TRAINING AND INNOVATION: THE USE OF INTERNAL LABOUR MARKET CHANNELS TO IMPROVE WORKERS SKILLS. FIRM-LEVEL EVIDENCE FROM ITALY

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Abstract. In order to upgrade the skill workforce the firm has at least two main channels at its disposal: the external labour market strategy, mainly based on hiring and firing mechanisms; the internal labour market strategies, which improve the skill base of the employees through training activities. The main objective of the present work is to verify the relations between innovative strategies and the training activities, deepening the understanding of the relations between technological and organisational innovations and the training activities implemented by the firms. The firm level analysis is based on a unique 'two-periods' panel dataset which include data on manufacturing firms for an Italian, highly industrialised, local production system (the Milan area), located in the Lombardy region. The results suggest that the firms use specific training activities in accordance with the innovation introduced. As a whole it emerges that the upskilling phenomenon is more related to the organisational changes than to technological innovation. In addition, the contextual introduction of organisational and technological change does not seem to favour more training activities.

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1. Introduction

In recent years, it is prevalent in organizational and economic debates a new approach to work organization and human resource management that aims to achieve competitive advantages for the company through the increase of the degree of commitment (identification, commitment, confidence) of workers to the organization [McDuffie 1995, Becker et al. 1997, Roberts 2004]. In this view, investments in job training and skills development of human resources represent a crucial element for firm superior performance [Black and Lynch, 1995, 1996]. Combining training with incentive compensation systems and the opportunity to participate in decisions that affect the working processes, workers increase their degree of identification and satisfaction to the firm and are thus driven to provide their "discretionary effort" to the organization [Appelbaum et al. 2000].
The economic and organizational literature has devoted much attention to the analysis of the factors that can stimulate or discourage investment in training by enterprises [see among others Croce 2006; Castany 2010], as well as many studies have addressed the impact of training on workers - in terms for example of skills development and employability [Conti 2005; Andersen 2008; Bassanini 2005; Dieckoff 2007]- and on firm performance - especially in terms of labour productivity [Black and Lynch 1998; Cedefop 2009].

The issue concerning the human capital/innovation relations is relevant both at macro and micro economic level. Focusing the attention on the latter, at firm level the linkage between human capital and innovation is not trivial at all, especially when the interactions between innovation and high/low skilled workers are considered. Training and innovation may act, also according to the management strategy, as complements: on the one hand, the upgrading of the workforce skill base allows a better exploitation of the implemented innovations; on the other hand, high skilled workers provide the fertile soli over which further innovation may be implemented. It can also be the case that technological change may complement some high skilled workers performances but not others [Autor *et al.*, 2001]. As for the low skilled workers it may be the case that innovations substitute for some less skilled activities but not for others. The argument for the organisational changes and the relationship they have with training activities goes in the same way. Lindbeck and Snower [1997] have argued that recent organisational transformations, concerning the diffusion and adoption of new human resource management practices, could explain as well a shifting toward a demand for high skilled workers [Caroli and Van Reenen 2001; Caroli *et al*. 2001]. However, at the same time an improved skill base may represent an ‘enabler’ for further organisational changes. [Bartel, Ichniowsi, Shaw, 2007]. In synthesis, much of the economic literature pointed out the presence of two relevant ‘mechanisms’ at the basis of the worforce upskilling in the last decades. The most deep rooted explanation calls for technological change as the driver of the bias in labour demand: the

'Skill-Biased Technological Change' (SBTC) explanation [see among many others Berman *et al.*, 1994; Sanders, ter Weel, 2000; Autor *et al.*, 2001][1]. The more recent explanation in the rise of demand for skilled workers is the so called 'Skill-Biased Organizational Change' (SBOC), according to which the implementation of 'bundles' of *High Performance Work Practices (HPWP)*, such as decentralization, delayering, team work, necessitate of more responsible and autonomous workers, with higher skills[2]. Although the two hypothesis explaining the trend in the upskilling of the workforce composition have been ususally studied and developed separately they ought not to be considered as substitutes. On the contrary, in our opinion, they should be studied in a framework of complementarities, as the firm activities concerning technological and organisational innovations can be considered as complementary [Antonioli, 2009; Aghion *et al.*, 1999; Bresnahan, 1999; Caroli, 2001; Milgrom, Roberts, 1990].
The channels through which the firms may improve their workforce skills subsequently to innovations are essentially two [Behaghel, Caroli and Walkowiak 2007]: hiring new workers recurring to external labour markets, thus acquiring from the outside the firm boundaries the required new knowledge and competencies; implementing training activities, that is to say using a typical instrument of internal labour markets to improve the firm workforce skills. These two strategies to improve and extend the skill base of the workforce, in order to complement the innovations introduced, are not strictly substitutes. Each firm can decide the appropriate strategy or mix of strategies according to the relative costs and benefits, which may also depend on the types and intensity of innovative activities implemented. On this respect the geographical location of the firms may be relevant: dense labour markets may be associated to a diffused use of external labour market strategies, because finding the right skills on the external labour market becomes easier and less costly [Behaghel, Caroli and Walkowiak, 2007].

In this work we devote our attention to the internal labour market strategy, in order to disentangle the impact of innovations on training activities implemented by the firms. In so doing we provide further evidence on the Italian context, for which the following studies present some results. Guidetti and Mazzanti [2007] provide evidence on the relation between innovation and training. In particular, focusing the analysis on two Italian local production systems the authors recognize the importance of some practices related to HRM in playing a pivotal role as drivers of training

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[1] For empirical evidence on the SBTC we remind the interested reader to the following works: on Anglo-Saxon countries (e.g. Bartel, Lichtenberg, 1987; Berman *et al*., 1994; Autor *et al.,* 1998; Morrison Paul, Siegel, 2001; Machin, 1996); on European countries (e.g. Goux, Maurin, 2000; Mairesse *et al.,* 2001; Aguirregabiria, Alonso-Borrego, 2001).

[2] Some interesting empirical works that confirm the SBOC hypothesis are: Caroli, Van Reenen (2001), Falk (2001) Caroli *et al.* (2001) and Bauer, Bender (2004).

intensity. The contribution by Antonelli, Antonietti and Guidetti [2010] regards the entire Italian context. The authors put in evidence the role of innovation in impacting the propensity to invest in training. Moreover, the same positive effect is recognisable on two other measures of training: training form and training intensity in terms of share of employees involved.

In this work we focus our attention on a representative sample of manufacturing firms located in a highly industrialised province: Milan in Lombardy region. Following the recent stream of literature that recognise the importance of internal labour markets we aim to supply some evidence useful for understanding the role that innovation plays in training processes developed within manufacturing firms. The main question that arises is: do firms that innovate in technologies of production and work organisation adopt training policies to accompany these change processes?

The micro focus of the work, which relies on empirical data stemming from original surveys on manufacturing firms, allows us to use a wide set of information. The panel structure of our data allows us to consider the role of innovation on training programs implemented by the firm, deepening our understanding of the determinants of firm strategic decisions concerning the human capital development of the workforce.

The paper is organized as follows. Section 2 outlines the data and the empirical model. Section 3 illustrates the main results of the empirical investigation and, finally, section 4 is left to concluding remarks.

2. Data and Methodology

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

The sample on which the analysis is conducted consists of 140 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 2005 and 2008 edition included some parts additional to the standard questionnaire. The standard part of the questionnaire comprises a section devoted to contractual and socio-demographic characteristics of the labour force (e.g. types of contract, sex, qualifications, education, origin, hirings, terminations), one relative to time and absences from work, and one relative to the levels and composition of pay. The additional parts concerned the

work organization and HRM practices used (e.g. autonomous and semiautonomous teamwork, job rotation, multi tasking, appraisals systems, training), the features of industrial relations (e.g. workplace union structure, company-level agreement, joint committees) and some firms characteristics (e.g. technological innovations, collaborative networks, market competitiveness).
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 analyse only the manufacturing firms. Careful selection of the quality of the replies and matching between the respondents of two years generate a sample of 140 manufacturing firms for the development of our analysis.

Table.1 – Distribution of the firms: sample vs. universe

	Population (Istat 2001)		Sample	
	n	%	n	%
Food	462	3.5	7	5.0
Chemical	990	7.5	34	24.3
Rubber	835	6.3	9	6.4
Metal-Machinery	6915	52.5	74	52.9
Textile	1044	7.9	5	3.6
Other manufacturing	2922	22.2	11	7.9
Total	13168	100.0	140	100.0
SME (<250 emp.)	12940	98.3	119	85.0
Large (≥250 emp.)	228	1.7	21	15.0

The distribution of firms reported in Table 1 shows that firms in our sample have a good representativeness in terms of sectoral distribution (though chemicals firms are over represented), while the representativeness by size classes is decidedly lower. However, firms that can be classified as SME (Small and Medium Enterprises) are 85% of the sample: this substantial proportion of small and medium firms was indubitably a strength of the sample. Indeed, existing studies tend to focus on large-sized firms; nevertheless, in order to reach a higher comprehension of the phenomenon, we think that it would be really better to cover also smaller units. This is true especially in country, like Italy, characterized by a particularly low average size of firms in comparative terms.

On the basis of our unique sample, which has a panel structure, we aim to provide evidence of the existence of internal labour market mechanisms that are used to improve the workforce skill base, without necessarily recurring to the external labour markets. Put it another way we are interested in determining the relationship between innovation activities and training programmes (internal labour market mechanism), which are instruments to improve the workforce skill base without recruiting new works (external labour market mechanism).

Hence, the regression equation below (1) has training indexes as dependent variables, capturing the extension and intensity of the training programs in terms of employees involved and hours devoted to training activities, as explained below in more details:

$$(1)\ [Training]_{i,t} = a + b_{0i,t}[controls] + b_{1i,t}[technological\ innovation] + b_{2i,t}[organisational\ innovation] + b_{3i,t}[innovation\ interactions] + u_{i,t}$$

where *i* represents each observation; *b* represent vectors of coefficients, which are related to each vector of independent variables (covariates); *a* represents the constant of the model and *u* represents the error terms. Among the covariates on the right hand side we can distinguish (see tab.A.1 in Appendix for detailed descriptions of the variables): (i) firm structural variables (controls), which give information on sector, size, group belonging, as well as labour contracts (labour flexibility); (ii) technological innovation variables, which include product and process innovations, captured through dummy variables that are used to construct a composite index of innovation intensity; (iii) organisational innovation variables, which are synthesised as well in a composite index, providing information on the intensity of innovation activities in the organisational sphere. It is convenient to underline that frequently, in the skill bias empirical literature, the innovation variables, especially the organizational ones, have been measured as simple dummies [Caroli, Van Reenen, 2001; Bauer and Bender, 2004; Piva *et al.* 2005]. In our case, the richness of micro-level data not only reduces, to some extent, the likelihood of relevant variables being omitted, but also gives an original and essential value added to this study.

The dependent variables are four and capture two main training instruments, which both refer to an internal labour market strategy: internal and external training courses (tab.2). The first two dependents are the share of employees involved in internal courses (EMPSHARE_INTTRAIN) and the hours per capita (over all the employees) devoted to such courses (HOURS_INTTRAIN); the other two dependents provide the same information, but they are referred to external courses (EMPSHARE_EXTTRAIN and HOURS_EXTTRAIN).

Tab.2-Summay statistics and description of the dependent variables

Variable	Description		Mean	Std. Dev.	Min	Max	Obs.
EMPSHARE_ INTTRAIN	Number of employees involved in internal training courses/Total number of employees	overall	0.1900	0.2861	0	1	N = 280
		between		0.2354	0	1	n = 140
		within		0.1642	-0.3099	0.6900	T = 2
HOURS_ INTTRAIN	Amount of training hours for internal course/Total number of employees	overall	0.3976	0.4499	0	1	N = 280
		between		0.3705	0	1	n = 140
		within		0.2563	-0.102	0.8976	T = 2
EMPSHARE_ EXTTRAIN	Number of employees involved in external training courses/Total number of employees	overall	0.1344	0.2077	0	1	N = 280
		between		0.1613	0	0.6407	n = 140
		within		0.1312	-0.342	0.6116	T = 2
HOURS_ EXTTRAIN	Amount of training hours for external course/Total number of employees	overall	0.4703	0.4591	0	1	N = 280
		between		0.4034	0	1	n = 140
		within		0.2207	-0.029	0.9703	T = 2

The empirical analysis is based on panel data econometrics. Pooled, fixed effects (FE) and random effects (RE) estimations were carried out, but only the results from the random effects model are reported in the next section. This is due both because our data are plausibly better fitted by a RE model, since we deal with a random sample drawn from a population of firms, and because the Hausman test carried out in order to verify which of the two models, FE or RE, is to be chosen almost always prefer the RE, but for the specifications having as dependent HOURS_EXTTRAIN. Indeed, from a conceptual point of view, dealing with random draws from a population, as in our case, it does make sense to treat the error component as random draws from the population as well (Wooldridge, 2001). Moreover, in cases where the key variables do not vary too much over time, as in our sample, FE can lead to imprecise estimates. Hence, both for conceptual reasons and for the information provided by the Hausman test we prefer the RE model to be applied in our analysis.

Another point it is worth stressing concern the use of an interaction variable between technological and organizational innovation indexes constructed as the product of the two indexes. Such a product is obtained using the mean-centered indexes so that the centered indexes (c_InnoTech and c_InnoOrg) and the interaction term (InnoTech*InnoOrg) can be simultaneously included in the regression specification avoiding potential problems of multicollinearity. Contextually doing more of the two innovation activities may be relevant for the intensity of training undergone by the firms.

3. Results

In the following tables (tabb.3 and 4) the sets of results deriving from the equation (1) specification, alternatively using our different dependent variables, are reported. In both the tables of results the first model (1) includes, for each dependent, the innovation composite index as main explicative variables, the second model (2) includes the interaction between the two innovation composite indexes and the last one (3) comprises the single innovation variables that have been used to construct the additive composite indexes, in order to provide a closer look to the specific innovative activities related to training programs.

The comments will concern the RE results, which are similar to the simple OLS pooled and which are preferred to the FE results by the implementation of the Hausman test as reported at the bottom of each table[3]. The first three columns provide the results for the share of employees involved in internal training programs (EMPSHARE_INTTRAIN) and the last three columns have the hours per capita devoted to internal programs as dependent (HOURS_ INTTRAIN).

At first we can appreciate the negative impact given by the small size (SME dummy) on the share of workers involved in training programs. Small firms may have less resources to devote to training activities and they may be less interested in improve the workforce skills because they are less interested by international competition that calls for continuous investment in human capital in order to remain competitive. The other controls do not seem to be relevant in determining the share of employees involved in training programs.

Turning now to the innovation variables, we can see from model (1) and (2) that only the composite index of organisational innovation, which proxy the intensity of innovation over several organisational aspects, has a positive and significant impact. This result coupled with the absence of significance for technological innovation both in model (1) and (2), with the lack of significance of the interaction term (INNOTECHORG_C) and of the single organisational innovation aspects leads to conclude that the share of employees involved in training programs is influenced by the overall intensity of organisational innovation: innovating in several organisational aspects matters more than innovating in single organisational aspects.

Looking at the results for the training hours per capita as a dependent (HOURS_ INTTRAIN) it is possible again to appreciate the role of firm size. Moreover, it is now the presence of firm level union representative to gain a high level of significance. We may hypothesise that where the workers are able to make their voice listen through the instrument of the union, then they are able to obtain more in terms of training intensity: the training coverage is unaffected by the presence of union representative, but the hours of training per capita is affected by the union presence. We cannot exclude the possibility that part of such hours are devoted to standard types of training, directly bargained at firm level and involving safety and security issues, probably more ‘felt’ and discussed in unionised context rather than in non-unionised ones. The textile sector acquires a negative significant impact: in a low value added sector the amount of hours devoted to formal

[3] The full set of results for FE and pooled OLS are available upon request from the authors.

training programs is less than that devoted in the food sector, which is the benchmark sector in the specification. The temporal dimension matters as well: training hours per capita for internal courses were significantly lower in 2005 than in 2008.

Finally, what is more important are the results of both the technological and organisational innovation variables in model (1), which are significant and highly significant respectively, implying a positive impact of innovations in the intensity of training activities. However, such a positive impact holds if the innovation strategies in technology and organisation are somehow distinct. The interaction of the two innovation variables, capturing high intensity in innovation on both technology and organisation, does not provide significant results as model (2) shows. The third model points out the single innovation aspects that drive the sign of the composite indexes. As it can be seen the technological innovation that influence the amount of training hours per capita concerns the coordination of activities in the production process: that is to say the information and communication technologies introduced in order to manage the production process. As far as the organisational dimension is concerned it is the introduction of practices regarding the polyvalence of the employees on more than one task.

In synthesis we may argue that in presence of innovations the firms do not react widening the ‘audience’ of internal training activities, but they react providing more training to ‘the same audience’ that probably would have received some training also in the absence of organisational changes. We may concluded that the upskilling of the competences, at least as far as internal programs are concerned, is likely to involve the same workers from time to time, which are called to further improve their skills in presence of organisational changes and technological innovations.

Tab. 3 – Results from Random Effects models for internal training programs

	(1)	(2)	(3)	(1)	(2)	(3)
		EMPSHARE_INTTRAIN			HOURS_ INTTRAIN	
D2005	-0.021	-0.017	-0.025	-0.116^{**}	-0.084	-0.110^{*}
	(0.034)	(0.030)	(0.035)	(0.057)	(0.054)	(0.058)
Chemical	-0.046	-0.049	-0.038	-0.022	-0.023	0.020
	(0.141)	(0.138)	(0.144)	(0.116)	(0.116)	(0.128)
Rubber	-0.088	-0.094	-0.064	-0.033	-0.035	0.020
	(0.145)	(0.143)	(0.151)	(0.186)	(0.187)	(0.192)
Metal-Machinery	0.031	0.032	0.046	-0.020	-0.019	0.027
	(0.142)	(0.139)	(0.148)	(0.108)	(0.107)	(0.121)
Textile	-0.115	-0.103	-0.090	-0.329^{***}	-0.322^{***}	-0.253^{*}
	(0.142)	(0.139)	(0.145)	(0.117)	(0.116)	(0.137)
OtherManufacturing	-0.030	-0.019	-0.030	-0.159	-0.153	-0.133
	(0.152)	(0.150)	(0.159)	(0.131)	(0.131)	(0.142)
SME	-0.226^{***}	-0.226^{***}	-0.234^{***}	-0.297^{***}	-0.297^{***}	-0.318^{***}
	(0.079)	(0.077)	(0.079)	(0.080)	(0.080)	(0.082)
Flexdip	0.065	0.108	0.017	0.638	0.654	0.623
	(0.413)	(0.419)	(0.418)	(0.769)	(0.773)	(0.769)
ShareHighSkilledWC	0.330	0.338	0.349^{*}	0.179	0.182	0.196
	(0.211)	(0.208)	(0.209)	(0.231)	(0.232)	(0.228)
ShareLowSkilledWC	0.067	0.062	0.068	0.180	0.178	0.190
	(0.098)	(0.097)	(0.100)	(0.137)	(0.137)	(0.142)
UnionRepresentative	0.039	0.036	0.037	0.209^{***}	0.208^{***}	0.204^{***}
	(0.042)	(0.042)	(0.041)	(0.066)	(0.066)	(0.065)
Compet Compet	-0.016	-0.023	-0.010	-0.013	-0.016	0.012
	(0.085)	(0.085)	(0.083)	(0.131)	(0.131)	(0.130)
InnoTech	0.002			0.131^{*}		
	(0.047)			(0.073)		
InnoOrg	0.143^{*}			0.337^{**}		
	(0.074)			(0.135)		
c_ InnoTech		0.007			0.134^{*}	
		(0.046)			(0.073)	
c_ InnoOrg		0.173^{**}			0.352^{***}	
		(0.076)			(0.135)	
InnoTech*InnoOrg		-0.283			-0.158	
		(0.178)			(0.344)	
InnoProc			-0.047			-0.062
			(0.048)			(0.066)
InnoCoo			0.047			0.195^{***}
			(0.053)			(0.071)

Dec			0.054			0.011
			(0.075)			(0.096)
AutTW			-0.009			0.045
			(0.065)			(0.103)
SemiAutTW			-0.027			-0.014
			(0.079)			(0.113)
Pol			0.088			0.151*
			(0.061)			(0.092)
Rot			0.051			0.140
			(0.068)			(0.103)
Cons	0.264*	0.310*	0.244	0.396**	0.520***	0.339*
	(0.159)	(0.159)	(0.166)	(0.180)	(0.181)	(0.191)
N	215	215	215	215	215	215
r2_o	0.200	0.210	0.221	0.299	0.300	0.324
sigma_u	0.155	0.152	0.149	0.120	0.121	0.114
sigma_e	0.221	0.222	0.225	0.382	0.384	0.379
rho	0.332	0.319	0.305	0.090	0.090	0.082
Hausman test:						
FE vs RE (p-val)	0.237	0.223	0.460	0.8281	0.879	0.655

Notes: Standard errors in parentheses; levels of significance * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Looking at the results for the external training activities we can see that the role of firm size weakens (tab.4), at least for the share of employees involved in external training programs (EMPSHARE_EXTTRAIN). Such a result seems to imply that the investment capacity is not relevant for the implementation of training programs outside the firms boundaries, telling us that to some extent such training activity could be compulsory for the firms, that is to say external training courses concerns compulsory issues. In terms of sectors, the rubber sector join the textile one in showing a negative significance impact on external training activities, at leas as far as the share of employees is concerned. Overall it may be said that sector specificities are likely to be important in influencing training decisions. Coupled with such a result we notice that the presence of high skilled white collars and that of union representatives are relevant as well. If for the presence of union representatives the explanation goes as above, as far as the role of the workforce composition is concerned it can be argued that having higher shares of high skilled white collars, that is to say managers and supervisors, positively impact on the coverage of training programs in terms employees involved because this kind of employees is that more involved in training activities, in order to avoid their competences to become obsolete.

Focusing on the innovation variables the evidence points to an absence of their influence for the training coverage in terms of employees involved (EMPSHARE_EXTTRAIN), consistently with the case of internal courses. However, it is worth stressing two significant organisational changes in model (3): a negative sign for task rotation and a positive sign for workers polyvalence. The two contrasting signs probably offset each others in the composite organisational index leading to a not significant result for it. Moreover we have to notice that task rotation is more consistent with work-shadowing, informal forms of skill upgrading, justifying the negative relation with formal programs, while, on the other side, the workers polyvalence is consistent with formal training programs as external courses.

On the side of training hours per capita (HOURS_EXTTRAIN) the role of innovation re-emerges. In particular, both the technological and the organisational composite indexes turn to be significant. The result for technological innovation seems to be consistent with a strategic behaviour of the firms more oriented to innovation implementation rather than innovation ‘creation’. In fact, it might be the case that once a new product or technology is adopted a quota of training hours goes to training provided by the producer of the technology adopted, since the knowledge related to the new technology adopted is external to the firm. Hence, the training channel that needs to be activated in order to acquire the competences to fully exploit the innovation adopted regards external training courses but the share of personnel involved may be unaffected because the courses are likely

addressed to the group of employees that deals with the relevant innovation introduced and not to all the workers, so that for the workers involved the hours spent in external training activities rises.
The much stronger evidence for organisational innovation seems to imply that once several organisational aspects are deeply touched by changes, as it is synthesised by the composite index, there is a need to upgrade the competences of a small share of employees both with internal and external training programs, as the results on internal training shows as well.
Thus, innovations seems to induce an upskilling trend through training programs for a small share of the employees, likely those more involved in the changes introduced being them of technological or organisational nature.

Tab. 4 – Results from Random Effects models for external training programs

	(1)	(2)	(3)	(1)	(2)	(3)
		EMPSHARE_EXTTRAIN			HOURS_EXTTRAIN	
D2005	-0.019	-0.011	-0.017	-0.116**	-0.084	-0.123**
	(0.027)	(0.026)	(0.026)	(0.057)	(0.054)	(0.050)
Chemical	-0.028	-0.029	-0.037	-0.022	-0.023	-0.004
	(0.089)	(0.090)	(0.091)	(0.116)	(0.116)	(0.170)
Rubber	-0.199**	-0.200**	-0.198**	-0.033	-0.035	-0.312
	(0.094)	(0.095)	(0.098)	(0.186)	(0.187)	(0.220)
Metal-Machinery	-0.124	-0.123	-0.129	-0.020	-0.019	-0.198
	(0.092)	(0.092)	(0.094)	(0.108)	(0.107)	(0.162)
Textile	-0.201**	-0.196**	-0.203**	-0.329***	-0.322***	-0.380
	(0.093)	(0.092)	(0.097)	(0.117)	(0.116)	(0.239)
OtherManufacturing	-0.073	-0.069	-0.089	-0.159	-0.153	-0.167
	(0.112)	(0.111)	(0.113)	(0.131)	(0.131)	(0.182)
SME	0.073	0.073	0.061	-0.297***	-0.297***	-0.060
	(0.046)	(0.045)	(0.044)	(0.080)	(0.080)	(0.094)
Flexdip	-0.153	-0.143	-0.140	0.638	0.654	-0.717
	(0.224)	(0.229)	(0.219)	(0.769)	(0.773)	(0.510)
ShareHighSkilledWC	0.281**	0.283**	0.253**	0.179	0.182	0.270
	(0.126)	(0.126)	(0.126)	(0.231)	(0.232)	(0.251)
ShareLowSkilledWC	0.067	0.066	0.027	0.180	0.178	0.317**
	(0.063)	(0.064)	(0.062)	(0.137)	(0.137)	(0.140)
UnionRepresentative	0.045	0.045	0.047	0.209***	0.208***	0.226***
	(0.029)	(0.029)	(0.029)	(0.066)	(0.066)	(0.072)
Compet Compet	0.044	0.042	0.048	-0.013	-0.016	0.060
	(0.064)	(0.065)	(0.063)	(0.131)	(0.131)	(0.129)
InnoTech	0.030			0.131*		
	(0.032)			(0.073)		
InnoOrg	0.036			0.337**		
	(0.059)			(0.135)		
c_ InnoTech		0.032			0.134*	
		(0.032)			(0.073)	
c_ InnoOrg		0.047			0.352***	
		(0.063)			(0.135)	
InnoTech*InnoOrg		-0.106			-0.158	
		(0.128)			(0.344)	
InnoProc			0.015			0.054
			(0.032)			(0.074)
InnoCoo			0.013			0.108
			(0.037)			(0.073)

Dec			-0.024			0.056
			(0.043)			(0.107)
AutTW			0.080			-0.044
			(0.052)			(0.108)
SemiAutTW			-0.032			-0.037
			(0.044)			(0.104)
Pol			0.091**			0.050
			(0.043)			(0.086)
Rot			-0.109**			0.002
			(0.048)			(0.089)
Cons	0.028	0.047	0.063	0.396**	0.520***	0.350
	(0.092)	(0.096)	(0.100)	(0.180)	(0.181)	(0.223)
N	215	215	215	215	215	215
r2_o	0.202	0.203	0.240	0.299	0.300	0.289
sigma_u	0.044	0.044	0.040	0.120	0.121	0.280
sigma_e	0.179	0.180	0.179	0.382	0.384	0.294
rho	0.057	0.056	0.048	0.090	0.090	0.476
Hausman test:						
FE vs RE (p-val)	0.425	0.551	0.884	0.034	0.036	0.081

Notes: Standard errors in parentheses; levels of significance * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4. Conclusions

With respect to our main research question, i.e. whether or not the intensity and the coverage of training activities are driven by the implementation of organizational and technological innovations, the analysis described above shows two main results. First, innovation seems to act as driver for training firms investments only with regards to some specific occupational group, i.e. the ones involved in the innovation processes, while it seems to have none effect for the employees not involved in such processes. Second, organizational changes seem to matter more than technological innovation in explaining firms' training strategy. In this regard, an explanation concerns the nature of organizational changes: autonomous teams, rotation over tasks and polyvalent workers call for a more skilled workforce. Indeed, the introduction of such organizational changes leaving the skill base unaltered does not seem to be a consistent strategy.

Other relevant findings concern the role of firm size, which is more related to the adoption of internal training courses. The reason here is quite intuitive and lies in the costs of this kind of training activities. Indeed, internal training requires firms to have space, competencies (or money to acquire it), time, and a considerable number of employees to involve in training courses; it is very hard for small businesses to meet all these requirements.

Finally the presence of structured workplace industrial relations (i.e. the presence of trade union employees' representatives) positively influences the adoption of training initiatives. However, unions seems not able to influence the coverage of training programs; this represents one of the main challenges for unions in the modern workplace and future studies in this field should devote greater attention to this aspects.

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Appendix

Tab.A1-Variable description

	CONTROLS
D2005	Year dummy for the 2005
Sectors	Dummies (Food, Chemical, Rubber, Metal-Machinery, Textile, Other Manufacturing)
Size (SME, Large)	Dummies
UnionRepresentative	Dummy: 1 if union representatives are in the firms; 0 otherwise
Compet	Index of competition level for the firm: 0 local, 1 regional, 2 national, 3 international. Rescale in the interval (0,1)
Flexdip	Share of employees with non-permanent contracts
ShareBC	Blue Collars/Total employees
ShareHighSkilledWC	HighSkilled White Collars (Managers and Middle Managers)/Total employees
ShareLowSkilledWC	LowSkilled White Collars (Clerks)/Total employees
	INNOVATIONS
InnoTech	Index of technological innovation. Average of the sum of product and process innovation dummies. Interval (0,1)
InnoOrg	Index of organisational innovation. Average of the sum of organizational innovation dummies: delayering, autonomous teams, semi-autonomous teams, task 'polyvalence', task rotation. Interval (0,1)
c_InnoTech	InnoTech index centered around its mean
c_InnoOrg	InnoOrg index centered around its mean
InnoTech*InnoOrg	Product between c_InnoTech and c_InnoOrg
InnoProc	Dummy: 1 if technological innovation in process occurred; 0 otherwise
InnoCoo	Dummy: 1 if technological innovation in coordinating production activities (IT) occurred; 0 otherwise
Dec	Decentralise decisional activities (0 if no employees are involved; 1 if less than 30% employees are involved; 2 if more than 30% employees are involved)
AutTW	Autonomous team working (0 if no employees are involved; 1 if less than 30% employees are involved; 2 if more than 30% employees are involved)
SemiAutTW	Semi-autonomous team working (0 if no employees are involved; 1 if less than 30% employees are involved; 2 if more than 30% employees are involved)
Pol	Employees polyvalence over more than one task (0 if no employees are involved; 1 if less than 30% employees are involved; 2 if more than 30% employees are involved)
Rot	Rotation over several tasks (0 if no employees are involved; 1 if less than 30% employees are involved; 2 if more than 30% employees are involved)

Tab.A1-Summary statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
Food	overall	0.050	0.218	0.000	1.000	N = 280
	between		0.219	0.000	1.000	n = 140
	within		0.000	0.050	0.050	T = 2
Chemicals	overall	0.243	0.430	0.000	1.000	N = 280
	between		0.430	0.000	1.000	n = 140

	within		0.000	0.243	0.243	T =	2
Rubber	overall	0.064	0.246	0.000	1.000	N =	280
	between		0.246	0.000	1.000	n =	140
	within		0.000	0.064	0.064	T =	2
Machinery	overall	0.529	0.500	0.000	1.000	N =	280
	between		0.501	0.000	1.000	n =	140
	within		0.000	0.529	0.529	T =	2
Textile	overall	0.036	0.186	0.000	1.000	N =	280
	between		0.186	0.000	1.000	n =	140
	within		0.000	0.036	0.036	T =	2
OtherManifactures	overall	0.079	0.270	0.000	1.000	N =	280
	between		0.270	0.000	1.000	n =	140
	within		0.000	0.079	0.079	T =	2
UnionRepresentative	overall	0.484	0.501	0.000	1.000	N =	277
	between		0.479	0.000	1.000	n =	139
	within		0.147	-0.016	0.984	T =	2
SME	overall	0.843	0.365	0.000	1.000	N =	280
	between		0.360	0.000	1.000	n =	140
	within		0.060	0.343	1.343	T =	2
Large	overall	0.157	0.365	0.000	1.000	N =	280
	between		0.360	0.000	1.000	n =	140
	within		0.060	-0.343	0.657	T =	2
Compet	overall	0.792	0.219	0.000	1.000	N =	265
	between		0.197	0.167	1.000	n =	139
	within		0.096	0.292	1.292	T =	2
Flexdip	overall	0.032	0.049	0.000	0.300	N =	280
	between		0.040	0.000	0.240	n =	140
	within		0.029	-0.113	0.177	T =	2
ShareBC	overall	0.353	0.304	0.000	1.000	N =	280
	between		0.295	0.000	1.000	n =	140
	within		0.075	-0.007	0.713	T =	2
ShareHighSkilledWC	overall	0.157	0.156	0.000	0.760	N =	280
	between		0.150	0.000	0.730	n =	140
	within		0.043	-0.078	0.392	T =	2

ShareLowSkilledWC	overall	0.463	0.229	0.000	1.000	N = 280
	between		0.217	0.000	0.955	n = 140
	within		0.076	0.143	0.783	T = 2
InnoTech	overall	0.356	0.424	0.000	1.000	N = 263
	between		0.343	0.000	1.000	n = 139
	within		0.257	-0.144	0.856	T = 2
InnoOrg	overall	0.262	0.206	0.000	1.000	N = 223
	between		0.170	0.000	0.750	n = 126
	within		0.117	-0.088	0.612	T = 2
c_InnoTech	overall	0.000	0.406	-0.477	0.765	N = 263
	between		0.340	-0.477	0.765	n = 139
	within		0.228	-0.621	0.621	T = 2
c_InnoOrg	overall	0.000	0.206	-0.265	0.735	N = 223
	between		0.170	-0.265	0.488	n = 126
	within		0.117	-0.347	0.347	T = 2
InnoTech*InnoOrg	overall	0.018	0.085	-0.173	0.335	N = 215
	between		0.065	-0.136	0.256	n = 123
	within		0.057	-0.178	0.214	T = 2
InnoProc	overall	0.376	0.485	0.000	1.000	N = 263
	between		0.396	0.000	1.000	n = 139
	within		0.286	-0.124	0.876	T-bar = 1.892
InnoCoo	overall	0.335	0.473	0.000	1.000	N = 263
	between		0.375	0.000	1.000	n = 139
	within		0.293	-0.165	0.835	T-bar = 1.892
Dec	overall	0.262	0.303	0.000	1.000	N = 223
	between		0.256	0.000	1.000	n = 126
	within		0.168	-0.238	0.762	T-bar = 1.769
AutTW	overall	0.197	0.317	0.000	1.000	N = 223
	between		0.255	0.000	1.000	n = 126
	within		0.193	-0.303	0.697	T-bar = 1.769
SemiAutTW	overall	0.244	0.318	0.000	1.000	N = 223
	between		0.252	0.000	1.000	n = 126
	within		0.200	-0.256	0.744	T-bar = 1.769
Pol	overall	0.365	0.345	0.000	1.000	N = 223
	between		0.297	0.000	1.000	n = 126

	within		0.187	-0.135	0.865	T-bar = 1.769

Rot	overall	0.242	0.321	0.000	1.000	N = 223
	between		0.276	0.000	1.000	n = 126
	within		0.179	-0.258	0.742	T-bar = 1.769