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The Role of Innovation in Skill Development: Evidence from Small and Medium-Sized Enterprises in Viet Nam

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Abstract: *Using the Small and Medium Enterprise Survey in Vietnam and three proxies of innovation, we study the impact of firm innovation on on-the-job training in the manufacturing sector from 2007 through 2015. To address potential measurement errors and omitted variable problems, we use the average level of innovation in the same sector in other districts as an instrument for firms' innovations. We find that firms provide additional training for existing workers when introducing new technology, and high-value-added firms provide additional training for existing workers. Moreover, government assistance may not be the main reason that encourages firms to provide training. The results also show that firms hire more skilled workers when implementing innovations.*

Keywords: firm innovation, training, small and medium-sized enterprises

JEL Classification: O33, J24

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1. Introduction

Shortages of high-quality human capital remain a primary challenge faced by firms in developing countries. In addition, most human capital accumulation in the form of on-the-job training happens inside firms (Acemoglu and Pischke, 1998). Thus, employer-provided training is especially crucial to develop and update workers' skills in a context of rapidly changing preferences and technologies (Almeida, Behrman, and Robalino, 2012). On-the-job training can help workers be more productive, adapt more easily to firm innovation, use capital and machinery more efficiently, and positively affect the performance of their peers.

The empirical literature also indicates a complementarity between skills and technology (Acemoglu and Pischke, 1998; Berman, Bound, and Griliches, 1994; Bugamelli and Pagano, 2004; Doms, Dunne, and Troske, 1997; Disney, Haskel, and Heden, 2003). To remain competitive in the context of rapidly changing preferences and technologies, firms must continually acquire new production and management technologies, which increase demand for higher skilled workers (Saraf, 2017).

Although training seems to benefit both firms and workers, the relationship between on-the-job training and innovations is far from obvious. On the one hand, innovations make formal education and previously acquired skills obsolete. Consequently, both workers and firms prefer to invest in on-the-job training to match the specific requirements of each wave of innovation (Bartel and Sicherman, 1999). Innovation can also lead to higher profits that create resources for training (Dostie, 2018). Empirical studies find that more innovative firms tend to train more (Pierre and Scarpetta, 2004; Gonzales-Velosa, Rosas, and Flores, 2016). Bartel and Sicherman (1998) also show that production workers in manufacturing industries with higher rates of technological change are more likely to receive formal company training, and low-skilled non-production workers receive significantly more training than higher skilled non-production workers. On the other hand, firms may not want to provide general training to their workers, who can then leave the firm in search of higher pay in other firms (Becker, 1962).

Using five rounds from the Small and Medium Enterprise Survey of Viet Nam over the period 2007–2015, this paper aims to answer the following questions: (i) Do innovations affect on-the-job training for workers?, (ii) Do innovations increase training for both entry-level workers and more experienced ones?, and (iii) Do firms that innovate more tend to hire more skilled workers?

To address potential measurement errors or omitted variable problems, we used the average level of innovation in the same sector in other districts as an instrument for firms' innovations in Viet Nam. By instrumenting on-the-job training, we can estimate the local average treatment effect of innovation on training. The results of our empirical analyses indicate that firms provide more training for existing workers when they introduce new technology, and high-value-added firms provide more training for existing workers. Moreover, government assistance may not be the main factor that encourages firms to provide training. The results also show that firms hire more skilled workers when implementing innovations.

This paper makes the following contribution to the literature. First, it complements studies such as that by Bartel and Sicherman (1998) in examining the impact of innovations on different employee training outcomes in a developing country, a topic that has not much been explored. Second, it examines the relationship between innovations and different types of workers that may have different effects on firm productivity. Third, it provides evidence of the effects of different types of innovations on the hiring of skilled workers.

The paper is organised as follows. Section 2 describes the background of on-the-job training and government policies in Viet Nam. Section 3 discusses our data, along with descriptive analyses of trends of training and innovations, then presents the empirical model strategy. Section 4 gives the estimation results with robustness checks. Section 5 summarises the key findings and presents some policy recommendations.

2. On-the-Job Training and Government Policies in Viet Nam

Viet Nam is at a crucial stage in its economic development. After 3 decades of remarkable economic growth and poverty reduction, Viet Nam is facing the challenge of how to continue the country's success story over the next decade and beyond. Like other East Asian countries, there is wide consensus in Viet Nam that good education is essential to national development (Bodewig et al., 2014).

The Government of Viet Nam has identified high-quality human resources, including that built through vocational training, as one of the three pillars of its sustainable economic growth strategy (Yoon, Dang, and Nguyen, 2018). To fulfill this strategy, the government has established a coherent and consistent series of laws on vocational training (including the 2006 Law on Vocational Training[1] and other relevant documents). The Law on Vocational Training set up a fundamental framework for skills development. Training objectives stress the acquisition of practical capacities. Financial incentives enable training institutions to generate tax-free income, and public and private vocational training institutions are considered equal and eligible for financial incentives such as land assignment, premises rent, and credit access. Expenses for firm-based training are deductible from firms' taxable revenue (National Assembly, 2006).

Despite the government's many efforts, however, Viet Nam has some of the lowest rates of on-the-job training in the region (Asian Development Bank [ADB], 2014). Many firms underinvest in training as a result of the free-rider problem – as trained workers are free to move around firms, firms are never sure of recouping their investment in training workers, while non-training competitors may attract trained workers from other firms. According to the Japan External Trade Organization, 69% of enterprises stated that increasing wages are a problem owing to scarce skills. Enterprises have started to compete for skilled workers by offering higher salaries in some provinces (Japan External Trade Organization, 2006). Thus, fear of poaching reduces firms' incentives to train their workers (ADB, 2014).

[1] The Law on Vocational Training (amended in 2014) includes articles stipulating financial incentives for on-the-job training for all firms, while the Law on Provision of Assistance for Small and Medium-Sized Enterprises stipulates more support for small firms.

Additional explanations for the low level of on-the-job training relate to the level of industrial development in Viet Nam. Most small firms producing at low cost tend not to value the development of their human resources, compared with firms producing high-quality goods with high technology. Firms may simply lack awareness of the role of firm-based training in productivity gains. They tend not to see or appreciate the linkages between worker training and increased net profits. Moreover, the government and enterprises seem to regard vocational training as the operation of training schools, instead of more flexible on-the-job training. As such, enterprises may view enterprise-based training as too costly (ADB, 2014).

3. Empirical Methodology

3.1. Data Description

This paper uses a dataset drawn from the Viet Nam Small and Medium Scale Manufacturing Enterprise Survey (VSMES). The VSMES is carried out every 2 years on more than 2,500 enterprises across 10 provinces, with a large proportion of the firms surveyed across all years of the survey. This biannual panel dataset spans 2005–2015. The population of non-state manufacturing enterprises in the 10 selected provinces is based on two data sources from the General Statistics Office of Viet Nam: the Establishment Census and the Industrial Survey. The VSMES data include both registered and nonregistered household firms. The enterprises are distributed across approximately 18 sectors, and the most commonly represented sectors are food processing, fabricated metal products, and manufacturing of wood products. Enterprises are classified as micro, small, medium, and large according to the current World Bank definitions. Of these firms, more than 72% are microenterprises. The VSMES also provides comprehensive information about firms and their activities, such as firm demographics, ownership, business activities, employment, wages, assets, capital, business performance, revenue, and profit.

The VSMES is particularly well suited for a study of the relationship between innovations and employee training because it records a vast amount of information on this subject, including firms' innovations, labour composition, training of new and existing workers, and duration of the training. We use datasets for 2007–2015 to

examine the trends and characteristics of on-the-job training in Viet Nam's economy. In addition, to minimise the possibility that parameter estimates are influenced by the exit and entry of firms rather than within-firm variations, we restrict the sample to firms that appear at least twice during this period.

Training Variables

We use information from the employment module that includes questions asking firm managers and/or owners whether firms provide on-the-job training for new and existing workers. The survey defines on-the-job training as training received while at the job during 'normal' working hours, that is, formal in-house training with an identifiable start and end. We also use the share of skilled workers at managerial levels to measure the composition of workers by professional and education levels.

Table 1 provides a summary of the statistical description of firm training. On average, 13% of firms report training new workers and 5% report training existing workers. However, the number of firms that have trained existing workers varies over time. The share of enterprises that have trained new workers increased during 2009–2015. Firms belonging to high- and medium-value-added sectors offered more training to both new and existing workers. Small and medium-sized enterprises (SMEs) tend to invest more in training than do micro firms.

Table 1: Descriptive Statistics

	2007	2009	2011	2013	2015	Average
Firm's training for new workers (:=1)	0.17	0.06	0.07	0.18	0.19	0.13
%Micro firms	0.10	0.02	0.02	0.12	0.13	0.08
Small and medium firms	0.34	0.12	0.19	0.35	0.37	0.27
Low-value-added sectors	0.15	0.05	0.06	0.14	0.15	0.11
Medium-value-added sectors	0.20	0.06	0.07	0.22	0.22	0.16
High-value-added sectors	0.14	0.05	0.13	0.21	0.23	0.15
Firm's training for existing workers (:=1)	0.06	0.03	0.06	0.04	0.07	0.05
Micro firms	0.02	0.01	0.03	0.02	0.03	0.02
Small and medium firms	0.14	0.07	0.13	0.10	0.16	0.12
Low-value-added sectors	0.04	0.02	0.06	0.03	0.05	0.04
Medium-value-added sectors	0.07	0.04	0.06	0.04	0.08	0.06
High-value-added sectors	0.04	0.04	0.06	0.04	0.07	0.05

Firms introduce new products (:=1)	0.05	0.03	0.04	0.01	0.26	0.08
Micro firms	0.03	0.02	0.04	0.00	0.26	0.08
Small and medium firms	0.08	0.05	0.05	0.01	0.26	0.09
Low-value-added sectors	0.04	0.02	0.03	0.00	0.24	0.07
Medium-value-added sectors	0.05	0.03	0.04	0.01	0.28	0.08
High-value-added sectors	0.06	0.04	0.09	0.01	0.23	0.08
Firms introduce new technology (:=1)	0.16	0.13	0.14	0.07	0.05	0.11
Micro firms	0.09	0.07	0.09	0.05	0.03	0.06
Small and medium firms	0.32	0.24	0.24	0.10	0.11	0.21
Low-value-added sectors	0.14	0.11	0.13	0.08	0.05	0.10
Medium-value-added sectors	0.17	0.13	0.13	0.05	0.06	0.11
High-value-added sectors	0.17	0.14	0.19	0.07	0.03	0.12
Firms introduce product improvement (:=1)	0.45	0.41	0.38	0.17	0.13	0.31
Micro firms	0.37	0.32	0.34	0.13	0.11	0.45
Small and medium firms	0.62	0.58	0.51	0.26	0.21	0.19
Low-value-added sectors	0.32	0.30	0.32	0.13	0.12	0.23
Medium-value-added sectors	0.51	0.47	0.40	0.19	0.14	0.35
High-value-added sectors	0.63	0.54	0.55	0.24	0.17	0.44
Number of observations	2,111	2,537	2,419	2,455	2,142	11,664

Notes: Mean values. Micro firms have up to 10 employees. Low-value-added sectors include food and beverages, tobacco, textiles, apparel, leather, and recycling. Medium-value-added sectors include wood, paper, publishing, rubber, petroleum, chemicals, non-metallic minerals, basic metals, and fabricated metals. High-value-added sectors include electronic machinery, vehicles, transport equipment, and furniture.
Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

Innovation Variables

We define innovations as the implementation of new production processes in the workplace. In our empirical work, we use various proxies to measure whether these processes are implemented, such as whether firms apply new technology, improve existing products, or introduce new products. These questions are worded as follows: 'Has the firm introduced new product groups?', 'Has the firm introduced new production processes/new technology since the last survey?', and 'Has the firm made any improvements in existing products or changed specification since the last survey?' Respondents could answer either 'Yes' or 'No'. We constructed a measure that takes on the binary value of 0 and 1, where 0 corresponds to the response 'No' and 1 to the response 'Yes'.

The share of firms adopting new technologies decreased from 16.0% in 2007 to 6.4% in 2013 and 4.9% in 2015 (Table 1). This decrease in the adoption of new technology can be attributed to SMEs, which saw the greatest decline in adoption rates. All types of firms tend to be more willing to improve their existing products than to introduce a new production process. One notable point is that the share of firms introducing new products decreased from 5% in 2007 to 1% in 2013, before increasing significantly to 26% in 2015. This sharp increase could be a result of the establishment of the National Technology Innovation Fund in 2014 or the Viet Nam Inclusive Innovation Project in 2013 to improve the technological and innovative capacity of SMEs by helping them develop and acquire new technology and innovations (Brandt et al., 2016).

3.2. Baseline Model

To investigate the correlation between firms' innovations and on-the-job training, we begin the analysis with the following equation:

$$y_{ijt} = \alpha + \beta Innovation_{ijt} + \gamma X_{ijt} + \lambda_i + \varphi_t + \varepsilon_{ijt} \quad (1)$$

where y_{ijt} is the firm-level outcome of interest (on-the-job training) *i* in sector *j* at time *t*. Our main variable, $Innovation_{ijt}$, is the innovations by firm *i* in sector *j* at time *t*, defined as an indicator of whether firms have implemented innovations such as introducing new products, new technology, or product improvement. The coefficient of interest is β capturing the relationship between innovations and training. X_{ijt} is firm characteristics, including firm size, industrial zone dummies, and dummies for firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). Firm size accounts for the fact that innovations tend to increase with firm size, and that working in a larger firm boosts the likelihood of being trained (Goux and Maurin, 2000; Ng, 2005). In the case of Viet Nam, type of ownership has been shown to be a critical variable in the adoption of different human resource practices (Zhu, Sarkis, and Lai, 2008); therefore, we include dummies for types of ownership. Since both innovations and human resource practices vary across production sectors, we include

dummies indicating whether the sectors are low-, medium- or high-value-added.[2] λ_i and φ_t are firm and time fixed effects. The standard errors are clustered at the firm level throughout the analysis. Finally, in all of the above equations, wherever the outcome of interest is a dummy variable, we use linear probability models to avoid the incidental parameter problem.

3.3. Instrumental Variable Method

Our goal is to identify β in Equation 1. If innovations are exogenous, the ordinary least squares (OLS) estimate of β indicates the impact of innovations on training. The positive value of β implies that innovations promote training by firms; otherwise, innovations do not have a beneficial effect. However, there are three reasons why innovations may not be exogenous. First, there may be reverse causality between innovations and training, which increases the number of skilled employees, guarantees firms access to leading knowledge, and thereby increases a firm's propensity to invest in innovations (Bauernschuster, Falck, and Heblich, 2009). Second, certain unobserved firm attributes can be correlated with both innovations and training. Third, since our innovations measure is self-reported and retrospective, it may contain a large measurement error. These factors all indicate that the OLS estimation of β from Equation 1 could be biased and inconsistent.

One way to reduce the endogeneity bias, the omitted unobservable firm attributes problem in particular, is to use the fixed effect estimation. The main advantage of the fixed effect model is that it explicitly controls for firm fixed effects and removes the bias caused by time-invariant firm characteristics. However, the fixed effect model has two limitations: (i) it cannot resolve the endogeneity bias caused by unobserved time-variant factors, and (ii) measurement errors can induce a large attenuation bias in the fixed effect estimator.

To circumvent the disadvantages of the fixed effect estimator, we adopt the instrumental variable approach. We take the average number of innovations among the sample of firms in the same sector in other districts as an instrumental variable. This

[2] Low-value-added sectors include food and beverages (1), tobacco (2), textiles (3), apparel (4), leather (5), and recycling (19). Medium-value-added sectors include wood (6), paper (7), publishing (8), rubber (11), petroleum (9), chemicals (10), non-metallic minerals (12), basic metals (13), and fabricated metals (14). High-value-added sectors include electronic machinery (15), vehicles (16), transport equipment (17), and furniture (18).

satisfies two conditions: (i) since innovations by firms in one sector may have spillover effects on other firms in the same sector, they may highly correlate with a given firm's innovations; and (ii) sectors in each district may determine firms' innovations independently. In particular, it is less likely that district or province characteristics may affect innovation by sectors in a given year in the whole country.[3] Even if this were to happen, time dummies may capture this effect. Our first stage specification is as follows:

$$Innovation_{ijdt} = \psi + \theta Innovation_{-djt} + \rho X_{ijt} + \theta Z_{pjt} + \phi_i + \eta_t + \mu_{ijt} \quad (2)$$

where the variable $Innovation_{-djt}$ is the average number of innovations in sector j and year t in other districts d. We also control for firm X_{ijt} and province characteristics (Z_{pjt}). Firm and year fixed effects are included to capture common national time trends and province characteristics that may correlate with the instrumental variable.

4. Empirical Results

4.1. Ordinary Least Squares Estimates

In Table 2, we first present the OLS results as a benchmark. The independent variables include varied innovations, as well as firm and year fixed effects. In all estimations, standard errors are adjusted for the clustering of observations of the same firms. We find that firms provide more on-the-job training when they introduce new technology and improve existing products, as shown in columns (2) and (3). In columns (4)–(6), we control for other firm characteristics, including firm size, industrial zone dummies, and dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). Even controlling for these variables in the regressions, we find that our result for the relationship between innovations and training does not change much. Columns (5) and (6) of Table 3 show

[3] In addition, reverse causality is less likely to happen. Training at an individual firm does not impact the level of innovation in that sector. This situation only happens when a firm is very large or a sector is highly concentrated.

that firms with higher levels of technology introduction and product improvement have a higher number of trained workers.

Table 2: Innovations and On-the-Job Training

(Ordinary Least Squares Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Training for workers					
Firms introduce new products	0.014			0.012		
	(0.016)			(0.015)		
Firms introduce new technology		0.056***			0.051***	
		(0.013)			(0.014)	
Firms improve existing products			0.028***			0.025***
			(0.009)			(0.009)
Other firm characteristics	No	No	No	Yes	Yes	Yes
Observations	11,664	11,664	11,664	11,647	11,647	11,647
R-squared	0.027	0.029	0.042	0.033	0.035	0.034
Number of firms	3,284	3,284	3,284	3,284	3,284	3,284
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.
Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

Table 3 depicts an OLS regression with different training outcomes as the dependent variables. The instrumental variables include varied innovations, firm characteristics, and firm and year fixed effects. As illustrated in columns (2) and (5), the probability of firms with new technology training new and existing workers increases by nearly 0.04. The result in column (6) demonstrates that improving existing products appears to be associated with more training for existing workers rather than for new ones.

Table 3: Innovations and On-the-Job Training by Types of Workers (Ordinary Least Squares Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Training for new workers			Training for existing workers		
Firms introduce new products	0.015			–0.006		
	(0.015)			(0.010)		
Firms introduce new technology		0.034**			0.037***	
		(0.013)			(0.010)	
Firms improve existing products			0.004			0.035***
			(0.009)			(0.006)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,647	11,647	11,647	11,647	11,647	11,647
R-squared	0.049	0.049	0.049	0.008	0.011	0.013
Number of firms	3,283	3,283	3,283	3,283	3,283	3,283
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.
Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

4.2. Instrumental Variable Estimates

The endogeneity bias that may arise from reverse causality and measurement errors leads us to use the instrumental variables estimation to account for unobserved time-varying factors that may simultaneously influence decisions to provide training and firm's innovations. We estimate Equation 1 using the fixed effects regression with an instrumental variable, which is the average level of innovations of firms in other districts. All models include time dummies to account for changes over time in the economic environment. In all estimations, we also add firm characteristics to control for time-varying effects that may bias the results. The tables provide estimated coefficients with robust standard errors clustered at the firm level. The F-statistic of excluded instruments in the first stages in all specifications is well above the critical values (10) identified by Staiger and Stock (1997), showing that the instrument is robust.

The results confirm the positive effect of innovations on the training of existing workers (Table 4). The coefficients of the indicator of innovations are not statistically significant in columns (1) and (3), indicating that innovations have not affected firm training for new workers. The estimated effect in column (5) is statistically significant and indicates an increase of 0.065 in the probability of training existing workers. Similarly, the result in column (6) shows that, as firms improve their existing products, their probability of training existing workers increases by 0.025. However, because the instrumental variable estimate mainly applies to the subgroup of individuals more affected by sectorial innovation in other districts, this estimate may be interpreted as a local average treatment effect (Imbens and Angrist, 1994).

Table 4: Innovations and On-the-Job Training
(Instrumental Variable Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Training for new workers			Training for existing workers		
Firms introduce new products	0.007			0.033		
	(0.036)			(0.026)		
Firms introduce new technology		–0.052*			0.065***	
		(0.030)			(0.020)	
Firms improve existing products			–0.008			0.025**
			(0.018)			(0.011)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,644	11,644	11,644	11,644	11,644	11,644
R-squared	0.049	0.043	0.048	0.006	0.009	0.013
Number of firms	3,280	3,280	3,280	3,280	3,280	3,280
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics for an excluded instrument in (1) and (4): 1220						
F- statistics for an excluded instrument in (2) and (5): 799						
F-statistics for an excluded instrument in (3) and (6): 1127						

Notes: Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). In the first stage of the fixed effects instrumental variable regression of innovations, the average level of innovations in the same province is used as an instrument for firms' level of technological change, and the F-statistics for an excluded instruments in all regressions are larger than 10, implying that the instrument is strong (see Staiger and Stock, 1997). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.
Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

One of our identification assumptions in our instrumental variable estimation is that firms' innovations are determined independently by sectors in each district. However, this assumption could be violated. Innovations may depend on provincial economic development, which may also correlate with sectorial growth at the province level. Therefore, provincial economic development, which could simultaneously affect innovation variables and training outcomes, biases our estimates.

Table 5: Innovations and On-the-Job Training – Robustness Check (Instrumental Variable Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Training for new workers			Training for existing workers		
Firms introduce new products	0.005			0.033		
	(0.036)			(0.026)		
Firms introduce new technology		–0.045			0.054***	
		(0.031)			(0.020)	
Firms improve existing products			–0.002			0.010
			(0.018)			(0.011)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Other province variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,644	11,644	11,645	11,644	11,644	11,644
R-squared	0.049	0.045	0.049	0.013	0.017	0.017
Number of firms	3,280	3,280	3,280	3,280	3,280	3,280
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics for an excluded instrument in (1) and (4): 1227						
F-statistics for an excluded instrument in (2) and (5): 791						
F-statistics for an excluded instrument in (3) and (6): 1108						

Notes: Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). Other province variables include a province's employment and output. In the first stage of the fixed effects instrumental variable regression of innovations, the average level of innovations in the same province is used as an instrument for firms' level of technological change, and the F-statistics for an excluded instrument in all regressions are larger than 10, implying that the instrument is strong (see Staiger and Stock, 1997).***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

To check for potential biases, we conduct a sensitivity analysis by adding in a province's economic variables, including provincial outputs and employment. If the

results are biased because of confounding economic development, we would expect the estimates to be sensitive to adding these variables. The results in Table 5, column (5) indicate that the coefficient of firms improving existing products is statistically significant and positively associated with a higher probability of training existing workers, confirming the impact of innovations on a firm's level of training.

Table 6 shows the results for the relationship between firms' innovation and share of skilled workers for both OLS and instrumental variable estimates. Columns (3) and (6) demonstrate that, as firms improve their existing products, the share of skilled workers tends to increase. Other columns show mixed results from the OLS and instrumental variable estimates.

Table 6: Innovations and High-Skilled Workers

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Share of high skilled workers					
	OLS Estimates			IV Estimates		
Firms introduce new products	0.010			0.145***		
	(0.014)			(0.038)		
Firms introduce new technology		0.027**			–0.028	
		(0.012)			(0.041)	
Firms improve existing products			0.037***			0.108***
			(0.009)			(0.024)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Other province variables	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,547	9,547	9,547	9,080	9,080	9,080
R-squared	0.068	0.068	0.069	0.071	0.054	0.066
Number of firms	3,283	3,283	3,283	3,283	2,816	2,816
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics for an excluded instrument in (4): 935						
F-statistics for an excluded instrument in (5): 696						
F-statistics for an excluded instrument in (6): 873						

IV = instrumental variable, OLS = ordinary least squares.

Notes: Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). Other province variables include a province's employment and output. In the first stage of the fixed effects instrumental variable regression of innovations, the average level of innovations in the same province is used as an instrument for firms' level of technological change, and the F-statistics for an excluded instrument in all regressions are larger than 10, implying that the instrument is strong (see Staiger and Stock, 1997).***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

4.3. Heterogeneity

The literature shows a link between firm size and innovation, and large firms tend to do more training (Pierre and Scarpetta, 2004). Previous studies estimate the regressions exploring the relationships between firm size and innovation, and firm size and training using a linear probability model. The same specification used for the regressions in Table 3 are presented in Tables 7 and 8. These results confirm that estimates of the impact of innovations differ according to firm size. However, the findings are mixed. The OLS results in Table 7 indicate that the impact of innovations on firm training is more profound in larger firms for both new and existing workers. By contrast, the instrumental variable estimates in Table 8 show that micro firms tend to provide more training for existing workers when they introduce more innovation.

Firms with government assistance may overcome resource constraints to provide more training. Table 9 provides OLS estimates for separate samples of firms with and without government assistance using the same specification. Several findings emerge. The results in this table show that, although the magnitudes of coefficients of innovations for firms with government assistance (including financial and technical assistance such as tax exemptions or reductions, training, trade promotion, and quality assurance) are higher than those for firms without government assistance, they are only statistically significant for firms improving existing products, and the magnitude of the coefficients is larger than that of firms without government assistance. This shows that government assistance may encourage firms to provide training for existing workers when they improve existing products. However, the instrumental variable estimates in Table 10 show that firms with government assistance do not provide more training for either new or existing workers when they innovate.

Next, we examine whether exporting firms linked to the global value chain provide more training. The results are also mixed. The OLS results in Table 11 confirm this prediction. The results in columns (3) and (6) indicate that exporting firms provide three times as much training as the average for both new and existing workers when they improve existing products. At the same time, there is much more training for existing workers when exporting firms introduce new technology. However, the instrumental variable estimates in Table 12 show that, compared to non-exporting firms, exporting firms do not provide more training for workers when they innovate.

We also run a separate regression for some high-value-added sectors,[4] where there may be higher demand for training when innovations are applied (Table 13). We find a positive and significant relationship between innovations and on-the-job training for firms in high-value-added sectors. In addition, we found no statistically significant effects of innovations on the training of new workers.

[4] High-value-added sectors include electronic machinery, vehicles, transport equipment, and furniture.

Table 7: Innovations and On-the-Job Training by Firm Sizes (Ordinary Least Squares Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Micro firms						Small and medium firms					
	Training for new workers			Training for existing workers			Training for new workers			Training for existing workers		
Firms introduce new products	0.003			–0.011			0.014			0.002		
	(0.014)			(0.008)			(0.037)			(0.032)		
Firms introduce new technology		0.037**			0.023**			0.044**			0.063***	
		(0.016)			(0.011)			(0.024)			(0.018)	
Firms improve existing products			0.003			0.015***			0.029			0.088***
			(0.009)			(0.005)			(0.02)			(0.016)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,232	8,232	8,232	8,232	8,232	8,232	3,416	3,416	3,416	3,416	3,416	3,416
R-squared	0.041	0.042	0.041	0.007	0.009	0.009	0.061	0.063	0.062	0.015	0.022	0.032
Number of firms	2,622	2,622	2,622	2,622	2,622	2,622	1,321	1,321	1,321	1,321	1,321	1,321
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Micro firms have up to 10 employees. Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.
Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

Table 8: Innovations and On-the-Job Training by Firm Size (Instrumental Variable Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Micro firms						Small and medium firms					
	Training for new workers			Training for existing workers			Training for new workers			Training for existing workers		
Firms introduce new products	–0.002			0.051**			0.027			–0.047		
	(0.039)			(0.025)			(0.090)			(0.059)		
Firms introduce new technology		–0.10**			0.060**			0.057			0.057*	
		(0.042)			(0.023)			(0.052)			(0.034)	
Firms improve existing products			–0.021			0.020*			0.090*			0.041
			(0.019)			(0.011)			(0.05)			(0.027)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,932	7,932	7,932	7,932	7,932	7,932	3,092	3,092	3,092	3,092	3,092	3,092
R-squared	0.044	0.028	0.042	–0.003	0.005	0.009	0.064	0.066	0.061	0.017	0.024	0.030
Number of firms	2,322	2,322	2,322	2,322	2,322	2,322	997	997	997	997	997	997
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics for an excl. IV	813.6	418.5	757.5	813.6	418.5	757.5	375.5	315.8	297.4	375.5	315.8	297.4

Notes: Micro firms have up to 10 employees. Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). In the first stage of the fixed effects instrumental variable regression of innovations, the average level of innovations in the same province is used as an instrument for firms' level of technological change, and the F-statistics for an excluded instrument in all regressions are larger than 10, implying that the instrument is strong (see Staiger and Stock, 1997). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.
Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

Table 9: Innovations and On-the-Job Training with Government Assistance (Ordinary Least Squares Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	With government assistance						Without government assistance					
	Training for new workers			Training for existing workers			Training for new workers			Training for existing workers		
Firms introduce new products	0.066			–0.022			0.013			–0.015		
	(0.074)			(0.068)			(0.016)			(0.011)		
Firms introduce new technology		0.056			0.057			0.036**			0.030***	
		(0.049)			(0.042)			(0.016)			(0.012)	
Firms improve existing products			0.046			0.046*			0.008			0.032***
			(0.035)			(0.025)			(0.01)			(0.007)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,131	2,131	2,131	2,131	2,131	2,131	9,516	9,516	9,516	9,516	9,516	9,516
R-squared	0.059	0.060	0.060	0.057	0.062	0.062	0.054	0.054	0.053	0.005	0.007	0.009
Number of firms	1,519	1,519	1,519	1,519	1,519	1,519	3,226	3,226	3,226	3,226	3,226	3,226
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Government assistance includes financial and technical assistance such as tax exemptions or reductions, training, trade promotion, and quality assurance. Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

Table 10: Innovations and On-the-Job Training with Government Assistance (Instrumental Variable Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	With government assistance						Without government assistance					
	Training for new workers			Training for existing workers			Training for new workers			Training for existing workers		
Firms introduce new products	–0.011			–0.322*			0.008			0.045		
	(0.222)			(0.178)			(0.041)			(0.028)		
Firms introduce new technology		0.081			0.119			–0.08**			0.054**	
		(0.129)			(0.093)			(0.039)			(0.021)	
Firms improve existing products			0.061			0.002			–0.024			0.020*
			(0.088)			(0.057)			(0.02)			(0.011)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,089	1,089	1,089	1,089	1,089	1,089	9,180	9,180	9,180	9,180	9,180	9,180
R-squared	0.057	0.060	0.060	–0.001	0.056	0.057	0.053	0.044	0.052	–0.002	0.005	0.009
Number of firms	477	477	477	477	477	477	2,890	2,890	2,890	2,890	2,890	2,890
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics for an excl. IV	55.6	45.1	77.6	55.6	45.1	77.6	945	576.4	813	945	576.4	813

Notes: Government assistance includes financial and technical assistance such as tax exemptions or reductions, training, trade promotion, and quality assurance. Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). In the first stage of the fixed effects instrumental variable regression of innovations, the average level of innovations in the same province is used as an instrument for firms' level of technological change, and the F-statistics for an excluded instrument in all regressions are larger than 10, implying that the instrument is strong (see Staiger and Stock, 1997). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

Table 11: Innovations and On-the-Job Training in Exporting Firms (Ordinary Least Squares Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Exporting firms						Non-exporting firms					
	Training for new workers			Training for existing workers			Training for new workers			Training for existing workers		
Firms introduce new products	–0.043			0.117			0.019			–0.014		
	(0.078)			(0.072)			(0.015)			(0.009)		
Firms introduce new technology		0.008			0.102**			0.04***			0.031***	
		(0.053)			(0.044)			(0.014)			(0.010)	
Firms improve existing products			0.135**			0.148***			–0.004			0.027***
			(0.053)			(0.040)			(0.01)			(0.006)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	712	712	712	712	712	712	10,935	10,935	10,935	10,935	10,935	10,935
R-squared	0.057	0.056	0.073	0.045	0.048	0.069	0.052	0.053	0.052	0.009	0.011	0.012
Number of firms	314	314	314	314	314	314	3,192	3,192	3,192	3,192	3,192	3,192
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

Table 12: Innovations and On-the-Job Training in Exporting Firms (Instrumental Variable Estimates)

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Exporting firms						Non-exporting firms					
	Training for new workers			Training for existing workers			Training for new workers			Training for existing workers		
Firms introduce new products	0.056			0.123			–0.001			0.033		
	(0.145)			(0.121)			(0.038)			(0.027)		
Firms introduce new technology		0.039			0.053			–0.053*			0.058***	
		(0.140)			(0.071)			(0.032)			(0.020)	
Firms improve existing products			0.135			0.024			–0.021			0.022**
			(0.102)			(0.052)			(0.02)			(0.011)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	586	586	586	586	586	586	10,834	10,834	10,834	10,834	10,834	10,834
R-squared	0.053	0.056	0.073	0.045	0.045	0.046	0.052	0.046	0.051	0.005	0.009	0.012
Number of firms	188	188	188	188	188	188	3,091	3,091	3,091	3,091	3,091	3,091
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics for an excl. IV	72.6	65.3	93.7	72.6	65.3	93.7	1123	725	1006	1123	725	1006

Notes: Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). In the first stage of the fixed effects instrumental variable regression of innovations, the average level of innovations in the same province is used as an instrument for firms' level of technological change, and the F-statistics for an excluded instrument in all regressions are larger than 10, implying that the instrument is strong (see Staiger and Stock, 1997). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

Table 13: Innovations and On-the-Job Training in High Value-Added Sectors

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS Estimates						IV Estimates					
	Training for new workers			Training for existing workers			Training for new workers			Training for existing workers		
Firms introduce new products	0.033			0.016			0.025			0.014		
	(0.053)			(0.044)			(0.097)			(0.062)		
Firms introduce new technology		0.020			0.076**			0.011			0.087*	
		(0.040)			(0.033)			(0.067)			(0.048)	
Firms improve existing products			0.023			0.051***			0.024			0.050**
			(0.028)			(0.016)			(0.04)			(0.020)
Other firm characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,293	1,293	1,293	1,293	1,293	1,293	1,116	1,116	1,116	1,116	1,116	1,116
R-squared	0.043	0.043	0.044	0.015	0.028	0.027	0.043	0.043	0.044	0.015	0.027	0.027
Number of firms	550	550	550	550	550	550	373	373	373	373	373	373
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummy effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistics for an excluded instrument in (7) and (10): 60												
F- statistics for an excluded instrument in (8) and (11): 90												
F-statistics for an excluded instrument in (9) and (12): 130												

IV = instrumental variable, OLS = ordinary least squares.

Notes: High-value-added sectors include electronic machinery, vehicles, transport equipment, and furniture. Standard errors are robust to heteroskedasticity and those clustered at the firm level are reported in parentheses. Other firm characteristics include firm employment, firm ages, industrial zone dummy, dummies for types of firm ownership (i.e. private firms, firms with state capital, and firms with foreign capital). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level. In the first stage of the fixed effects instrumental variable regression of innovations: (a) Average level of innovations in the same province is used as an instrument for firms' level of technological change; (b) The F-statistics for an excluded instrument in all regressions are larger than 10, implying that the instrument is strong (see Staiger and Stock, 1997). ***Significant at the 1% level, **significant at the 5% level, *significant at the 10% level.

Source: Authors' calculations from the Small and Medium Enterprise Survey of Viet Nam, 2007–2015.

5. Conclusion

This paper explored the relationship between innovations and training provided by firms. We used firm-level data from SMEs in Viet Nam for the period 2007–2015. To address potential measurement errors or omitted variable problems, we used the average level of innovations in the same sector in other districts as an instrument for firms' innovations in Viet Nam. We find that firms provide more training for existing workers when they introduce new technology, and high-value-added firms provide more training for existing workers. Moreover, government assistance is not a primary factor motivating firms to provide training. The results also show that firms hire more skilled workers when implementing innovations.

Some policy implications can be drawn from the empirical results. As firms innovate, they may require more on-the-job training. Therefore, the government could step in to support them. One possible policy is to increase tax deductions for firms for on-the-job training expenditure. However, our results imply that the government could also improve information campaigns and simplify the procedure for firms to apply for assistance, whether or not tax policy is changed to promote on-the-job training. In addition, as firms hire more skilled workers as they innovate, the government may need to invest to improve the quality of in-classroom training to satisfy a higher skills requirement in the labour force. The government should also encourage firms to work with vocational training centres in preparing curricula and participating in teaching. All of these initiatives may encourage SMEs in Viet Nam to increase investment in training, and thereby help realise their growth potential through increased labour productivity as a result of human capital upgrading.

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