236	0.389	0.489	0	1
Size*	236	51.013	52.683	2	241
Education*	236	0.157	0.206	0	1

Notes: Missing values have been replaced by an interpolation of the value based on specific characteristics of each firm, when feasible, or with the simple mean conditional on specific characteristics of the firm as well, when interpolation procedure was not feasible.

*These variables were used in the probit estimates for each year T: 2005 and 2008.

APPENDIX B – Questionnaire

In this section we report an extract from questionnaires (2005 and 2008) to illustrate the information source from which we constructed our main variables on innovation and training.

Technological Innovation

Has the firm introduced major technological innovations in the past three years?

If yes, such innovation concerned:

- a. process of product transformation
- b. coordination of activities (ICT)

Organizational Innovation

Show the degree of utilisation (*No* utilisation; *Moderate* utilisation, less than 30% of employees involved; *High* utilisation, more than 30% of employees involved) of the following organisational practices:

- a. decision-making decentralisation
- b. autonomous teams;
- c. semi-autonomous teams
- d. polyvalence on several tasks
- e. job rotation.

Training

Has the firm implemented training activities in the past year?

If yes, please report the number of employees involved and the total amount of hours dedicated to the following training activities:

- a. External courses

b. Internal courses

c. On the job training

APPENDIX C – Mundlack-Chamberlain procedure for non-random selection sample

In order to solve the non-random selection issue we implemented a version of the Mundlack-Chamberlain procedure (Mundlak, 1978; Chamberlain, 1984) proposed by Wooldridge (1995). We estimated the variables of interest through a two-step procedure (Wooldridge, 2002). In the first step we estimated a probit equation both for the 2005 sample and the 2008 sample (Table C1) in order to calculate the Inverse Mills Ratio (IMR henceforth), which is the ratio between the probability density function $f(\cdot)$ and the cumulative density function $F(\cdot)$ retrieved by the probit estimations:

$$(2) TRAIN_{D_{2005,i}} = \beta_0 + \beta_{1,i}Controls_{2005,i} + \beta_{2,i}INNOORG_{2005,i} + \beta_{3,i}INNOTECH_{2005,i} + \varepsilon_{2005,i}$$

$$(3) TRAIN_{D_{2008,i}} = \gamma_0 + \gamma_{1,i}Controls_{2008,i} + \gamma_{2,i}INNOORG_{2008,i} + \gamma_{3,i}INNOTECH_{2008,i} + u_{2008,i}$$

From the two estimations we obtain the IMRs for the two years:

$$(2.a) IMR_{2005} = f(\hat{\beta}x)/F(\hat{\beta}x)$$

$$(3.a) IMR_{2008} = f(\hat{\gamma}x)/F(\hat{\gamma}x)$$

where x is a vector of regressors including both controls and innovation variables (INNOORG and INNOTECH) and $\hat{\beta}$ and $\hat{\gamma}$ are vectors of coefficients estimates from the probit estimations.

Table C1. Probit estimates on each T (2005 and 2008)

	2005 TRAIN_D_2005	2008 TRAIN_D_2008
Sectors	Yes	Yes
Size	0.00514	0.0128*

	(1.43)	(2.33)
Education	1.981*	1.187
	(2.32)	(1.44)
Group	0.306	0.302
	(1.64)	(1.40)
Competition	0.106	-0.132
	(0.17)	(-0.21)
Union	0.485	-0.0639
	(1.41)	(-0.17)
Temporary	1.927	-5.662*
	(0.64)	(-2.03)
Organisational innovation	1.014	0.800
	(1.26)	(0.96)
Technological innovation	0.358	1.225*
	(1.07)	(2.38)
Cons	-0.587	0.0437
	(-0.64)	(0.05)
<i>N</i>	140	140
<i>PseudoR2</i>	0.31	0.33
<i>Chi2(13)</i>	57.02	54.36

Note: The construction of the IMR2005 and IMR 2008 is based on all the information at our disposal, that is to say exploiting the maximum number of observations, including both small and large firms.

It is important to clarify that, in this first step, a full set of controls potentially influencing the decision to adopt some kind of training activity was used. Some of these controls were not included in the outcome equation (UNION, EMP_DEGREE and EMP) – the pooled estimation of the second step described below – because they were related less to the type of training and more to the decision to train the employees. In this way we also dealt with identification problems that might be generated by a perfect overlapping of the covariate in the selection equations, the two single probits, and in the outcome equation, the pooled regression of the second step.

This latter consists in estimating a pooled panel regression (Wooldridge, 2002) for the 'selected' sample ($TRAIN_{D_{i,t}} = 1$): that is to say, for the firms doing training activities, including among the regressors, also the IMRs, for both the 2005 and the 2008 samples, each multiplied by the corresponding time dummy (2005_D and 2008_D):

$$(4) TRAIN_{t,i} = \alpha_0 + \alpha_{1,i}Controls_{t,i} + \alpha_{2,i}INNOORG_{t,i} + \alpha_{3,i}INNOTECH_{t,i} + \alpha_{4,i}IMR * 2005_D_i + \alpha_{5,i}IMR * 2008_D_i + \sigma_i + v_{t,i}$$

This two-step procedure allowed us to deal with selection bias in a context of panel data also in the presence of a very short T.

Notes

¹ Similar to this is the OECD's definition of technological and organisational innovation as reported in the Oslo Manual (OECD, 2005).

² As far as endogeneity due to simultaneity is concerned, two main problems hampered the possibility to cope with it fully: the first was the lack of appropriate instruments in our dataset; the second was the very short time dimension ($T=2$), which in practice prevented us from using at least a first difference approach including lagged values of the innovation variables in a first-difference specification of our model (Caroli and Van Reenen, 2001).

³ The results from the SUR specifications are available from the authors upon request.

⁴ The results are available from the authors upon request.

References

- Añón Higón, D. (2011), 'The impact of ICT in innovation activities: Evidences for UK SMEs,' *International Small Business Journal*, 30, 684-699.
- Antonelli, G., Antonietti, R., and Guidetti, G. (2010), 'Organizational Change, Skill Formation, Human Capital Measurement: Evidence from Italian Manufacturing Firms,' *Journal of Economic Surveys*, 24, 206-247.
- Antonoli, D., Mazzanti, M., and Pini, P. (2010), 'Productivity, Innovation Strategies and Industrial Relations in SMEs: Empirical Evidence for a Local Production System in Northern Italy,' *International Review of Applied Economics*, 24, 453-82
- Ballot, G., and Taymaz, E. (1997), 'The dynamics of firms in a micro-to-macro model: The role of training, learning and innovation,' *Journal of Evolutionary Economics*, 7, 435-457
- Barney, J. (1991), 'Firm resources and sustained competitive advantage,' *Journal of Management Executives*, 17, 99-120.
- Barney, J. (1995), 'Looking inside for competitive advantage,' *Academy of Management Executives*, 9, 49-61.
- Barrett, A., and O'Connell, P. (2001), 'Does training generally work? The returns to in-company training,' *Industrial and Labor Relations Review*, 54, 647-662.
- Barron, J., Berger, M., and Black, D. (1999), 'Do workers pay for on-the-job training?' *Journal of Human Resources*, 34, 235-252.
- Bartel, A., Ichniowski, C. and Shaw, K. (2007), 'How does information technology affect productivity? Plant-level comparison of product innovation, process improvement and worker skills,' *The Quarterly Journal of Economics*, 122, 1721-1758.
- Behaghel, L., Caroli, E., and Walkowiack, E. (2012), 'Information and communication technologies and skill upgrading: the role of internal vs external labour markets,' *Oxford Economic Papers*, 64, 490-517.
- Black, S., and Lynch, L. (2001), 'How to compete: The impact of workplace practices and information technology on productivity,' *Review of Economics and Statistics*, 83, 434-445.
- Black, S., and Lynch, L. (2004), 'What's driving the new economy? The benefits of workplace innovation,' *Economic Journal*, 114, 97-116.
- Black, D., Noel, B. and Zheng, W. (1999), 'On-the-job training, establishment size, and firm size: Evidence for economies of scale in the production of human capital,' *Southern Economic Journal*, 66, 82-100.
- Boothby, D., Dufour, A., and Tang, J. (2010), 'Technology adoption, training and productivity performance,' *Research Policy*, 39, 650-661

- Bornay-Barrachina, M., De la Rosa-Navarro, D., López-Cabrales, A., and Valle-Cabrera, R. (2012), 'Employment relationships and firm innovation: The double role of human capital,' *British Journal of Management*, 23, 223–240.
- Boselie, P., Dietz, G., and Boon, C. (2005), 'Commonalities and contradictions in HRM and performance research,' *Human Resource Management Journal*, 15, 67-94.
- Boxall, P. (1996), 'The strategic HRM debate and the resource-based view of the firm,' *Human Resource Management Journal*, 6, 59-75.
- Bryan, J. (2006), 'Training and performance in small firms,' *International Small Business Journal*, 24, 635-660.
- Bresnahan, T., Brynjolfsson, E., and Hitt, L. (2002), 'Information technology, workplace organization, and the demand for skilled labor: Firm-level evidence,' *Quarterly Journal of Economics*, 117: 1, 339–376.
- Cameron, A., and Trivedi, P. (2010), *Microeconometrics Using Sata*, College Station, Texas: Stata Press.
- Caroli, E., Greenan, N., and Guellec, D. (2001), 'Organizational change and skill accumulation,' *Industrial and Corporate Change*, 10, 481-506.
- Caroli, E., and Van Reenen, J. (2001), 'Skill-biased organizational change? Evidence from a panel of British and French establishments,' *The Quarterly Journal of Economics*, 116, 1449-1492.
- Cedefop (2010), *Employer-provided vocational training in Europe*, Research Paper n. 2, Luxembourg: Publications Office of the European Union.
- Chamberlain, G. (1984), 'Panel data', in *Handbook of Econometrics*, eds. Z. Griliches and M. Intriligator, Amsterdam: North-Holland, pp.1247–317.
- Chen, C.-J., and Huang, J.-W. (2009), 'Strategic human resource practices and innovation performance – The mediating role of knowledge management capacity,' *Journal of Business Research*, 62, 104-114.
- Chi, W., Freeman, R., and Kleiner, M. (2011), 'Adoption and termination of employee involvement programs,' *Labour*, 25, 45-62.
- Choi, J., and Price, R. (2005), 'The effects of person–innovation fit on individual responses to innovation,' *Journal of Occupational and Organizational Psychology*, 78, 83–96.
- Creswell, J. (2004), *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (2nd ed.). Columbus, Ohio: Merrill Prentice Hall.
- Damanpour, F. (1991), 'Organizational innovation: A meta-analysis of effects of determinants and moderators,' *Academy of Management Journal*, 34, 550-590.

- Damanpour, F., and Aravind, D. (2012), 'Managerial Innovation: Conceptions, Processes, and Antecedents,' *Management and Organization Review*, 8, 423–454.
- De Kok, J. (2002), 'Impact of firm-provided training on production. Testing for firm-size effects,' *International Small Business Journal*, 20, 271-295.
- De Jong, J., and Vermeulen, P. (2006), 'Determinants of product innovation in small firms,' *International Small Business Journal*, 24, 587-609.
- Della Torre, E., and Solari, L. (2011), 'High performance work systems, technological innovations and firm performance in SME. Evidences from Italy,' *International Journal of Entrepreneurial Venturing*, 3, 375-391.
- Dustman, C., and Rochina-Barrachina, M. (2007), 'Selection correction in panel data models: An application to the estimation of females' wage equations,' *Econometrics Journal*, 10, 263-293
- Edquist, C., Hommen, C. L., and McKelvey, M. (2001), *Innovation and employment: Process versus product innovation*, Cheltenham: Edward Elgar.
- European Commission (2007), *Enterprise Observatory Survey*, Flash Eurobarometer No 196, Brussels.
- European Commission (2010), *EUROPE 2020. A European strategy for smart, sustainable and inclusive growth*, COM(2010) 2020, Brussels.
- Gainey, T., and Klaas, B. (2005), 'Outsourcing relationships between firms and their training providers: The role of trust,' *Human Resource Development Quarterly*, 16, 7-25.
- Galanki, E., Bourantas, D., and Papalexandris, N. (2008), 'A decision model for outsourcing training functions: Distinguishing between generic and firm-job-specific training content,' *International Journal of Human Resource Management*, 19, 2332-2351.
- Guidetti, G., and Mazzanti, M. (2007), 'Training and organisational innovations in a local industrial system: Empirical evidence from Emilia-Romagna,' *Human Resource Management Journal*, 17, 283–306.
- Hoque, K., and Bacon, N. (2006), 'The antecedents of training activity in British small and medium-sized enterprises,' *Work, Employment & Society*, 20, 531-552.
- Huselid, M., and Becker, G. (1996), 'Methodological issues in cross-sectional and panel estimates of the human resource-firm performance link,' *Industrial Relations*, 35, 400-422.
- Janod, V., and Saint-Martin, A. (2004), 'Measuring the impact of work reorganization on firm performance: evidence from French manufacturing, 1995–1999,' *Labour Economics*, 11, 785-798.

- Johnson, J., Baldwin, J., and Diverty, B. (1996), 'The implications of innovation for human resource strategies,' *Futures*, 28, 103-119.
- Klein, K., and Sorra, J. (1996), 'The challenge of innovation implementation,' *Academy of Management Review*, 21, 1055-1080.
- Klein, K.J., Conn, A.B., and Sorra, J.S. (2001), 'Implementing computerized technology: An organization analysis,' *Journal of Applied Psychology*, 86, 811-824.
- Klein, K.J., and Knights, D. (2005), 'Innovation implementation overcoming the challenge,' *Current Directions in Psychological Science*, 14, 243-246.
- Lado, A., and Wilson, M. (1994), 'Human resource systems and sustained competitive advantage: A competency-based perspective,' *Academy of Management Review*, 19, 699-727.
- Laursen, K., and Foss, J. (2003), 'New human resource management practices, complementarities and the impact on innovation performance,' *Cambridge Journal of Economics*, 27, 243-263.
- Laursen, K., and Manhke, V. (2001), 'Knowledge strategies, firms types, and complementarity in human-resource practices,' *Journal of Management and Governance*, 5, 1-27.
- Lepak, D., and Snell, S. (2002), 'Examining the human resource architecture: The relationship among human capital, employment, and human resource configurations,' *Journal of Management*, 28, 517-543.
- Li, Y., Zhao, Y. and Liu, Y. (2006), 'The relationship between HRM, technology innovation and performance in China,' *International Journal of Manpower*, 27, 679-697.
- Lynch, L. (1991), 'The role of off-the-job vs on-the-job training for the mobility of women workers,' *The American Economic Review*, 81, 151-156.
- Lynch, L., and Black, S. (1998), 'Beyond the incidence of employer-provided training,' *Industrial and Labor Relations Review*, 52, 64-81.
- Lopez-Cabrales, A., Pérez-Luño, A., and Cabrera, R. (2009), 'Knowledge as a mediator between HRM practices and innovative activity,' *Human Resource Management*, 48, 485-503.
- MacDuffie, J. (1995), 'Human resource bundles and manufacturing performance: Organizational logic and flexible production systems in the world auto industry,' *Industrial and Labor Relations*, 48, 197-221.
- Mainga, W., Hirschsohn, P., and Shakantu, W. (2009), 'An explanatory review of the relationship between enterprise training and technology upgrading: evidence from South African manufacturing firms,' *International Journal of Human Resource Management*, 20, 1879-1895.

- Marler, J.H., Liang, X.Y., and Dulebohn, J.H. (2006), 'Training and effective employee information technology use', *Journal of Management*, 32, 721–743.
- Martínez-Costa, M., and Jiménez-Jiménez, D. (2009), 'The effectiveness of TQM: The Key role of organizational learning in small businesses,' *International Small Business Journal*, 27, 98-125.
- Massa, S., and Testa, S. (2008), 'Innovation and SMEs: Misaligned perspectives and goals among entrepreneurs, academics, and policy makers,' *Technovation*, 28, 393-407.
- Michie, J., and Sheehan, M. (1999), 'HRM practices, R&D expenditure and innovative investment: Evidence from the UK's 1990 Workplace Industrial Relations Survey,' *Industrial and Corporate Change*, 8, 211- 234.
- Milgrom, P., and Roberts, J. (1990), 'The economics of modern manufacturing: Technology, strategy and organization,' *American Economic Review*, 80, 511-528.
- Milgrom, P., and Roberts, J. (1995), 'Complementarities and fit strategies, structure, and organizational change in manufacturing,' *Journal of Accounting Economics*, 19, 179-208.
- Mundlak, Y. (1978), 'On the pooling of time series and cross-sectional data,' *Econometrica*, 46, 69–86.
- Neirotti, P. and Paolucci, E. (2013), 'Why do firms train? Empirical evidence on the relationship between training and technological and organizational change,' *International Journal of Training & Development*, 17, 93-115.
- Nonaka, I. (1991), 'The knowledge creating company,' *Harvard Business Review*, 69, 96-104.
- Nonaka, I., and Takeuchi, H. (1995), *The knowledge-creating company: How Japanese companies create the dynamics of innovation*, New York: Oxford Press.
- Nonaka, I., and Toyama, R. (2007), 'Why do firms differ? The theory of the knowledge-creating firm,' in *Knowledge Creation and Management. New Challenges for Managers*, eds. K. Ichijo and I. Nonaka, New York: Oxford Press, pp.13-31.
- Nyberg, A.J., Moliterno, T.P., Hale, D., and Lepak, D.P. (2014), 'Resource-based perspective on unit-level human capital: A review and integration,' *Journal of Management*, 40, 316-346.
- OECD (2006), *Territorial Review. Milan, Italy*, Paris: OECD Publishing.
- OECD (2005), *Oslo Manual. Guidelines for collecting and interpreting innovation data*, Paris: OECD Publishing.
- Osterman, P. (1995), 'Skill, training and work organization in American establishments,' *Industrial Relations*, 34, 125-146.

- Ram, M., Edwards, P., Gilman, M., and Arrowsmith, J. (2001), 'The dynamics of informality: Employment relations in small firms and the effects of regulatory change,' *Work, Employment and Society*, 15, 854-61.
- Sadler-Smith, E., Sargeant, A., and Dawson, A. (1998), 'Higher level skills training and SMEs,' *International Small Business Journal*, 16, 84-94.
- Sawang, S., and Unsworth, K.L. (2011), 'A model of organizational innovation implementation effectiveness in small to medium firms,' *International Journal of Innovation Management*, 15, 989-1011.
- Sheehan, M. (2013), 'Human resource management and performance: Evidence from small and medium-sized firms' *International Small Business Journal*, Epub ahead of print, 6 January 2013. DOI: 10.1177/0266242612465454.
- Shipton, H., West, M., Dawson, J., Birdi, K., and Patterson, M. (2006), 'HRM as a predictor of innovation,' *Human Resource Management Journal*, 16, 3-27.
- Storey, D. (2004), 'Exploring the link, among small firms, between management training and firm performance: A comparison between the UK and other OECD countries,' *International Journal of Human Resource Management*, 15, 112-130.
- Storey, D., and Westhead, P. (1997), 'Management training in small firms - a case of market failure?' *Human Resource Management Journal*, 7, 61- 71.
- Thornhill, S. (2006), 'Knowledge, innovation and firm performance in high- and low-technology regimes,' *Journal of Business Venturing*, 21, 687-703.
- Tidd, J., Bessant, J., and Pavitt, K. (2001), *Managing Innovation. Integrating technological, market and organizational change*, Chichester: Wiley.
- Waddoups, C. (2012), 'Employer-sponsored training and longer-tenured workers: Evidence from Australia,' *Industrial Relations*, 51, 966-986.
- Walsworth, S., and Verma, A. (2007), 'Globalization, human resource practices and innovation: Recent evidence from the Canadian Workplace and Employee Survey,' *Industrial Relations*, 46, 222-240.
- Way, S. (2002), 'High performance work systems and intermediate indicators of firm performance within the US small business sector,' *Journal of Management*, 28, 765-785.
- Whitfield, K., (2000), 'High-Performance Workplaces, Training, and the Distribution of Skills,' *Industrial Relations*, 39, 1-25.
- Wilkinson, A. (1999), 'Employment relations in SMEs,' *Employee Relations*, 21, 206-217.

- Wooldridge J. (1995), 'Selection corrections for panel data models under conditional mean independence assumptions,' *Journal of Econometrics*, 68, 115-132.
- Wooldridge J. (2002), *Econometric Analysis of cross Section and Panel Data*, Cambridge, Massachusetts: MIT Press.
- Wright P., McMahan G. and McWilliams A. (1994), 'Human resources and sustained competitive advantage: A resource-based perspective,' *International Journal of Human Resource Management* 5, 301-326.
- Wright P., Dunford B. and Snell S. (2001), 'Human resources and the resource based view of the firm,' *Journal of Management*, 27, 701-721.
- Zellner A. (1962), 'An efficient method of estimation seemingly unrelated regressions and tests for aggregation bias,' *Journal of American Statistical Association*, 57, 348-368.