Do unions increase participation in further education?

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Abstract

The race between education and technology is a key issue for trade unions. Unions often include skill-upgrading and training in collective bargains, which might be an important tool to facilitate lifelong learning. In this paper, I investigate how trade unions influence workers' participation in further education using Norwegian matched employer-employee panel data on full-time workers and a fixed-effects framework. In contrast to most existing studies, which rely on more or less representative surveys, our data comprise the entire working population over a period of 16 years, allowing us to control for unobserved individual heterogeneity. An increase in the workplace union density is estimated to raise the individual propensity to participate in tertiary vocational education. I also find that workers in unionized establishments enjoy higher salaries during further education, but at the expense of lower post-training wage premiums. In addition, unions are found to lower employee turnover. Together, these findings give empirical support to the theoretical prediction of Acemoglu & Pischke (1999), where firms may optimally choose to sponsor investments in workers' skills in absence of perfect competition in the labor market.

JEL Classification: I21, P36, J51, C23

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1 Introduction

The process of technological change and its implications for the labor market has been a source of extensive debate since the first industrial revolution. In recent decades, the concern of labor-replacing technologies has been fueled by the progress in the use of computers (Autor et al., 2003), industrial robots (Acemoglu & Restrepo, 2020; De Vries et al., 2020), and artificial intelligence and mobile robotics (Frey & Osborne, 2017). Recent studies document evidence of rising inequality following serious structural change in the composition of skills (Acemoglu, 2002; Autor & Dorn, 2013), as well as a decrease in the labor share of income due to a slowdown in the creation of new tasks and in the reinstatement of displaced labor (Acemoglu & Restrepo, 2019). The bias in recent technological change in favor of highly skilled workers has put Tinbergen's classical race between education and technology back on the agenda (Tinbergen, 1974; Katz & Murhpy, 1992; Autor, et al., 2020). In order to keep track of the accelerating pace of technological developments, more investments in complementary education and skills are required to get the most out of the benefits made possible by new technology (Brynjolfsson & McAfee, 2012). In addition to formal education throughout childhood and youth, rapid technological advances also necessitates lifelong learning and contiuous skill-upgrading of workers (OECD, 2021).

The race between education and technology has been an important focus of trade unions. Faced with investments in labor-replacing technologies, unions may either oppose new technology and, under certain conditions, take the role as 'Luddites' (Dowrick & Spencer, 1994), or they may bargain for workers' skills to keep up with the technological progress (Heyes & Stuart, 1998). When unions include skill-upgrading and training in collective bargaining, this is an important tool to facilitate lifelong learning. In Norway, collective agreements include provisions on further educations which, to a large extent, place responsibility of funding educational leaves and associated costs on the employer. Moreover, by compressing the structure of wages, unions may increase the firms' willingness to sponsor general training in the case of oligopsonistic labor markets, as the post-training productivity will be increasing at a faster rate than wages (Booth et al., 2003).

In this paper, I investigate how trade unions influence workers' participation in further education, their wages during and after training, as well as their post-training likelihood of leaving their jobs. To measure further education, I concentrate on participation in tertiary vocational education among

full-time employees with an educational attainment at the secondary level. Tertiary vocational schools were incorporated in the Norwegian legislation following the Competence Reform and they specialize in further education of craft workers. Participation in tertiary vocational education thus represent a well-suited measure of further education and lifelong learning. In a recent survey of the need for competence in Norwegian firms, more than half of the firms report a lack of workers with tertiary vocational education (Rørstad, et al., 2023).

There is a large literature on what unions do. In the seminal works by Freeman & Medoff (1979; 1984), unions are portrayed with two faces. On the one hand, the *monopoly face* represents the monopoly power attained by unionized workers through collective bargaining. On the other hand, the *exit voice/institutional response face* refers to various mechanisms through which unions may influence internal relations. While the monopoly bargaining power of unions is widely recognized to add a union-premium on wages (Blanchflower & Bryson, 2004), the question of how unions influence productivity has been more debated. The empirical evidence is mixed and found to vary across countries and different institutional contexts (Doucouliagos, et al., 2017). Recent studies of the Norwegian labor market document a positive causal effect of union density (Barth, et al., 2020) and collective agreements (Svarstad & Kostøl, 2022) on firm-level productivity. Both studies, as well as most other studies of what unions do, explain their results within the framework of the two-face methodology of Freeman and Medoff. However, when unions bargain not only for wages but also for the access to and funding of training and further education, both the wage premium of unionized workers *and* the positive effect of unions on productivity could reflect changes in individual worker productivity.

According to standard human capital theory, unions are likely to reduce workers' investments in training by reducing wage differentials (e.g. Mincer, 1981). Acemoglu & Pischke (1999), however, show how firms may invest in the general skills of their employees if labor markets are imperfect – in contrast to the case where labor markets are fully competitive, in which case firms never pay for investments in general training (Becker, 1964). In other words, if wage-compression reduces workers' investments in skills, this reduction may be offset by increased incidence of firm-sponsored general training. In this case, the theoretical effect of unions on training is ambiguous. Booth & Chatterji (1998), however, argue that reduced turnover in unionized firms will increase firms' incentives to invest in the skills of their workers, as the risk of losing the investment to

competitors is lowered. Furthermore, unions may use their bargaining power to require firm-sponsoring of general training as part of their compensation package (Booth, et al., 2003).

The empirical evidence on how unions influence workers' participation in training is mixed. Different findings may be ascribed to different sources of data (e.g., cross-section surveys vs. panel data from administrative registers), different measures of training (e.g., job-specific training vs. formal general education), and different measures of unionization (e.g., individual union membership vs. workplace union density).[1] In the US, Duncan & Stafford (1980) and Mincer (1981) find negative effects of union membership on training, while Lynch (1992) and (1997) both report positive findings. Studies from the UK generally find a positive relationship between union coverage and training (Booth, 1991; Green, et al., 1999; Booth, et al., 2003). Hoque & Bacon (2008), however, find no consistent relationship between workplace union density and training. In Norway, the empirical evidence of how unions influence workers' participation in training is very limited. Stuart & Teige (2010) describe how Norwegian trade unions at the national level were deeply involved in the development of a competence reform designed to promote lifelong learning and skill-upgrading of adult workers during the 1990s. However, the authors note that weaker union structures at the local level constrained the implementation of the reform, which calls for an analysis of how unions influence participation in further education at the workplace level.

Using a panel of matched employer-employee data, comprising all Norwegian working individuals in the period 2004-2019, I find that participation rates in tertiary vocational education are positively related to workplace union density. To take account of possible endogenous selection into unions, I exclude the individual contribution to the workplace union density for all individuals. Furthermore, I include individual fixed effects to control for time-invariant unobserved heterogeneity, as well as industry trends to take account of idiosyncratic shocks at the industry level. A ten-percentage point increase in workplace union density is estimated to increase the individual propensity to participate in further education by 2-5 percent, depending on various model restrictions and specifications. In Norway, collective agreements are invoked once the workplace union density reaches certain thresholds. The findings may thus be explained by provisions in collective agreements to stimulate further education.

[1] See Table 2 in Waddoups (2014) for a systematic comparison of previous studies.

I also find evidence suggesting that unions compress the distribution of wages, thereby lowering the wage return of further education. While this will lower workers' incentives to invest in skills, it may increase firms' incentives to sponsor the education of their workers in absence of perfect competition in the labor market. Indeed, the results suggest that workers in unionized firms take lower wage cuts during education than workers in non-unionized firms. Furthermore, I find lower turnover amongst workers with a tertiary vocational degree in unionized firms compared to non-unionized firms. Together, these results suggest that higher participation rates in unionized firms could also be explained by firms optimally choosing to sponsor educational leaves.

The study adds an important contribution to the literature on unions and training by providing evidence using a comprehensive panel of matched employer-employee data from administrative registers. In contrast to most existing studies, which rely on more or less representative surveys, our data comprise the entire working population over a period of 16 years, allowing us to control for unobserved individual heterogeneity. Furthermore, the study contributes to the literature by utilizing data which allow us to concentrate on a particular type of formal *further* education offered to workers with upper secondary educational attainment. This complements existing studies relying on the more vaguely defined concepts of job-related training and general education.

The remainder of the paper is organized as follows. In Section 2, I present a simple conceptual framework to motivate some hypotheses for the empirical analysis. Section 3 then gives a short description of the Norwegian institutional context, before the data and descriptive statistics are presented in Section 4. In Section 5, I describe the methodological approach and discuss issues of identification. Section 6 documents the results, while Section 7 concludes.

2 Conceptual framework

Before presenting the data and empirical approach, this section outlines a simple conceptual framework in order to motivate a few hypotheses about how unions influence the incentives of individuals and firms to invest in further education. The framework consists of a one-period model, in which individuals supply one unit of labor inelastically to firms who produce a single good. Individuals either work in unionized or non-unionized firms. The individuals, who are otherwise equal, may choose to invest in further education, while firms may choose to sponsor a share $0 \leq \lambda \leq 1$ of the investment cost c.

The participation constraint of individuals employed in non-unionized establishments is described by the following condition:

$$\widetilde{w} \equiv w^e - w \geq (1-\lambda)c \quad (1)$$

where $\widetilde{w}$ denotes the differential between the wage paid to trained and non-trained workers, respectively, and λ the share of the educational expenses sponsored by non-unionized firms. It is clear that the individual incentive for participating in further education is increasing in the wage differential $\widetilde{w}$ and the share of costs that is sponsored by the firm.

Correspondingly, the participation constraint of individuals employed in unionized establishments is as follows:

$$\widetilde{w}_u \equiv w_u^e - w_u \geq (1-\lambda_u)c \quad (2)$$

where the wage rates and the share of investment costs sponsored by firms are allowed to vary between unionized and non-unionized establishments. Without modelling this explicitly, we will assume that unions contribute to compress the distribution of wages, such that the wage differential between trained and non-trained workers is lower in unionized establishments, that is $\widetilde{w}_u < \widetilde{w}$.[2] It follows from this that workers in unionized establishments have less incentives to invest in further education, which is also the result in standard human capital theory (Mincer, 1981).

Under perfect competition, equilibrium wages are set equal to the marginal productivities of the two types of labor. The marginal product of labor is assumed to be given by $1+\mu$ for workers who have completed further education, where the parameter $\mu > 0$ reflects the increase in labor productivity from investing in further education. If the firm tries to pay a trained worker a wage below the equilibrium wage rate, the workers will immediately quit and receive the equilibrium wage elsewhere, in which case the trained workers are replaced with new non-trained workers. It thus follows that firms never will sponsor training if markets are perfectly competitive, which is a standard result in human capital theory (Becker, 1964).

[2] Indeed, this is a common characteristic of unions (see e.g., Acemoglu et al., 2001). This is also found in a recent empirical study of the Norwegian labor market (Kostøl & Svarstad, 2023).

However, if we allow firms to have some degree of monopsony power in the labor market, they may enjoy a quasi-rent from investing in skills. If the firm chooses to sponsor a share of each workers' educational expenses equal to λ, it will earn an excess profit equal to $1 + \mu - w^e - \lambda c$ for each worker who remains in the firm. If a worker chooses to quit the firm, the firm will earn $1 - w - \lambda c$, where we assume that workers who quit are replaced by non-trained workers. If we let q denote the instantaneous quit rate, the firm's expected return from investing in education is:

$$(1 - q)(1 + \mu - w^e) + q(1 - w) - \lambda c \tag{3}$$

If $q < 1$, the firm will be able to extract a quasi-rent by setting the wage paid to trained workers below the marginal product of trained labor. The firm will only choose to sponsor training if the expected return from doing so exceeds $(1 - w)$, that is if the following condition is satisfied:

$$(1 - q)(1 + \mu - w^e) + q(1 - w) - \lambda c \geq 1 - w \tag{4}$$

Rearranging terms then yields the following participation constraint of the firm:

$$\lambda \leq \frac{(1 - q)(\mu - \widetilde{w})}{c} \tag{5}$$

It is clear from the condition in (6) that the firm's willingness to sponsor further education is increasing in the productivity effect μ, while decreasing in the wage differential $\widetilde{w}$ and the quit rate q. This also illustrates two channels through which unions may influence firms' incentives for investing in the skills of their workers.

As previously noted, unions are known to compress the distribution of wages (Acemoglu, et al., 2001) *and* to reduce labor turnover (Freeman & Medoff, 1984; Booth & Chatterji, 1998). We may summarize these previous findings in the literature as two hypotheses:

- ***Hypothesis 1:*** *The wage differential between otherwise equal workers with and without further education is lower in unionized firms than in non-unionized firms*
- ***Hypothesis 2:*** *The turnover among trained workers is lower in unionized firms than in non-unionized firms*

If hypotheses 1 and 2 are true, and as long as the productivity gains from investing in education is the same in unionized and non-unionized firms, unionized firms are predicted to sponsor a larger share of educational expenses than non-unionized firms according to (5).

- ***Prediction:*** *Unionized firms will sponsor a larger share of educational expenses than non-unionized firms if hypotheses 1 and 2 are true.*

Whether participation in further education turns out to be larger in unionized or non-unionized firms remains theoretically ambiguous. If we combine the participation constraint of individuals in (2) with the firm's participation constraint in (5), we are left with the following condition:

$$1 - \frac{\widetilde{w}}{c} \leq \lambda \leq \frac{(1-q)(\mu - \widetilde{w})}{c} \tag{6}$$

That is, unions are predicted to increase participation in further education if the firm has sufficiently strong monopsony power in the labor market, as measured by the quit rate q and the difference between the productivity and wage differentials of education $\mu - \widetilde{w}$. This is ultimately an empirical question.

3 The Norwegian institutional context

An important characteristic of the Norwegian labor market, is the prominent role of social dialogue between collective organizations, ranging from the tripartite collaboration with trade union and enterprise confederations and the Government at the national level, down to deliberations between management and trade union representatives at the shop floor (Dølvik, 2022). Industrial relations are organized through an interaction between legislation and collective agreements, where the importance of the latter is high compared to other countries. While trade union density has declined during the last decades, unionized workers still amounted to 38 percent of all private sector workers in 2017 (Kjellberg & Nergaard, 2022), which is high compared to most countries outside Scandinavia.[3] The same applies to the coverage rate of collective bargaining, though the coverage rate is lower than in many other Western European countries, where collective agreements at sectoral level may be required by law to extend to all firms and workers irrespective of union

[3] See the dataset on 'Trade Unions and Collective Bargaining' in the OECD statistical database.

membership.[4] Collective bargaining in Norway has a clear hierarchical structure (Svarstad & Kostøl, 2022). At the national level, a few major confederations determine the content of the basic agreements, which form the basis for all business sector agreements, which is then adapted to local conditions at the workplace level. In contrast to sectoral agreements, local agreements automatically extend to all workers in occupations covered by the agreement, irrespective of union membership. Collective bargaining coverage in Norway thus depends on the existence of local agreements. In general, if the workplace union density among workers within the same bargaining area is above a certain threshold, the union will demand a collective agreement. The required thresholds vary across different trade unions, usually in the range between 10 and 50 percent. [5]

There are long traditions for involving collective organizations in determining the design and content of the education system in Norway.[6] Indeed, The Norwegian Confederation of Trade Unions (LO) was the main driving force behind the development of what was to ultimately become the Norwegian Competence Reform in the late 1990s (Teige & Stuart, 2012). Concerned with declining membership and the risk of social exclusion and long-term unemployment of low-skilled members due to technological changes, there was an increasing awareness of the importance of lifelong access to skills development. Moreover, the tripartite social pact of wage restraint with the Government and the Confederation of Enterprise (NHO) in the period 1992-1997 caused LO to turn its attention to bargaining for training and skill-upgrading of existing workers (Payne, 2006).

The Competence Reform had several important implications for the access to education and training of adult workers. Among these were the introduction of a statutory right of all adults to complete basic education, as well as the right to educational leave from the workplace for up to three years to participate in relevant training and further education. Moreover, vocational schools providing craft workers with tertiary vocational education and training was formally legislated.[7]

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[4] This is the case in Austria, Belgium, Finland, France, Germany, the Netherlands, and Portugal (García-Serrano 2009). A comprehensive overview of the prevalence and functioning of collective agreements in the OECD, including differences in the practice of *ergo omnes* clauses and extensions are found in the OECD report "Negotiating Our Way Up" (2019)

[5] As shown in Figure 3 in Svarstad & Kostøl (2022), the coverage rate of collective agreements is strictly increasing in workplace union density in the range between 10 and 50 percent.

[6] Se Appendix A1 for a description of the Norwegian education system.

[7] See Payne (2006, p. 483-484) for an overview of other elements of the reform.

However, the reform did not resolve the issue of funding, which was an important requirement from the trade unions (Stuart & Teige, 2010). Up to the present date, the responsibility of funding further education of adult workers is not regulated in the legislation. However, in line with the Norwegian tradition of regulating industrial relations through an interaction between legislation and collective agreements, the responsibility of further education is incorporated into collective agreements. In the Basic Agreement between LO and NHO,[8] chapter 18 regulates development of workers' competence. Here it says that '*Both supplementary studies and further education will benefit the enterprise as well as the individual employee and therefore they must accept responsibility for developing such qualifications*' (§18-2). Regarding the question of funding, the agreement goes ever further: '*The costs of supplementary and further education must be borne by the enterprise. Responsibility for ensuring that any competence gap is covered satisfactorily rests with the enterprise and all its employees*' (§18-3).

In addition to the provisions in collective agreements, most trade unions offer some kind of financial support to members who want to participate in further education. For example, all members in 12 trade unions organized underneath the umbrella of LO have access to the confederation's educational fund. The perhaps most comprehensive financial support is offered to members of The Association for Management and Technology (FLT). Provided that the member is covered by a collective agreement at the workplace, the employer has agreed to pay NOK 1.20 per hour worked by the employee to a fund for further education. The union has also established its own company to facilitate education and training for its members in collaboration with education providers in Norway and Sweden (Undertun & Drange, 2018).

4 Data

The main data source is the register-based employment statistics produced by Statistics Norway, which is a combination of several administrative registers.[9] The population comprises all Norwegian individuals in the age 20-65 years who work at least one hour during the reference week in the period 2004-2019. In total, this amounts to 44,576,541 observations of 3,359,905

[8] For the latest version of the Basic Agreement in English (2018-2021), see https://www.lo.no/contentassets/2b75318eaad64229a5c5d135c81c4ecf/basic_agreement_lo-nho_2018-2021.pdf

[9] All data are provided by Statistics Norway through their web-application '*microdata.no*', which gives Norwegian researchers access to anonymized individual level data from administrative registers.

individuals. The reference week is the week containing the 16th of November, which is most often the third week of November. Individuals have their own unique identifying number, enabling us to track workers across time. As individuals enter and exit the labor market during the years of our sample, our panel is unbalanced. We use information on negotiated hours to define full-time workers as individuals who are working 30 hours or more during the reference week. Importantly, negotiated hours are not influenced by educational leaves. This implies that a full-time employee with a 50 percent educational leave still classifies as a full-time employee. As we are interested in measuring further education of already established workers, we choose to leave out part-time workers. This restriction reduces our population to 28,088,775 observations.

Education is measured using two different variables. The first measures the individual's highest level of education at a given point in time, while the second measures ongoing participation in courses provided by tertiary vocational schools. As tertiary vocational education requires a degree from a secondary vocational school, we restrict the population to individuals who have finished a degree at the secondary vocational level. This reduces the number of observations to 9,622,713. We further reduce the population by leaving out individuals who have a degree from higher education, as the courses offered at tertiary vocational schools are less relevant for these individuals.[10] This leaves us with a total of 7,518,692 observations of 852,850 individuals.[11]

Information on individual union membership is derived from data on union dues, which is reported to the tax authorities by the unions. Furthermore, we have information about individuals' age, sex, and annual wage income. Each individual is linked to their current main employer each year, defined as the workplace where the individual works the most hours. By linking individuals and workplaces, we are able to identify workplace industry codes at the 5-digit level, as well as aggregate information at the workplace level derived from the composition of different individual workers' characteristics. Importantly, this allows us to calculate workplace union density as the ratio of union members relative to the number of employees in each establishment. Table A1 in the Appendix summarizes the main descriptive statistics.

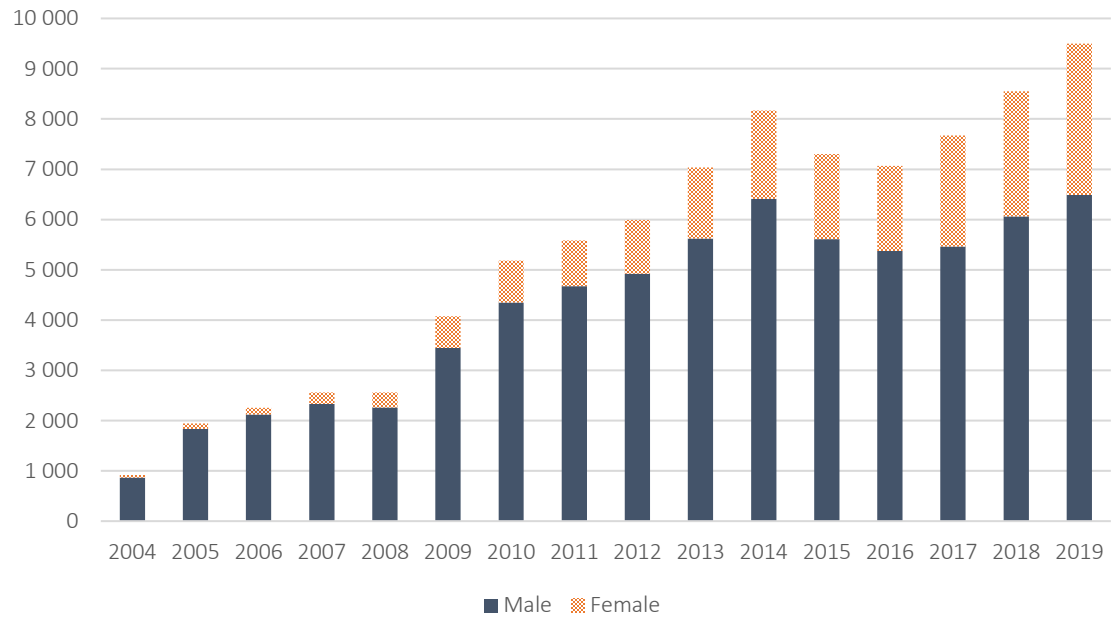
[10] In Table A2 in the Appendix, I show that the results are robust but become somewhat weaker when we relax these restrictions on the estimation sample, as we would expect.

[11] Note that these sample restrictions imply that an individual may enter the sample when graduating from a secondary vocational school but then leave the sample if she finishes a degree within higher education.

4.1 Descriptive statistics

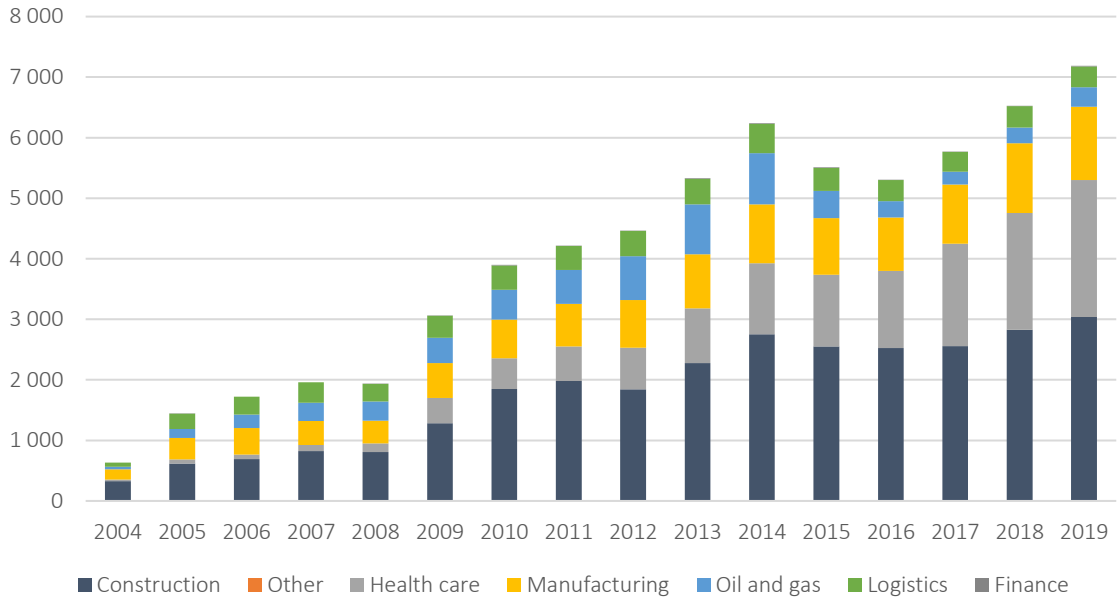
The data show a significant increase in the number of participants in tertiary vocational education during our sample period. As illustrated in Figure 1, the number of workers participating grew from less than 1,000 individuals in 2004 to about 9,000 in 2019. The figure also illustrates that a larger share of the participants are men. However, the growth has been largest among women, from almost no participants in 2004 to more than 3,000 participants in 2019. As shown in Figure 2, a large share of the participants works within construction, manufacturing industries or oil and gas – industries dominated by male workers. The fast growth of female students can, to a large extent, be explained by the Government's funding of tertiary vocational education of health care workers as of 2009.[12]

Figure 1 Number of participants in tertiary vocational education



[12] See the Government's white paper '*St.meld nr. 44*' (2008-2009).

Figure 2 Participation in tertiary vocational education by industry



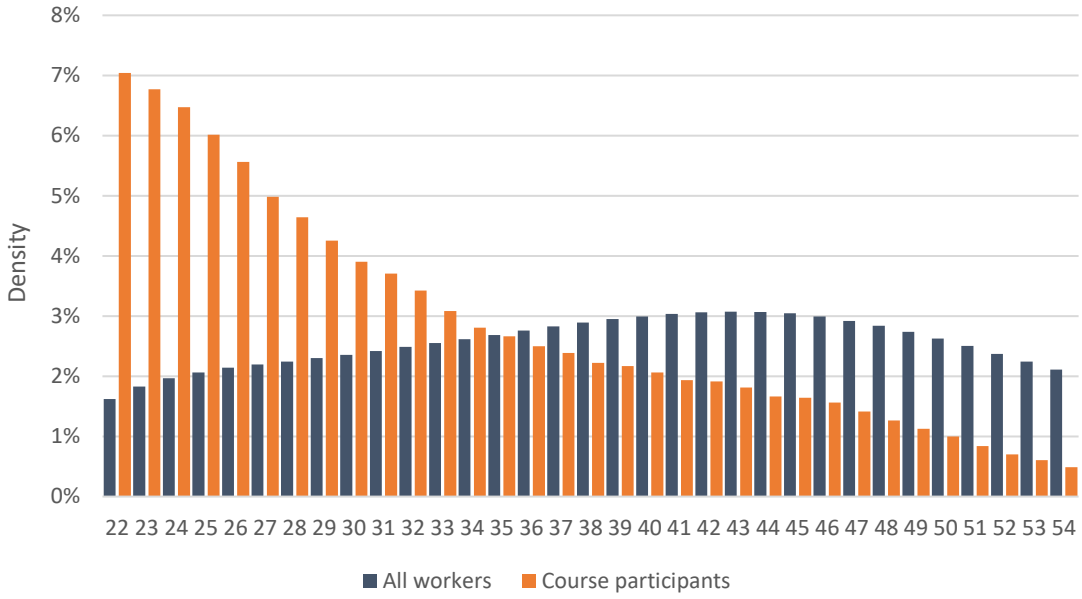
In Figure 3, I have illustrated the age profiles of workers who have participated in tertiary vocational education in the period 2004-2019, as well as for all vocational workers in our sample.[13] A large share of the participants is in the age between 20 and 30 years. However, while the participation rates fall as workers grow older, 46 percent of all full-time workers participating in tertiary vocational education are above 30 years. This illustrates the role of tertiary vocational education as a provider of lifelong learning to workers.

To get a picture of how participation in tertiary vocational education is influenced by unions, we have calculated participation rates for both union members and non-union members, as well as participation rates for full-time workers employed in a workplace where the union density exceeds 50 percent of the workers or not in Figure 4. The participation rates are simply defined as the number of participants in one or more courses in a given year, divided by the number of full-time workers in the corresponding group the same year. The participation rate is 20 percent higher for unionized workers than for non-union workers, and 34 percent higher for workers employed in workplaces where at least 50 percent of the workers are union members. While only suggestive,

[13] Note that individuals are counted each year they participate in one or more courses. In other words, an individual participating in two courses one year and three courses the next year, is counted two times in the figure.

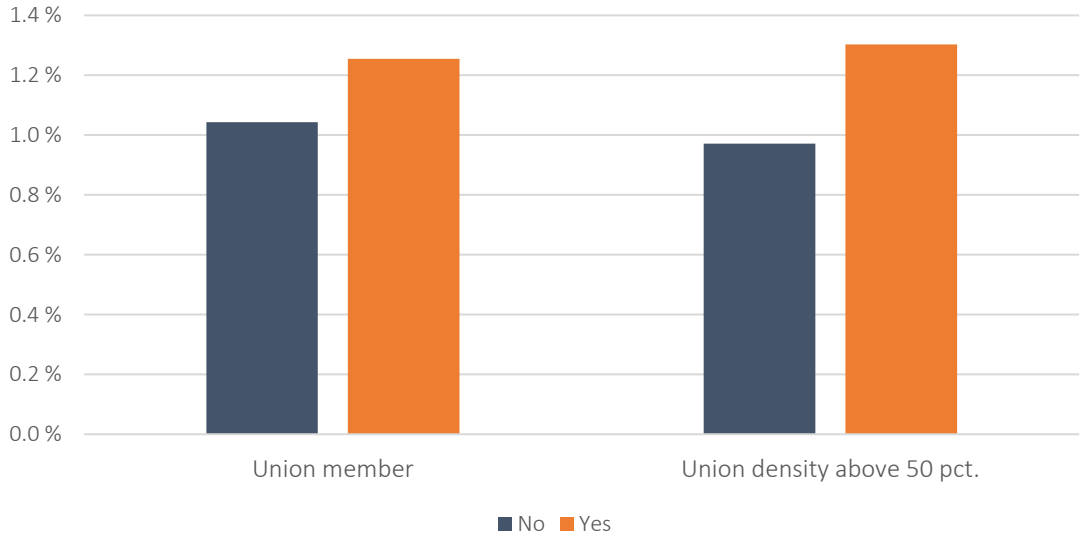
the raw data suggests a positive correlation between unionization and participation in tertiary vocational education.

Figure 3 Age profiles of participants in tertiary vocational education



Note: The figure illustrates the age distribution of participants in tertiary vocational education compared to all vocational workers. The figure in censored in both directions.

Figure 4 Participation rates in tertiary vocational education by individual union membership and workplace union density



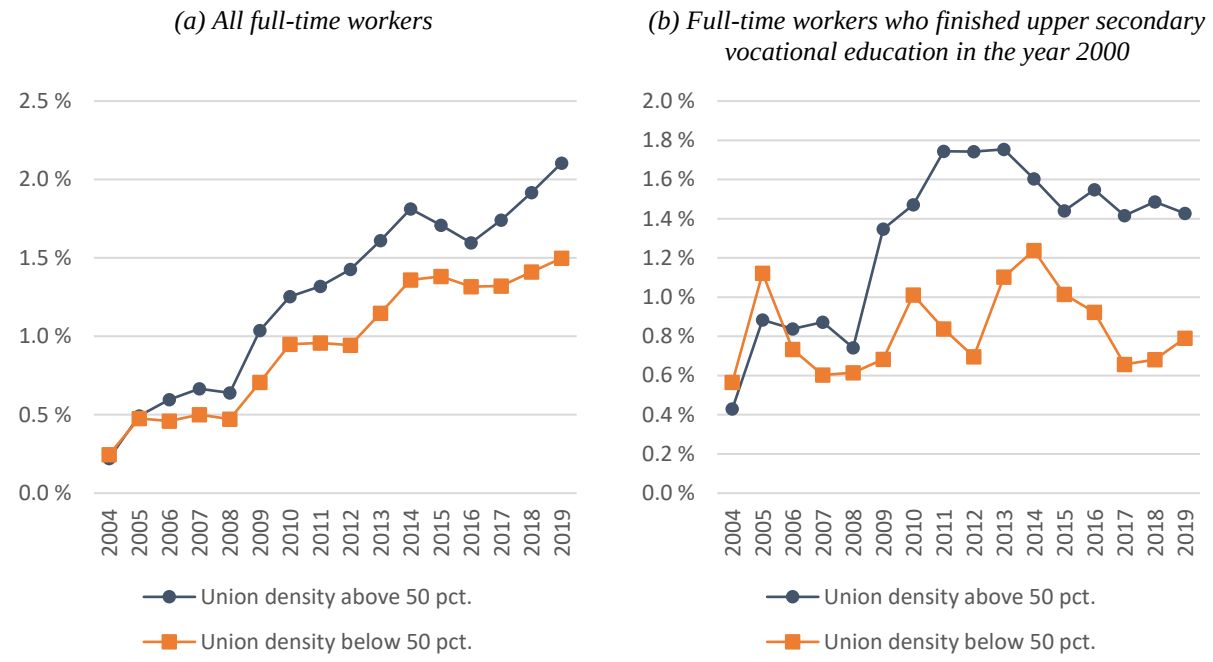
Note: The figure illustrates participation rates in tertiary vocational education among full-time employees and how participation varies with whether the individual is a union member or not and whether the union density at the workplace where the individual is employed is higher than 50 pct. of the workers or not.

In Figure 5, we illustrate how the participation rates in tertiary vocational education by workplace union density vary over time. Panel (a) shows how participation rates have been increasing, both among workers employed in establishments where the union density is above and below 50 percent. However, the increase appears to be stronger for individuals employed in workplaces where the union density exceeds 50 percent. In Panel (b), we further restrict the sample to workers who finished their upper secondary *vocational* education in the year 2000. We do this for two reasons. First, requiring that workers have finished their upper secondary vocational education in the year 2000 allows us to study a more homogenous group of workers over a period of 16 years.[14] Second, by requiring workers to have graduated four years prior to the start of our period of analysis, we leave out any effect of onboarding of fresh graduates. The figure clearly suggests a higher participation rate among workers employed in establishments where the union density exceeds 50 percent of the workers.

Higher participation rates in further education in unionized firms could be explained by employers' incentives to sponsor further education. As shown in the conceptual model in Section 2, firms will sponsor the further education of their employees if unions contribute to a sufficiently large compression of the distribution of wages. The incentives to sponsor education would be further strengthened if unions also succeed in lowering turnover rates. Figure 6 shows estimated residuals from a regression of wages (in natural logarithms) on age, age squared, yearly dummies and industry fixed effects among workers in the years before and after finishing tertiary vocational education. The residuals are compared between workers employed in unionized and non-unionized firms. We see that the wage residuals are approximately equal to 0 for both groups of workers, before they make a significant drop in year -1, illustrating that the loss in wage income due to educational leaves make up an important cost of further education. The figure clearly indicates a lower drop in earnings for workers in unionized firms, which could indicate that their employers are sponsoring a share of their leaves. In line with the theory model, this could be explained by higher wage returns after finishing tertiary vocational education among workers in non-unionized firms, as indicated by Figure 6.

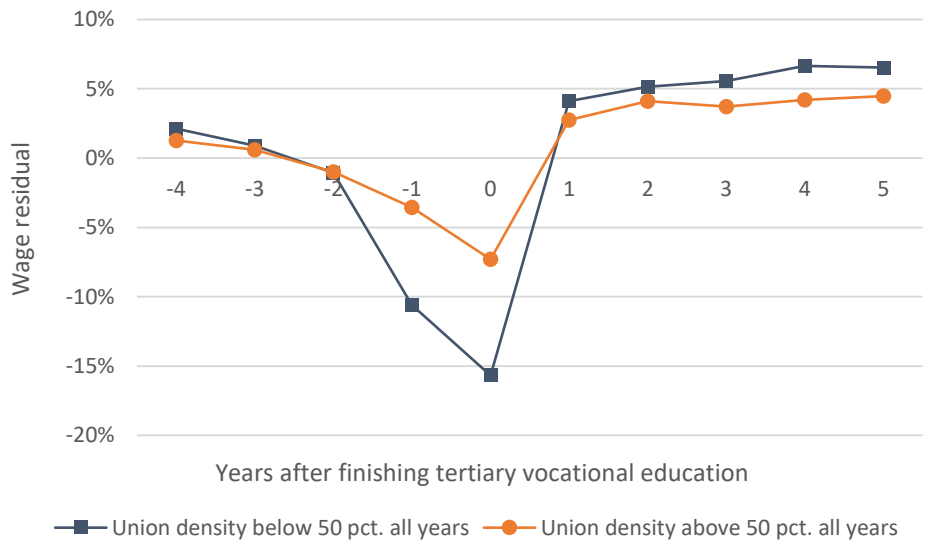
[14] By the start of our period of analysis in 2004, the median full-time worker with upper secondary vocational education finished in the year 2000 is 26 years old, and 40 years old in 2019.

Figure 5 Participation rates in tertiary vocational education by workplace union density over time



Note: Both figures illustrate yearly participation rates in tertiary vocational education among full-time employees with upper secondary education as highest level of educational attainment (N=7,507,965). Panel (b) further restricts the sample to workers who finished their upper secondary vocational education in the year 2000 (N=223,923).

Figure 6 Wage developments in the years before and after finishing tertiary vocational education



Note: The figure compares annual wages for full-time employees in establishments where the union density is below/above 50 percent all years

In Figure 7, we calculate cumulative turnover rates among workers in unionized and non-unionized firms in the years following tertiary vocational education. The figure suggests lower turnover rates among workers in unionized firms. After five years, 26 percent of workers employed in non-unionized establishments have left the firm they were employed in when they completed further education, as compared to 18 percent of workers in unionized establishments. Lower turnover rates in unionized firms will strengthen firms' incentives to sponsor the educational leaves of their employees if unions compress the distribution of wages.

Figure 7 Employee turnover among workers finishing tertiary vocational education

Note: The figure compares cumulative turnover rates among full-time employees in establishments where the union density is below/above 50 percent all years

In summary, the raw data suggest a positive relationship between unionization and participation in further education, along with lower returns to education, lower wage declines during education, as well as lower turnover rates in in unionized establishments. These findings are consistent with the conceptual model outlined in Section 2. In the next section, I present the methodological framework for analyzing these relationships further.

5 Methodology

The descriptive statistics largely confirm the hypotheses that the return to further education and employee turnover are lower in unionized establishments. The data also show lower wage reductions during education among workers in unionized workplaces, which indicates that

unionized establishments sponsor a larger share of the cost of absence from work. Ultimately, the descriptive statistics suggest that participation in further education is higher in more unionized establishments. In this section, I present empirical specifications for investigating these relationships more carefully using matched employer-employee panel data and a fixed-effects framework.

5.1 Participation in further education

In order to estimate the net effect of how unions influence workers' participation in further education, we estimate a linear probability model (LPM) conditional on workplace union density. As endogenous variable, we construct a binary variable taking the value 1 if the individual participates in one or more courses taught by a tertiary vocational school in a given year, and 0 if not. That is, if we let the discrete variable X_{it} denote the number of courses taught at tertiary vocational schools in which individual i participates in year t, we define the participation indicator P_{ijt} as:

$$P_{ijt} = \begin{cases} 1 \text{ if } X_{it} > 0 \\ 0 \text{ if } X_{it} = 0 \end{cases}$$

We then estimate the following model,

$$P_{ijt} = \beta_0 + \beta_1 UD_{it} + I_j + \delta_t + u_i + \varepsilon_{it} \quad (7)$$

where UD_{it} is a continuous variable between 0 and 1 measuring the union density at the workplace where individual i is employed at time t. I_j denotes fixed effects at the industry level, while δ_t captures any time-specific shocks common to all individuals. u_i denotes fixed effects at the individual level, controlling for any time-invariant unobserved individual heterogeneity, while ϵ_{it} denotes random shocks. The parameter of interest is β_1.

5.2 Wage effects

In order to assess how unions influence the wage dispersion between workers with and without further education, we create a three-step categorical variable E_{it} which takes on one of the following values:

$$E_{it} = \begin{cases} 0 \text{ if individual } i \text{ has not participated in any courses by time } t \\ 1 \text{ if individual } i \text{ is currently participating in one or more courses at time } t \\ 2 \text{ if individual } i \text{ has completed further education by time } t \end{cases}$$

In order to simplify the analysis, the value of E_{it} is restricted to be increasing monotonically over time for each individual. The value of E_{it} shifts from 0 to 1 the first year an individual participates in one or more courses at the tertiary vocational level, and then shifts from 1 to 2 the last year of uninterrupted participation. E_{it} then remains equal to 2, regardless of whether the individual chooses to participate in more courses at the tertiary vocational level at a later point in time.[15] We then specify a simple Mincerian earnings equation, where we include our measure of further educational attainment along with a measure of workplace unionization, as well at their interactions:

$$w_{ijt} = \alpha_0 + \alpha_1 age + \alpha_2 age^2 + \alpha_3 E_{it}^{=1} + \alpha_4 E_{it}^{=2} + \alpha_5 U_{it} + \alpha_6 E_{it}^{=1} \times U_{it} + \alpha_7 E_{it}^{=2} \times U_{it} + I_j + \delta_t + u_i + \epsilon_{it} \quad (8)$$

where U_{it} is a binary variable equal to 1 if the number of union members amounts to at least 50 percent of the employees in the workplace.[16] This specification captures both the potential negative wage effect of educational leaves and the potential positive wage premium of further education, as captured by α_3 and α_4, respectively. Furthermore, the interaction coefficients α_6 and α_7 measures how these wage effects vary between unionized and non-unionized establishments. A positive value of α_4 together with a negative value of α_7 will give support to the assumption that unions contribute to reduce the wage premium of tertiary vocational education. A negative value of α_3, together with a positive value of α_6, will imply that workers in unionized firms face lower declines in annual earnings due to educational leaves compared to workers in non-unionized firms. This is consistent with the prediction of the theory model in Section 2, that unionized firms will sponsor a larger share of educational expenses. α_5 gives additional information on how wages, on average, are influenced by unionization. The included age polynomial is a proxy for individual experience,[17] while I_j, δ_t, u_i and ϵ_{it} are defined as in (7).

[15] Note, however, that this is not the case for individuals who advances to higher education, as these individuals leave the sample once graduated.

[16] Compared with the continuous measure of union density used in equation (8), this binary measure of unionization simplifies estimation and interpretation of the model. By choosing a cut-off at 50 percent, we require the majority of workers to be union members, which is also the requirement for implementing a collective agreement by one of the largest Norwegian trade unions ('Fellesforbundet'). See Section 3 for more details on the Norwegian institutional context.

[17] When including individual fixed effects, however, the individual's age will be perfectly correlated with the time dummies and is thus excluded from the estimation.

5.3 Turnover

While unions may reduce the wage returns to education, this only benefits the firm if it is able to prevent trained workers from quitting. In the conceptual framework outlined in Section 2, this can only be obtained if the firm exhibits some degree of monopsony power in the labor market. Going beyond the theory model, however, turnover could also be reduced by increasing employee satisfaction, for example by improving the quality of industrial relations, which may be achieved through unionization (Freeman & Medoff, 1984).

In order to estimate how unions influence employee turnover, we construct a binary variable τ_{ijty} equal to 0 if individual i working in industry j is employed at the workplace where she finished her tertiary vocational education in year y at time t. The variable is only defined for values of $t = [y, y+5]$. In other words, we follow workers from the year they finish their further education and the five preceding years. Moreover, we only include individuals who have been employed at their current workplace for at least one year at time $t = y$. We then estimate the following linear probability model:

$$\tau_{ijty} = \gamma_0 + \gamma_1 U_{it} + I_j + \delta_t + u_i + \xi_{it} \quad (9)$$

where the explanatory variables are defined as in (8) and (9). The parameter of interest is γ_1.

5.4 Identification

In the above estimations, we are interested in identifying how trade unions influence the wage return of education, employee turnover, the degree of firm sponsored training and ultimately participation in further education. However, the interpretation of the parameters of interest as causal effects rests on an identifying assumption of no endogenous selection into unions. This assumption could easily be violated if workers choose to unionize in response to low wages, high turnover or in order to get access to educational grants provided by trade unions.[18] However, as argued in Booth et al. (2003), the potential endogeneity problem induced by individual union member status is likely to be reduced when considering workplace union density, as we do in our

[18] As union memberships may be rather expensive, and as both the Norwegian Working Environment Act and collective agreements require some seniority in the firm before workers are entitled to educational leaves and grants, endogenous selection into unions of individuals seeking to participate in further education is not likely to represent a big problem.

analysis. In order to further mitigate the issue of endogenous unionization, we exclude the individual's contribution to the workplace union density for all workers, leaving us with a leave-out mean measure of union density invariant to changes in the individual's union status.

While we are mitigating the issue of endogenous selection into unions by using individual fixed effects and by measuring workplace union density as leave-out mean, we cannot rule out the possibility of idiosyncratic shocks influencing both participation in further education, wages or turnover, *and* union density at the workplace level. To reduce this potential issue, we include linear industry trends to absorb productivity shocks common to all workplaces within industries. Moreover, we include certified sickness absenteeism at the workplace level as a proxy for idiosyncratic productivity shocks.

6 Results

In this section, we present the results of the analyses of how unions influence participation in further education, the distribution of wages and employee turnover.

6.1 Participation in further education

The results from estimating a linear probability model (LPM) of how unions influence the individual's propensity to participate in tertiary vocational education are shown in *Table 1*. Using the OLS-estimator in *Models 1a-1d*, we find a positive relationship between workplace union density and the individual propensity to participate in tertiary vocational education. The correlation drops but remains statistically significant when we include individual fixed effects to control for unobserved heterogeneity in *Model 1e*. The estimated coefficient should be interpreted as percentage point change in individual participation in tertiary vocational education if the workplace union density increases from 0 to 1. If we compare the coefficient with the average participation rate in further education, which is equal to 1.2 percent, an increase in the workplace union density by ten percentage points is estimated to increase the participation rate by 2.2 percent.

In Table 2, we measure union density as leave-out mean in all models to mitigate the potential issue of time-varying endogenous selection into unions. When we compare the results in *Model 2a* and *Model 1e*, we see that the estimated coefficient on union density remains almost unchanged. In other words, the estimated effect does not appear to be a result of individual selection into union memberships.

Table 1 The effect of workplace union density on the individual propensity to participate in tertiary vocational education

	Model 1a	***Model 1b***	***Model 1c***	***Model 1d***	***Model 1e***
Estimator	OLS	OLS	OLS	OLS	FE
Union density	0.0054***	0.0025***	0.0048***	0.0082***	0.0025***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0004)
Year dummies		✓	✓	✓	✓
Industry fixed effects			✓	✓	✓
Sex and age				✓	
Individual fixed effects					✓
No. of individuals	851,881	851,881	851,881	851,881	847,025
Avg. obs. per individual	8.7	8.7	8.7	8.7	8.8
Total observations	7,445,676	7,445,676	7,445,676	7,445,676	7,445,649

*Note: Union density is a continuous variable ranging from 0 to 1 that measures the share of unionized workers at the workplace. Models 1a-1c are estimated using pooled ordinary least squares, exploiting variation across both time and between individuals. Models 1d-1e are estimated using the within estimator to control for individual unobserved heterogeneity. Industry fixed effects are included as dummy variables at the 2-digit NACE level. Robust standard errors in in parentheses. * p<0.05, ** p<0.01, *** p<0.001*

The rest of the models presented in Table 2 put various restrictions on the model to test the robustness of the coefficient on union density. To ease interpretation, we have calculated the estimated marginal effect of a ten-percentage point increase in union density when evaluated at the average participation rates under each restriction. In *Model 2b*, we restrict the sample to individuals employed in establishments with at least 10 employees. Next, to control for entry and exit from the labor market, we further restrict the sample to individuals who are employed in full-time positions throughout our period of analysis in *Model 2c*. In *Models 2d and 2e*, we then restrict our attention to males and individuals employed in private sector, respectively. In *Model 2f,* we only consider workers who received their diploma from secondary vocational education in the year 2000 or earlier, in order to exclude potential effects of onboarding of newly certified workers. To control for individuals who's education is related to entry or exit of a firm, we restrict the sample to workers who are currently employed in the same firm as they were both in the previous and in the consecutive year in *Model 2g*, labeled as 'stayers'. In *Model 2h*, we include the number of working days lost due to sickness absence per employee as a proxy for idiosyncratic productivity shocks at the workplace level. Finally, we include industry-by-time interactions in *Models 2h* to absorb productivity shocks common to all workplaces within the same industry.

Overall, the estimated effect of workplace union density on individual participation in further education proves to be robust to the various specifications and restrictions. A ten percentage points increase in union density is estimated to increase participation rates by 2-5 percent. Table A3 in the Appendix reports further results showing that the estimated coefficient is robust to the inclusion

of individual union status to proxy individual productivity differences,[19] as well as an interaction term between union membership and workplace union density. Table A3 also includes two models where union density is entered as five splines (0-0.2, 0.2-0.4, etc.) to capture possible nonlinearities, but there are no clear signs of threshold effects.[20]

Table 2 The effect of union density, measured as leave-out mean, on the individual propensity to participate in tertiary vocational education under various restrictions

	Model 2a	***Model 2b***	***Model 2c***	***Model 2d***	***Model 2e***	***Model 2f***	***Model 2g***	***Model 2h***	***Model 2i***
Union density	0.0026***	0.0030***	0.0022***	0.0024***	0.0023**	0.0025***	0.0030***	0.0031***	0.0042***
	(0.0004)	(0.0005)	(0.0007)	(0.0006)	(0.0006)	(0.0004)	(0.0007)	(0.0007)	(0.0007)
Sick absenteeism								✓	
Industry trends									✓
Min. 10 empl.		✓	✓	✓	✓	✓	✓	✓	✓
Present all years			✓						
Male workers				✓					
Private sector					✓				
Certified pre-2000						✓			
Stayers							✓	✓	✓
Avg. part. Rate	1.2 %	1.3 %	0.5 %	1.3 %	1.3 %	0.5 %	1.0 %	1.0 %	1.0 %
Partial effect at avg.	2.2 %	2.4 %	4.2 %	1.8 %	1.8 %	5.4 %	3.1 %	3.1 %	4.3 %
No. of individuals	827,592	740,928	121,796	448,591	506,641	358,078	499,733	499,733	499,733
Avg. obs. per ind.	8.6	7.8	16	9.3	8.9	10.9	7.2	7.2	7.2
Total observations	7,129,995	5,751,520	1,948,731	4,162,764	4,521,542	3,889,178	3,596,081	3,596,081	3,596,081

*Note: All models are estimated using the fixed effects estimator and include year dummies, industry fixed effects (at the 2-digit NACE level) and individual fixed effects. Union density is a continuous variable ranging from 0 to 1 that measures the share of unionized workers at the workplace, measured as leave-out mean. 'Certified pre-2000' denotes workers who received their diploma from secondary vocational education in the year 2000 or earlier. 'Sick absenteeism' is a variable measuring the number of days of absenteeism due to sickness per employee at the workplace. 'Industry trends' comprises a set of industry-time-dummies. The table report average participation rates in tertiary vocational education for each sub-sample, as well as estimated partial effects of a ten percentage points increase in union density. Robust standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001*

6.2 Returns to further education

The above results suggest a positive effect of workplace unionization on the individual's propensity to attend further education at tertiary vocational schools. This effect may be explained by financial incentives included in collective agreements. As indicated by the conceptual model in Section 2, however, higher participation rates in unionized firms could also be the result of firms optimally sponsoring the education of their workers. This hypothesis is investigated by estimating how workers' wages vary with further educational attainment and union density.

[19] For example, previous studies suggest a positive correlation between individual union membership and certified sickness absence (Mastekaasa, 2013).

[20] The results are also robust when measuring participation in further education as a continuous variable equal to the number of courses the individual participates in each year (results available upon request)

The results of estimating equation (9) are shown in Table 3, where all models are estimated using individual fixed effects, industry fixed effects, year dummies and controls for age and age squared. Participation in further education is captured by E_{it}, where the base level $E_{it} = 0$ means the individual has never participated in tertiary vocational education.

Table 3 The effect of unionization on the wage returns of further education

	Model 3a	***Model 3b***	***Model 3c***	***Model 3d***	***Model 3e***	***Model 3f***
$UD_{it} \geq 0.5$	0.0780 ***	0.0190 ***	0.0150 ***	0.0000	0.0000	0.0001
	(0.0008)	(0.0006)	(0.0008)	(0.0006)	(0.0006)	(0.0006)
$E_{it} = 1$	- 0.1794 ***	- 0.1755 ***	- 0.1409 ***	- 0.0592 ***	- 0.0592 ***	- 0.0598 ***
	(0.0056)	(0.0046)	(0.0092)	(0.0004)	(0.0004)	(0.0044)
$E_{it} = 2$	0.1551 ***	0.1361 ***	0.0932 ***	0.0820 ***	0.0819 ***	0.0798 ***
	(0.0045)	(0.0039)	(0.0065)	(0.0043)	(0.0043)	(0.0043)
$E_{it} = 1 \times UD_{it} \geq 0.5$	0.0875 ***	0.0696 ***	0.0669 ***	0.0285 ***	0.0286 ***	0.0264 ***
	(0.0056)	(0.0052)	(0.0100)	(0.0051)	(0.0051)	(0.0051)
$E_{it} = 2 \times UD_{it} \geq 0.5$	- 0.0080 *	- 0.0048	- 0.0197 ***	- 0.0148 ***	- 0.0146 ***	- 0.0139 ***
	(0.0047)	(0.0040)	(0.0066)	(0.0045)	(0.0045)	(0.0045)
Sick absenteeism					✓	✓
Industry trends						✓
Min. 10 employees		✓	✓	✓	✓	✓
Certified pre-2000			✓			
Stayers				✓	✓	✓
No. of individuals	838,656	740,191	408,470	584,536	584,536	584,536
Avg. obs. per ind.	8.7	7.8	9.5	6.2	6.2	6.2
Total observations	7,309,459	5,747,001	3,887,782	3,598,622	3,598,622	3,598,622

*Note: All models are estimated using the fixed effects estimator and controls for sex, age and age squared, year dummies, industry fixed effects (at the 2-digit NACE level) and individual fixed effects. Union density is a continuous variable ranging from 0 to 1 that measures the share of unionized workers at the workplace, measured as leave-out mean. E_{it} denotes a categorical variable equal to 0 if the individual has no further education, 1 if the individual is currently participating in further education, and 2 if the individual has finished further education. 'Sick absenteeism' is a variable measuring the number of days of absenteeism due to sickness per employee at the workplace. 'Industry trends' comprises a set of industry-time-dummies. Robust standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01.*

In *Model 3a*, we see that workers employed in unionized firms, proxied by a union density amounting to at least 50 percent of the employees, on average are paid 7.8 percent higher annual wages. In non-unionized firms, participation in further education is estimated to lower annual earnings by 17.9 percent during the studies, while paying a wage premium of 15.5 percent when the education is completed. In unionized firms, the wage loss during studies is significantly lower, while the return to further education is somewhat smaller. Recall that all individuals included are full-time vocational workers. Absence during studies thus reflects educational leaves, and not that workers reduce their position in the firm. A smaller wage loss during education indicates that unionized firms sponsor further education to a larger extent than non-unionized firms. Importantly, this does not necessarily imply that this is the optimal choice of the firm. It could also be regulated in collective agreements. However, the results also indicate that unions compress the structure of

wages, thereby reducing the returns to further education. Together, these findings are consistent with the prediction of the theory model that wage compression increases the firm's incentive to sponsor further education if labor markets are imperfect. The results in *Models 3b-3f* largely show that this story is robust to various restrictions on the estimation sample.

6.3 Turnover

Estimations of the relationship between employee turnover and unionization is shown in Table 4. The results show a significant negative correlation between cumulative turnover rates and workplace union density in the years following completion of tertiary vocational education. The negative correlation becomes stronger when we restrict the sample to workers employed in establishments with at least ten employees in *Model 4b* and does not change much when we add further restrictions. Combined with the finding in the previous section that unions seem to lower the return on further education, lower turnover rates may give unionized firms higher incentives to sponsor further education.

Table 4 The effect of unions on cumulative employee turnover rates in the years following completion of tertiary vocational education

	Model 4a	***Model 4b***	***Model 4c***	***Model 4d***	***Model 4e***
Union density	-0.0905***	-0.1408***	-0.1455***	-0.1412***	-0.1334***
	(0.0168)	(0.0223)	(0.0408)	(0.0223)	(0.0223)
Sick absenteeism				✓	✓
Industry trends					✓
Min. 10 empl.		✓	✓	✓	✓
Certified pre-2000			✓		
No. of individuals	19,663	17,979	5,157	17,979	17,979
Avg. obs. per ind.	4.2	3.9	4.6	3.9	3.9
Total observations	81,852	70,792	23,559	70,792	70,792

*Note: The endogenous variable is cumulative turnover rate in the years following completion of further education at tertiary vocational schools. All models are estimated using the fixed effects estimator and include controls for sex, age and age squared, year dummies, industry fixed effects (at the 2-digit NACE level) and individual fixed effects. Union density is a continuous variable ranging from 0 to 1 that measures the share of unionized workers at the workplace, measured as leave-out mean. 'Certified pre-2000' denotes workers who received their diploma from secondary vocational education in the year 2000 or earlier. 'Sick absenteeism' is a variable measuring the number of days of absenteeism due to sickness per employee at the workplace. 'Industry trends' comprises a set of industry-time-dummies. Robust standard errors in parentheses. *** p<0.001*

7 Conclusion

In this paper, I have investigated how trade unions influence workers' participation in further education, as measured by participation in courses at tertiary vocational schools. Using a panel of matched employer-employee data comprising all Norwegian working individuals in the period 2004-2019, I have estimated how the individual propensity to participate in further education is

influenced by workplace union density. Focusing on full-time employees with an educational attainment at the secondary level, I have found that a ten percentage points increase in workplace union density is estimated to increase the individual propensity to participate in further education by about 2-5 percent. The results prove robust to a wide range of specifications and sample restrictions. These results are also comparable to previous findings in other countries. For example, Booth et al. (2003) find that union covered workers in the UK are 5 percent more likely to receive training than non-covered.

In Norway, most trade unions provide grants and financial support to members who participate in further education. While employers are required by law to provide workers with educational leaves, unions may further promote lifelong learning through collective agreements, which states that both employers and employees are equally responsible for investments in required skills and training. To some extent, the agreements also place the responsibility of funding educational leaves and associated costs on the employer. As the coverage of collective agreement increases monotonically in union density, the estimated effect could reflect the implementation of collective agreements. I do not find evidence of threshold effects when testing for nonlinearities. This could indicate that it is the strength of the union that matters, and not merely the presence of a collective agreement.

The interpretation of the results as causal effects rests on an identifying assumption of no endogenous selection into unionized firms of workers who intent to participate in further education. I largely mitigate this issue by including fixed effects to control for unobserved individual heterogeneity, and by constructing a measure of workplace union density invariant to changes in individual union memberships. However, I cannot rule out the possibility that the estimator is biased by idiosyncratic shocks influencing both participation rates and workplace union density. Future studies should investigate this potential issue further.

As most education is free of charge in Norway, the largest cost of further education is the loss of income due to absence from work. I find that annual wages during education is reduced by less in unionized establishments than in non-unionized establishments. This may explain why participation rates are higher in unionized establishments. If firms possess monopsony power in the labor market, they may optimally choose to sponsor further education if union wage compression lowers the return on further education. I find evidence of slightly lower returns to

further education and significantly lower turnover among employees in unionized establishments. These results are consistent with a causal interpretation that unions promote further education.

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Data Availability Statement

The data that support the findings of this study are provided by Statistics Norway through the online application microdata.no, which is available to all researchers at approved research institutions in Norway free of charge. Scripts for reproduction are available upon request.

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Appendix

A1 The Norwegian education system

As illustrated in Figure A1, the Norwegian school system consists of a primary, secondary, and tertiary level.[21] All children and youth have a statutory right and obligation to complete primary and lower-secondary education. Furthermore, everyone who completes the lower-secondary level are entitled to education at the upper-secondary level, but not required to participate. Starting from upper-secondary education, the schooling system is divided into two tracks – a general studies program qualifying for higher education at colleges or universities, and a vocational program leading to a craft certificate and qualification for tertiary vocational education. Students choosing the vocational track can also take an extra year of schooling to qualify for higher education. Higher education at colleges and universities is divided into courses at the bachelor, master, and PhD level, while tertiary vocational education mostly comprises vocationally oriented courses of varying length. The Government is the main provider of education at all levels, which is offered free of charge. Private schools mostly operate at the tertiary level.

In Figure A2, we have illustrated the development of educational attainment of the Norwegian population. Children begin at primary school the year they turn 6 and finish lower secondary school the year they turn 16. Upper secondary school has a length of 3-4 years, while bachelor's and master's degrees have expected lengths of 3 and 5 years, respectively. In other words, regular students finish their initial educational track when aged 19-25 years. However, educational breaks are common due to military service, stays at boarding schools or breaks to attain work experience, implying that many students may be several years older when finishing their final education. In order to concentrate on working individuals finished with their initial education, we thus restrict the sample in the figure to individuals aged 30-66 years. The figure clearly illustrates a trend of massive investments in skills. In 1980, the share of working individuals holding a bachelor's or master's degree or a PhD was 13 percent, whereas the same share amounted to 43 percent in 2020.

[21] For more information, see the Norwegian Agency for Quality Assurance in Education for more details on the Norwegian education system https://www.nokut.no/en/norwegian-education/general-information-about-education-in-norway/

The share of workers with primary or lower secondary education as highest attainment level has consequently been steadily declining. While the share of workers with educational attainment at the upper secondary level has also been declining, this trend is less pronounced. However, these numbers camouflage a growing trend of workers participating in tertiary vocational education. During the last decade, the number of students in tertiary vocational education has doubled (Statistics Norway, 2021).

Figure A1 The Norwegian school system

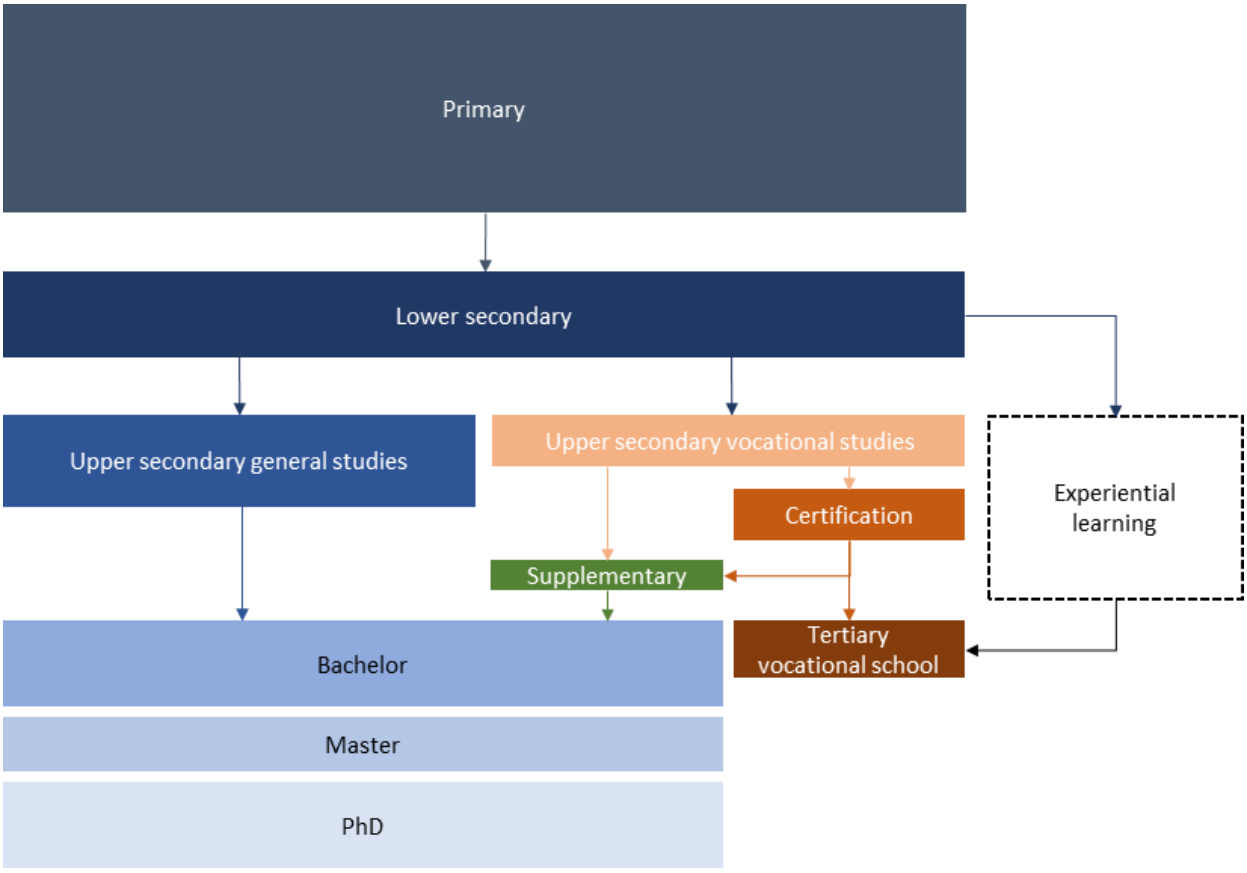
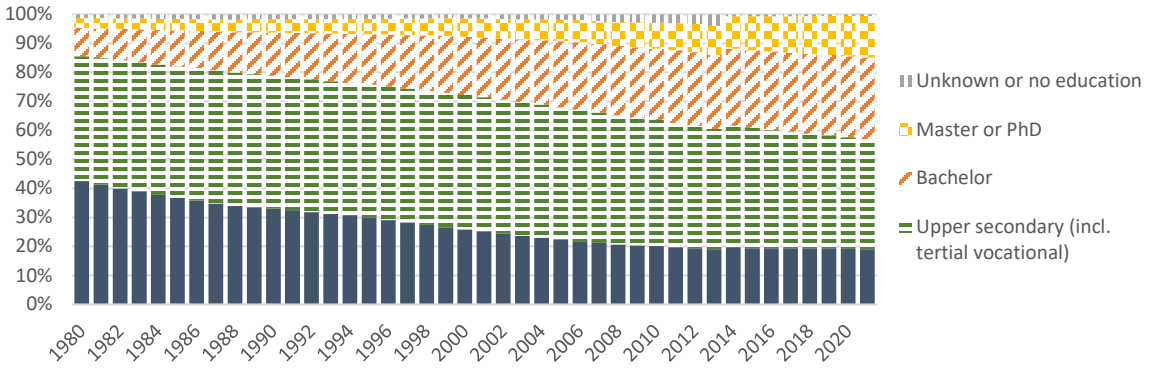


Figure A2 Educational attainment among Norwegian males and females. 30-66 years.1980-2020.



Note: Upper secondary education includes tertiary vocational education. Attainment levels for immigrants with unknown educational background are estimated values from 2014 and onwards, causing a statistical break in 2014. Source: Statistics Norway, Educational attainment of the population, Table 08921.

A2 Descriptive statistics

Table A1 Descriptive statistics

Variable	Mean	Std. dev.	N	1 %	25 %	50 %	75 %	99 %
Male	72 %	0.45	7,507,939	0	0	1	1	1
Age	41	11	7,507,939	21	33	41	50	64
Annual wage	478,970	209,156	7,309,753	35,400	349,000	445,000	571,000	1,250,000
Union member	50.6 %	0.500	7,507,939	0	0	1	1	1
Union density	47.5 %	0.344	7,445,646	0	0.111	0.525	0.798	1
Participation rate	1.2 %	0.107	7,507,939	0	0	0	0	1
Length of studies	2.8	1.4	86,370	1	2	3	4	7
Number of courses	3.0	1.7	86,370	1	2	3	4	8
Courses per year	1.1	0.2	86,370	1	1	1	1	2

Note: 'Participation rate' measures the share of workers participating in one or more courses taught at a tertiary vocational school in a given year. 'Length of studies' denotes the number of years under further education. 'Number of courses' measures the total number of courses the individual participates in, while 'Courses per year' measures the number of courses the individual participates in each year during the education. The last three variables are only defined for individuals while participating in further education.

A3 Supplementary estimation results

Table A2 The effect of union density on the individual propensity to participate in tertiary vocational education estimated on various samples

	Model 2a	***Model 2b***	***Model A2a***	***Model A2b***	***Model A2c***	***Model A2d***
Union density	0.0026***	0.0030***	0.0020***	0.0024***	0.0013***	0.0016***
	(0.0004)	(0.0005)	(0.0003)	(0.0004)	(0.0001)	(0.0002)
Min. 10 empl.		✓		✓		✓
Sample	Preferred	Preferred	Extended	Extended	Full	Full
No. of individuals	827,592	740,928	1,009,826	916,313	3,172,324	2,856,585
Avg. obs. per ind.	8.6	7.8	9.1	8.2	8.4	7.7
Total observations	7,129,995	5,751,520	9,160,112	7,517,330	26,529,884	21,961,613

*Note: All models are estimated using the fixed effects estimator and include year dummies, industry fixed effects (at the 2-digit NACE level) and individual fixed effects. Union density is a continuous variable ranging from 0 to 1 that measures the share of unionized workers at the workplace, measured as leave-out mean. Models 2a and 2b are estimated using our preferred sample, as in Table 2. In Models A2a and A2b, the sample includes vocational workers who also hold an academic degree. Models A2c and A2d are estimated using the full sample including workers without vocational training. Robust standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001*

Table A3 The effect of union density, measured as leave-out mean, on the propensity of full-time workers to participate in tertiary vocational education under various restrictions

	Model A3a	***Model A3b***	***Model A3c***	***Model A3d***
Union density (UD)	0.0026***	0.0025***		
	(0.0007)	(0.0010)		
- $0.2 \leq UD < 0.4$			0.0003	0.0002
			(0.0003)	(0.0003)
- $0.4 \leq UD < 0.6$			0.0010***	0.0008**
			(0.0003)	(0.0004)
- $0.6 \leq UD < 0.8$			0.0015**	0.0012***
			(0.0004)	(0.0004)
- $0.8 \leq UD \leq 1$			0.0019***	0.0015***
			(0.0005)	(0.0005)
Union member (U)	0.0009**	0.0008		0.0009**
	(0.0004)	(0.0006)		(0.0004)
UD x U		0.0001		
		(0.0011)		
No. of individuals	584,752	584,752	584,752	584,752
Avg. obs. per ind.	6.2	6.2	6.2	6.2
Total observations	3,600,013	3,600,013	3,600,013	3,600,013

*Note: All models are estimated using the fixed effects estimator and include year dummies, industry fixed effects and individual fixed effects. The sample includes certified workers employed in establishments with at least ten employees, who are currently employed in the same firm as they were both in the previous and in the consecutive year. Union density is a continuous variable ranging from 0 to 1 that measures the share of unionized workers at the workplace, measured as leave-out mean. Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.*