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INNOVATION IN TRANSITION COUNTRIES: THE ROLE OF TRAINING

Antonella Biscione, Chiara Burlina, Raul Caruso, Annunziata, de Felice

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Innovation in Transition countries: the role of training

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

Chiara Burlina
Gran Sasso Science Institute (GSSI)

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

Annunziata de Felice
Department of Law, University of Bari Aldo Moro

Abstract: *This paper analyses the effect of different training programs on the firms' innovation activities of 27 transition economies. Despite the ongoing debate on training and its effects on innovation, there are no previous studies investigating the role of different typologies of training. The results of the cross-country analysis show a positive relation between definite training and propensity to innovate, controlling several firms' characteristics such as size, presence of females in the board, personnel's education and managers' past experience. We also find a positive effect when considering other definitions of training (problem solving, commercial, managerial, or on-the-job vs. in-class), thus suggesting the need for policy makers and practitioners to invest in ad-hoc training programs to foster innovation in transition economies.*

Keywords: Transition Economies; Innovation; Training

JEL: O14; O32; P27; P36

1. Introduction

This paper is focused on the impact of training programs on innovation in a panel of firms from transition economies. Training is considered one of the most relevant dimensions of Human Resource Management (Weil and Woodall, 2005) because it enables workers to become more efficient and effective through the acquisition of knowledge, skills and abilities (Betcherman, 1992).

Then, training may have a substantial impact on the innovation activity of firms. According to the OECD (2000), training programs have to be listed among the key factors which affect firm's competitiveness, better organisation of the innovation process and product are more important than pure innovation and research development (R&D). And these conditions become even more evident when small and middle-size enterprises (SMEs) or developing economies are concerned (Robertson, 2003). Thus, there is an increasing attention among scholars of different disciplines (management, economics, organization science, political science) to better understand the positive effects of training in enhancing firms' performances (Caloghirou et al., 2018, Capozza and Divella, 2019, Protogerou et al., 2017).

This work in particular focuses on the impact of training programs on firms' innovation in transition economies. We consider different types of training activities. That is, we intend to shed some light on how different training programs affect both product and process innovation, considering a sample of firms belonging to 27 transition countries (World Bank, 2002; IMF 2000). Our analysis is developed using the information deriving from the World Bank's Enterprise Surveys carried out between 2018 and 2020. This survey reports data on firm's characteristics (such as size, industry, management composition), on innovation capacity and distinguish among six categories of training programs, namely: (i) mathematical, (ii) problem solving; (iii) managerial; (iv) foreign language; (v) communication; (vi) job specific. We empirically test if training programs, grouped according to different categorizations, might affect firm's propensity to perform both product and process innovations, also considering the size of the firm. Independently of the categorization of the training activity, our results lead to the same outcome: training becomes a necessary condition for innovation for the firms in our sample, no matter if the firm is small, medium, or large. Ongoing training and upskilling of the workforce can encourage creativity and new ideas can be formed as a direct result of training and development.

Thus, this paper aims to fill the gap in the literature on training by reporting new evidence that not only training *per se* matters, but also the typology of training programs affects firm's innovation propensity. These findings might be important not only from an academic viewpoint, but also for policy makers, in particular for policies related to incentives targeting transition economies. To gain competitive advantage and reach the standards of developed economies, institutions and firms need to develop specific policies devoted to increase the quality and quantity of training programs both internal and external to the firm.

The rest of the paper is developed as follows: Section 2 presents the literature related to training programs and innovation; Section 3 describes the data and the model used in the empirical study, the results of which are reported and discussed in Section 4; finally, Section 5 concludes, outlining the main contributions of the paper and the related policy implications.

2. Theoretical background

An extensive literature that makes a distinction between general and specific human capital (Becker, 1962) explores the effects of the different elements of human capital and worker skills on firm-level innovative performance (Capozza and Divella, 2019, van Uden et al., 2017; Teixeira and Tavares-Lehmann, 2014; Jones and Grimshaw, 2012; Schneider et al., 2010; Freel, 2005; Laursen and Foss, 2003). One of the most important specific elements of human capital is represented by the investment in training (van Uten et al., 2017; Acemoglu, 1997). In fact, the literature has emphasized the role of training on employee's knowledge acquisition at firm level to improve the ability to work and create new knowledge that, combined with the current knowledge, can generate new innovations (Caloghirou et al., 2018; Cordón-Pozo et al., 2017; Minbaeva et al. 2014; Amara et al., 2008; Walswoth and Verma, 2007). Several empirical studies analyze the relationship between training and innovation showing mixed results. Some works carried out mainly on developed countries find a positive impact of training on technological innovations (Caloghirou et al., 2018; Gallié and Legros, 2012; Zhou et al., 2011; Santamaria et al., 2009; Beugelsdijk, 2008; Foss and Laursen, 2003). In particular, for British manufacturing and service SMEs, evidence shows that this association depends on training intensity and firm size (Freel, 2005). Training activities are crucial factors for the product and process innovations of Spanish firms in low and medium technology industries operating in the manufacturing sector (Santamaria et al., 2009), for the flexible labor on product innovation in the Netherlands (Zhou et al., 2011), and for young firms operating in some European countries (Protogerou et al., 2017). When the effects of training and R&D expenditure on firms' innovation activities are considered, results for Spanish manufacturing firms show a positive and significant relationship between training and product innovation only for small firms, but not for large ones (Gonzalez et al., 2016). Yet, the study carried out by Caloghirou et al. (2018) deserves particular attention. The authors examine the role of employee training analyzing Greek manufacturing firms during times of economic crisis (2011 and 2013) and explore the effects of knowledge flows derived from employee training on the probability of firms to innovate. Their findings confirm the existence of a positive and significant association between training and product innovation. Also, more recent papers that analyze the relationship between different human capital factors and innovation in developing countries and transition economies provide positive evidence of this relationship. For instance, a study on Sub-Saharan countries show that training is a key driver for firms' innovation (van Uden, Knoben and Vermeulen, 2017). Analyzing the impact of general and specific human capital on firms' innovation in Transition countries, Nazarov and Akhmedjonov (2012) show that university education does not improve firms' capacity to introduce new products, while training plays a key role. The authors also highlight that, in transition economies, innovation is more based on the absorption of new technologies than on invention. In other words, the adoption of new technology firms needs employees with more specific knowledge rather than general knowledge. The work of Domadenik and Farčnik (2012) on Slovenian companies in manufacturing and service sectors comes to the same conclusion even though they use patents as a proxy for measuring innovation. In contrast with the previous literature, some studies both for industrialized countries such as Swiss firms in manufacturing industry (Arvanitis et al., 2016) and for low-tech industries in some developing economies (Goedhuys et al., 2013), and more specifically in Tanzania (Goedhuys, 2007) and Ghana (Robson et al., 2009) show that training has not significant relationship with innovation. Notwithstanding this literature, evidence on the role of training in firms' technological activity remains underestimated, in particular for

Transition economies. In this research we emphasize the role of training as a specific element of human capital, and differently from the previous research that used a dichotomic variable to measure training, in our work we employ a categorial variable to capture the different forms of training programs and their effects on innovation. In fact, with a specific training program, workers are more prone to acquire the specific knowledge to develop innovations (Cordón-Pozo et al., 2017). Therefore, the aim of this paper is to contribute to the literature by analyzing the effects of different training programs on the firms' innovation activities in a set of 27 Transition countries by enriching this strand of literature.

3. Data and empirical methodology

In order to investigate the effect of training programs on innovative activities of firms, in this paper we exploit the establishment-level data taken from the World Bank's Enterprise Surveys (hereinafter ES) that follows a methodology similar to that of the Oslo manual (OECD, 2005).

ES 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/Manager of each firm. The surveys give detailed fashion on private sector firms operating in non-agricultural economy[1] chosen according to the stratified random sample approach[2]. In particular, the surveys provide information on: (i) the innovation behavior of firms, (ii) innovative activities, organization practices, management and employees, (iii) other information on firms. The latest survey also has a module devoted to environmental issues. Our sample is based on data from 15,508 firms from 27 countries of Eastern Europe and Central Asia[3]. At the beginning of the 1990s, all the countries examined had experienced several changes to move from a planned to a market economy.

[1]The sectors included are all manufacturing sectors, construction, services, transport, storage, communications and IT in accordance with the classification ISIC Revision 3.1. While excluded sectors are financial intermediation, real estate and renting activities and finally, public and utilities.
[2] The stratification levels are as follows: region, sector and firm dimension.
[3] The list of countries considered in our analysis is included in Table 1 in the Appendix.

A measure of innovation is our dependent variable, and we refer to three types of innovation: (i) product innovation, (ii) process innovation and finally (iii) technological innovation. Therefore, we construct three binary variables to distinguish between different types of innovation outcome. The value of product innovation is 1 if the firm has introduced new or improved products, 0 otherwise; process innovation is equal to 1 if the firm has introduced new or improved process, 0 otherwise; and technological innovation takes the value of 1 if the firm has introduced product and process innovation combined and the value 0 otherwise.

The main explanatory variables of interest are the training programs considered as source of a specific form of human capital. To observe the impact of training programs on innovation activities adopted by firms, we employ an ordered variable equal to 0 for firms that declare they do not offer training practices, 1 if company provides its employees with a defined training program and finally, 2 if firm offers an undefined training activity[4].

The analysis includes a set of control variables to account for factors that are supposed to influence the capacity of firms to innovate. To assess the effect of other factors related to the human capital, we consider: (i) a variable that describes the percentage of firm's permanent full-time workers holding a university degree and (ii) the years that the top manager spent in that specific sector. In order to investigate the impact of firm's ownership on the decision to implement an innovation, we consider two variables. A dummy variable that assumes the value of 1 if the firms is run by female and 0 otherwise and a variable that manages to identify if the firms is in the hands of one or more owners. As a proxy of innovation inputs, we include the expenditure on research and development activities in the latest three years. 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 to purchase external 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 firm's innovative behavior. Therefore, we consider the degree of internationalization of firms

[4] Defined training includes mathematical, commercial, and managerial training programs. Undefined training refers to other types of training which cannot be grouped in defined categories.

and the level of competition in the market. This last one is described by a variable that groups the number of competitors into four categories: 1 (no direct competitors), 2 (1-5 competitors), 3 (6-20 competitors) and 4 (more than 20 competitors). Other characteristics are also considered: (i) size, an ordered variable that is equal to 1 for small firms (5-19 employees), 2 for medium firms (20–99 employees) and 3 for large firms (more than 100 employees); (ii) the firm's age measured as the difference between the year in which the survey is conducted and the year the firm starts its business activity and (iii) whether the firm is an independent economic unit (taking the value of 1) or part of a group of firms (taking 0).

We also employ a sector variable to control for the different technological opportunities available for firms by the industry sector. Hence, firms are grouped in: (i) manufacturing; (ii) retail services and (iii) other services. Finally, we split our sample in four macro-regions[5] to check differences in technological capacity at the geographical level.

Given the nature of our dependent variables, we opt for binary probit models to analyse the effect of training on our different innovation outcomes. Probit equations, instead of linear probability models, are normally used in the literature to overcome heteroskedasticity biases. The regression coefficients of the probit model have effects on a cumulative normal function of the probabilities that Y = 1 (in our case, the probability that a firm innovates). The equation is as follows (De Faria et al., 2020):

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

where ϕ denotes the cumulative probability distribution function of the standard normal distribution, and transforms the regression into the interval (0, 1). Therefore, our dependent variable Y takes value 1 if the firm innovates (product, process, or both), 0 otherwise. The training variable takes values from 0 to 2 according to the type of training performed by the firm, and X is a vector of controls for firms' characteristics.

[5]Countries are grouped into the following macro-regions:

I. European Former-USSR Countries: Belarus, Georgia, Lithuania, Estonia, Latvia, Moldova, Ukraine.
II. Former Yugoslavian Countries and Albania: Albania, Croatia, Montenegro, North Macedonia, Bosnia and Herzegovina, Serbia, Slovenia, Kosovo.
III. Eurasian Former-USSR Countries: Azerbaijan, Armenia, Kyrgyz Republic, Tajikistan, Uzbekistan, Kazakhstan.
IV. Central European countries: Bulgaria, Czech Republic, Romania, Slovak Republic, Poland, Hungary.

We introduce clustered standard errors at country level, which allows us to relax the assumption of independence between clusters, in our case countries (Cameron and Trivedi, 2010). Finally, 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).

Table 1 presents the variables' descriptive statistics and Table A2, in the Appendix, shows the variables' correlation matrix. Table 2 contains the list and description of variables included to account for factors that could affect the propensity of a firm to innovate.

Table 1. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Proportion
Product innovation	15,424	0.328	0.470	0	1	0.33
Process innovation	15,313	0.192	0.394	0	1	0.19
Technological Innovation	15,508	0.394	0.489	0	1	0.39
Defined training	15,508	0.550	0.840	0	2	
No training						0.68
Definite training type						0.09
Not definite training type						0.23
Multi-implant	15,505	0.104	0.305	0	1	0.10
Owner	15,087	83.22	24.59	1	100	
Manager experience	15,113	18.57	10.61	1	65	
Credit line	15,258	0.394	0.489	0	1	0.39
External knowledge	15,373	0.144	0.351	0	1	0.14
Firms 'Age	15,372	18.25	13.95	0	205	
Competitors	13,954	3.069	0.973	1	4	
No direct competitors						0.05
1-5 competitors						0.29
6-20 competitors						0.20
More than 20 competitors						0.46
Region	15,508	2.456	1.138	1	4	
European former-USSR Countries						0.25
Central European countries						0.30
Former Yugoslavian Countries and Albania						0.17
Eurasian former-URSS countries						0.27
Female	15,396	0.344	0.475	0	1	0.34
Firm size	15,484	1.746	0.782	1	3	
Small						0.47
Medium						0.32
Large						0.21
Industry	15,508	1.744	0.871	1	3	
Manufacturing						0.54
Services						0.18
Retail						0.28
RD	15,508	0.231	0.422	0	1	0.23
Export	15,508	14.96	29.22	0	100	
Education	15,508	0.102	0.303	0	1	0.10

Table 2. Description of variables

Variable	Description
Product Innovation	1 if a firm, in the last three years, has introduced new or improved product, 0 otherwise
Process Innovation	1 if a firm, in the last three years, has introduced new or improved process, 0 otherwise
Technological Innovation	1 if a firm, in the last three years, has introduced a technological innovation (product and process innovation combined), 0 otherwise
Defined Training	0 if a firm does not offer training activities; 1 if the training activities are identified 2 if the training activities are not identified
Multi-implant	1 if a firm is a part of a multi-establishment, 0 otherwise
Owner	Percentage held by largest owner or owners
Manager Experience	Year of experience working in the sector of top manager
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

Firm's Age	Difference between the current year and the year the firm registers to start the business activity
Competitors	Number of direct competitors:
	1 if a firm has not 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
Country Regions	Region in which firm is located
	1 for European Former-USSR Countries
	2 for Central European Countries
	3 for Former Yugoslavian Countries and Albania
	4 for Eurasian Former-USSR Countries
Female Ownership	1 if a firm has female owners, 0 if firm ownership is exclusively male
Firm Dimension	
Small Firm	1 if a firm has <=19 employees
Medium Firm	2 if a firm has >=20 and <=99
Large firm	3 if a firm has >=100
Industry	Firm's macro-sector: manufacturing (=1), services (=2), and retail (=3)
RD	Expenditure on R&D activities in the last three years
Export	Percentage of exported products
Credit line	1 if a firm, in the fiscal year, has a line of credit or a loan from a financial institution, 0 otherwise
uni90	Percentage of permanent full-time employees with a university degree (at 90 percentile)

4. Results and discussion

In our basic specification, we estimate each regression equation considering three dependent variables: (i) technological innovation; (ii) product innovation and (iii) process innovation. The results obtained from probit regressions are presented in Table 3. Specifically, this table reports the estimated marginal effects of the explanatory variables on the probability of a firm introducing an innovation, when all the regions in our sample are included. Findings in columns 1, 3 and 5 refer to a simple model which takes into account only industry and country region fixed effects. Columns 2, 4 and 6 provide the evidence obtained when we include a set of control variables.

Table 3. Regression results for defined vs. undefined training – Marginal Effects

VARIABLES	(1) Technological Innovation		(2) Product Innovation		(3) Process Innovation	
Ref. cat.: No training						
Definite training type	0.285***	0.127***	0.237***	0.096***	0.232***	0.104***
	[0.025]	[0.022]	[0.023]	[0.020]	[0.024]	[0.018]
Not definite training type	0.233***	0.128***	0.189***	0.099***	0.167***	0.090***
	[0.016]	[0.015]	[0.014]	[0.013]	[0.015]	[0.014]
Ref. cat.: Large firms						
Small firms		0.016		0.024*		-0.013
		[0.016]		[0.014]		[0.015]
Medium firms		0.029**		0.025**		0.007
		[0.014]		[0.011]		[0.014]
Firms' Age		-0.001		-0.000		-0.000
		[0.001]		[0.000]		[0.000]
Female ownership		-0.008		0.006		-0.020*
		[0.017]		[0.017]		[0.011]
Firm's Age*Female		0.001**		0.001		0.001***
		[0.001]		[0.001]		[0.000]
External knowledge		0.184***		0.141***		0.122***
		[0.013]		[0.014]		[0.009]
Education		0.030**		0.048***		0.007
		[0.014]		[0.012]		[0.014]
Export		0.000**		0.000		0.000**
		[0.000]		[0.000]		[0.000]
RD		0.191***		0.188***		0.104***
		[0.021]		[0.018]		[0.012]

Multi-implant		0.042**		0.025		0.042***
		[0.017]		[0.021]		[0.010]
Owner		-0.000		-0.000		-0.000*
		[0.000]		[0.000]		[0.000]
Manager experience		0.001**		0.001		0.001
		[0.001]		[0.000]		[0.000]
Credit line		0.085***		0.068***		0.063***
Ref. cat.: No direct competitors						
1-5 competitors		0.027		0.023		0.015
		[0.019]		[0.017]		[0.013]
6-20 competitors		0.034		0.022		0.038***
		[0.023]		[0.019]		[0.013]
more than 20 competitors		-0.044**		-0.045**		-0.006
		[0.021]		[0.019]		[0.013]
Ref. cat.: Retail						
Manufacturing	0.123***	0.100***	0.124***	0.107***	0.085***	0.065***
	[0.016]	[0.015]	[0.016]	[0.017]	[0.011]	[0.012]
Services	-0.007	0.004	0.004	0.011	-0.010	0.001
	[0.014]	[0.012]	[0.014]	[0.013]	[0.009]	[0.009]
Ref. cat.: Central European Countries						
European Former-USSR Countries	0.188***	0.143***	0.173***	0.131***	0.104***	0.082***
	[0.043]	[0.036]	[0.028]	[0.025]	[0.033]	[0.028]
Former Yugoslavian Countries and Albania	0.231***	0.180***	0.231***	0.187***	0.134***	0.098***
	[0.051]	[0.039]	[0.044]	[0.032]	[0.047]	[0.036]
Eurasian Former-USSR Countries	0.077*	0.066*	0.090***	0.072***	0.028	0.030
	[0.042]	[0.034]	[0.034]	[0.027]	[0.029]	[0.030]
Observations	15,508	13,060	15,424	13,028	15,313	12,973

Notes: Clustered standard errors at Country level in parentheses. *** p<0.01, ** p<0.05, * p<0.10

The main results confirm the key role played by training programs in innovation. In particular, our findings show that when firms offer training programs to their employees, they are more likely to trigger a technological innovation than firms that do not provide such programs. Our findings show that this relationship is stronger for product than for process innovation when we consider the fixed effect. This is in line with the work of Frenz and Lambert (2019). Noteworthy results are observed when considering the different types of training. Distinguishing between defined and undefined training programs, we find that both strongly affect the probability to introduce firms' product and process innovation, although they differ in magnitude. In fact, the likelihood to implement innovation is greater for firms that provide defined training. This result can be explained by the fact that a defined training is designed to meet the specific needs of the firms. In particular, employees require targeted and specific training to solve more complex problems. In addition, when firms have more product lines, employees need different and specific training programs (Teruel and Segarra-Blasco, 2015). Our results are in the same vein as previous studies (i.e. Caloghirou et al., 2018; Cordón-Pozo et al., 2017) which show that training improves work's capability, knowledge and generate new innovation activities.

Moving on to consider each dependent variable and the set of control variables, the estimated definite and indefinite training coefficients are quite stable across product and process innovations and on average equal to 9.8% and 9.7%, respectively. Looking at the general human capital both education and top manager experience have a positive effect on the decision to adopt a technological innovation. In particular, with respect to education, our findings reveal that a one percentage point increase in workers with tertiary-education yields a 4.8% increase in the probability to implement a product innovation given that education improves technical expertise, promotes creativity, and facilitates the use of tools and equipment. The top manager with experience has a modest positive effect on the propensity to innovate. With the increasing of experience over the years, the top manager strengthens his innovation capabilities. As a consequence, for each additional year of experience, the firm's innovativeness increases by 0.1%. The acquisition of external knowledge from other organizations such as firms, research entities, is an additional and complementary input with respect to the internal knowledge. Their combination generates a new technological innovation (Caloghirou et al., 2018; Cordón-Pozo et al., 2017; Minbaeva et al. 2014) and in our findings this combination promotes creation and development of a new product and production process. Also, the R&D expenditures strongly increase the probability to introduce firms' innovation. In addition, firms with a line of credit have another source to invest in new product and process activities. In fact, they are 8.5% more reactive to adopt an innovation than those without a credit line.

Considering the firm size, we find that middle size firms with respect to large ones show a significant and positive impact on innovation performance although in the production of new goods even small firms show a positive correlation that is statistically significant at the minimum conventional level 10%. However, the marginal effect associated with medium size (25%) is greater than that of small ones (24%). This is an unexpected result since the innovation literature highlights the role of large companies or small firms in the innovative activity for their peculiar characteristics (i.e. Lin et al., 2019; Stock et al., 2002). On the contrary, empirical studies neglect to study innovation in medium-sized companies.

Turning to firm ownership, we find that firms run only by men are more innovative in process activity than those in which there are also women. Conversely, the interaction term between the firm's age and the presence of female in the firms is positively correlated with the innovation process. In this regard, considering the firm's age as a type of knowledge stock of the firm (Caloghirou et al., 2018), the plausible explanation is that the older the firms the more knowledge they have accumulated which is then used for ideas aimed at innovating mainly the production process. Yet, by looking at the owner variable which 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. Therefore, the concentration of ownership harms the firms (De Andrés-Alonso et al., 2000). In fact, in the considered Transition countries, when firms have a high level of contraction their propensity to improve firm’s efficiency is low. It follows that ownership concentration becomes an obstacle to the productive efficiency because it reduces the number of high-risk projects implemented due to the low specialization of owners in technical decisions (Ortega-Argilés and Moreno, 2009).

Also, the market competition of firms can impact the level of innovation. Our results highlight two different effects of market competition on innovation. When firms have a limited number of direct competitors, the relationship between the degree of market competition and innovation appears to be positive, fully confirming the hypothesis of the presence of the escape-competition effect. In this case, firms are forced to improve the efficiency of their production process to strengthen or maintain their market niche (Castellacci and Fevolden, 2014). On the contrary, firms that face many competitors show a negative association with technological innovation. This result is in line with the traditional approach better known as the Schumpeterian effect which states that a high level of competition in the market competition could reduce the monopoly rents of potential innovative firms, thereby reducing their incentives to engage in R&D (Scherer 1967; Geroski 1990; Nickell 1996).

As regards the variable that captures the export propensity, it is positively and significantly associated with process innovation. This positive relationship with process innovation probably reflects the need to export goods with competitive prices. To this end, it is required a better production efficiency which often means lower costs. Also, the multi-plant organization improves the efficiency of the production system. In fact, our results reveal that the firm’s propensity to introduce a process innovation is strongly affected by group affiliation.

Given the results on the relative strength of the medium firms, the industrial structure of the transition countries examined and considering the magnitude of the estimation of medium and small-sized firms with respect to large ones, we explore the effect of training programs on innovative activities by considering the three size classes of firms. Therefore, we re-run the baseline model splitting our sample according to the size of the firms. Table 4 reports the results for small, medium, and large firms, respectively.

Overall, the main results are also confirmed when we perform this further estimation to examine and highlight the firms' dimension heterogeneity. Differences are found only in the value of the estimated coefficient for both defined and undefined training. In fact, the likelihood to implement innovation is greater in medium and large firms that provide defined training, while the effect of undefined training is greater in small and medium firms. Concerning this last result, medium firms are more dynamic and show higher efficiency with respect to small and large ones. This probably depends on the fact that the medium enterprise is able to combine the polyarchic system that characterizes the small entities with the hierarchical system typical of the great dimension. Therefore, medium dimension benefits from the advantages of the great ones that balance the disadvantages of the small ones (Arrighetti and Traù, 2013). In fact, on the one hand our findings show that medium firms as well as small ones have a high level of concentration that is negatively related to the decision to implement the technological innovation. On the other hand, in medium firms such as in large ones, general knowledge levels captured by managers with experience and qualified workers (education) are high. In addition, and in line with the literature, while larger and medium firms have a higher gender diversity potential only in older companies, the small firms do not capture the advantage of gender diversity during the innovation process (Biscione et al., 2021; Teruel and Segarra-Blasco, 2015). Also, and differently from small firms, medium and large firms show a greater propensity to export since they achieve their production efficiency.

Interestingly our findings show that the multi-implant variable is associated positively with small and large firms' innovation activities. This probably means that small firms are small group affiliations, and they are specialized in the production of specific goods, while large firms are headquarters (Gumpert et al., 2018).

The results obtained from the market competition confirm the presence of the escape-competition effect when the number of competitors is limited. It is the large firms' case. On the contrary, considering the small firms the Schumpeterian effect prevails, while for medium-sized companies, both effects are mixed. In addition, firms' size is not a barrier to access to external funding, as well as to acquire external knowledge from other organizations and implement internal R&D activity.

Table 4. Regression results for defined vs. undefined training by firms' size – marginal effects

	Small firms			Medium firms			Large firms		
VARIABLES	Technological Innovation	Product Innovation	Process Innovation	Technological Innovation	Product Innovation	Process Innovation	Technological Innovation	Product Innovation	Process Innovation
Ref. cat.: No training									
Definite training type	0.116***	0.083***	0.081***	0.158***	0.104***	0.131***	0.098***	0.102***	0.109***
	[0.032]	[0.028]	[0.022]	[0.036]	[0.038]	[0.026]	[0.020]	[0.025]	[0.021]
Not definite training type	0.125***	0.100***	0.065***	0.148***	0.108***	0.111***	0.099***	0.088***	0.106***
	[0.021]	[0.020]	[0.015]	[0.020]	[0.018]	[0.018]	[0.019]	[0.020]	[0.022]
Firms' Age	-0.001	-0.001	0.000	-0.001	-0.001	-0.000	-0.001	0.000	-0.000
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Female ownership	0.008	0.007	-0.010	-0.005	0.012	-0.022	-0.047	-0.034	-0.019
	[0.024]	[0.019]	[0.018]	[0.027]	[0.027]	[0.029]	[0.030]	[0.036]	[0.027]
Firm's Age*Female	0.001	0.001	0.001	0.001*	0.001	0.001	0.002***	0.001	0.002**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
External knowledge	0.211***	0.162***	0.119***	0.156***	0.127***	0.108***	0.178***	0.125***	0.153***
	[0.017]	[0.019]	[0.013]	[0.022]	[0.022]	[0.013]	[0.020]	[0.020]	[0.021]
Education	0.000	0.018	-0.017	0.079***	0.091***	0.046***	0.070***	0.096***	0.039
	[0.017]	[0.013]	[0.015]	[0.028]	[0.025]	[0.018]	[0.024]	[0.028]	[0.029]
Export	0.000	0.000	0.000	0.000	-0.000	0.001**	0.001**	0.000	0.001*
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
RD	0.198***	0.180***	0.099***	0.179***	0.185***	0.098***	0.200***	0.211***	0.127***
	[0.029]	[0.025]	[0.016]	[0.031]	[0.028]	[0.014]	[0.016]	[0.017]	[0.022]
Multi-implant	0.079**	0.044	0.054***	0.019	0.026	0.024	0.026	0.002	0.052***
	[0.033]	[0.040]	[0.016]	[0.024]	[0.026]	[0.019]	[0.018]	[0.020]	[0.015]
Owner	-0.000	-0.000	-0.000**	-0.001**	-0.000	-0.000	0.000	0.000	-0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Manager experience	0.000	-0.000	0.000	0.002***	0.001*	0.001	0.002*	0.002*	0.001
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Credit line	0.087***	0.074***	0.055***	0.089***	0.063***	0.078***	0.071***	0.060***	0.053***
	[0.014]	[0.013]	[0.012]	[0.019]	[0.016]	[0.014]	[0.019]	[0.017]	[0.020]
Ref. cat.: No direct competitors									
1-5 competitors	0.003	0.014	-0.001	0.046*	0.009	0.028	0.043	0.058*	0.031
	[0.027]	[0.029]	[0.019]	[0.027]	[0.022]	[0.024]	[0.034]	[0.033]	[0.043]
6-20 competitors	-0.020	-0.009	0.002	0.069***	0.025	0.064***	0.088**	0.082*	0.074*
	[0.039]	[0.036]	[0.019]	[0.024]	[0.022]	[0.021]	[0.036]	[0.042]	[0.042]
more than 20 competitors	-0.078**	-0.062*	-0.025	-0.040	-0.064**	0.001	0.016	0.019	0.028
	[0.032]	[0.035]	[0.015]	[0.028]	[0.025]	[0.027]	[0.034]	[0.034]	[0.047]
Ref. cat.: Retail									
Manufacturing	0.102***	0.097***	0.057***	0.105***	0.113***	0.073***	0.091***	0.132***	0.071***
	[0.018]	[0.020]	[0.011]	[0.019]	[0.022]	[0.019]	[0.027]	[0.028]	[0.027]
Services	0.002	0.006	0.003	0.004	0.019	-0.015	0.016	0.012	0.029
	[0.015]	[0.013]	[0.009]	[0.023]	[0.019]	[0.023]	[0.037]	[0.038]	[0.037]
Ref. cat.: Central European Countries									
European Former-USSR Countries	0.133***	0.121***	0.067***	0.138***	0.141***	0.079**	0.171***	0.142***	0.123***
	[0.033]	[0.028]	[0.023]	[0.040]	[0.025]	[0.038]	[0.048]	[0.037]	[0.041]
Former Yugoslavian Countries and Albania	0.161***	0.177***	0.072*	0.184***	0.196***	0.114**	0.206***	0.202***	0.128***
	[0.039]	[0.035]	[0.038]	[0.054]	[0.042]	[0.051]	[0.036]	[0.035]	[0.037]
Eurasian Former-USSR Countries	0.047	0.057*	0.022	0.080**	0.080***	0.038	0.088**	0.104***	0.038
	[0.036]	[0.033]	[0.024]	[0.035]	[0.022]	[0.038]	[0.039]	[0.034]	[0.049]
Observations	6,209	6,196	6,185	4,268	4,256	4,230	2,583	2,576	2,558
Number of Countries	27	27	27	27	27	27	27	27	27
Pseudo R2	0.128	0.117	0.119	0.138	0.122	0.125	0.170	0.155	0.156
Wald Chi-2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: Clustered standard errors at Country level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.10$

4.1 Alternative types of training programs

To provide additional support to the analysis, we re-run the baseline model splitting our sample according to the training program workers have followed. First, we re-run the analysis to highlight the effect of training programs on innovative activities by grouping these programs into the following categories: (i) mathematical related training; (ii) commercial related training, (iii) managerial related training and finally (iv) other training types. Then, following the classification used by Dostie (2018), we also regressed the baseline model considering another definition of the training activity namely *on-the-job vs. in-class*. In Table 4, we show the estimation findings.

Table 4. Regression results for four training types – marginal effects[6]

VARIABLES	(1) Technological Innovation	(2) Product Innovation	(3) Process Innovation
Ref. cat.: No training			
Mathematical related training	0.067	0.053	0.070**
	[0.043]	[0.033]	[0.030]
Commercial related training	0.150***	0.136***	0.123***
	[0.032]	[0.033]	[0.022]
Managerial related training	0.145***	0.095***	0.111***
	[0.023]	[0.021]	[0.024]
Other	0.128***	0.100***	0.090***
	[0.015]	[0.013]	[0.014]
Ref. cat.: Large firms			
Small firms	0.017	0.025*	-0.013
	[0.016]	[0.014]	[0.015]
Medium firms	0.029**	0.025**	0.007
	[0.014]	[0.011]	[0.014]
Firms' Age	-0.001	-0.000	-0.000
	[0.001]	[0.000]	[0.000]
Female ownership	-0.007	0.007	-0.020*
	[0.017]	[0.017]	[0.011]
Firm's Age*Female	0.001**	0.001	0.001***
	[0.001]	[0.001]	[0.000]
External knowledge	0.184***	0.140***	0.122***
	[0.013]	[0.014]	[0.009]
Education	0.030**	0.048***	0.007
	[0.014]	[0.012]	[0.014]
Export	0.000**	0.000	0.000**
	[0.000]	[0.000]	[0.000]
RD	0.190***	0.188***	0.104***
	[0.021]	[0.018]	[0.012]
Multi-implant	0.041**	0.024	0.042***
	[0.017]	[0.021]	[0.009]
Owner	-0.000	-0.000	-0.000*
	[0.000]	[0.000]	[0.000]
Manager experience	0.001**	0.001	0.001

[6] The four classes of training are as follows:

(i) mathematical which groups numeracy or math skills and problem solving or critical thinking skills;
(ii) commercial, which includes foreign language skills and interpersonal and communication skills;
(iii) managerial, that stands for managerial and leadership skills and job-specific technical skills;
(iv) other, that defines other types of training which cannot be grouped in the other three categories.

	[0.001]	[0.000]	[0.000]
Credit line	0.085***	0.068***	0.062***
	[0.012]	[0.011]	[0.010]
Ref. cat.: No direct competitors			
1-5 competitors	0.027	0.023	0.015
	[0.019]	[0.017]	[0.014]
6-20 competitors	0.033	0.022	0.038***
	[0.024]	[0.019]	[0.013]
more than 20 competitors	-0.045**	-0.045**	-0.006
	[0.021]	[0.019]	[0.013]
Ref. cat.: Retail			
Manufacturing	0.101***	0.107***	0.065***
	[0.015]	[0.017]	[0.012]
Services	0.004	0.011	0.001
	[0.013]	[0.013]	[0.009]
Ref. cat.: Central European Countries			
European Former-USSR Countries	0.143***	0.130***	0.082***
	[0.036]	[0.025]	[0.028]
Former Yugoslavian Countries and Albania	0.179***	0.187***	0.098***
	[0.038]	[0.032]	[0.036]
Eurasian Former-USSR Countries	0.066**	0.072***	0.030
	[0.033]	[0.027]	[0.030]
Observations	13,060	13,028	12,973

Notes: Clustered standard errors at Country level in parentheses. *** p<0.01, ** p<0.05, * p<0.10

In general, results are in line with those obtained by the baseline estimate. The four training types are consistent with firms' innovation activities except for mathematical related training which seems to have a positive impact only on process innovation. This result probably depends on the fact that companies offer mathematical training programs to their employees to improve their skills. These workers are responsible for the increase in the production process efficiency. Therefore, employees with mathematical skills can apply their knowledge in the implementation of mathematical models so as to reduce the experiment costs (Solovev et al., 2019). The other training programs, although exhibiting a strong correlation with both product and process innovation, differ in magnitude. In particular, the coefficient of commercial training is slightly larger compared with the other typologies. This probably happens because firms want to become competitive in other markets or maintain their market niche. To this end firms offer commercial training to their employees to improve foreign language skills or more interpersonal and communication skills. Finally, managerial training also shows a significant and positive relationship with product and process innovation. This result probably implies that both innovation forms require a sound management that takes into account the cash flow problems when new products are developed (Frenz and Lambert, 2019). All controls are confirmed.

The results of the baseline model are also confirmed when we distinguish training programs using the classification suggested by Dostie (2018). Findings collected in Table 5 once again highlight the positive impact of training on firms' innovation activities.

The result related to on-the-job training or informal training also deserves particular attention. In fact, the likelihood to implement innovation is greater when firms offer on-the-job training with respect to classroom training or formal training. This result is in the same vein as the literature (Dostie, 2018; Sung and Choi, 2014; Pischke, 2005) that highlights how employees within firms may receive more informal training with respect to formal one. Conversely, among employees formal training is more selective (Sung and Choi, 2014). Thus, the former might have a higher impact on the firms' propensity to innovate than the latter (Nazarov and Akhmedjonov, 2012) both in product and process innovation as our results show. In addition, and in line with our main findings, medium firms with respect to large ones show a significant and positive impact on innovation performance.

Table 5. Regression results for class vs. on-the-job training – marginal effects[7]

VARIABLES	(1) Technological Innovation	(2) Product Innovation	(3) Process Innovation
Ref. cat.: No training			
Class	0.066	0.052	0.069**
	[0.043]	[0.034]	[0.030]
On-the-job	0.148***	0.110***	0.116***
	[0.021]	[0.019]	[0.019]
Other	0.128***	0.100***	0.090***
	[0.015]	[0.013]	[0.014]
Ref. cat.: Large firms			
Small firms	0.016	0.024*	-0.013
	[0.016]	[0.014]	[0.015]
Medium firms	0.029**	0.025**	0.007
	[0.014]	[0.011]	[0.014]
Firms' Age	-0.001	-0.000	-0.000
	[0.001]	[0.000]	[0.000]
Female ownership	-0.007	0.007	-0.020*
	[0.017]	[0.017]	[0.011]
Firm's Age*Female	0.001**	0.001	0.001***
	[0.001]	[0.001]	[0.000]
External knowledge	0.184***	0.140***	0.122***
	[0.013]	[0.014]	[0.009]
Education	0.030**	0.048***	0.006
	[0.014]	[0.012]	[0.014]
Export	0.000**	0.000	0.000**
	[0.000]	[0.000]	[0.000]
RD	0.190***	0.188***	0.104***
	[0.021]	[0.018]	[0.012]
Multi implant	0.041**	0.024	0.042***
	[0.017]	[0.021]	[0.009]
Owner	-0.000	-0.000	-0.000*
	[0.000]	[0.000]	[0.000]
Manager experience	0.001**	0.001	0.001
	[0.001]	[0.000]	[0.000]
Credit Line	0.085***	0.068***	0.062***
	[0.012]	[0.011]	[0.010]
Ref. cat.: No direct competitors			

[7] In the class category we can find numeracy or math skills, problem solving or critical thinking skills, and foreign language skills; the on-the-job group includes managerial and leadership skills, interpersonal and communication skills, and job-specific technical skills. Finally, as the previous classification, other training programs are stand-alone.

1-5 competitors	0.027	0.023	0.015
	[0.019]	[0.017]	[0.014]
6-20 competitors	0.033	0.022	0.038***
	[0.023]	[0.019]	[0.013]
more than 20 competitors	-0.045**	-0.045**	-0.006
	[0.021]	[0.019]	[0.013]
Ref. cat.: Retail			
Manufacturing	0.101***	0.107***	0.065***
	[0.015]	[0.017]	[0.012]
Services	0.004	0.011	0.001
	[0.012]	[0.013]	[0.009]
Ref. cat.: Central European Countries			
European Former-USSR Countries	0.143***	0.131***	0.082***
	[0.036]	[0.025]	[0.028]
Former Yugoslavian Countries and Albania	0.180***	0.187***	0.098***
	[0.038]	[0.032]	[0.035]
Eurasian Former-USSR Countries	0.066**	0.072***	0.030
	[0.033]	[0.027]	[0.030]
Observations	13,060	13,028	12,973

Notes: Clustered standard errors at Country level in parentheses. *** p<0.01, ** p<0.05, * p<0.10

5. Conclusion

The purpose of this study was to investigate the effect of different training programs on both product and process innovation, considering a sample of firms belonging to 27 Transition countries by using firm-level data drawn from the World Bank Enterprise Surveys. We have employed a probit model to analyze the different effect of training on innovation and divided the training groups in: (i) defined and undefined; (ii) mathematical, commercial, managerial, and other categories; (iii) on-the-job training and in-class training. We have also checked firm-size given the relative strength result of middle firms.

The main findings show that despite any classification, training programs play a key role in developing firms' innovation activities regardless their size. In particular, both defined and undefined training programs positively affect the probability to introduce firms' product and process innovation, although they differ in magnitude. The likelihood to implement innovation seems to be greater for firms that provide its employees with programs of defined training. In fact, defined training is planned to meet the specific need of the company.

Controls have the expected impact. Both education and top manager experience have a positive effect on the decision to adopt a technological innovation. The top manager with experience has a modest positive effect on the propensity to innovate. With the increasing of experience over the years, the top manager strengthens his innovation capabilities. The acquisition of external knowledge from other organizations, such as firms and research entities, is an additional and complementary input with respect to internal knowledge. Results also highlight that firms with certain characteristics seem to be more reactive to innovation. For instance, the training positive effect on innovation is always higher for middle-size firms with respect to small and large ones. This evidence is inconsistent with the previous research in which emerges the role of training on innovation performance in larger companies or small firms. Therefore, our results seem to highlight that middle size firms enjoy the benefits of large firms, which in turn manage to offset the disadvantages of small firms. The main results are confirmed also when we perform alternative estimations according to the various types of training. When distinguishing among mathematical, commercial, managerial, and other training types, we find that every training program exhibits a strong correlation with firms' innovation activity, but differences are in magnitude. While following the classification suggested by Dostie (2018), informal training shows a great impact on product and process innovation with respect to formal training.

Our study is limited mainly by the generalizability of the results since the analysis is based on a survey conducted over a short term since we use cross-sectional data. Future research based on panel data could empirically evaluate the direction of causality. Despite such a limitation, our findings may have relevant implications. First, training seems to have a key role in firms' innovation activities in Transition economies. Then, policymakers should target incentives in firms to increase training programs and in particular specific training types. On the other side, managers should spend more time to identify the needs of the company and to organize specific courses for their employees. Second, training could be addressed to improve product or process innovation. In order to give more detailed suggestions for policy makers on planning actions, further research should be conducted at the sectoral level. This type of analysis would allow the study of the peculiarities of each sector. Finally, more specific studies could consider the role of medium dimension of firms in innovation. This dimension is often forgotten.

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APPENDIX

Table A1. List of Countries

Albania	Georgia	Montenegro
Armenia	Hungary	Poland
Azerbaijan	Kazakhstan	Romania
Belarus	Kosovo	Serbia
Bosnia and Herzegovina	Kyrgyz Republic	Slovak Republic
Bulgaria	Latvia	Slovenia
Croatia	Lithuania	Tajikistan
Czech Republic	Macedonia, FYR	Ukraine
Estonia	Moldova	Uzbekistan

Table A2. Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Technological Innovation	1.000															
(2) Product Innovation	0.864	1.000														
(3) Process Innovation	0.605	0.332	1.000													
(4) Class of Training	0.229	0.194	0.210	1.000												
(5) Defined Training	0.223	0.188	0.203	0.993	1.000											
(6) Types of Training	0.227	0.191	0.207	0.997	0.989	1.000										
(7) Firms' Age	0.062	0.060	0.081	0.074	0.073	0.074	1.000									
(8) Female ownership	0.025	0.025	0.022	0.019	0.017	0.018	0.103	1.000								
(9) External Knowledge	0.262	0.236	0.248	0.229	0.222	0.225	0.038	0.018	1.000							
(10) Education	0.038	0.047	0.018	0.025	0.019	0.027	-0.091	0.004	0.092	1.000						
(11) Export	0.136	0.105	0.142	0.127	0.126	0.127	0.114	-0.006	0.100	-0.045	1.000					
(12) RD	0.313	0.307	0.265	0.229	0.219	0.226	0.074	0.000	0.359	0.085	0.161	1.000				
(13) Multi implant	0.064	0.045	0.075	0.084	0.080	0.082	0.056	0.013	0.042	0.008	0.044	0.056	1.000			
(14) Owner	-0.061	-0.051	-0.064	-0.058	-0.057	-0.057	-0.130	-0.225	-0.037	-0.005	-0.048	-0.069	-0.038	1.000		
(15) Manager Experience	0.049	0.029	0.046	0.077	0.079	0.078	0.323	0.067	0.004	-0.085	0.083	0.017	-0.003	-0.085	1.000	
(16) Competitors	-0.099	-0.093	-0.056	-0.066	-0.066	-0.065	-0.045	0.004	-0.031	0.004	-0.043	-0.058	-0.031	0.042	-0.031	1.000