DOES TRAINING EXPLAIN INNOVATION IN TRANSITION ECONOMIES?

Antonella Biscione
CESPIC, Catholic University "Our Lady of Good Counsel"

Chiara Burlina
"Marco Fanno" Department of Economics and Management, University of Padova

Raul Caruso
Department of Economic Policy and CSEA, Università Cattolica del Sacro Cuore, CESPIC Catholic University "Our Lady of Good Counsel"

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Antonella Biscione
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Chiara Burlina
"Marco Fanno" Department of Economics and Management, University of Padova

Raul Caruso
Department of Economic Policy and CSEA, Università Cattolica del Sacro Cuore,
CESPIC Catholic University "Our Lady of Good Counsel"

Abstract: *Training has generally been linked to firm's innovation propensity, but evidence remains sparse on the role of different typologies of training for firms in transition economies. Using a unique sample from the World Bank Enterprise Surveys (wave 2018-2020), we test the effect of training programs on innovation in 27 countries of Eastern Europe and Central Asia. We test several definitions of training, and our results show that both product and process innovations benefit from all the proposed activities. To validate our findings, we employ a specific instrumental variable approach by applying the Lewbel's special regressor technique, whose outcome confirms our baseline results. Our contribution is twofold: first, we exploit a new database for transition countries that fill the gap in the literature on training programs also in these economies; second, for a policy perspective, we highlight the need to invest and promote training to boost innovation capacity of firms in these countries to reach the level of developed economies.*

Keywords: Transition economies; Innovation; Training programs

JEL: O14; O32; P27; P36

1. Introduction

The aim of this paper is to extend our understanding of the relationship between different training programs and innovative activities of firms in transition countries by exploiting firm-level data. Most research on this topic has been mainly conducted in developed countries and most studies show a positive effect of training on innovation (i.e., Cozzarin and Percival, 2023; Caloghirou et al., 2018; Protogerou et al., 2017). Conversely, findings are conclusive in developing transition economies (van Uden et al., 2017, Capozza and Divella, 2019; Nazarov and Akhmedjonov, 2012). However, such research is particularly important for the latter groups of countries because investments in R&D of firms are lower than developed economies and therefore firms must rely upon on-job training programs to both improve skills of workforce and stimulate innovation (Lenihan et al., 2019; Vona and Consoli, 2015; Romijn and Albaladejo, 2002) especially in transition countries where innovative activities have experienced a setback due to the financial crises of 2008/2009 (Friz and Gunther, 2021).

Then, this paper contributes to the topic in several aspects. We test the relation between training programs and innovation using a different classification of training. We group training activities drawing inspiration from the classification proposed by Dostie (2018) and Cozzarin and Percival (2023). We run this analysis for 27 transition economies of Eastern Europe and Central Asia [1], exploiting a unique firm-level sample from the World Bank Enterprise Surveys, conducted between 2018 and 2020. We start with a probit model and then we also perform an instrumental variable (IV) approach to account for potential endogeneity issues arising from the innovation propensity and training activities. The general findings highlight that training is positively associated with innovation and this result appears to be confirmed for both process and product innovation. To provide additional support to the analysis, we re-run the baseline model using an alternative classification of the different types of training. Regardless of the categorization of the training activity, our results lead to the same outcome: training seems to be a necessary condition for innovation for the firms in our sample.

The remainder of the article is structured in the following way: the next section presents the literature related to training programs and innovation; Section 3 describes the data and

[1] The countries included among the transition economies are: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kosovo, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Tajikistan, Ukraine, Uzbekistan.

the methodology used in the empirical study, whose basic results are reported and discussed in Section 4. Section 5 presents robustness check and finally, the last section concludes and outlines the main contributions of the paper.

2. Literature survey

2.1 Training activities and innovation

Among all human resources, training is crucial to enhance the intangible resources of firms and contribute to their innovative performance (Martins, 2021; Moretti and Biancardi, 2020). Most previous firm-level research focused on the relationship between generic[2] training and innovation (Aghion, 2018; Dearden et al., 2006; Bartel, 2000) not considering the specific training content. Quite the contrary, the empirical literature on the relationship between in-firm specific training and innovation is relatively scarce, particularly in relation to the impact of different training programs on innovation in transition economies. Thus, in what follows we survey the existing literature on the relationship between training programs and innovation strategies. In particular, the survey is organized grouping the literature according to the countries analyzed: developed and transition and emerging countries. The earlier empirical study on the effect of training on innovation focused on developed countries is carried out by Laplagne and Bensted (1999). Using information taken from the Australian Workplace Industrial Relations Survey (AWIRS) on medium and large workplaces, the authors investigate the effect of formal training on both innovation and workplace performance. Findings indicate a positive association between training and innovation in workplaces which experiences a strong labour productivity growth. Laursen and Foss (2003), exploring data on manufacturing firms from a Danish survey conducted in 1996, examine the link between human resource management (HRM) systems and innovation performance. The empirical evidence demonstrates that HRM system dominated by firms providing both internal and external training to their workforce innovates more than firms offering only internal training. Using data from the Survey of Enterprise in Northern Britain in 2001, Freel (2005) investigates the association between firm-level innovativeness and a variety of indicators of skills, such as the training activity.

[2] Cordón-Pozo et al. (2017) distinguish between generic and specific training. Generic training aims at improving skills of employees in general, while the training type contributes to the development of specific knowledge and skills.

Showing that this correlation depends on the intensity of training and the sector under study, the analysis reveals that the service sector is more training-intensive than the manufacturing sector. The research also shows that firms in manufacturing sector with a higher training intensity are more likely to be involved in incremental innovation activities in both product and process innovation. Employing the Spanish Business Strategies Survey data on manufacturing firms in low and medium technology industries, Santamaria et al. (2009) investigate how the innovation activities in enterprises may depend on both non-formal R&D strategies and the use of external sources. Results show that training activities are crucial factors for product and process innovations during the period 1998-2002. Bauernschuster et al. (2009) using German firm level data from 1997-2002 to explore whether training is a necessary condition for achieving successful innovation and operating on the technological frontier show a strong relationship between continuous training and innovation. Zhou et al. (2011) analyze the impact of the flexible labor on product innovation in firms operating in Netherlands for the period 1993-2001 finding a positive association between training and innovation. This relation emerges also in the work of Gallié and Legros, (2012) when they study the effects of human capital and technological capital on innovation in French manufacturing firms during the period 1986-1992. Moving to more recent studies, González et al. (2016), exploit data drawn from the Survey on Business Strategies over the period 2001-2011 to observe the effect of training programs on radical and incremental innovation in Spanish manufacturing firms; they show that in small firms training enhances incremental innovation, whereas in large ones on-the-job training positively impacts radical innovation. In the same vein, Cordón-Pozo et al. (2017), exploiting data from Spanish firms belonging to the Technology Innovation Panel for the period 2007-2012, highlight the importance of a specific innovation training program in the development of product innovations. Their findings also show that the positive effect of training on innovation is more pronounced when firms cooperate with external partners.

Considering the European survey carried out during 2010-2011 and focusing on a set of European countries, Protogerou et al. (2017) investigate the impact of different intangible sources on innovation performance. The authors find a positive effect of training activities on both product and process innovations in young firms. Børing (2017) focusing on Norwegian companies for the period 2008-2010 examines the nexus between firms' innovation activities and training considered as a method to create new ideas among the employees finding a significant impact of training on innovation changes and this effect is even stronger when combined with education. Caloghirou et al. (2018) exploiting data on Greek manufacturing firms during times of economic crisis (2011 and 2013) confirm that there is a positive and significant correlation between training and product innovation also during this turbulent time.

When distinguishing between different forms of training, Cozzarin and Percival (2023) investigate the impact of a set classroom training programs – i.e. managerial training, professional training, apprenticeship training, sales and marketing training – on technological innovation of Canadian firms. Their results show a positive relationship between training activities and product and process innovation when they are combined, while when process and product innovation are considered separately, the results highlight that training has a strong effect only on the first innovative activity and particularly on the improved products rather than on new ones. A positive effect is also documented by Dostie (2018) grouping the four categories of training into two broader ones: classroom and on-the-job training. He finds that both reveal a positive and significant effect on innovation. Based on previous literature we expect that training will positively affect firms' innovative capacities.

2.2 Training in transition economies

Despite the abundance of literature on training activities and innovation in developed countries, there are just very few studies dealing with this topic in transition economies. Since the beginning of the 20th century, these countries have been developing faster and some of them have been converging to the EU-15 standards in terms of GDP per capita and technological change (Cieślik and Wciślik, 2020). Among the policies put in place to boost firm's economic and innovation performance, Czech Republic has implemented ad-hoc training activities to deal with information and communication technologies (Lloyd-Reason et al., 2002). On the same vein, a survey conducted in multinational firms in Kazakhstan reveals that trained employees positively affect overall firm performance indicators. However, these studies do not clearly identify the type of training performed. On the contrary, Nazarov and Akhmedjonov (2012) explore the impact of education and on-the-job training on firms' performance in Central and Eastern Europe in terms of product innovation during the period 2002-2005. Based on the Business Environment and Enterprise Performance Survey data (BEEPS II and III), results indicate that university education does not improve the ability of firms to introduce new products, while training plays a key role in fostering innovation. Interestingly, the results also reveal that, in transition economies, innovation relies more on the absorption of new technologies than on inventing new ones. Van Uden, Knoben and Vermeulen (2017) explore how various combinations of human capital - schooling, formal training, and employee slack time - have an impact on innovation for a set of firms belonging to several Sub-Saharan countries using data from the Enterprise Survey of the World Bank. The results demonstrate that both formal training and slack time spent on developing new ideas are key factors for innovation. Capozza and Divella (2019) employing data on Eastern Europe and Central Asia taken from the Business Environment and Enterprise Performance Survey (BEEPS V) show that on-the-job training drives business innovation in a set of transition economies.

Despite the recent evidence on the impact of different training programs and innovation in developed economies, much remains unexplored in transition countries. Therefore, the goal of this paper is to fill this gap by investigating how different types of training programs, following the two classifications proposed by Cozzarin and Percival (2023) and Dostie (2018), affect the innovation propensity of firms in transition countries.

3. Data and empirical methodology

3.1 Data description

To test the relation between training activities and innovation, we rely on firm-level data drawn from the World Bank Enterprise Surveys (hereinafter WBES[3]) conducted in 2018-2020. The survey collects information on private firms operating in non-agricultural sectors. The sectors are: manufacturing, construction, services, transport, storage, communication, and IT in accordance with the classification ISIC Revision 3.1. The excluded sectors are financial intermediation, real estate and renting activities and, finally, public services and utilities. Respondent firms derive from a stratified random sample technique, considering region, sector, and firm dimension. This reduces the

[3] WBES is part of a joint initiative of the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB) and the World Bank Group (WBG). The surveys were performed in a two-step procedure. In the first step, a telephone questionnaire was conducted to assess eligibility and schedule appointments, while in the second, a face-to-face interview was carried out with the Manager/Owner of each firm.

selection bias and provides a representative population structure of firms in each country. Each wave of the survey collects information on innovation behaviour of firms, innovative activities, organization practices, management, employees, and environmental corporate issues.

To measure firm's innovation propensity, we consider both product and process innovations. We distinguish among those firms that have implemented product or process innovation in the last three years. We build to separate dummy variables taking value 1 if the firms conduct product or process innovation, 0 otherwise. Moreover, as some firms do both product and process innovation, we build a categorical variable taking value 1 in presence of product innovation, 2 for process innovation, 3 if a firm does both, and 0 if there are no innovation implemented.

Following Cozzarin and Percival (2023), we build our training variable as a categorical one taking values from 0 to 4 as follows: 0 if the firm declares no training activities; 1 if the firm claims to perform *mathematical-related training*, which groups numeracy or math skills and problem solving or critical thinking skills; 2 stands for *commercial-related training*, which includes foreign language skills and interpersonal and communication skills; 3, for *managerial-related training* which includes managerial and leadership skills and job-specific technical skills; and, 4 for *other non-specified* training activities.

Based on the four categories expressed by Cozzarin and Percival (2023), we group defined and undefined training activities in a categorical variable divided as follows: 1 for those types of training that are *defined*, that is mathematical, commercial, managerial, 2, for *undefined training*, i.e. other non-specified training activities, and 0 if the company does not train at all.

The second set of training-related indicators follows the classification proposed by Dostie (2018). We build a categorical variable taking value 1 for the *in-class* training, which includes numeracy or math skills, problem solving or critical thinking skills, and foreign language skills; 2 for *on-the-job* training that is based on managerial and leadership skills, interpersonal and communication skills, and job-specific technical skills, 3 for *non-defined* training programs and 0 if the firm does not offer any training activities.

Thus, we end up with three sets of indicators for training activities: one very specific set is based on each training performed by the company, and two additional ones are based on this first definition.

Among the controls, we include human capital proxied by the percentage of full-time workers holding a university degree and the number of years spent by top managers in that specific sector. To capture any gender-driven differences, we employ a dummy variable that takes the value of 1 if the firm is run by female and 0 otherwise. To control the organizational composition of the firm, we consider the percentage of firms held by one or more persons, to identify the ownership structure of the company. To proxy for the past R&D capacity of the firm, we include in the model research and development activities performed in the latest three years, as a dummy variable taking value 1 if the firms invest in R&D, 0 otherwise. Since external sources of knowledge also contribute to the innovative performance of the firm, we introduce a dummy variable equal to 1 if a firm, over the last three years, has invested financial resources in external knowledge, namely the purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other businesses or institutions, or to 0. In addition, as firms can also finance innovation projects through external financial sources, we consider access to a line of credit or a loan from a financial institution. The characteristics of the market in which the firm operates may also affect a firm's innovative behaviour. Therefore, we consider the internationalization degree of firms, expressed as the percentage of exported products, and the competition level in the market proxied by a categorical variable taking value from 1 to 4 defining the number of competitors as follows: 1 if there are no direct competitors, 2 from 1 to 5 competitors, 3 from 6 to 20 competitors, and 4 for more than 20 competitors. We check for some structural characteristics of the firms such as: the size measured as the number of employees; the age computed as the difference between the year in which the survey is conducted and the year the firm started its business activity, and whether the firm is an independent economic unit (taking the value of 1) or part of a group of firms (taking 0). Finally, we include in the model sector and country fixed effects. Descriptive statistics are reported in Table 1, while the correlation matrix is presented in Table A1 in the Appendix.

Table 1. Summary statistics and description of variables

Variable	Description	Mean	St.Dev.	Min	Max
Dependent variables:					
Product Innovation	1 if a firm, in the last three years, has introduced new or improved product; 0 otherwise	0.314	0.464	0	1
Process Innovation	1 if a firm, in the last three years, has introduced new or improved process; 0 otherwise	0.186	0.389	0	1
Innovation	Categorical variable taking values: 0 if the firm has no innovation; 1 if a firm, in the last three years, has introduced new or improved product; 2 if a firm, in the last three years, has introduced new or improved process: 3 if a firm, in the last three years, has introduced both product and process innovation in the last three years;	0.678	1.026	0	3
Focal regressors:					
Defined Training	Training type according to the following categories: 0 if a firm does not offer training activities; 1 if the training activities are identified; 2 if the training activities are not identified.	0.527	0.829	0	2
4 Types Training	Training type according to the following categories: 0 if a firm does not offer training activities; 1 Mathematical related training; 2 Commercial related training; 3 Managerial related training. 4 Other	1.075	1.689	0	4
In-class vs. on-the-job	Training type according to the following categories: 0 if a firm does not offer training activities; 1 In-class; 2 On-the-job; 3 Other.	0.813	1.265	0	3
Controls:					
Multi-implant	1 if a firm is a part of a multi-establishment, 0 otherwise	0.099	0.299	0	1
Owner	Percentage held by largest owner or owners	83.19	24.61	1	100
Manager Experience	Year of experience working in the sector of top manager	18.30	10.47	1	65
Ext. Knowledge	External Knowledge: 1 if a firm, in the last three years, has spent on the acquisition of external knowledge (purchase or licensing of patents and non-patented inventions, know-how, and other types of knowledge from other businesses or organizations), 0 otherwise	0.139	0.346	0	1
Firm's Age (ln)	Difference between the current year and the year the firm registers to start the business activity in natural logarithm	17.94	13.83	0	205
Competitors	Number of direct competitors, following these categories: 1 if a firm has no direct competitors; 2 if a firm has :>= 1-and <= 5 competitors; 3 if a firm has>= 6 and <=20 competitors; 4 if a firm has more than 20 competitors.	3.091	0.968	1	4
Female Ownership	1 if a firm has female owners, 0 if firm ownership is exclusively male	0.341	0.474	0	1
Employees	Number of employees	2.631	0.769	0	5.323
RD	1 if a firm invest on R&D activities in the last three years	0.228	0.420	0	1
Export	Percentage of exported products	14.23	28.44	0	100
Credit line	1 if a firm, in the fiscal year, has a line of credit or a loan from a financial institution, 0 otherwise	0.388	0.487	0	1
Education	Percentage of permanent full-time employees with a university degree (at 90 percentile)	0.106	0.308	0	1

3.2 Methodology

As far as our dependent variables proxying for innovation propensity are dummies, we employ several binary probit models. The coefficients of the probit model have effects on a cumulative normal function of the probabilities that Y is equal to 1, in our case the probability that a firm innovates. The equation behind the model is as follows:

$$P(Y = 1|x_1, \dots, x_k) = \phi(\beta_0 + \beta_1 TRAINING + \beta_2 X)$$

where ϕ denotes the cumulative probability distribution function of the standard normal distribution and transforms the regression into the range (0, 1). Therefore, our dependent variable Y takes value 1 if the firm innovates (product or process), and 0 otherwise. To deal with the overall innovation variable, we shift to a multinomial probit model to take into account the three possible outcomes (product, process or both).

The training variable takes different values according to the definition of training used in the analysis, while X is a vector of controls for firms' characteristics. Due to potential endogeneity arising among the innovation propensity and training activities, we also rely on an instrument variable (IV) approach, where instruments are required to be strongly related to the endogenous variable, but weakly related to the outcome variable. Moreover, instruments must be exogenous and independent of other variables in the estimated equation. Moreover, a third condition has to be respected: the endogenous variables have to be continuous. In our case this assumption is not verified, as far as our training variables are all categorical. To overcome this issue, we employ the special regressor Lewbel (SRL) approach which allows categorical endogenous regressors (Lewbel, 2000; Lewbel et al., 2012). This model is more suitable than a 2SLS approach, if an appropriate instrument is not included, or than IV-probit with maximum likelihood estimation, which is generally inconsistent when endogenous regressors are not continuous (Dong and Lewbel, 2015). The SRL approach assumes that the model includes a particular special regressor, δ, that is exogenous and appears additively in the model. It must be continuously distributed with a large support and should present thick tails. In our case, a special instrument is represented by the export propensity of firms. Export can be considered a suitable "special" regressor, as it is exogenous to the relation between training activities and innovation (Aw et al., 2007; Ramadani et al., 2019). The SRL approach, except the special regressor, also admits the use of instrumental variables to tackle endogenous regressors. Unfortunately, to the best of our knowledge, it is difficult to find a huge number of different instruments which satisfy the assumptions of the SRL for the four training activities presented in the definition by Cozzarin and Percival (2023) and the three forms of training presented by Dostie (2018). Thus, we instrument only the *defined* and *undefined* training as these two variables are computed as the sum of the categories of the previous classifications.

The two selected instruments are the percentage of population older than 15 with tertiary schooling (*Completed tertiary schooling*) in line with Nazarov and Akhmedjonov (2012) and the trade union density rate (*Trade Union*), which is computed as the share of employees who are union members (Bauernschuster et al., 2009; Addison, 2005; Addison et al., 2004). These data are extracted from the World Bank and ILO, respectively. Both variables are at country level, but the *Completed tertiary schooling* is measured in year 2010 while the *Trade Union* in 2012, as they report fewer number of missing values and are quite in the past with respect to the year of our observations. Despite this, some countries like Azerbaijan, Belarus, Georgia, Kosovo, Macedonia, Uzbekistan do not report tertiary education rates nor trade union participation. For this reason, the final number of observations is reduced with respect to the baseline models.

4. Results

4.1 Product and process innovation

Table 2 shows the results when the four training activities are analysed. Specifically, columns [1] and [3] report the coefficients, while the other columns show the marginal effects ([2] and [4]) of our estimations. We compute the marginal effects of each explanatory variable on the probability that the observed dependent variable is equal to 1, which is more informative than leaving the results expressed as odds ratios or relative risks (Greene, 1996; Christofides et al, 1997). The main results that emerge from column [2] and [4] highlight that training programs are significantly and positively associated with product and process innovation, and both. When firms provide training programs to their employees, they are more likely to trigger an innovation than firms that do not provide such programs. However, the magnitude of the effect of training programs changes with respect to the type of program offered by the firm. The effect of commercial training on innovation activities is stronger than the other types. With respect to firms offering no training, the probability to engage product and process innovations increases by 13.4% and 11.7%, respectively, when firms offer this training activity. The possible explanation of this result is that firms have a need to improve skills in foreign languages or in communication to become more competitive in other markets or maintain their market niche. In addition, companies provide mathematical training programs to improve the problem-solving skills of their employees. Therefore, employees with mathematical skills can apply their knowledge in the implementation of mathematical models to reduce experiment costs, save resources and spur innovation (Solovev et al., 2019). Finally, managerial training also shows a significant and positive relationship with both innovation modes. This finding probably implies that both innovation forms require a sound management that considers cash flow constraints when new products are developed.

Table 2. Regression results for four training programs

	(1)	(2)	(3)	(4)
	Product Innovation		Process Innovation	
	Coeff[a]	ME[b]	Coeff[a]	ME[b]
Ref. cat.: No training				
Mathematical related training	0.221***	0.069***	0.327***	0.078***
	[0.077]	[0.025]	[0.083]	[0.022]
Commercial related training	0.419***	0.135***	0.471***	0.118***
	[0.073]	[0.025]	[0.075]	[0.022]
Managerial related training	0.279***	0.088***	0.442***	0.110***
	[0.060]	[0.020]	[0.063]	[0.018]
Other	0.314***	0.099***	0.338***	0.081***
	[0.030]	[0.010]	[0.033]	[0.008]
Employees	-0.024	-0.007	0.027	0.006
	[0.017]	[0.005]	[0.019]	[0.004]
Firms' Age (ln)	-0.021	-0.006	0.014	0.003
	[0.019]	[0.006]	[0.021]	[0.005]
Female ownership	0.065**	0.020**	0.026	0.006
	[0.026]	[0.008]	[0.029]	[0.007]
Ext. Knowledge	0.439***	0.133***	0.526***	0.118***
	[0.036]	[0.011]	[0.037]	[0.008]
Education	0.130***	0.039***	0.073	0.017
	[0.040]	[0.012]	[0.046]	[0.010]
Export	-0.001	0	0.001**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]
R&D	0.605***	0.183***	0.463***	0.104***
	[0.030]	[0.009]	[0.032]	[0.007]
Multi-implant	0.101**	0.031**	0.149***	0.034***
	[0.041]	[0.013]	[0.044]	[0.010]
Owner	-0.001	0.000	-0.001**	-0.000**
	[0.000]	[0.000]	[0.001]	[0.000]
Manager Experience	0.003**	0.001**	0.003**	0.001**
	[0.001]	[0.000]	[0.001]	[0.000]
Credit line	0.200***	0.060***	0.281***	0.063***
	[0.025]	[0.008]	[0.028]	[0.006]
Competitors	-0.084***	-0.025***	-0.011	-0.002
	[0.012]	[0.004]	[0.014]	[0.003]
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	14,105	14,105	14,059	14,059
Pseudo R-squared	0.151		0.17	

Notes: [a] Coefficient; [b] Marginal Effect. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

The results of the control variables confirm our expectations. Education level of employees has a positive effect on the decision to innovate, while nothing can be said to the impact of the number of employees. Regarding education, our findings reveal that the probability of implementing product innovation increases by 4% if firms have highly educated workforce. Whereas for each additional year of top manager experience, the firm's capacity to innovate increases by 0.1%. Also, the R&D expenditures strongly increase the probability to introduce innovation. The acquisition of external knowledge from business and institutions enhances the probability of product and process innovation. In other words, the higher the knowledge sharing with external actors, the higher the incentive to create and develop new product and production processes. Furthermore, our results indicate that the probability of being innovative increases by about 6% for firms with access to financial support. In other words, firms with a line of credit are more prone to introduce innovation than firms that do not have access to this financial resource. Considering the firm size, we do not find any significant results. However, for firms that are part of a group the probability to engage innovative activities rises by around 3% compared to unaffiliated firms. Turning to firm ownership, we find no evidence that firms run by a woman are more willing to innovate. Yet, by looking at the owner variable that shows identity between ownership and control (Dostie, 2018), it is negatively related to the decision to implement process innovation activities compared to firms in which the degree of ownership concentration is not in the hands of one or more owners. Market competition of firms can negatively impact the innovation level, especially when product innovation is considered (Mulkay, 2019). This result seems to validate the traditional approach better known as the Schumpeterian effect according to which a high level of competition in the market could reduce the monopoly profits and rents for potentially innovative firms, thereby reducing their incentives to engage in R&D (Nickell, 1996; Geroski, 1990; Scherer, 1967).

Exporting is another factor positively associated with the propensity to adopt a process innovation. Several reasons may account for this result. First, compared to non-exporters, exporters operate in more dynamic and competitive markets. Hence, they need to implement innovation to maintain their competitiveness level (Coad et al., 2019). Second, export markets give more and better opportunities for learning and imitation in new technologies. Additionally, export markets can also boost innovation by expanding market dimensions so that the cost of innovation is spread across a larger market (Aghion et al. 2018; Bernard et al., 2018; Bustos 2011; Lileeva and Trefler 2010). Besides, we control the firm's organization whether the firm is an independent economic unit, or it belongs to a group. Our results suggest that for firms that are part of a group the probability to engage innovative activities rises by around 3% compared to unaffiliated firms (Castellacci, 2015; Chang et al., 2006).

Table 3 reports the estimates of training type grouped between *defined* and *undefined*. As for Table 2, our results are expressed in marginal effects reported in columns [2] and [4]. In general, results appear to be in line with the baseline estimates of Table 2. Looking at the effect of the defined training on innovation, we find that it is statistically significant for both innovation options although the effect turns out to be larger for the process innovation. In fact, the probability that firms adopt a process innovation increases by 10.4% when they provide defined training to their workers. Conversely, the likelihood to undertake a product innovation rises by 9.5% if firms provide their employees with undefined training. This result can be explained by the fact that a defined training is designed to meet the specific needs of the firms. In other words, employees need targeted and specific training to solve more complex problems. In addition, when firms have multiple product lines, employees need different and non-specific training programs. For what concerns the control variables, they are in line with both sign and significance as the results reported in Table 2.

Table 3. Regression results for defined vs. undefined training

	(1)	(2)	(3)	(4)
	Product Innovation		Process Innovation	
	Coeff[a]	ME[b]	Coeff[a]	ME[b]
Ref. cat.: No training				
Defined training type	0.303***	0.095***	0.422***	0.104***
	[0.042]	[0.014]	[0.045]	[0.012]
Undefined training type	0.313***	0.099***	0.338***	0.081***
	[0.030]	[0.010]	[0.033]	[0.008]
Employees	-0.023	-0.007	0.027	0.006
	[0.017]	[0.005]	[0.019]	[0.004]
Firms' Age (ln)	-0.021	-0.006	0.014	0.003
	[0.019]	[0.006]	[0.021]	[0.005]
Female ownership	0.066**	0.020**	0.026	0.006
	[0.026]	[0.008]	[0.029]	[0.007]
Ext. Knowledge	0.440***	0.133***	0.526***	0.118***
	[0.036]	[0.011]	[0.037]	[0.008]
Education	0.129***	0.039***	0.074	0.017
	[0.040]	[0.012]	[0.046]	[0.010]
Export	-0.001	0	0.001**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]
R&D	0.606***	0.183***	0.463***	0.104***
	[0.030]	[0.009]	[0.032]	[0.007]
Multi-implant	0.102**	0.031**	0.150***	0.034***
	[0.041]	[0.012]	[0.044]	[0.010]
Owner	-0.001	0	-0.001**	-0.000**

	[0.000]	[0.000]	[0.001]	[0.000]
Manager Experience	0.003**	0.001**	0.003**	0.001**
	[0.001]	[0.000]	[0.001]	[0.000]
Credit line	0.201***	0.061***	0.282***	0.063***
	[0.025]	[0.008]	[0.028]	[0.006]
Competitors	-0.084***	-0.025***	-0.01	-0.002
	[0.012]	[0.004]	[0.014]	[0.003]
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	14,105	14,105	14,059	14,059
Pseudo R-squared	0.151		0.17	

Notes: [a] Coefficient; [b] Marginal Effect. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

The last set of estimates is based on the classification suggested by Dostie (2018), testing the *in-class* vs. *on-the-job* training on firms' innovation propensity. Results are reported in Table 4 and show that the likelihood to implement innovation is greater if firms offer *on-the-job training* than classroom training or formal training. In more detail, the probability for firms with *on-the-job* training is approximately one and a half times higher with respect to those firms with classroom training versus the baseline category. This result is consistent with previous literature pointing to the fact that employees receive informal training rather than formal one, because the former is less expensive than the latter (Dostie, 2018).

Table 4. Regression results for in-class vs. on-the-job training

	(1)	(2)	(3)	(4)
	Product Innovation		Process Innovation	
	Coeff[a]	ME[b]	Coeff[a]	ME[b]
Ref. cat.: No training				
In-class	0.216***	0.067***	0.325***	0.077***
	[0.077]	[0.025]	[0.083]	[0.022]
On-the-job	0.331***	0.105***	0.454***	0.113***
	[0.048]	[0.016]	[0.051]	[0.014]
Other	0.314***	0.099***	0.338***	0.081***
	[0.030]	[0.010]	[0.033]	[0.008]
Employees	-0.024	-0.007	0.027	0.006
	[0.017]	[0.005]	[0.019]	[0.004]
Firms' Age (ln)	-0.021	-0.006	0.014	0.003
	[0.019]	[0.006]	[0.021]	[0.005]
Female ownership	0.065**	0.020**	0.026	0.006
	[0.026]	[0.008]	[0.029]	[0.007]
Ext. Knowledge	0.440***	0.133***	0.526***	0.118***
	[0.036]	[0.011]	[0.037]	[0.008]
Education	0.129***	0.039***	0.073	0.016
	[0.040]	[0.012]	[0.046]	[0.010]
Export	-0.001	0.000	0.001**	0.000**
	[0.000]	[0.000]	[0.000]	[0.000]
R&D	0.605***	0.183***	0.463***	0.104***
	[0.030]	[0.009]	[0.032]	[0.007]
Multi-implant	0.101**	0.031**	0.149***	0.034***

	[0.041]	[0.013]	[0.044]	[0.010]
Owner	-0.001	0	-0.001**	-0.000**
	[0.001]	[0.000]	[0.001]	[0.000]
Manager Experience	0.003**	0.001**	0.003**	0.001**
	[0.001]	[0.000]	[0.001]	[0.000]
Credit line	0.200***	0.060***	0.281***	0.063***
	[0.025]	[0.008]	[0.028]	[0.006]
Competitors	-0.084***	-0.025***	-0.011	-0.002
	[0.012]	[0.004]	[0.014]	[0.003]
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	14,105	14,105	14,059	14,059
Pseudo R-squared	0.151		0.17	

Notes: [a] Coefficient; [b] Marginal Effect. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

4.2 Overall innovation

We repeat the same estimates for the three specifications of training programs by looking at the overall innovation as dependent variable. Results reported in Table 5 are related to the marginal effects deriving from the multinomial probability model, while the coefficients are presented in Tables A2-A4 in the Appendix.

Table 5. Regression results training (marginal effects).

	(1)	(2)	(3)	(4)
	No Innovation	Product Innovation	Process Innovation	Overall Innovation
	ME	ME	ME	ME
Ref. cat.: No training				
Mathematical related training	-0.081***	0.008	0.015	0.058***
	[0.026]	[0.022]	[0.015]	[0.018]
Commercial related training	-0.146***	0.037*	0.020	0.088***
	[0.025]	[0.022]	[0.014]	[0.017]
Managerial related training	-0.139***	0.030*	0.050***	0.059***
	[0.021]	[0.017]	[0.013]	[0.013]
Other	-0.120***	0.040***	0.021***	0.058***
	[0.010]	[0.009]	[0.005]	[0.007]
Defined training type	-0.125***	0.026**	0.032***	0.066***
	(0.014)	(0.012)	(0.008)	(0.009)
Undefined training type	-0.120***	0.040***	0.022***	0.058***
	(0.010)	(0.009)	(0.005)	(0.006)
In-class	-0.078***	0.007	0.015	0.056***
	[0.025]	[0.022]	[0.015]	[0.018]
On-the-job	-0.142***	0.033**	0.038***	0.070***
	[0.017]	[0.014]	[0.010]	[0.011]
Other	-0.120***	0.041***	0.022***	0.057***
	[0.010]	[0.009]	[0.005]	[0.007]
Controls	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES

Observations	14,152	14,152	14,152	14,152

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

It is interesting to note from Table 5 that, when a firm does not innovate, all the training activities have a “bad impact” on the dependent variable. Thus, training is much more important when a firm is an innovative one. For these latter Managerial and on-the-job training are preferrable activities when a firm develop product or process innovation, while other non-specified training activities are always a good option for firms independently from the type of innovation performed. While, when a firm decides to invest both in product and process innovation, all the training is good to increment the innovation propensity, even if the better option is to invest in commercial training which increases the innovative output by almost 9%, the highest value with respect to other categories.

4.3 Geographical heterogeneity

Being aware of the different historical path of each Country belonging to the transition economies, we perform a further estimation to identify the effect of training on the technological capacity at the geographical level. In more detail, we split our sample in four macro-regions to understand where the impact of training on innovative activity is most pronounced. We follow a recent classification proposed by Biscione et al. (2022) to identify the four groups of transition countries: (i) European Former-USSR Countries, such as Belarus, Estonia Georgia, Latvia, Lithuania, Moldova, Russia, Ukraine; (ii) Central European Countries which comprehend Bulgaria, Czech Republic, Hungary, Poland, Romania, Slovak Republic; (iii) Former Yugoslavian Countries and Albania, that include Albania, Bosnia and Herzegovina, Croatia, Kosovo, Montenegro, North Macedonia, Serbia and Slovenia; and (iv) Eurasian Former-USSR Countries, with Armenia, Azerbaijan, Kazakhstan, Kyrgyz Republic, Tajikistan, and Uzbekistan. Tables 6.1 and 6.2 show the marginal effects of training for product and process innovation, respectively; while, due to lack of space, the marginal coefficients for the overall innovation variable (as in table 5) are reported in the table from A5 to A8 in the Appendix. All the tables show only the variables of interest; however, all the controls, country and industry fixed effects are included in the estimates.

Table 6.1. Product innovation

	(1) Region 1	(2) Region 2	(3) Region 3	(4) Region 4	(5) Region 1	(6) Region 2	(7) Region 3	(8) Region 4	(9) Region 1	(10) Region 2	(11) Region 3	(12) Region 4
Ref. cat.: No training												
Mathematical related training	0.149***	-0.036	0.071	0.072								
	[0.046]	[0.043]	[0.073]	[0.046]								
Commercial related training	0.198***	0.033	0.281***	0.035								
	[0.043]	[0.049]	[0.059]	[0.048]								
Managerial related training	0.120***	0.012	0.136***	0.108***								
	[0.039]	[0.032]	[0.049]	[0.038]								
Other	0.079***	0.082***	0.104***	0.145***								
	[0.018]	[0.017]	[0.023]	[0.023]								
Defined training type					0.152***	0.005	0.165***	0.080***				
					[0.026]	[0.024]	[0.036]	[0.027]				
Undefined training type					0.079***	0.082***	0.104***	0.146***				
					[0.018]	[0.017]	[0.023]	[0.023]				
In-class									0.149***	-0.036	0.071	0.068
									[0.046]	[0.043]	[0.073]	[0.046]
On-the-job									0.153***	0.018	0.191***	0.084***
									[0.030]	[0.028]	[0.040]	[0.031]
Other									0.079***	0.082***	0.104***	0.146***
									[0.018]	[0.017]	[0.023]	[0.023]
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	4,498	3,692	2,323	3,592	4,498	3,692	2,323	3,592	4,498	3,692	2,323	3,592

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table 6.2. Process innovation

	(1) Region 1	(2) Region 2	(3) Region 3	(4) Region 4	(5) Region 1	(6) Region 2	(7) Region 3	(8) Region 4	(9) Region 1	(10) Region 2	(11) Region 3	(12) Region 4
Ref. cat.: No training												
Mathematical related training	0.125***	0.004	0.110*	0.059								
	[0.041]	[0.035]	[0.065]	[0.041]								
Commercial related training	0.172***	0.131***	0.128**	0.040								
	[0.040]	[0.047]	[0.052]	[0.037]								
Managerial related training	0.109***	0.105***	0.178***	0.071**								
	[0.035]	[0.031]	[0.046]	[0.031]								
Other	0.066***	0.079***	0.105***	0.077***								
	[0.015]	[0.014]	[0.020]	[0.019]								
Defined training type					0.133***	0.087***	0.148***	0.059***				
					[0.024]	[0.022]	[0.033]	[0.022]				
Undefined training type					0.066***	0.078***	0.105***	0.077***				
					[0.015]	[0.014]	[0.020]	[0.019]				
In-class									0.125***	0.004	0.110*	0.058
									[0.041]	[0.035]	[0.065]	[0.041]
On-the-job									0.136***	0.112***	0.158***	0.060**
									[0.028]	[0.027]	[0.036]	[0.025]
Other									0.066***	0.079***	0.105***	0.077***
									[0.015]	[0.014]	[0.020]	[0.019]
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	4,487	3,685	2,309	3,578	4,487	3,685	2,309	3,578	4,487	3,685	2,309	3,578

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table 6.1 highlights the presence of geographical heterogeneity when product innovation is the dependent variable: European Former-USSR Countries offer better training than other regions, followed by Former Jugoslavian Countries and Albania, in particular when detailed training programs are put in place. On the contrary, Central European Countries do not reveal any specific relation between training an innovation. This result is probably due to the fact that, before entering in the European Community, these Countries had to align their workforce and innovations to the European standards (Hernandez et al., 2021). Same findings hold true also when we consider process innovation, as reported in Table 6.2. When we analyse the categorical variable for overall innovation, as reported in Tables A5 to A8 in the Appendix, we find that having training without innovation is harmful for all the countries, independently from their geographical location. While the effect of the training is positively associated for all the companies in the transition economies that performs both product and process innovations.

We can conclude that, despite the different historical paths of each country, all the economies under scrutiny invest in training, being aware that this might help to innovate and reach higher products and processes, competitive with the already developed markets.

5. Robustness checks

Before running the SRL model, we run a IV two-stage least square (2SLS) model on the overall innovation, our categorical variable, so we consider this latter as a continuous one. This procedure helps us to better understand if the two instrumental variables are robust enough to move to the SRL approach. The results of the IV-2SLS model are reported in Table A9 in the Appendix, and by looking at the coefficient of the second stage it becomes clear that the IV-2SLS approach is not consistent with the nature of our regressors. However, just focusing on the quality of our instruments, the coefficients of *Completed tertiary schooling* and *Trade Union,* at the bottom of Table A9, are statistically significant in the first stage supported by the F-statistic greater than 10, which is a value generally accepted as a rule of thumb for the reliability of instruments. Moreover, the LM-underidentification test is significant, thus our instruments are not underidentified and the Wald-F statistics has a value of 15.17, greater than the Stock-

Yogo (7.03), which imposes that our instrument are not weak. Thus, *completed tertiary schooling* and *trade union* are suitable instruments for the SRL approach.

To deal with the two binary variables, product or process innovation, we report in Column 1 and 2 in Table 7 the marginal effects of the SRL model, while from the categorical variable of overall innovation we extract those firms which perform both product and process innovation and we report the SRL marginal effects in Column [3]. The first intuition behind the model is that the special regressor represented by export is significant for both process and overall innovation activities, thus it respects the assumption of the SRL model. As regards the two main endogenous variables, *defined* and *undefined* training, we obtain the same sign and significance as in the previous models, except for undefined training for product innovation which is not supported any longer. Moreover, having *defined* training activities will stimulate innovation propensity of firms four times more than introducing not identified training.

Table 7. Marginal Effects of the IV-SRL estimates

	(1) Product Innovation	(2) Process Innovation	(3) Innovation
Ref. cat.: No training			
Defined training type	0.871**	0.605**	0.661***
	[0.336]	[0.235]	[0.107]
Undefined training type	0.163	0.135***	0.159***
	[0.063]	[0.045]	[0.043]
Employees	0.026***	0.018***	0.021***
	[0.009]	[0.007]	[0.004]
Firms' Age (ln)	0.004	0.003	0.004
	[0.004]	[0.004]	[0.003]
Female ownership	0.012	0.006	0.007*
	[0.008]	[0.006]	[0.004]
Ext. Knowledge	0.036	0.025	0.026*
	[0.028]	[0.018]	[0.014]
Education	0.044**	0.031**	0.032***
	[0.018]	[0.014]	[0.008]
Export	-0.001**	-0.001**	-0.001**
	[0.001]	[0.001]	[0.001]
R&D	0.067**	0.050**	0.058***
	[0.029]	[0.023]	[0.009]
Multi-implant	0.019	0.011	0.011
	[0.015]	[0.001]	[0.008]
Owner	-0.001	0.001	0.001
	[0.001]	[0.001]	[0.001]
Manager Experience	-0.001**	-0.001**	-0.001***
	[0.001]	[0.001]	[0.001]

Credit line	-0.007	-0.006	-0.004
	[0.008]	[0.005]	[0.004]
Competitors	-0.005	-0.005**	-0.004**
	[0.005]	[0.002]	[0.002]
Observations	9,450	9,425	9,487
Wald χ^2	22.45**	22.48**	34.42***

Notes: Bootstrapped standard errors in parentheses (50 reps.). *** p<0.01, ** p<0.05, * p<0.10

For what concerns control variables, the number of employees turns out to be positive and statistically significant for all the three innovation specifications, which is consistent with previous literature (Vaona and Pianta, 2008). The level of employees' education is positive and significant, and in line with the results obtained with the probit models, as well as the R&D expenditure (Shefer and Frenkel, 2005). Unfortunately, other regressors such as manager experience and the multi-implant lost significance. Despite this, the main variables of interest are robust to the IV approach and validate our baseline findings.

6. Conclusion

This study has investigated the effect of different training programs on innovative activities, by exploiting firm-level data drawn from the World Bank Enterprise Surveys. We consider product, process innovation and both. To do this, we have employed a probit model considering different classifications of training activities. Regardless of the categorization of the training activity, our results lead to the same outcome: training seems to be a necessary condition for innovation for the firms in our sample. In addition, to deal with the issue of endogeneity, we have employed the special IV regression estimation the same sign and significance as in the previous models, except for undefined training for product innovation which is not supported any longer.

Our study is limited mainly by the generalization of the results as we use cross-sectional data, thus observing only a static relation between training programs and firm's innovation activities. This limitation stresses the need of further research based on panel data that could corroborate the evidence obtained. Despite this limitation, our study might offer insights for policymakers and entrepreneurs, for policies related to incentives targeting transition economies. Policymakers should in particular support and boost innovation activities through initiatives to raise the awareness among entrepreneurs and managers of how firms can improve their innovation level. In more detail, institutions should incentivize public-private investments in worker training programs to help firms to increase their technological capabilities. At the same time, firms should devote much more attention to training practices organizing continuous activities of knowledge update for existing employees and coaching and assistance for newcomers, only in this way can they better exploit the benefits derived from these activities to develop innovation capacity of the firms.

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APPENDIX

Table A1. Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
(1) prod_inno	1.000																						
(2) proc_inno	0.342	1.000																					
(3) No training	-0.212	-0.225	1.000																				
(4) Defined tr.	0.118	0.136	-0.468	1.000																			
(5) Undefined tr.	0.155	0.158	-0.794	-0.166	1.000																		
(6) Mathematical tr.	0.035	0.047	-0.225	0.482	-0.080	1.000																	
(7) Commercial tr.	0.078	0.084	-0.237	0.506	-0.084	-0.024	1.000																
(8) Managerial tr.	0.081	0.093	-0.315	0.674	-0.112	-0.032	-0.033	1.000															
(9) Other tr.	0.155	0.158	-0.794	-0.166	1.000	-0.080	-0.084	-0.112	1.000														
(10) In-class tr.	0.035	0.046	-0.226	0.482	-0.080	0.999	-0.021	-0.032	-0.080	1.000													
(11) On-the-job tr.	0.114	0.127	-0.401	0.856	-0.142	-0.040	0.589	0.787	-0.142	-0.040	1.000												
(12) Employees	0.087	0.122	-0.198	0.110	0.146	0.050	0.073	0.063	0.146	0.050	0.095	1.000											
(13) Age (ln)	0.053	0.069	-0.088	0.025	0.080	0.007	0.017	0.018	0.080	0.006	0.025	0.237	1.000										
(14) Female own.	0.026	0.026	-0.023	0.027	0.007	0.010	0.018	0.017	0.007	0.010	0.025	-0.012	0.090	1.000									
(15) Ext. Know.	0.241	0.249	-0.259	0.171	0.172	0.068	0.102	0.114	0.172	0.068	0.155	0.121	0.027	0.016	1.000								
(16) Education	0.032	0.009	-0.040	0.076	-0.007	0.023	0.013	0.080	-0.007	0.024	0.072	-0.095	-0.100	0.004	0.082	1.000							
(17) Export	0.110	0.143	-0.135	0.055	0.112	0.024	0.021	0.044	0.112	0.025	0.048	0.266	0.111	-0.006	0.103	-0.046	1.000						
(18) R&D	0.309	0.269	-0.255	0.186	0.157	0.069	0.101	0.135	0.157	0.070	0.171	0.170	0.050	-0.004	0.362	0.074	0.160	1.000					
(19) Multi-implant	0.054	0.080	-0.103	0.083	0.058	0.026	0.057	0.054	0.058	0.025	0.079	0.150	0.063	0.011	0.046	0.005	0.049	0.065	1.000				
(20) Owner	-0.047	-0.058	0.059	-0.026	-0.048	-0.005	-0.021	-0.017	-0.048	-0.005	-0.027	-0.131	-0.121	-0.215	-0.038	-0.013	-0.048	-0.062	-0.036	1.000			
(21) Manager Exp.	0.039	0.050	-0.075	-0.012	0.092	-0.007	-0.011	-0.003	0.092	-0.007	-0.009	0.062	0.454	0.064	0.011	-0.077	0.090	0.021	0.006	-0.085	1.000		
(22) Credit	0.129	0.142	-0.130	0.043	0.116	0.008	0.031	0.031	0.116	0.008	0.045	0.150	0.103	-0.003	0.097	-0.061	0.111	0.117	0.036	-0.057	0.060	1.000	
(23) Competitors	-0.095	-0.056	0.080	-0.049	-0.055	-0.034	-0.025	-0.025	-0.055	-0.034	-0.036	-0.056	-0.047	0.006	-0.034	0.010	-0.051	-0.049	-0.033	0.043	-0.035	-0.028	1.000

Table A2. Multinomial probit for the four training activities.

VARIABLES	(2) Product Innovation	(3) Process Innovation	(4) Overall Innovation
Ref. cat.: No training			
Mathematical related training	0.208*	0.336**	0.542***
	[0.119]	[0.151]	[0.128]
Commercial related training	0.431***	0.485***	0.814***
	[0.114]	[0.140]	[0.116]
Managerial related training	0.396***	0.654***	0.667***
	[0.091]	[0.106]	[0.099]
Other	0.392***	0.448***	0.621***
	[0.045]	[0.055]	[0.051]
Employees	-0.051**	0.009	0.012
	[0.026]	[0.033]	[0.030]
Firms' Age (ln)	-0.069**	-0.072*	-0.035
	[0.031]	[0.040]	[0.037]
Female ownership	0.065	-0.029	-0.052
	[0.058]	[0.075]	[0.067]
Firm's Age (ln)*Female	0.001	0.004	0.006***
	[0.002]	[0.003]	[0.002]
Ext. Knowledge	0.545***	0.704***	0.930***
	[0.055]	[0.066]	[0.058]
Education	0.132**	-0.004	0.235***
	[0.059]	[0.083]	[0.071]
Export	-0.001	0.002***	0.000
	[0.001]	[0.001]	[0.001]
R&D	0.697***	0.467***	1.037***
	[0.046]	[0.058]	[0.050]
Multi-implant	0.098	0.142*	0.256***
	[0.063]	[0.075]	[0.069]
Owner	-0.001	-0.001	-0.002**
	[0.001]	[0.001]	[0.001]
Manager Experience	0.006***	0.008***	0.005**
	[0.002]	[0.002]	[0.002]
Credit line	0.248***	0.374***	0.456***
	[0.037]	[0.047]	[0.045]
Competitors	-0.123***	-0.035	-0.081***
	[0.018]	[0.024]	[0.022]
Constant	-0.446***	-1.431***	-1.910***
	[0.159]	[0.193]	[0.193]
Industry FE	YES	YES	YES
Country FE	YES	YES	YES
Observations	14,152	14,152	14,152
Wald test	3236	3236	3236

Notes: The reference category is " Firms that do not innovate in the previous three years". Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table A3. Multinomial probit for the *defined* vs. *undefined* training.

VARIABLES	(1) Product Innovation	(2) Process Innovation	(3) Overall Innovation
Ref. cat.: No training			
Defined training type	0.358***	0.531***	0.677***
	[0.065]	[0.079]	[0.070]
Undefined training type	0.391***	0.447***	0.620***
	[0.045]	[0.055]	[0.051]
Employees	-0.050*	0.009	0.013
	[0.026]	[0.033]	[0.030]
Firms' Age (ln)	-0.069**	-0.072*	-0.035
	[0.031]	[0.040]	[0.037]
Female ownership	0.064	-0.031	-0.053
	[0.058]	[0.075]	[0.067]
Firm's Age (ln)*Female	0.001	0.004	0.007***
	[0.002]	[0.003]	[0.002]
Ext. Knowledge	0.545***	0.703***	0.932***
	[0.055]	[0.066]	[0.058]
Education	0.133**	-0.000	0.235***
	[0.059]	[0.083]	[0.071]
Export	-0.001	0.002***	0.000
	[0.001]	[0.001]	[0.001]
R&D	0.698***	0.468***	1.037***
	[0.046]	[0.058]	[0.050]
Multi-implant	0.099	0.143*	0.257***
	[0.063]	[0.074]	[0.069]
Owner	-0.001	-0.001	-0.002**
	[0.001]	[0.001]	[0.001]
Manager Experience	0.006***	0.008***	0.005**
	[0.002]	[0.002]	[0.002]
Credit line	0.249***	0.375***	0.456***
	[0.037]	[0.047]	[0.045]
Competitors	-0.123***	-0.034	-0.081***
	[0.018]	[0.024]	[0.022]
Constant	-0.446***	-1.431***	-1.910***
	[0.159]	[0.193]	[0.193]
Industry FE	YES	YES	YES
Country FE	YES	YES	YES
Observations	14,152	14,152	14,152
Wald test	3235	3235	3235

Notes: The reference category is " Firms that do not innovate in the previous three years". Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table A4. Multinomial probit for the *in-class* vs. *on-the-job* training.

VARIABLES	(1) Product Innovation	(2) Process Innovation	(3) Overall Innovation
Defined training type	0.202*	0.332**	0.537***
	[0.118]	[0.151]	[0.128]
Undefined training type	0.411***	0.597***	0.726***
	[0.074]	[0.088]	[0.079]
Employees	0.392***	0.448***	0.621***
	[0.045]	[0.055]	[0.051]
Firms' Age (ln)	-0.050**	0.009	0.012
	[0.026]	[0.033]	[0.030]
Female ownership	-0.069**	-0.072*	-0.035
	[0.031]	[0.040]	[0.037]
Firm's Age (ln)*Female	0.065	-0.029	-0.053
	[0.058]	[0.075]	[0.067]
Ext. Knowledge	0.001	0.004	0.006***
	[0.002]	[0.003]	[0.002]
Education	0.545***	0.703***	0.932***
	[0.055]	[0.066]	[0.058]
Export	0.131**	-0.002	0.233***
	[0.059]	[0.083]	[0.071]
R&D	-0.001	0.002***	0.000
	[0.001]	[0.001]	[0.001]
Multi-implant	0.697***	0.467***	1.037***
	[0.046]	[0.058]	[0.050]
Owner	0.098	0.142*	0.256***
	[0.063]	[0.075]	[0.069]
Manager Experience	-0.001	-0.001	-0.002**
	[0.001]	[0.001]	[0.001]
Credit line	0.006***	0.008***	0.005**
	[0.002]	[0.002]	[0.002]
Competitors	0.248***	0.374***	0.456***
	[0.037]	[0.047]	[0.045]
competitors	-0.123***	-0.035	-0.081***
	[0.018]	[0.024]	[0.022]
Constant	-0.446***	-1.432***	-1.909***
	[0.159]	[0.193]	[0.193]
Industry FE	YES	YES	YES
Country FE	YES	YES	YES
Observations	14,152	14,152	14,152
Wald test	3232	3232	3232

Notes: The reference category is "Firms that do not innovate in the previous three years". Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table A5. Overall innovation for European Former-USSR Countries

	(1) No Innovation	(2) Product Innovation	(3) Process Innovation	(4) Overall Innovation
Ref. cat.: No training				
Mathematical related training	-0.151***	0.042	0.012	0.096***
	[0.046]	[0.040]	[0.026]	[0.033]
Commercial related training	-0.214***	0.051	0.013	0.148***
	[0.044]	[0.038]	[0.025]	[0.032]
Managerial related training	-0.157***	0.050	0.035	0.071**
	[0.041]	[0.035]	[0.024]	[0.027]
Other	-0.075***	0.009	-0.001	0.067***
	[0.018]	[0.015]	[0.009]	[0.013]
Defined training type	-0.172***	0.047**	0.0218	0.103***
	[0.027]	[0.023]	[0.016]	[0.019]
Undefined training type	-0.075***	0.009	-0.001	0.066***
	[0.018]	[0.015]	[0.009]	[0.013]
In-class	-0.151***	0.0426	0.012	0.095***
	[0.046]	[0.040]	[0.026]	[0.033]
On-the-job	-0.181***	0.049*	0.025	0.105***
	[0.031]	[0.027]	[0.018]	[0.022]
Other	-0.075***	0.009	-0.001	0.066***
	[0.018]	[0.015]	[0.009]	[0.013]
Controls	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	4,523	4,523	4,523	4,523

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table A6. Overall innovation for Central European Countries

	(1) No Innovation	(2) Product Innovation	(3) Process Innovation	(4) Overall Innovation
Ref. cat.: No training				
Mathematical related training	0.060	-0.071**	-0.027	0.038
	[0.043]	[0.033]	[0.019]	[0.032]
Commercial related training	-0.086*	-0.033	0.064*	0.055*
	[0.051]	[0.039]	[0.037]	[0.032]
Managerial related training	-0.095**	-0.009	0.080***	0.024
	[0.037]	[0.027]	[0.027]	[0.018]
Other	-0.125***	0.048***	0.044***	0.032***
	[0.018]	[0.015]	[0.011]	[0.011]
Defined training type	-0.053**	-0.029	0.051***	0.031**
	[0.026]	[0.020]	[0.017]	[0.014]
Undefined training type	-0.125***	0.047***	0.043***	0.033***
	[0.018]	[0.015]	[0.011]	[0.010]
In-class	0.060	-0.071**	-0.027	0.038
	[0.043]	[0.033]	[0.019]	[0.032]
On-the-job	-0.092***	-0.016	0.076***	0.032**
	[0.031]	[0.023]	[0.022]	[0.016]
Other	-0.125***	0.048***	0.044***	0.032***
	[0.018]	[0.015]	[0.011]	[0.011]
Controls	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	3,701	3,701	3,701	3,701

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table A7. Overall innovation for Former Jugoslavian Countries and Albania

	(1) No Innovation	(2) Product Innovation	(3) Process Innovation	(4) Overall Innovation
Ref. cat.: No training				
Mathematical related training	-0.130*	0.015	0.064	0.049
	[0.075]	[0.069]	[0.056]	[0.048]
Commercial related training	-0.254***	0.146**	-0.018	0.127***
	[0.059]	[0.060]	[0.027]	[0.044]
Managerial related training	-0.183***	0.023	0.048	0.111***
	[0.049]	[0.047]	[0.030]	[0.038]
Other	-0.120***	0.018	0.018	0.084***
	[0.022]	[0.021]	[0.012]	[0.018]
Defined training type	-0.193***	0.058	0.031	0.103***
	[0.036]	[0.036]	[0.022]	[0.027]
Undefined training type	-0.120***	0.018	0.018	0.084***
	[0.022]	[0.021]	[0.012]	[0.018]
In-class	-0.130*	0.015	0.064	0.049
	[0.075]	[0.069]	[0.056]	[0.048]
On-the-job	-0.212***	0.071*	0.023	0.117***
	[0.039]	[0.040]	[0.022]	[0.030]
Other	-0.121***	0.018	0.018	0.084***
	[0.022]	[0.021]	[0.012]	[0.018]
Controls	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	2,331	2,331	2,331	2,331

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table A8. Overall innovation for Eurasian Former-USSR Countries

	(1) No Innovation	(2) Product Innovation	(3) Process Innovation	(4) Overall Innovation
Ref. cat.: No training				
Mathematical related training	-0.101**	0.037	0.025	0.037
	[0.047]	[0.041]	[0.028]	[0.033]
Commercial related training	-0.046	0.007	0.016	0.023
	[0.052]	[0.043]	[0.025]	[0.028]
Managerial related training	-0.142***	0.063*	0.035	0.042*
	[0.040]	[0.034]	[0.025]	[0.024]
Other	-0.166***	0.088***	0.021*	0.055***
	[0.024]	[0.022]	[0.011]	[0.015]
Defined training type	-0.106***	0.043*	0.026	0.036**
	[0.028]	[0.024]	[0.016]	[0.017]
Undefined training type	-0.166***	0.089***	0.021*	0.055***
	[0.024]	[0.022]	[0.011]	[0.015]
In-class	-0.095**	0.034	0.025	0.036
	[0.047]	[0.041]	[0.027]	[0.032]
On-the-job	-0.110***	0.046*	0.027	0.036*
	[0.033]	[0.028]	[0.018]	[0.019]
Other	-0.166***	0.089***	0.021*	0.055***
	[0.024]	[0.022]	[0.011]	[0.015]
Controls	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Observations	3,597	3,597	3,597	3,597

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10

Table A9. IV-2SLS approach on the overall innovation

	Overall Innovation
Ref. cat.: No training	
Defined training type	11.585*
	[6.825]
Undefined training type	-0.875
	[0.750]
Employees	-0.263
	[0.163]
Firms' Age (ln)	0.056
	[0.066]
Female ownership	-0.013
	[0.116]
Firm's Age (ln)*Female	-0.008
	[0.009]
Ext. Knowledge	-0.336
	[0.565]
Education	-0.618
	[0.381]
Export	0.001
	[0.002]
R&D	-0.395
	[0.598]
Multi-implant	-0.214
	[0.234]
Owner	-0.001
	[0.001]
Manager Experience	0.010
	[0.006]
Credit line	0.221***
	[0.079]
Competitors	0.047
	[0.074]
Constant	0.087
	[0.351]
Defined training type	
Completed tertiary schooling	-0.001**
	[0.004]
Trade Union	0.001
	[0.001]
Undefined training type	
Completed tertiary schooling	-0.006***
	[0.001]
Trade Union	-0.002***
	[0.002]
Observations	9,979
F-statistics	12.50
LM-underidentification test	3.037**
Wald-F statistics	15.17

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10