The relationship between training and innovation activities in enterprises*

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Abstract

We examine the relationship between enterprises' use of employee training (or education) as a method to stimulate new ideas or creativity among their staff and enterprises' innovation activities. A data set of about 5200 Norwegian enterprises is used. Based on correlation coefficients, we find a positive relationship between enterprises' use of employee training and their innovation activities. This relationship is not found significant for innovative enterprises that developed the innovations mainly by themselves or together with external partners if we control for enterprises' use of brainstorming sessions and/or work teams to stimulate new ideas or creativity among their staff. Training can, however, be argued to be indirectly related to innovation strategies since it is combined with other human resource (HR) practices.

Keywords: Training, innovative and non-innovative enterprises, innovation data, matched employer–employee register data, correlation

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1. Introduction

This article examines how training is related to innovation activities. Training can be considered as a measure of human capital.[1] Both human capital and innovation are regarded as underlying drivers of economic development. Some studies have emphasised the significant role of human capital in this context (Mincer 1996, Galor and Tsiddon 1997), while other studies have focused on the importance of innovation in the context of economic development (Baumol 2002, Hashi and Stojčić 2013).

Training is shown to result in significant wage returns for the individual,[2] and appears to offer further benefits in terms of higher employment stability and to be quite portable among jobs (Blundell et al. 1999). The economic literature finds that participation in training is beneficial for both the participating workers and their employers (De Grip and Sauermann 2013). There is also evidence that on-the-job training has a positive impact on productivity at the firm level (Almeida and Carneiro 2009) or industrial level (Sepúlveda 2010), that work-related training is associated with higher industrial productivity (Dearden et al. 2006), that firm productivity correlates positively with a higher innovation output (Crépon et al. 1998), and that there is a positive relationship between innovation in firms and their productivity which is primarily due to product innovation (Hall 2011, p. 188).[3]

We focus on enterprises' use of employee training (or education) as a method to stimulate new ideas or creativity among their staff. The main purpose of this study is to examine whether the proportion of enterprises that use this training method is higher among innovative enterprises than among non-innovative enterprises. Innovative enterprises consist of product- and/or process-innovative enterprises, including enterprises with ongoing or abandoned innovation activities for product and process innovations. In the empirical analysis we control for several enterprise and employee characteristics.

The article contributes to the literature in this field in two ways. First, when examining how training is related to innovation activities, we control for enterprises' use of two other methods than training to stimulate new ideas or creativity among their staff. These two other methods are brainstorming sessions and (multidisciplinary or cross-functional) work teams. The question is whether there is a significant relationship between training and enterprises' innovation activities if we control for the two other methods than training or not. Due to multicollinearity between enterprises' use of brainstorming sessions and work teams, we use a (dummy) variable which account for enterprises' use of both of these methods.

[1] Human capital theory has been developed by Schultz (1961) and Becker (1964).

[2] Estimating the effects of private-sector training on wages will suffer from so-called ability bias (Leuven and Oosterbeek 2008).

[3] Furthermore, the most 'successful' product innovators are the more productive firms (OECD 2009, p. 148).

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Second, we examine whether the relationship between training and innovation activities is sensitive to enterprises' innovation strategies. We distinguish two different innovation strategies: innovation activities are developed mainly by the enterprises themselves or together with external partners. About two-thirds of the innovative enterprises in the sample have developed their innovations mainly by themselves, and about one fifth of the innovative enterprises have developed their innovations together with external partners. The question is whether the results are related to these facts.

There may be a potential endogeneity problem of using the variables that are related to the methods of stimulating new ideas or creativity as explanatory variables in regressions. Due to lack of suitable instruments, we are unable to use instrumental variables (IV) techniques. Instead the analysis is based on correlation coefficients.

We use a firm-level data set, which consists of Norwegian enterprises in the business enterprise sector. This data set is based on matched employer–employee register data, which are linked to innovation survey data.

In the next section we present relevant previous studies and the two working hypotheses in the analysis. Section 3 describes the data set. Descriptive statistics are given in Section 4. In Section 5 we deal with the potential endogeneity problem and the multicollinearity problem. The correlation coefficients are presented in Section 6. Summary and conclusions are given in Section 7.

2. Relevant previous studies and the two working hypotheses

To the best of our knowledge, few studies have focused on how training is related to innovation. Some exceptions are Bassanini et al. (2007), Bauernschuster et al. (2008), Kaloudis et al. (2008), Næss et al. (2009), OECD (2011), Cedefop (2012), Nazarov and Akhmedjonov (2012), Neirotti and Paolucci (2013), Sung and Choi (2014), and González et al. (2015).[4] Bassanini et al. (2007) examine workplace training in Europe in a comparative perspective, and conclude that training and investment in R&D (research and development) are complementary. Bauernschuster et al. (2008) find evidence that continuous training does have a positive effect on a firm's innovations in a simple multivariate regression framework, but the positive effect disappears when using an instrumental variable approach. Kaloudis et al. (2008) and Næss et al. (2009) are two reports from a project on framework conditions for investment in training in Norway and internationally. Using Norwegian data, Kaloudis et al. (2008, p. 14) find a clear and strong positive relationship between innovation activities and training activities in the business sector, while Næss et al. (2009, p. 53) conclude that the same relationship is found both in Norway and in the EU. In a report on skills and innovation,

[4] Acemoglu (1997) shows that in a frictional labour market, part of the productivity gains from general training will be captured by future employers.

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the OECD (2011, p. 133) argues that training at work contributes to the technological capabilities of firms and is positively related to innovation. The analyses in Cedefop (2012, p. 37) show that there seems to be a positive correlation between work organisation, workplace learning and innovation. Nazarov and Akhmedjonov (2012) examine the determinants of innovation amongst firms in Eastern Europe and the former Soviet Union, and find that on-the-job-training increases a firm's ability to innovate in countries with transition economies. Neirotti and Paolucci (2013, p. 109) find that training plays an important role in anticipating innovation, given its contribution to the absorption of new external knowledge. The study by Sung and Choi (2014, p. 407) demonstrates that financial investment in corporate training significantly increases organisational innovation. González et al. (2015) show that performing R&D and worker training simultaneously significantly increases the probability of innovating.

Based on previous studies outlined above, we expect to find a positive relationship between training and innovation. There is also a need for more detailed explanations on why training is related to innovation. Here we rely on the conceptual framework in Neirotti and Paolucci (2013) and Sung and Choi (2014). Neirotti and Paolucci (2013, p. 95) argue that training can have an important role in a knowledge absorption process. For example, training may facilitate employees' exposure to a variety of knowledge. Training may also encourage openness to new ideas, where these ideas are likely to be a source of technological and organisational innovations. In addition, training may favour the routinisation of innovations in production technologies and business processes.

Sung and Choi (2014, p. 393-394) emphasise that the training and development investments of an organisation create a climate for constant learning. This facilitates the exchange of knowledge and ideas among employees, which in turn promote the generation of new knowledge and innovation.

When presenting the correlation coefficients, we relate the results to different innovation strategies. This approach is based on studies that have linked innovation to a firm's strategy (Autant-Bernard et al. 2007, Fauchart and Keilbach 2009), and linked training to a firm's innovation strategy (Baldwin 1999, 2000). In line with the study by Bönte and Dienes (2013),[5] innovative enterprises can be said to follow an 'in-house strategy' if they developed the innovations mainly by themselves, and a 'cooperation strategy' if they developed the innovations together with external partners. Both enterprises that follow an 'in-house strategy' and a 'cooperation strategy' may need to develop more transferable skills that can be used in many different parts of the business. They may, for example, need a higher proportion of employees trained in the use of new equipment or methods. We would therefore expect that training is positively related to innovation for enterprises that follow an 'in-house strategy' or a 'cooperation strategy'.

[5] Bönte and Dienes (2013, p. 502) do not analyse firms' innovation strategies in general, but innovation sourcing strategies that are exclusively related to the development of process innovations.

The focus in this article is not on training activities in firms in general, but on employee training used as a method to stimulate new ideas or creativity among the staff.[6] Both Neirotti and Paolucci (2013) and Sung and Choi (2014) emphasise that training may stimulate (new) ideas, which again are probably positively related to enterprises' product and process innovation activities. Other studies have established the link between creativity and innovation (Udwadia 1990). Thus, the relationship between innovation activities and the training method used in our empirical analysis is expected to be positive and significant. The same relationship is expected to be found for enterprises that follow one of the two innovation strategies. Since the main purpose of the study is to examine whether innovation activities are related to this training method, we formulate the two working hypotheses as follows:

Hypothesis 1: There is a positive relationship between enterprises' innovation activities and their use of employee training as a method to stimulate new ideas or creativity among their staff.

Hypothesis 2: The statement in Hypothesis 1 holds for enterprises that follow an 'in-house strategy' or a 'cooperation strategy'.

In the analysis we control for enterprises' use of brainstorming sessions and/or work teams to stimulate new ideas or creativity. Several studies have suggested the potential association of these methods with innovation. Some examples are Paulus and Brown (2007), and Fay et al. (2015).

3. The data set

We use Norwegian firm-level data, which are based on two data sources: matched employer–employee register data and innovation data. The employer–employee register data comprise administrative files for 2010 from Statistics Norway. These administrative files contain information on all employees aged 15 years and above, and all plants and enterprises in Norway in 2010.

The innovation data are from the Norwegian survey on the innovation activity in the business enterprise sector for 2010, conducted by Statistics Norway (Wilhelmsen and Foyn 2012). This survey is part of Eurostat's Community Innovation Survey (CIS), and the data used in the analysis belong to the seventh CIS survey (CIS 2010). The survey measures the extent to which firms have introduced product or process innovations during the period from 2008 through 2010. The innovation survey covers the entire manufacturing sector, and large parts

[6] On the other hand, employee training on how to develop new ideas or creativity can involve both off-the-job training and on-the-job training. Off-the-job training is employee training at a site away from the actual work environment (not necessarily outside the enterprise's premises), while on-the-job training is employee training at the place of work while the employee is doing the actual job.

of the services sector along with selected other industries. This survey is in the form of a representative sample survey of enterprises with between 5 and 49 employees (20–49 employees for the NACE alphabetical codes G and H), with the addition of complete coverage of enterprises with more than 50 employees.

Firms are defined at the enterprise level in the innovation data, and both at the enterprise and plant level in the matched employer–employee register data, where an enterprise consists of at least one plant. Since the employer–employee register data are linked to the innovation data, firms are defined at the enterprise level in the analysis. The following variables used in the analysis are from the innovation data: dummy variables which account for innovation activities and industrial sectors, and enterprises' use of methods to stimulate new ideas or creativity among their staff. The other variables are from the employer–employee register data.

3.1. The sample of firms

There are 5204 enterprises in the sample. The classification of industrial sectors is based on the Standard Industrial Classification (SIC2007). Table 1 shows the number of enterprises in the sample by industrial sector. We see that the largest proportions of enterprises (unweighted results) are within the 'manufacturing' sector, 'construction', 'information and communication', and 'wholesale and retail trade; repair of motor vehicles and motorcycles'. The lowest proportions of enterprises (unweighted results) are within 'administrative and support service activities', 'water supply; sewerage, waste management and remediation activities', and 'electricity, gas, steam and air conditioning supply'.

[Table 1 about here]

The weighted results in Table 1 show a lower proportion of enterprises within the 'manufacturing' sector, but a higher proportion of enterprises within 'wholesale and retail trade; repair of motor vehicles and motorcycles', compared with the unweighted results. These results indicate that the 'manufacturing' sector is overrepresented in the sample, while the sector of 'wholesale and retail trade; repair of motor vehicles and motorcycles' is underrepresented. All weighted results are based on sampling weights from the innovation data.

3.2. The variables

3.2.1. The innovation variables

Three innovation variables are used in the analysis, which are all dummy variables. One of these dummy variables is 'being an innovative enterprise'. This variable is coded 1 if an

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enterprise is innovative (i.e. product- and/or process-innovative); 0 if it is not innovative (i.e. not product- or process-innovative).

The second and third dummy variables are related to enterprises' innovation strategies. There are five possible innovation strategies: An innovative enterprise developed the product and/or process innovations (i) mainly by itself, (ii) together with enterprises in its enterprise group, (iii) by itself by adapting or modifying products and/or processes originally developed by other enterprises or institutions, (iv) together with other enterprises or institutions, and (v) mainly by other enterprises or institutions. Institutions include research institutes, universities and university colleges. Multiple innovation strategies are possible for each enterprise.

The second dummy variable is 'following an 'in-house strategy'' (i.e. being an innovative enterprise that developed the innovations mainly by itself): Coded 1 if an innovative enterprise choose at least one of the innovation strategies (i), (ii) and (iii) above, but not (iv) and (v); 0 otherwise. The third dummy variable is 'following a 'cooperation strategy'' (i.e. being an innovative enterprise that developed the innovations together with external partners): Coded 1 if an innovative enterprise choose the innovation strategy (iv), but not (v);[7] 0 otherwise.

Product-innovative enterprises are enterprises which introduced a product (i.e. a good or service) that is new or significantly improved with respect to its characteristics or intended uses during the period 2008–2010. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Process-innovative enterprises are enterprises which implemented a new or significantly improved method of production or delivery during the period 2008–2010. This includes significant changes in techniques, equipment and/or software. Enterprises are also classified as product- or process-innovative in the analysis if they have any innovation activities that did not result in a product or process innovation during the period 2008–2010 as a result of the activities becoming abandoned or suspended before completion, or the activities were still ongoing at the end of the 2010.

3.2.2. The training variable

The training variable refers to the training method, i.e. the method of training employees on how to develop new ideas or creativity. This is a dummy variable which is coded 1 if an enterprise used employee training (or education) during the period 2008–2010 as a method to stimulate new ideas or creativity among its staff; 0 otherwise.

[7] 68% (weighted result) of the enterprises that choose the innovation strategy (iv), but not (v), also choose at least one of the strategies (i), (ii) and (iii), since multiple innovation strategies are possible.

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3.2.3. The control variables

Both dummy and continuous variables are included in the set of control variables. The dummy variables are: brainstorming sessions, (multidisciplinary or cross-functional) work teams, geographic markets, industrial sector (alphabetical NACE codes, SIC2007), and enterprises' geographical location (measured by county).[8] The variable for brainstorming sessions is coded 1 if an enterprise used brainstorming sessions during the period 2008–2010 as a method to stimulate new ideas or creativity among its staff; 0 otherwise. The variable for work teams is coded 1 if an enterprise used multidisciplinary or cross-functional work teams during the period 2008–2010 as a method to stimulate new ideas or creativity among its staff; 0 otherwise.

Three dummy variables are used to control for geographic markets, measured as the markets where the enterprises have sold products in the period 2008–2010. The first variable is coded 1 if an enterprise has only sold products on the Norwegian market (0 otherwise), the second variable is coded 1 if an enterprise has only sold products abroad (0 otherwise), and the third variable is coded 1 if an enterprise has sold products both in Norway and abroad (0 otherwise).

The following continuous control variables have been used: proportion of females of total employees, average age of the employees, educational level, and firm size (measured as the number of employees). Educational level is measured as proportions of employees at different highest attained educational levels. The educational levels are: primary school, secondary school, and higher education.

4. Descriptive statistics

4.1. Innovation and methods to stimulate new ideas or creativity

Table 2 presents employee and enterprise characteristics by innovation status. We see from the table that 23% of the enterprises are innovative. The majority of the innovative enterprises (62%) have developed their innovations mainly by themselves; 19% have developed the innovations together with external partners. These innovation strategies are mutually exclusive by the way we have defined the two activities (see Section 3.2.1); none of the innovative enterprises have developed the innovations both mainly by themselves and together with external partners.[9]

[8] We control for 19 counties in Norway.

[9] The remaining innovative enterprises (i.e. innovative enterprises that did not developed their innovations mainly by themselves or together with external partners) have developed the innovations mainly by other enterprises or institutions. We find that 19% (weighted result) of the innovative enterprises choose the innovation strategy (v). How this innovation strategy is related to training is not

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[Table 2 about here]

The table shows the proportion of enterprises that have used any of the three methods to stimulate new ideas or creativity among the staff. Among all enterprises in the sample we find that the proportion of enterprises that have used brainstorming sessions is highest (41%), and that the proportion of enterprises that have trained employees on how to develop new ideas or creativity is lowest (19%). The same result holds for both innovative and non-innovative enterprises. There is also a relatively high proportion of enterprises that have used work teams (37% of all enterprises).

We see from the table that the proportion of enterprises that have used any of the three methods to stimulate new ideas or creativity is much higher among innovative enterprises than among non-innovative enterprises. In particular, we see that 32% of the innovative enterprises have trained employees on how to develop new ideas or creativity, while the corresponding proportion among non-innovative enterprises is 15%. This indicates that there is a positive relationship between innovation activities and the use of the training method, which in this case supports Hypothesis 1 in Section 2.

4.2. Other employee and enterprise characteristics

Table 2 shows that innovative enterprises are larger than non-innovative enterprises measured by the number of employees. The average number of employees is 53 among non-innovative enterprises, 103 among innovative enterprises, and 64 among enterprises in the sample as a whole.

There are small differences in the proportion of females of total employees (27% and 28%, respectively) and in the average age among the employees (40 and 41 years, respectively) between non-innovative and innovative enterprises. For the whole sample the proportion of females of total employees is 28%, and the average age among the employees is 40 years.

We find that innovative enterprises have a higher proportion of employees with higher education (31% and 19%, respectively) and lower proportions of employees with primary school (26% and 32%, respectively) and secondary school (35% and 37%, respectively) compared with enterprises that are not innovative.[10] This is not surprising. The reason is as follows: As emphasised above, the results indicate that there is a positive relationship between innovation activities and training. Thus, innovation activities may be positively related to

analysed in this study. We have no explanations either on how training is related to this innovation strategy.

[10] Innovative enterprises (8%) have also a lower proportion of employees with unknown educational level than non-innovative enterprises (12%).

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employees' educational level since adults with a high level of education are more likely to participate in lifelong learning than the low-educated (OECD 2014, Børing et al. 2013).

Furthermore, the proportion of enterprises that have sold products both in Norway and abroad is higher among innovative enterprises (48%) than among non-innovative enterprises (23%). Few innovative enterprises (4%) and non-innovative enterprises (2%) have only sold products abroad. Consequently, the proportion of enterprises that have only sold products at the Norwegian market is higher among non-innovative enterprises (75%) than among innovative enterprises (48%).

5. The potential endogeneity and multicollinearity problems

5.1. The potential endogeneity problem

Three of the variables are related to methods an enterprise may use to stimulate new ideas or creativity among its staff. These variables are: the training variable (i.e. the method of training employees) and the control variables for brainstorming sessions and work teams.

There may be a potential endogeneity problem of using each of these three variables as explanatory variables in regressions. One possibility is that we have a causality direction from the use of methods to stimulate new ideas or creativity to innovation: Enterprises that use such methods among their staff may experience an increase in their (product or process) innovation activities. We may also have the opposite causality direction from innovation to the use of methods to stimulate new ideas or creativity: Enterprises with the intension to develop new products or processes may use such methods among their staff. Thus, the causality may not only be that the use of methods to stimulate new ideas or creativity has an impact on innovation, but also that innovation affects the use of such methods.

There are also other reasons why endogeneity is of concern. Innovation and the use of methods to stimulate new ideas or creativity may be serially correlated over time. Firms might continuously make innovations (or not) and continuously invest in the use of such methods (or not) which might drive the correlation between innovation and this investment.

Finding suitable excluded instruments is in general quite challenging, and particularly challenging in this analysis. The reason is the long time period on which innovation and the use of methods to stimulate new ideas or creativity are defined. Even if each of these variables is measured during the period 2008–2010, we are unable to specify the order in which the activities were carried out. Without having suitable excluded instruments, we cannot use IV techniques. The analysis will instead be based on partial and semipartial correlation coefficients.

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5.2. The multicollinearity problem

We have tested for multicollinearity between the three methods to stimulate new ideas or creativity among the staff. Based on the pairwise and Spearman's rank correlation tests (unweighted results), we find that the correlation coefficient between the variables for brainstorming sessions and work teams is 68%, while the correlation coefficient between the method of training employees and each of the variables for brainstorming sessions and work teams is 43%. The correlation coefficients are significant at the 1 per cent level. We also find that 75% of the enterprises that use brainstorming sessions also use work teams, 39% of those that use brainstorming sessions also use the training method, and 41% of those that use work teams also use the training method (weighted results).

Since the variables for brainstorming sessions and work teams are highly correlated, we have generated a new dummy variable which is coded 1 if at least one of the dummy variables for brainstorming sessions and work teams is equal 1; 0 otherwise. The new variable is denoted 'brainstorming sessions and/or work teams', and is used as a control variable.

5.3. Controlling for educational level

An important question is whether the potential relationship between innovation and the training variable is driven by the mechanism put forward in Section 2 (importance of training in the knowledge absorption process), or whether the potential relationship is actually driven by other factors that are either observed or unobserved. An example: We would expect that firms with innovation have higher proportions of high-skilled employees. High-skilled employees, however, tend to receive more training, and might also be better in fostering innovation. This might cause a correlation between innovation and training which is actually driven by a third variable. Since high-skilled employees can be defined as employees with higher education, this can be seen as the underlying hypothesis of including educational level as a control variable.

Furthermore, there is an additional reason to control for educational level: Based on the training variable, we cannot differentiate between training and education used as a method to stimulate new ideas or creativity. Sung and Choi (2014) find that investment in employee development in the form of financial support for education outside an organisation is negatively associated with innovation. This illustrates how important it is to differentiate between training and education, and why we control for educational level.

6. The correlation coefficients

The partial and semipartial correlation coefficients are presented in Tables 3-5. In Table 3 we show the correlation coefficients of the variable 'being an innovative enterprise', Table 4

shows the correlation coefficients of the variable ‘following an ‘in-house strategy’’, while the correlation coefficients of the variable ‘following a ‘cooperation strategy’’ are shown in Table 5. The variables in the three tables also include dummy variables for geographical location, but the correlation coefficients of these dummy variables are not shown in the tables.

[Tables 3-5 about here]

6.1. Innovation and methods to stimulate new ideas or creativity

Table 3 shows that the method of training employees is positively and significantly related to enterprises’ innovation activities at the 1 per cent level if we do not control for enterprises’ use of brainstorming sessions and/or work teams (i.e. Model 1). This can be interpreted as indicating that the proportion of enterprises that use the training method is significantly higher among innovative enterprises than among non-innovative enterprises.

We also see from Table 3 that the method of training employees is positively related to innovation activities if we control for the use of brainstorming sessions and/or work teams (Model 2). This relationship is significant at the 5 per cent level. The table shows that the variable ‘brainstorming sessions and/or work teams’ is positively and significantly related to innovation activities at the 1 per cent level.

Tables 4 and 5 show that the use of the training method is significantly higher among enterprises that follow an ‘in-house strategy’ or a ‘cooperation strategy’ compared with other enterprises at the 1 per cent level if we do not control for enterprises’ use of brainstorming sessions and/or work teams (i.e. Model 1). We see that there is no significant direct relationship between the training method and each of the two variables which are related to enterprises’ innovation strategies if we control for the use of brainstorming sessions and/or work teams (Model 2).

These are both expected and non-expected results. We have expected that the method of training employees is positively related to enterprises’ innovation activities. The correlation coefficients show that there is a significant direct relationship between the training method and innovation if we control for enterprises’ use of brainstorming sessions and/or work teams to stimulate new ideas or creativity among the staff. It therefore seems that Hypothesis 1 is supported by the data. Enterprises’ use of brainstorming sessions and/or work teams is significantly higher among innovative enterprises than among non-innovative enterprises.

For both enterprises that follow an ‘in-house strategy’ and a ‘cooperation strategy’ we find no significant direct relationship between enterprises’ use of the method of training employees and their innovation activities if we control for the use of brainstorming sessions and/or work teams. Therefore, the results do not seem to support Hypothesis 2. This is non-expected due to the significant direct relationship between enterprises’ use of the training method and their

innovation activities, since most of the innovative enterprises in the sample either follow an ‘in-house strategy’ or a ‘cooperation strategy’.

These results do not necessarily mean that the method of training employees is not an important method to influence (positively) enterprises’ innovation strategies. Some studies within the human resource (HR) management literature have found that in order to foster innovation, one has to combine a range of HR policies and practices (see, for example, Michie and Sheehan 2005). Thus, one can argue that it is the combination of training with the use of brainstorming sessions and/or work teams (and also other practices) that would be expected to be correlated with innovation strategies, which is what we find in Tables 4 and 5. In Section 5.2 we also found that these methods to stimulate new ideas or creativity are correlated with each other. Even if we find no significant direct relationship between the training method and innovation strategies, training can be argued to be indirectly related to innovation strategies since it is combined with other HR practices.

The use of brainstorming sessions and/or work teams is significantly higher among enterprises that follow an ‘in-house strategy’ compared with other enterprises at the 1 per cent level. We find the same relationship for enterprises that follow a ‘cooperation strategy’ (at the 1 per cent level).

6.2. Other employee and enterprise characteristics

Tables 3-5 show that enterprises’ innovation activities are not significantly related to the average age among the employees. The average age is negatively and significantly related to the innovation variable ‘following an ‘in-house strategy’’, but not significantly related to the innovation variable ‘following a ‘cooperation strategy’’. We also find that the three innovation variables are not significantly related to the proportion of females of total employees.

From the tables we see that the proportion of employees with higher education is positively and significantly related to the three innovation variables. The proportion of employees with primary school is not significantly related to the innovation variables, except that we find a negative and significant relationship between this proportion and the variable ‘being an innovative enterprise’ if we do not control for the use of brainstorming sessions and/or work teams.

Enterprises that either only sold products abroad or sold products both in Norway and abroad in the period 2008–2010 are found to be more innovative than enterprises that only sold products on the Norwegian market in this period (i.e. the reference group). We find the same relationships for enterprises that follow an ‘in-house strategy’ and a ‘cooperation strategy’, except that there are no significant differences in the correlation coefficients between enterprises that only sold products abroad and the reference group among those that follow a

‘cooperation strategy’. The tables also show that firm size (measured as the number of employees) is positively and significantly related to the three innovation variables.

Furthermore, enterprises included in the ‘manufacturing’ sector (i.e. the reference group) are more innovative than enterprises included in the other industrial sectors. We find the same relationships for enterprises that follow an ‘in-house strategy’ or a ‘cooperation strategy’, with some exceptions: There are no significant differences in the correlation coefficients between enterprises included in the sector of ‘information and communication’ and the reference group among those that follow an ‘in-house strategy’. We find no significant differences in the coefficients either between enterprises included in the sectors of ‘water supply; sewerage, waste management and remediation activities’, ‘administrative and support service activities’ and the reference group among those that follow a ‘cooperation strategy’.

7. Summary and conclusions

We examine how enterprises’ use of employee training (or education) as a method to stimulate new ideas or creativity among the staff is related to their innovation activities. In the study we use matched employer–employee register data, which are linked to innovation data. The data sample consists of 5204 Norwegian enterprises in the business enterprise sector.

There may be a potential endogeneity problem of using the variables that are related to methods of stimulating new ideas or creativity as explanatory variables in regressions. These variables are enterprises’ use of the training method, brainstorming sessions and work teams. Since we lack suitable instruments, we cannot use instrumental variables (IV) techniques. The analysis is instead based on correlation coefficients.

In the analysis we compare correlation coefficients with and without control for enterprises’ use of brainstorming sessions and/or (multidisciplinary or cross-functional) work teams as a method to stimulate new ideas or creativity among their staff. Here we only summarise the correlation coefficients with control for enterprises’ use of this method.

Two working hypotheses are presented, which are denoted Hypothesis 1 and 2. Hypothesis 1 states that there is a positive relationship between enterprises’ use of the training method and their innovation activities. From the correlation coefficients we find a significant direct relationship between enterprises’ use of employee training and their innovation activities (at the 5 per cent level). Therefore, the results seem to support Hypothesis 1.

As defined in the analysis, innovative enterprises follow an ‘in-house strategy’ if they developed the innovations mainly by themselves, and a ‘cooperation strategy’ if they developed the innovations together with external partners. Descriptive statistics show that 62% of the innovative enterprises follow an ‘in-house strategy’, while 19% of the innovative enterprises follow a ‘cooperation strategy’.

Hypothesis 2 states that Hypothesis 1 holds for enterprises that follow an ‘in-house strategy’ or a ‘cooperation strategy’. The correlation coefficients show that there is no significant direct relationship between the method of training employees and innovation activities for both enterprises that follow an ‘in-house strategy’ and a ‘cooperation strategy’. It therefore seems that these results do not support Hypothesis 2. This is non-expected since Hypothesis 1 seems to be supported by the data, and that most of the innovative enterprises in the sample either follow an ‘in-house strategy’ or a ‘cooperation strategy’.

The correlation coefficients show that enterprises’ use of brainstorming sessions and/or work teams to stimulate new ideas or creativity among their staff is positively and significantly related to innovation activities. We also find that the relationship is positive and significant for enterprises that follow an ‘in-house strategy’ or a ‘cooperation strategy’.

The implication of the results found in this study is not necessarily that the method of training employees is not an important method to influence enterprises’ innovation strategies. Given the results of previous published research within the HR management literature (see Section 6.1), one can argue that it is the combination of other HR practices (as brainstorming sessions and/or work teams) that would be expected to be correlated with innovation strategies. This is what we find for enterprises that follow an ‘in-house strategy’ or a ‘cooperation strategy’. Thus, this indicates that the HR practices used in this study are significant methods to influence innovation strategies.

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Table 1: Proportion of enterprises in the sample by industrial sector, unweighted and weighted results

	Unweighted		
Industrial sector	Number	Per cent	Weighted
Mining and quarrying (B)	162	3%	2%
Manufacturing (C)	1605	31%	27%
Electricity, gas, steam and air conditioning supply (D)	123	2%	2%
Water supply; sewerage, waste management and remediation activities (E)	115	2%	2%
Construction (F)	617	12%	13%
Wholesale and retail trade; repair of motor vehicles and motorcycles (G)	532	10%	17%
Transportation and storage (H)	359	7%	6%
Accommodation and food service activities (I)	429	8%	9%
Information and communication (J)	592	11%	10%
Financial and insurance activities (K)	217	4%	3%
Professional, scientific and technical activities (M)	366	7%	8%
Administrative and support service activities (N)	87	2%	2%
Number of enterprises	5204	100%	100%

Note: Industrial sectors are based on the Standard Industrial Classification (SIC2007) (alphabetical NACE codes in parenthesis).

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Table 2: Descriptive statistics: enterprise and employee characteristics, proportion of enterprises by innovation status, weighted results

Enterprise and employee characteristics	Not innovative	Innovative	Total
Being an innovative enterprise	0%	100%	23%
Following an 'in-house strategy'	0%	62%	14%
Following a 'cooperation strategy'	0%	19%	4%
Brainstorming sessions	32%	72%	41%
Work teams	28%	67%	37%
Method of training employees	15%	32%	19%
Average firm size	53	103	64
Proportion of females of total employees	27%	28%	28%
Average age among the employees	40	41	40
Educational level			
Employees with primary school	32%	26%	31%
Employees with secondary school	37%	35%	36%
Employees with higher education	19%	31%	22%
Employees with unknown educational level	12%	8%	11%
Geographic markets			
Only sold products at the Norwegian market	75%	48%	69%
Only sold products abroad	2%	4%	2%
Sold products both in Norway and abroad	23%	48%	29%
Number of enterprises	3693	1511	5204

Table 3: Partial and semipartial correlation coefficients: being an innovative enterprise, weighted results

	Model 1			Model 2		
Variables	Partial	Semi-partial	Sign. value	Partial	Semi-partial	Sign. value
Brainstorming sessions and/or work teams				0.254	0.233	0.000
Method of training employees	0.141	0.131	0.000	0.031	0.027	0.028
Proportion of females of total employees	0.013	0.012	0.355	0.004	0.004	0.774
Average age among the employees	0.000	0.000	0.985	-0.001	-0.001	0.954
Educational level						
Employees with primary school	-0.039	-0.035	0.006	-0.022	-0.020	0.113
Employees with higher education	0.068	0.063	0.000	0.055	0.048	0.000
Geographic markets						
Only sold products abroad	0.048	0.044	0.001	0.039	0.035	0.005
Sold products both in Norway and abroad	0.173	0.162	0.000	0.142	0.128	0.000
Firm size	0.053	0.049	0.000	0.043	0.038	0.002
Industrial sector						
Mining and quarrying (B)	-0.078	-0.072	0.000	-0.074	-0.066	0.000
Electricity, gas, steam and air conditioning supply (D)	-0.087	-0.081	0.000	-0.093	-0.083	0.000
Water supply; sewerage, waste management and remediation activities (E)	-0.029	-0.027	0.037	-0.038	-0.034	0.006
Construction (F)	-0.110	-0.102	0.000	-0.098	-0.088	0.000
Wholesale and retail trade; repair of motor vehicles and motorcycles (G)	-0.083	-0.076	0.000	-0.077	-0.069	0.000
Transportation and storage (H)	-0.116	-0.107	0.000	-0.101	-0.090	0.000
Accommodation and food service activities (I)	-0.129	-0.119	0.000	-0.120	-0.107	0.000
Information and communication (J)	-0.031	-0.028	0.027	-0.035	-0.031	0.012
Financial and insurance activities (K)	-0.069	-0.063	0.000	-0.064	-0.057	0.000
Professional, scientific and technical activities (M)	-0.077	-0.071	0.000	-0.075	-0.066	0.000
Administrative and support service activities (N)	-0.069	-0.064	0.000	-0.063	-0.056	0.000
Number of enterprises			5204			5204

Notes: 1) The table shows the partial and semipartial correlation coefficient of the innovation variable 'being an innovative enterprise' with each variable in the table after removing the effects of all other variables in the table. 2) The corresponding significance is reported. 3) Correlation coefficients of the dummies for firms' geographical location are not shown in the table. 4) The reference firm is: employees with secondary school, only sold products on the Norwegian market, and included in the 'manufacturing' sector (alphabetical NACE code C).

Table 4: Partial and semipartial correlation coefficients: following an 'in-house strategy', weighted results

	Model 1			Model 2		
Variables	Partial	Semi-partial	Sign. value	Partial	Semi-partial	Sign. value
Brainstorming sessions and/or work teams				0.189	0.177	0.000
Method of training employees	0.082	0.078	0.000	0.001	0.001	0.956
Proportion of females of total employees	-0.007	-0.007	0.597	-0.014	-0.013	0.305
Average age among the employees	-0.031	-0.029	0.026	-0.032	-0.029	0.022
Educational level						
Employees with primary school	-0.014	-0.013	0.330	-0.001	-0.001	0.950
Employees with higher education	0.056	0.053	0.000	0.046	0.042	0.001
Geographic markets						
Only sold products abroad	0.065	0.062	0.000	0.058	0.054	0.000
Sold products both in Norway and abroad	0.150	0.143	0.000	0.126	0.117	0.000
Firm size	0.041	0.039	0.003	0.033	0.030	0.018
Industrial sector						
Mining and quarrying (B)	-0.067	-0.063	0.000	-0.063	-0.058	0.000
Electricity, gas, steam and air conditioning supply (D)	-0.067	-0.063	0.000	-0.071	-0.065	0.000
Water supply; sewerage, waste management and remediation activities (E)	-0.043	-0.040	0.002	-0.049	-0.046	0.000
Construction (F)	-0.113	-0.106	0.000	-0.103	-0.096	0.000
Wholesale and retail trade; repair of motor vehicles and motorcycles (G)	-0.104	-0.098	0.000	-0.100	-0.093	0.000
Transportation and storage (H)	-0.106	-0.100	0.000	-0.094	-0.087	0.000
Accommodation and food service activities (I)	-0.104	-0.098	0.000	-0.096	-0.089	0.000
Information and communication (J)	0.006	0.006	0.666	0.004	0.004	0.779
Financial and insurance activities (K)	-0.044	-0.042	0.002	-0.040	-0.037	0.004
Professional, scientific and technical activities (M)	-0.071	-0.067	0.000	-0.069	-0.064	0.000
Administrative and support service activities (N)	-0.053	-0.050	0.000	-0.048	-0.044	0.001
Number of enterprises			5204			5204

Notes: 1) The table shows the partial and semipartial correlation coefficient of the innovation variable 'following an 'in-house strategy'' with each variable in the table after removing the effects of all other variables in the table. 2) The corresponding significance is reported. 3) Correlation coefficients of the dummies for firms' geographical location are not shown in the table. 4) The reference firm is: employees with secondary school, only sold products on the Norwegian market, and included in the 'manufacturing' sector (alphabetical NACE code C).

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Table 5: Partial and semipartial correlation coefficients: following a 'cooperation strategy', weighted results

	Model 1			Model 2		
Variables	Partial	Semi-partial	Sign. value	Partial	Semi-partial	Sign. value
Brainstorming sessions and/or work teams				0.116	0.114	0.000
Method of training employees	0.065	0.064	0.000	0.014	0.013	0.332
Proportion of females of total employees	-0.007	-0.007	0.611	-0.011	-0.011	0.419
Average age among the employees	-0.004	-0.003	0.803	-0.004	-0.004	0.789
Educational level						
Employees with primary school	0.004	0.004	0.789	0.012	0.011	0.404
Employees with higher education	0.058	0.056	0.000	0.051	0.049	0.000
Geographic markets						
Only sold products abroad	0.007	0.007	0.607	0.002	0.002	0.868
Sold products both in Norway and abroad	0.084	0.083	0.000	0.068	0.066	0.000
Firm size	0.052	0.051	0.000	0.047	0.045	0.001
Industrial sector						
Mining and quarrying (B)	-0.038	-0.037	0.006	-0.035	-0.034	0.011
Electricity, gas, steam and air conditioning supply (D)	-0.034	-0.033	0.016	-0.035	-0.034	0.012
Water supply; sewerage, waste management and remediation activities (E)	-0.004	-0.003	0.800	-0.007	-0.007	0.601
Construction (F)	-0.051	-0.050	0.000	-0.044	-0.043	0.002
Wholesale and retail trade; repair of motor vehicles and motorcycles (G)	-0.074	-0.073	0.000	-0.071	-0.069	0.000
Transportation and storage (H)	-0.047	-0.046	0.001	-0.039	-0.038	0.005
Accommodation and food service activities (I)	-0.064	-0.063	0.000	-0.058	-0.057	0.000
Information and communication (J)	-0.067	-0.066	0.000	-0.069	-0.067	0.000
Financial and insurance activities (K)	-0.044	-0.043	0.002	-0.041	-0.040	0.003
Professional, scientific and technical activities (M)	-0.052	-0.051	0.000	-0.050	-0.049	0.000
Administrative and support service activities (N)	-0.017	-0.016	0.230	-0.013	-0.013	0.343
Number of enterprises			5204			5204

Notes: 1) The table shows the partial and semipartial correlation coefficient of the innovation variable 'following a 'cooperation strategy'' with each variable in the table after removing the effects of all other variables in the table. 2) The corresponding significance is reported. 3) Correlation coefficients of the dummies for firms' geographical location are not shown in the table. 4) The reference firm is: employees with secondary school, only sold products on the Norwegian market, and included in the 'manufacturing' sector (alphabetical NACE code C).