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The impact of training on labour productivity in the European utilities sector: an empirical analysis

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1. Introduction

The centrality of knowledge is a widely acknowledged paradigm in economic and management literature (Spender 1996; Foray, 2004). In the current landscape, where creativity, flexibility and innovation are crucial factors of a firm's competitiveness, business success relies on intellectual capital, accumulated through education, training and R&D activities, together with physical and financial capital (Howitt and Aghion, 1998; Haskel and Westlake 2018).

The systematic development of knowledge enhances the capability of firms to innovate by successfully understanding market changes, addressing investments and improving relations with external stakeholders. Firms support knowledge management through a proper internal organisation (Antonelli and Pegoretti 2008), which is expected to explore and exploit the knowledge-based resources of the firm (Nonaka and Takeuchi, 1995).

Firm-sponsored training has a central role in the internal organization of knowledge (Kianto et al., 2017). It improves workers' skills, enabling them to undertake more complex tasks or complete old tasks better or faster. It is thus expected to enhance employees' productivity by creating new skills and advancing existing ones. Several empirical studies confirm the positive effects of training on firms' labour productivity (e.g., Almeida and Carneiro, 2009). However, training effects are different according to the related industry (Koning and Vanormelingen, 2015). In particular, each sector is characterized by different technological trajectories that affect skills requirements and the consequent potential shortages in the labour market with the heterogeneous impact of training investments on firms' productivity. Accordingly, skill requirements and training effects may substantially differ across industries, while they show common features within the same industry.

In recent years, training has become increasingly important in the utilities sector. New technological developments, such as the increasing diffusion of big data tools and Artificial Intelligence technologies, have dramatically reshaped the relationship between humans and machines and redefined the required tasks and skills (e.g., Ahmad et al., 2016, Ponce Romero et al., 2017, Huang and Rust, 2018). At the same time, the impact of broad regulatory reforms has substantially changed the responsibilities that utilities have to fulfill (Worch et al., 2013). These changes require "not only technical replacements but also a new way of working, training staff, developing and using the knowledge required" (Arends and Hendriks, 2014, p. 1), thus emphasizing the critical role of training, and more generally of human capital development practices within the utilities sector. Moreover, utilities show a high propensity to adopt socially sustainable behaviors, which encompass promoting a firm's investment in workforce human capital (Arena et al., 2019). Although these peculiarities justify research on the role of training in the utilities sector, to the best of our knowledge, there are no recent studies connecting training and productivity in this sector.

According to these premises, this paper aims to empirically explore, through an economics approach, the relationship between firm training and productivity in the European utilities sector. To achieve this purpose, it employs data from balance sheets and sustainability reports of a panel of European utilities providing new insights about their attitude about firm training and on the (lagged) effect of training on labour productivity.

Grounding on a model based on the human capital theory where training affects labour quality and, therefore, productivity, this work offers empirical evidence of the effectiveness of training in this specific industry, which has been insofar partially neglected by the literature on this topic. The use of firm-level data, for the first time in the industry among economic studies[1], enables capturing the effects of training more precisely than individual or household data. Moreover, such analysis controls for the endogeneity of training by estimating a lagged production function. The chosen period is the one of the 2008-2010 crisis to stick to the hypothesis that firms emphasizing innovation and exploration of new opportunities engage more in training activities in periods of low demand conditions when the opportunity cost of training is lower (Knudsen and Lien, 2015; Mason and Bishop, 2015). During a partially overlapping period, i.e., between the end of the 2000s and the beginning of the 2010s, major technological and organizational changes affected the European utilities sector, although such changes were uncorrelated with the recession.

By testing the effectiveness of training investments in the utilities sector, this paper strengthens the streams of research that emphasize the role of training investments in imperfectly competitive markets and during severe recessions in a twofold way. First, it provides evidence of the positive relationship between training and productivity within the utilities sector, highlighting that training is a fundamental driver of the complementarity between sustainability and competitiveness. Second, it

[1] Managerial studies usually rely on firm-level data to analyse the role of training to stimulate organizational performance, but they use other methodologies.

stresses the importance of training investments during long-lasting recessions and in the presence of structural changes, thus suggesting that companies should keep training investments high when demand shrinks, like during the COVID-19 pandemic, and after technological breakthroughs, such as digitalization. Results also allow us to derive practical implications for both the industry and the policymaker.

The format of the paper is as follows. Section 2 carries on a review of the theoretical and empirical literature. Section 3 contextualizes the empirical analysis with respect to the utilities sector. Section 4 describes the model. Section 5 presents the dataset and the descriptive statistics. Section 7 shows the results of the regression. Section 8 discusses them. Section 9 features concluding remarks.

2. Literature review

Current thinking on training is shaped by the seminal work of Mincer (1958) and Becker (1964). Moving from a neoclassical approach, they define the firm's endowment of skills and knowledge, i.e., the human capital, as one of the main production factors. Assuming perfect competition, the basic model equals marginal productivity and wages and draws a crucial distinction between general and specific training. General training raises worker productivity in both training firms and outside firms; therefore, it is characterized by the portability of its benefits. The implication is that firms are expected to bear only specific training investments and can capture all the relevant benefits without financing general training.

However, further developments in human capital theory have shown that firms are also interested in investing in general training (Rosen, 1976), analysed from two approaches. A first approach focuses on imperfections in the skilled workers' labour market (Katz and Ziderman, 1990). These imperfections compress the wage structure and create a wedge between increases in wages and increases in labour productivity (Chang and Wang, 1995; Acemoglu and Pischke, 1999). As a result, since general training is supposed to have a higher impact on labour productivity than on wages, firms can pay for general training and accept sharing the benefits with the workers (Stevens, 1994). Moreover, under the hypothesis of imperfect labour markets, labour productivity is usually considered the best performance variable related to training. A second approach acknowledges that some kind of complementarity between general and specific training may occur due either to complementarities among productive inputs (Acemoglu, 1997) or the training process (Franz and Soskice, 1995). In this view, complementary investments in general training generate a larger increase in productivity and better economic performance (Barrett and O'Connell, 2001) than separate investments in specific training. In both frameworks, skills and competencies complement other inputs, such as physical capital and technology. Accordingly, the expected effect of training investments is not limited to individual productivity but spreads to the organization thanks to this broad complementarity among production inputs. Table A.1 in the Appendix summarizes the theoretical implications of these two approaches.

As far as the empirical literature is concerned, Dearden et al.'s (2006) contribution is the seminal one for this study. Starting from relatively large panel-type data, the authors measured a statistically significant impact of training on productivity, and to a lesser extent, on wages. In particular, the authors found an increase of 4% percent of the value added against an increase of 5% in the proportion of trained workers. Similar results are achieved by Almeida and Carneiro (2009), who report a positive effect of training on the firm's value added per employee and a positive rate of return of training investments among large Portuguese firms, and Sepulveda (2010), who finds evidence of a positive but decreasing effect of on-the-job training on productivity growth in US manufacturing industries. More recently, Colombo and Stanca (2014) found that training has a positive and significant impact on the productivity of Italian medium and large firms, while Koning and Vanormelingen (2015) robustly confirmed the existence of a wedge between wages and productivity and thus that employees and employers share benefits from training as predicted by the theory of imperfect competition in labour markets. Unlike these results, Jones et al. (2012) find that training has a more robust effect on wages than on firm productivity within the Finnish banking industry. Finally, other recent studies reported positive effects of specific types of training on firms' productivity in developing countries (Rodríguez‐Moreno and Rochina‐Barrachina, 2019; Hussen, 2020) and tested the effectiveness of training investments devoted to specific categories of workers finding substantially higher returns among large firms (Feltrinelli et al., 2017).

Overall, although a positive correlation between training and productivity has been found by the majority of the above-mentioned economic studies, only two of them (Sepulveda et al., 2010; Jones et al., 2012) looked at specific industries and discussed their results according to the peculiarity of the investigated sectors, although firm heterogeneity justifies the limitation of the analysis to a specific sector (Ichniowsky et al., 1997). None of these studies assessed the effectiveness of training investments in the utilities sector based on its particular features (see Section 3). The scarceness of industry-based studies was explicitly pointed out by Koning and Vanormelingen (2015), who, after having found a noticeable heterogeneity between different sectors, called for further analyses focusing on specific industries characterised by oligopolistic and monopolistic markets.

In addition, the literature review highlights the presence of other four knowledge gaps in the current studies. First, they usually do not address the endogeneity issue related to training variables that productivity may affect. Secondly, they assume training variables as a measure of human capital stock, while they can be considered as a measure of flow. Third, they do not take into account the adoption of socially sustainable practices as a possible tool for promoting the firm's investment in workforce human capital (Brammer et al., 2007; Arrigo, 2020) and as a discriminating factor to make training more effective by increasing the workers' intrinsic motivation and stimulating their willingness to improve their skills (Sacconi, 2007; De Grip and Sauermann, 2013). Finally, none of the reviewed papers specifically analyzed the relationship between training investments and productivity during recessions, despite the expected correlation between demand shocks and firms' decisions to provide training to their workforce (Colombo and Stanca, 2014). While some studies support the view that training investments follow a pro-cyclical pattern as a consequence of cost pressures (Felstead, 2018) and lower number of new hires (Majumdar, 2007), according to others these factors are more than offset by the reduction of the opportunity costs of providing training and the incentives to train generated by intensified competition (Green et al., 2016), particularly in fast-changing conditions (Felstead and Green 1996; Mason and Bishop, 2015). Moreover, if voluntary quit rates fall in times of recession, employers are more protected from the so-called "poaching" externalities arising from the likelihood that trained workers move to other firms after the training period (Stevens, 1996). All else being equal, these conditions may increase both the perceived cost-effectiveness of training during recessions and the perceived skill requirements needed to compete in rapidly evolving product markets.

Further open issues concern the size of the return of training on firm's productivity, as evidenced by the different beliefs of the managers as to its effectiveness (Collier et al., 2007) and the emergence of new themes, such as population aging and digitalization, that may cause substantial changes on firm-sponsored training and training policies as well as on their impact on productivity (Brunello and Wruuck, 2020). With regard to the choice of training variables, the empirical literature is far from being homogeneous and conclusive. Most common proxies are the hours/days of training per capita (Bishop, 1994; Kidder and Rouiller, 1997; Schonewille, 2001), the number (or the proportion) of trained employees (Black and Lynch, 2001; Barrett and O'Connell, 2001; Ichniowsky et al., 1997), training costs (D'Arcimoles, 1997), the content of the training activity (Barrett and O'Connell, 2001; Bartel, 2000), the decision to activate training within the company as a dummy variable (Delaney and Huselid, 1996).

3. The European utilities sector

The utilities sector represents an interesting field of analysis of the relationship between training and productivity. The regulated and imperfectly competitive structure of the market that still characterizes this industry in Europe (e.g., Massarutto, 2020; Peng and Poudineh, 2019) implies the presence of an oligopsonistic power in the labour market for specific job profiles (Ashenfelter et al., 2010), and therefore a wedge between marginal productivity and salaries (see Table A.1), which is expected to favour the investments in firm-sponsored training. However, the imperfectly competitive structure of the industry does not protect utilities from recessions. Demand-side shocks, such as the one suffered by the sector between 2008 and 2009 (Peritz et al., 2021), may determine a rise in the firms' levels of (unplanned) excess of capacity, which may create tensions in the market as companies seek to preserve their market share and profitability (Branston et al., 2014). As a consequence, recessions may have an impact on the level of firm-sponsored training too.

In parallel, major innovations (e.g., smart meters, smart grids, smart bin, etc.) created the need to build specific capabilities to address the needs of a wide range of customers that switched to environmentally-friendly products (Worch et al., 2013). These changes emphasized the necessity to implement new training programs for adult workers (Graf and Jacobsen, 2021) and accentuated the need for a major re-skilling of middle-aged workers to mitigate the risk of a negative impact of aging on productivity (Skold et al., 2018; Calvo-Sotomayor et al., 2019). Another relevant change dealt with the spread of the multi-utility model, which has led public utilities to manage a complex bundle of services in heterogeneous geographic markets and participate in increasingly active and adaptive networks (Jacobsson and Bergek, 2004).

Overall, these techno-organizational innovations have created new jobs requiring different skills (so-called green jobs), most of which are based on the combination of practical experience, codified knowledge, and soft skills across technical and managerial disciplines and functions (CEDEFOP, 2009). Moreover, public utilities increasingly employ a high rate of knowledge workers whose abilities and skills are grounded on the heuristic application of a core basis of theoretical knowledge (Antonelli et al., 2013). Such evolution of the sector also presents inherent challenges for the work organization of these companies. Indeed, many of them still have to cope with various sources of inefficiency that has traditionally characterized many utilities: bureaucratic structures (Roeger and Tavares, 2020), excessive unionization (Fortin et al., 2021), poor incentives for individual improvement (Arcos-Vargas et al., 2017), low functional flexibility induced by job guarantees (Burgoon and Raess, 2007), presence of cronyism (Martins, 2020).

Further drivers of firm-sponsored training in the utilities sector are not new but still exist. The fact that corporations are relatively large is positively related to training output. As shown by the literature, economies of scale are usually in place in this sector, in particular in the water (Carvalho et al., 2012) and electricity industry (Filippini, 1996; Kwoka, 2005), as well as among multi-utilities (Farsi et al., 2012), while the association between training intensity and firm performance is usually stronger in large firms (Jones et al., 2009). The specific nature of the tasks performed in these corporations, combined with their belonging to a regulated industry (Castanias and Elfat, 2001), implies a high demand for industry-specific skills that are likely to be internally developed by the corporate training system. In addition, public utilities are asked to meet the expectations of different groups of stakeholders typically associated with diverging interests (Arena et al., 2019, Salvioni and Gennari, 2019). This development implies a segmentation of training needs for firms operating in different geographical markets and the partial involvement of these subjects in all training activities related to sustainability issues. Final users must be "educated" to increase their environmental awareness about these services and adopt consistent behaviour in their daily lives. These features are in line with an extensive literature providing a robust theoretical framework underpinning the utilities' adherence to sustainability principles (Arena et al., 2019). Furthermore, the combination of these features supports the firms' propensity to adopt "sustainable" business strategies and comply with the associated reporting guidelines as well as to commit themselves to invest more in general training as a specific duty connected to such guidelines. It has been shown that adherence to sustainability reporting standards is positively related to prioritising training investments (Ioannou and Serafeim, 2017). Socially sustainable firms are deemed to attract motivated workers (Brekke and Nyborg 2004), thus getting higher benefits from training investments, while workers' loyalty decreases the probability that a worker quits the firm at the end of the upskilling process. The adoption of environmentally-sustainable attitudes, on the other hand, can prompt the workforce itself to ask for skill improvement and to more actively participate in firm-sponsored training activities (Huang et al., 2016) while enhancing the workers' sense of business ethics, engagement, and responsibility (Ji et al., 2012). Commitment to sustainability may also support the improvement of specific HRM practices such as workforce recruitment and knowledge management (Sanchez and Benito-Hernandez, 2015). All these aspects could lead to the expectation of higher returns to training investments in sustainable utilities. Previous evidence in this regard has shown that utilities reported more concern for codes of ethics and the health and safety of their employees (Amor- Esteban et al., 2018). Such tendency has been recently reinforced by Post-New Public Management approaches (Casady et al., 2020), which have induced public authorities to include environmental and social impact among the evaluation criteria of the activity of public utilities since they usually operate in regulated markets (Sidhoum and Serra, 2017).

A cross-industry analysis on training incidence and volumes also confirms these insights. According to the available data (EUROSTAT 2009), the "Production and distribution of electricity, water and gas" industries in the European Union report a large proportion of organizations providing training to their workers (78%), and assessing its impact (75%). Moreover, most of them regularly monitor the dynamics of skill demand, both in the short term (62%) and long term (55%). More importantly, training volumes (hours per employee) of the industry are the second-largest (15 hours per capita) after the financial intermediation sector (20 hours of training per employee).

< Figure 1 here >

4. The model

Traditionally, in economics, the performance of a firm or workplace is measured by its productivity. However, total productivity requires data that firms do not usually collect. In the absence of such a measure, it can be proxied by average labour productivity, given by the ratio between the firm's output and the number of workers.

Following a modelling strategy consolidated in literature (e.g., Konings and Vanormelingen, 2015), we assume a standard Cobb-Douglas production function as follows.

$$Q = AL^{\alpha} K^{\beta} \quad [1]$$

where Q measures the output, K the amount of capital, L the number of workers, A is an efficiency parameter reflecting the state of technology; α and β are numbers greater than zero, as is A. This function provides a convenient framework to analyze labour productivity, although its estimation is challenging as some inputs are chosen endogenously by the firm while others are not observable.

Then, following Bartel and O'Connell (2001), we assume that L is equal to the amount of effective labour employed (*Efflab*), reflecting the number of workers and the level of training received by the workforce.

$$Q = AK^{\beta} * Efflab^{\gamma} \quad [2]$$

In the relevant production function written in monetary terms, the output thus depends not only on the number of workers but also on their quality. This view is consistent with the human capital theory as it assumes that the workers' skills directly and positively affect their productivity. This model is also consistent with a theoretical framework based on complementarity between general and specific training and associated with imperfect competition, a typical market condition in the utilities sector.

$$Efflab = f(N, HC) \quad [3]$$

$$Efflab = \theta N(1 + \lambda HC) \quad [3']$$

Where f is linear, N is the number of workers, and HC is human capital; HC depends on education, training, and experience. The model assumes that training can benefit labour quality directly by equipping workers with more capabilities and indirectly by improving worker effort, reducing turnover, and fostering organisational innovation. Accordingly, the average labour productivity depends, among other factors, on the quality of labour, which is determined by the human capital of the workforce that, in turn, is a result of *training* and of other factors. Relying on this model, the empirical analysis tests the following research hypothesis: *firm-sponsored training investments positively impact the average labour productivity of firms operating in the utilities sector adhering to sustainability reporting guidelines*. This hypothesis is expected to be particularly valid in recessionary periods characterized by major technological and organizational changes.

5. Data and descriptive statistics

The empirical analysis focused on European utilities satisfying the following conditions: (i) they primarily operate in one of the industries identified by the statistical classification of economic activities in the European Community (NACE classification) with codes 351 (electric power generation, transmission and distribution), 352 (Manufacture of gas; distribution of gaseous fuels through mains), and 360 (Water collection, treatment and supply); (ii) they have a staff of more than 250 employees; (iii) they were active between 2008 and 2010. The choice of joining these industries together is justified because they possess the specific characteristics identified in Section 3. Moreover, they are usually grouped in sector-based analyses dealing with the same topic (Dearden, 2006) and represent the core business of most multi-utilities companies (Farsi and Filippini, 2009). We also considered only large firms as they usually have an in-house training department and present a higher incidence of employees with training needs.

The data are a match of two sources of information. First, we acquired relevant data collected in the Amadeus database for each firm, which contains comparable financial information from the balance sheets of European public and private companies. The selected population was equal to 1530 firms. In line with the purposes of the paper, we took information on turnover, firm location, number of workers, and the book value of fixed assets, net of capital depreciation as a proxy of physical capital. The second source is represented by yearly Sustainability Reports of these firms in the period between 2008 and 2010. The selected sample thus includes all those socially responsible firms publishing quantitative data on their annual training activities (in terms of hours or days) and the age and tenure of their workforce. The final dataset is composed of 97 firms, most of which are active in the energy sector (65%) while the rest of them (35%) mainly operate as water utilities , observed for three years across 17 countries of the European Union, an area characterized by a high degree homogeneity of the regulatory framework and market structure of these industries (Jaag and Trinkner, 2011; Ruester et al., 2014; Roeger and Tavares, 2018).

Descriptive statistics (Table 1) show that the average size of the selected firm is quite large: the average number of employees is 12,583 while the average turnover is 5,699,264 (in K€). As far as training is concerned, each employee received on average 25 hours of training per year although the median is significantly lower, at 20 hours. Few firms provided a substantial level of training (up to 101 hours per year) while most of the sample ranges between 12 and 35 hours per year. Despite this heterogeneity, such figures are substantially higher than those reported by EUROSTAT for all firms with more than 250 employees and referred to 2010 (8.1 hours per employee per year). This descriptive evidence thus confirms the relative importance of firm-provided training for utility companies adhering to sustainability reporting guidelines. Descriptive statistics show that most of the selected firms were owned by either a local or a national government during the analysed period. The diffusion of these firms is a sign of the persistent presence of non-competitive markets in the industry.

Table 1 – Descriptive statistics

Variables	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Turnover (K€)	291	5,699,264	15,800,000	2,248	121,000,000
Employees	291	12,583	33,679	20	242,714
Av_labour_productivity (K€ per employee)	291	585.82	879.94	0	932.5
Training hours per employee	194	25.96762	19.41894	0.3	101
State-owned enterprise	291	0.54	0.50	0	1.00
Fixed_assets K€	244	8,452,606	24,700,000	370.00	180,000,000
Labour Cost per employee (K€)	179	59.51	23.84	15.23	134.18
National GDP per capita (€)	291	27,864.39	6,635.438	6200	67,330

6. The econometric strategy

By keeping in mind that labour productivity is the better-suited variable to be affected by training according to both the theoretical framework and the economic model, the elaboration of the econometric strategy should also acknowledge that the empirical estimation is affected by several disturbing elements.

First, the relationship between training and productivity may be affected by endogeneity. Not only can training enhance productivity, but it is also possible that the decision to activate training depends on low levels of individual productivity, as in the case of massive hiring of fresh workers. Second, it is necessary to distinguish between the stock of human capital and the training flow, i.e., the internal investment in human capital in a given period, considering that human capital is subject to decay (Zwick, 2006). Indeed, skills acquired in the past become less valuable as knowledge becomes outdated, while workers forget past learning. Moreover, average human capital depreciates as new workers with no experience and previous training are hired by firms while experienced and trained workers retire, taking specific knowledge with them. In light of this, we used the number of training hours per year per employee as the primary proxy of training investments[2] and apply three adjustments to the economic model (Equation [2]) to ensure the reliability of the econometric estimates. First, following Bishop (1994), we estimated the lagged impact of training investments on productivity to avoid possible reverse causality and excluded any confounding effect stemming from the fact that current training reduces working hours and may thus lower productivity. Second, we added two control variables: i) a demand-related variable identified by the GDP per capita of the country where the firm is located, ii) an organizational-related variable given by a dummy variable associated with the firm's ownership, which takes the value of 1 if the majority of the shares is owned by the State or by a local government, and 0 otherwise. Third, as an explanatory variable, we replicated the analysis using the stock of training hours per employee, as measured by the depreciated sum of training hours per employee.

Before going on to explain the linear regression, two additional assumptions need to be fixed:

1. Because of the constraint arising from the available data, we do not distinguish here between general and specific training, thus assuming that their impact on productivity is indifferent and that they complement each other in this respect (Acemoglu and Pischke, 1999).

[2] This choice is consistent with previous quantitative studies on the impact of training on productivity, as emerged from the literature review (e.g., Dearden et al,, 2006). The main alternative would be the share of trained workers but for the utilities sector this variable would not be meaningful because of the presence of mandatory training that makes this share almost equal to 100% in all firms. Training cost would also be an ambiguous variable since firms take into account different components in calculating such costs. This is especially true if the sample includes different countries. With regard to the number of hours per employee, on the contrary, the provision of mandatory training does not substantially bias the results because it determines a homogenous increase of the relevant figures across the entire sample.

2. The figure per capita refers to all employees, not only to the recipients of training activities.

One can now return to the production function, writing it in log-linear form, replacing (3) into (2), and dividing all the variables by the number of employees while assuming constant returns to scale.

$$lnQ = lnA + \beta lnK + \theta \ln \mathrm{N} + \theta\lambda lnNlnHC + \varepsilon \qquad [4]$$

$$\ln\left(\frac{Q}{N}\right) = ln\left(\frac{A}{N}\right) + \beta ln\left(\frac{K}{N}\right) + \theta\lambda \ln\left(\frac{HC}{N}\right) + \theta + \varepsilon \qquad [4']$$

where A represents a set of unobservable firm-specific characteristics, Q is the output, K is the physical capital stock, N is the workforce, and HC is the human capital measured by the yearly flow of firm-sponsored training, while ε is the stochastic error. The basic equation of the panel linear regression will thus have the following structure:

$$y_{it=}\beta_{0+}\beta_1 k_{it} + \beta_2 h_{it-1} + \beta_3 Zz_{it} + \beta_4 k_{it-1} + v_{it} \qquad [5]$$

$$v_{it} = c_i + u_{it} \qquad [5']$$

where *y* is (Q/N) expressed in monetary terms (i.e., turnover per employee), which proxies average labour productivity[3], used as the dependent variable, *k* is the book value of physical capital scaled by the amount per employee at the end of the period, *h* is given by training hours per employee per year in *t-1*, while *z* is a vector of observable firm characteristics: country (proxied by GDP per capita), multi-utility, and state-owned companies. Continuous variables were all entered in logarithmic form in line with equation [4]. Subscript *i* indicates the representative firm while *t* represents the year of interest in the 2008-2010 period. Finally, v_{it} is the sum of the unobserved effect (c_i) and the idiosyncratic error (u_{it}). The estimate was firstly performed through a Pooled OLS estimator, the baseline model, and then through a random effect estimator, after performing a Hausman test and accepting the null hypothesis that both the fixed and random effects are both consistent estimators (see Table A.2 in the Appendix). The use of a panel data model and the time-varying nature of the

[3] Despite its limitations, the use of turnover per employee as proxy of average labour productivity is highly common in the human capital literature (e.g., Black and Lynch, 2001; Barrett and O'Connell, 2001; Hussen, 2020) when data on physical output are unavailable, like in this paper. Another possible variable is the value added per worker (Colombo and Stanca, 2014), but Amadeus database does not report firm's value added for some observed company. An alternative solution would be to use a proxy of total factor productivity (TFP) like in Levinsohn and Petrin (2003), but it would go beyond the scope of this paper.

explanatory variable, together with the assumption of constant returns to scale, allows the estimate to factor in the possibility of substantial staff reductions throughout the analyzed period due to economic hardship.

Then, as robustness check, we replaced flow variables with stock variables and estimated the following cross-sectional equation:

$$y_{i=}\beta_{0+}\beta_1 H_i + \beta_2 K_i + \beta_3 Z_i + u_i \quad [6]$$

where H is the stock of human capital given by cumulating the relevant flows over three years (2008-2010) measured by the log of yearly training hours per employee and depreciated by 25% each year, K is the mean of the book value of physical capital measured at the beginning and end of 2010, and Z is the vector of the control variables measured in 2010. This estimation is similar to the one proposed by Ackerberg et al. (2007) to control for the endogeneity of input factors of a production function.

7. Results

In Table 2, we present the coefficients of the log-linear estimation of equation [5]. The first column reports the results of a Pooled OLS estimate with robust standard errors. The second column reports the coefficient of the same regression but with clustered standard errors at firm level. The third column shows the results of the random effect estimator. The overall goodness of fit (adjusted-R^2) of the three models is satisfactory, ranging between 0.2 and 0.3. Coefficients generally take the expected signs, validating the research hypothesis that firm-sponsored training investments causes a significant and sizeable productivity effect in European utilities adhering to sustainability reporting guidelines. Notably, the relationship between training and productivity shows a positive and significant correlation between training observed in t-1 and average labour productivity observed in t. According to the parameters of the Pooled OLS estimator (0.288 and 0.282), the provision of an additional 10% of training hours per employee (2.5 hours on average) is associated with an average increase of the turnover per employee by approximately 2.75% (after having applied the inverse of the logarithmic transformation). This finding also implies that a worker receiving an average level of training (25 hours) is around 69% more productive than an untrained worker. This positive effect is confirmed by the random effect estimator, but in the latter case the coefficient has a lower magnitude (0.205) associated with an average impact of an additional 10% of training hours equal to 2%. This result indicates that failing to account for unobserved heterogeneity leads to overestimating the impact of training on productivity as suggested by the literature, but that after taking it into account, the productivity premium remains substantial. As far as control variables are concerned, we observe a positive correlation between fixed assets and productivity, which is in line with the model based on the production function, whereas the coefficient attached to GDP per capita and government ownership is not significant.

Table 2 - Impact of previous training on average labour productivity (in logarithmic form)

	(1) Pooled OLS estimator Turnover per employee	(2) Pooled OLS estimator Turnover per employee	(3) Random effect estimator Turnover per employee
Training hours (lagged)	**0.2882***** **(0.0908)**	**0.2819**** **(0.1174)**	**0.2048*** **(0.1150)**
Assets (lagged)	-0.0339 (0.0876)	-0.0333 (0.1005)	-0.0028 (0.0775)
Assets	0.1939* (0.1039)	0.1957 (0.1225)	0.1678** (0.0811)
Country GDP per capita	0.2234 (0.2869)	0.2212 (0.3518)	0.2909 (0.3551)
State-owned enterprise	-0.0494 (0.1522)	-0.0549 (0.2072)	-0.1801 (0.1929)
Constant	0.4305 (2.9023)	0.4374 (3.5480)	-0.0082 (3.6051)
Observations	133	131	131
R^2	0.230	0.230	
Adjusted R^2	0.1999	0.1996	
Between- R^2			0.2905

Note: Standard errors in parentheses (robust in the first column, clusterized in the second column). Training hours and assets are scaled by the number of employees. See Appendix for the results of the Hausman test comparing fixed effects and random effects estimators.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Similar results emerge when we use the stock of training hours as an explanatory variable in a cross-sectional OLS regression (Equation [6]). In this specification, training interventions are positively and significantly correlated with average productivity. Namely, the coefficient attached to training stock is almost 0.35 when using both robust and clustered standard errors (first and second column of Table 3, respectively), which are slightly higher than the one attached to training flow variables. Accordingly, training stock associates a 10% increase of training hours per employee with a 3.4% increase in average labour productivity. This result is in line with the literature suggesting that the impact of training on productivity could be underestimated if one neglects to consider the cumulative effect of past training (Colombo and Stanca, 2014). Moving on to control variables, both fixed assets and GDP per capita are positively related to productivity, whereas government ownership is again non-significant. The goodness of fit (adjusted R^2) of both models is slightly higher than 0.25.

Table 3 - Impact of training stock on average labour productivity (in logarithmic form)

	(1) Pooled OLS estimator Turnover per employee	(2) Pooled OLS estimator Turnover per employee
Training hours (stock)	**0.3476***** **(0.0919)**	**0.3497***** **(0.0991)**
Assets	0.1043*** (0.0352)	0.1039*** (0.0359)
Country GDP per capita	0.6001** (0.2759)	0.5999** (0.2763)
State-owned enterprise	-0.1758 (0.1986)	-0.1741 (0.2006)
Constant	-2.7878 (2.8275)	-2.7865 (2.8312)
Observations	75	74
R^2	0.300	0.299
Adjusted R^2	0.2596	0.2581

Standard errors in parentheses (robust in the first column, clustered in the second column). Training hours and assets are scaled by the number of employees.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Overall, the existence of a positive and statistically significant impact of training on productivity confirms the findings of the current empirical literature. However, the magnitude of the impact of training also shows that selected utility companies enjoy higher benefits than generic firms in generic industries (Koning and Vanormelingen, 2015; Colombo and Stanca, 2014). Only the comparison with the estimates of Dearden et al. (2006), which, however, referred to a previous period, shows a negative gap.

8. Discussion

Our evidence shows the positive and substantial impact of training on average productivity, highlighting the importance of employer-provided training for firm competitiveness in the utilities sector. As acknowledged by economic literature, these positive effects should be referred to both general and specific training, in line with the assumption of complementarity between these two forms of training.

European utility companies seem thus to realize substantial benefits from training investments. Within the chosen theoretical framework, the main explanation of this result concerns the characteristics of its workforce. The large proportion of knowledge workers, whose expertise is based on a heuristic application of a core of technical capabilities that characterize the utilities sector (Antonelli et al., 2013), is a valuable basis to exploit the potential complementarities between education and training, and thus to achieve remarkable productivity gains from training interventions. Moreover, it seems that other specific characteristics that connote work in utilities, such as bureaucracy, excessive unionization, poor incentives, job guarantees, and cronyism, either do not penalize the effectiveness of training investments or are less common than in the past.

Another possible explanation is strictly contingent on the structure of the utilities sector. Namely, the highly capital-intensive settings that characterize this oligopolistic sector compared to industries operating in conditions of perfect competition (Wissner, 2011) pave the way for higher levels of variable inputs, such as training, when applying an extended production function (Equation [2]). Utilities would thus get more benefits from training than firms operating in low capital-intensive industries. However, this answer raises a further issue. The capital deepening within the utilities sector could result from a company’s attitude toward investing in physical capital rather than in internal training. Under this hypothesis, utilities may effectively reallocate part of their investments from capital to labour. This argument is also valid in the presence of relentless technological change, such as the one we are currently witnessing with the diffusion of smart grids. Indeed, such new technologies require building a new knowledge infrastructure (Hendriks and Fruytier 2014) and thus necessitate increasing training investments triggering incremental learning (Grinsven and Visser, 2011). Accordingly, utilities should invest more in training to achieve further productivity gains, as it emerges that the relevant returns are still far from decreasing for the current levels of training.

There might be several reasons for such under-investment. One reason may be the lack of information on these returns (tacit knowledge is not readily observable) and the actual workers' contribution to the learning activity. A second reason could be the fear of poaching of trained workers by outside firms after the training period (Stevens, 1996). The third reason could be the lack of trainable workers in the labour market. Indeed, not every worker is trainable as one condition is that they have some initial education. Consequently, a share of the workforce should not be included when calculating the number of training hours per employee.

Finally, our results support the idea that adherence to sustainability principles has a twofold benefit for human capital management in the utilities sector. On the one hand, the social pillar prioritises training (Ioannou and Serafeim, 2017) as a component of those HRM practices that sustainable organizations typically promote. On the other hand, the environmental pillar may attract more motivated workers and push their attitude towards business ethics (Ji et al., 2012). Although neither motivation nor behavioural attitude can be measured quantitatively, it is reasonable to argue that they lie behind the effectiveness of training investments that emerge from our analysis.

9. Conclusions

The evolution of the European utilities sector has strengthened the effort that companies have traditionally devoted to human capital development, raising the question of the actual impact of these efforts on productivity. By analysing the balance sheet data of socially sustainable firms operating in the European utilities sector during the Great Recession (2008-2010), we found that training investments in this sector are considerable and increase average labour productivity. Our findings are confirmed when using training stock as the explanatory variable and assuming a high rate of obsolescence of human capital. These results extend the achievements of the previous literature on this topic to the utilities sector, one of the most engaged in training activities in Europe. Moreover, this suggests that the adherence to sustainability principles may serve as a vehicle to improve the effectiveness of training efforts and make training investments a possible basis for new forms of industrial relations able to address future challenges posed by smart grids and, more in general, by the increasing digitalisation of the sector. Indeed, like any radical technological change, digitalisation may be hampered by employees' resistance. An organizational commitment to investment in training could thus represent a way to support a successful digital transformation of the industry and fill up the delay highlighted by recent studies (Graf and Jacobsen, 2021).

These theoretical implications particularly apply to long-lasting recession periods. In such periods, the increased competition caused by the weak demand may obliges firms to compete more than before based on quality (Felstead et al., 2012) and to adopt innovative strategies that require more training to match the skill requirements needed to compete in future product markets (Dietz and Zwick, 2020). In this regard, results support the desirability of countercyclical training investments during the COVID-19 pandemic for a faster recovery after the crisis.

However, the evidence that productivity 'returns' to investment on training appear to be relatively high raises a different question: why do utilities not train even more since returns are substantial? Our explanation is twofold. First, the typical sources of underinvestment in firm training (Pedrini, 2017) could exist. In such a case, a possible institutional implication concerns the provision of public subsidies (or tax deductions) to training investments. In particular, given the role of technological changes in increasing the impact of training on productivity, such incentives should specifically be devoted to training interventions aimed at creating both specialists in new technologies (such as Artificial Intelligence) and multitask workers able to combine the use of these technologies with internal IT systems. Second, the utilities sector seems to be characterized by a relative overinvestment in physical capital than human capital. A regulatory framework that binds subsidies to physical capital investments to a simultaneous growth of firm-provided training could thus be a possible solution.

As far as managerial implications are concerned, locally embedded utilities could get in touch with their communities to improve the quality and stock of human capital in the relevant ecosystem, whose development, in turn, depends on high-quality, efficient, and environmentally-sustainable public services. As communities become aware of the utilities' crucial role in promoting a concrete path of sustainable development, specific initiatives could promote joint training programs and partnerships between utilities, governments, and universities. One possible outcome is the creation of Corporate Universities able to channel the knowledge spillovers flowing between higher education institutions and the industry, as well as strengthen the institutional and organizational linkages between the industry itself and public authorities (Antonelli et al., 2013).

This paper is also affected by some limitations. Although we used a longitudinal dataset, the choice of the random effect estimator raises a potential endogeneity issue related to unobserved heterogeneity of observed firms if such heterogeneity is correlated with independent variables. Moreover, a caveat of this paper is related to the firm size of the sample, which included only large firms; further research is needed to check if the same results are valid for small firms as well. However, the extension to small firms should be carefully evaluated because they conduct less formal and more informal training, which is not easily measurable.

Furthermore, small firms do not usually publish data on training hours but only information on training expenses. In this regard, a reform of accounting and reporting standards, or the introduction of a requirement to make sustainability reports publicly available for all utility companies, could improve the representativeness of empirical analyses on this topic. Other limitations include the factoring in country-specific training systems due to the high number of countries included in the sample and the geographical scope of the analysis. Finally, the paper does not address the effects of digitalization in terms of rapidly changing skill requirements for the whole industry, with the consequent need to upskill adult workers who are unable to use digital technologies properly and to activate new training courses about future developments of digital technologies affecting the utility sector.

Future research can also investigate the link between transfer of training and organizational-level outcomes, or what has been referred to as vertical transfer of training. This research can aim to measure a variety of outcomes at the individual and organizational levels of analysis and develop multi-level models that integrate the two perspectives to bridge the micro-macro gap in training research.

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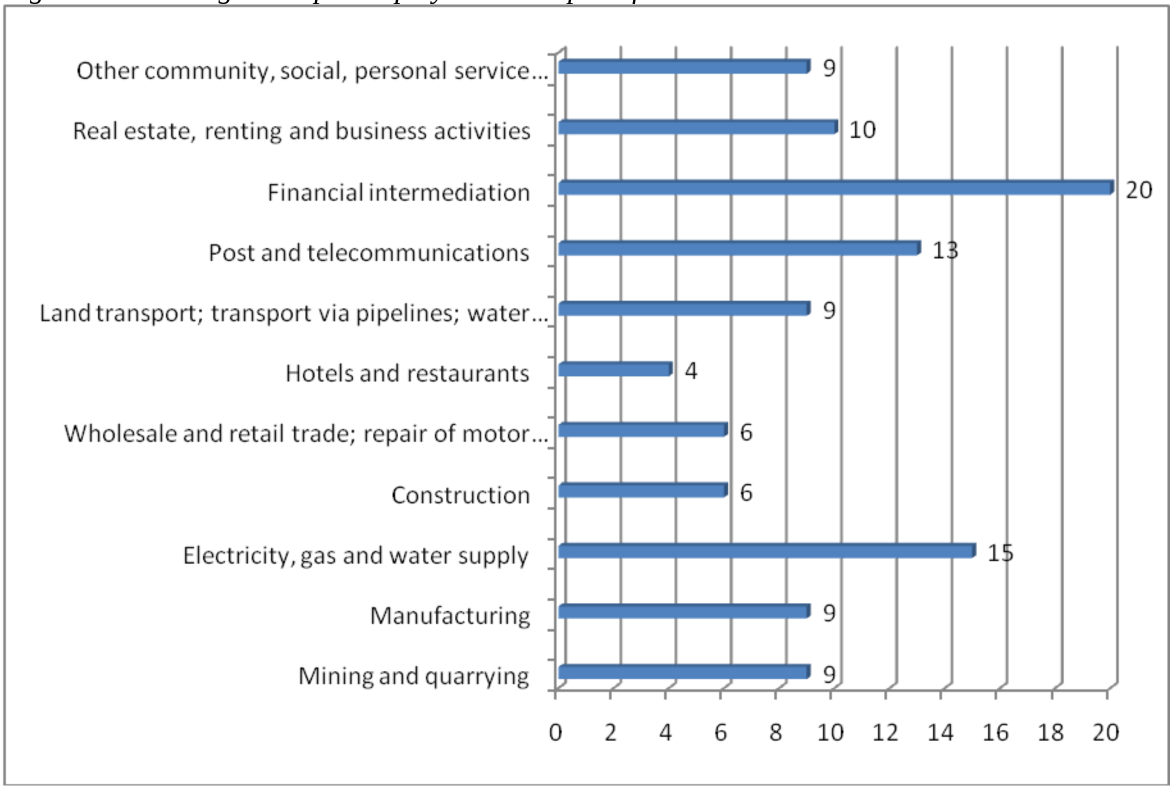
Figure 1 - Training hours per employee in European firms in 2005



Source: Eurostat (2009)