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Corporate training and skill gaps: Did COVID-19 stem EU convergence in training investments?

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Abstract

European firms have increasingly invested in training of employees but differences across countries and types of firms remain – and the COVID-19 shock may have exacerbated them. This report analyses European firms' investment in training over the last six years examining trends, factors supporting training investment as well as the impact of the COVID-19 shock. We base the empirical analysis on a unique dataset, the European Investment Bank's Investment Survey (EIBIS), which allows tracking corporate training investment on a yearly basis. To understand dynamics underpinning firms' decision to invest in their workforce, we examine transition patterns and employ dynamic panel data estimation. Finally, we analyze the impact of the COVID-19 pandemic on firms' investment in workforce training and transitions in and out of training. We find that despite a slow upward trend in training investment observed in recent years, supported by labour market recovery, differences across firms and countries have persisted. The pandemic risks aggravating these, through its asymmetric impact on labour markets and differences in corporate innovation, firm structure and resilience. While firm training can be an important element for firms and their workforce to adjust to the post-pandemic environment, asymmetries in training investment could make it harder for those already lagging. The paper concludes with a discussion of policy implications.

1. Introduction

The availability of talent and skills has been a significant investment obstacle for firms across the EU over the years, with several sources highlighting the persistence and prevalence of skill shortages (EIB, 2021; Eurofound-Cedefop, 2020; Cedefop 2018). Most recent data from the *European Investment Bank's Investment Survey* (henceforth referred to as EIBIS) shows that the limited availability of skills is an obstacle to investment for almost eight out of ten firms across the EU (79% in EIBIS 2021), making it the most frequently mentioned long-term barrier to investment. While some contention regarding the definition and incidence of skill shortages in labour markets remains (Cedefop, 2015; Cappelli, 2015; Richardson, 2007), evidence suggests that these can constitute a significant impediment to firms' productivity and competitiveness and can constrain their ability to remain at the top of the technological frontier (Healy et al., 2015; Bennet and McGuinness, 2009; Forth and Mason, 2006; Nickell and Nicolitsas, 1997; Haskel and Martin, 1996). For companies, one way to address shortage

[1] We are grateful for the comments and suggestions of Jochen Schanz. The views expressed in this publication are those of the authors and do not necessarily reflect the position of the European Investment Bank or of the European Centre for the Development of Vocational Training (Cedefop).

situations is to invest in workforce training, to build up much needed skill-sets in house, keep up with competitors and their positioning to attract required talent.

Skill shortages and skill gaps have a cyclical and a structural component and the same should hold for training investments, although firms' training decisions are more likely to involve systematic planning (Brunello and Wruuck, 2020; McGuinness et al., 2018). While skill shortages typically increase in an economic upturn and training investments tend to be the first to be slashed during recessions (Cedefop, 2010), the sensitivity of training investments to the business cycle and skill shortages is an empirical question. An economic upturn and tightening labour markets should induce corporate investment in human capital via several channels, notably by making training more important to retain and attract staff as opposed to reliance on external talent recruitment. Firms' increasing profitability, capital investments and a more positive business outlook would also support training decisions. However, greater staff turnover and poaching externalities could diminish incentives for general training investments in times of buoyant job markets. Training could also be counter-cyclical when recessions spur a cleansing of outdated organizational capital and investment in new products and (digital) technologies (Brunello, 2009).

Structural factors that affect skill shortages/gaps, including workforce demographics, globalisation and technological change, but also more recently the coronavirus pandemic and associated labour market policies (e.g. short-time working, furlough schemes) that can affect individuals' marginal utility for labour, also influence corporate training investment decisions. For example, firms may be reluctant to invest in an increasingly older workforce (Cedefop, 2012).[2] At the same time, rapid technological change, for instance linked to digitalisation, may prompt firms' investment in new competencies and the continuing training of existing staff (Cedefop, 2018). Country-specific institutional conditions, including labour market policies and regulations, also affect firms' willingness to invest in human capital (Brunello and Wruuck, 2020).

Understanding cyclical and structural patterns in corporate training, including the effects of the large-scale economic shock related to the coronavirus pandemic, is of key relevance for designing effective skills policies to accommodate recovery and adaptation to a post-COVID-19 economy. On the one hand, the pandemic has clearly accelerated digitalisation, increasing demand for digital skillsets related to the massive shift to remote work arrangements and e-commerce (Sostero et al., 2021; van Loo et al., 2021). In a quest to survive the creative destruction process fostered by the coronavirus health shock, many firms have sought to enhance their investments in a digital marketing and sales strategy[3]. Short-time work arrangements, furlough and remote work schemes may have also provided opportunities for (online) training, given overall financial support and time availability[4].

On the other hand, many firms may be hesitant to invest in human capital in a pandemic context given practical difficulties, high levels of uncertainty and (prospects of) a weakening labour market. The challenges posed by the increasing incidence of remote work and social distancing practices have also inhibited the provision of physical training within firms (OECD, 2021; van Loo et al., 2021) and have accentuated pre-existing inequalities in training access and productivity (Pouliakas and Branka, 2020).

[2] Structural and cyclical effects may also of course interact; for instance, the balance of investments in training towards older-aged workers could shift at times of economic recession, considering that the inflows into and out of employment tend to be larger for younger recruits (Brunello, 2009).

[3] https://www.cedefop.europa.eu/en/news/coronavirus-and-european-job-market-how-pandemic-reshaping-skills-demand

[4] https://www.cedefop.europa.eu/en/news/working-and-learning-remotely-europe-new-normal

Cyclical market failure linked to higher training coordination costs (e.g. linking training providers with beneficiaries, carrying out in-firm skills audits) and reliance on a low cost 'survival mode' product market strategy may be more pronounced given pandemic circumstances, particularly for weaker firms. While investment in training and upskilling/reskilling would be beneficial to the economy at large, helping to adapt to structural changes and supporting a strong recovery, individual firms may not undertake enough of it as they and their workforce get trapped in a self-fulfilling low-cost/low-skill cycle (Redding, 1996). Indeed, most recent data on firms' training investment based on EIBIS suggests a considerable drop by some 10 percentage points in the share of firms investing in training across the EU (EIB, 2022). Underinvestment, even if temporarily, may come at long-term costs in terms of slower adjustment to ongoing structural changes and lower competitiveness. The heterogeneous impact of the pandemic on labour markets further poses risks to longer-term convergence in the EU and differences in firms' human capital investment could further aggravate these (Schanz and Wruuck, 2021; EIB 2022).

The need to step up human capital investments and notably continuous adult learning, considering significant risks to labour markets linked to long-term mega-trends including digitalisation, automation and ageing, pre-dates the pandemic (Nedelkoska and Quintini 2018; Pouliakas 2018; EIB 2019, 2020). As highlighted by Cedefop (2020), about 46% of EU workers stand to benefit from additional upskilling or reskilling, with such low skills implying a substantial cost for the EU economy. As the main sponsors of adult learning activities (Cedefop, 2019), firms have a key role to play in this, but in an uncertain economic environment marked by the pandemic many corporates may choose to delay or cut human capital investment.

In this paper we examine EU firms' investments in employee training during times of both increasingly tightening labour markets, following recovery from the Great Financial Recession, and the economic and social shock linked to the COVID-19 pandemic that unfolded most recently. We seek to identify factors supporting training investment and its resilience and focus on its responsiveness to skill shortages/gaps[5]. To do so, the paper uses data from the European Investment Bank (EIB) investment survey (EIBIS) to assess the developments and determinants of training investments in EU countries and examine COVID-19-related risks to them.

The structure of the paper is as follows. Section 2 briefly reviews the recent literature and theories discussing determinants and obstacles to corporate training investment and its relationship with skill shortages and skill gaps. In section 3 we trace trends in EU firms' investment in employee training and skill gaps in recent years (since 2015/6). Section 4 reports on the outcomes of multivariate discrete choice regression analyses that aim to identify underlying characteristics supporting corporate training investment. It also deploys panel data methods to shed light on transitions into and out of training and the dynamics underpinning these. Section 5 aims to provide a preliminary investigation on the impact of the COVID-19 shock on corporate training investment, using information based on the 2020/2021 waves of the EIBIS. Section 6 concludes with recommendations for policy. The annexes describe more fully the empirical methodology employed and the EIBIS data and variables used in this report.

[5] In this paper we use a measure of the extent to which the lack of availability of staff with the right skills constitutes an obstacle to firms' investment activities. As it is not clear if this measure captures skill deficiencies in the external market, linked to an inability to fill vacancies (so-called skill shortages), or in the internal human resource pool, we loosely use the term 'skill gap' throughout the report (Cedefop, 2010).

2. Corporate training investment and skill shortages/gaps

2.1. The economics of corporate training

Firms weigh the (future discounted) economic benefits of investment in training, either general or firm-specific, against its immediate and opportunity costs, as has been well-noted by human capital theory (Becker, 1962; Ben-Porath, 1967; Mincer, 1974). The result of this calculus depends on firm-specific characteristics, resources, firm's operating environment, including adopted managerial and workplace practices and overall corporate learning culture (Cedefop, 2012; Polacheck et al., 2021). For example, it is well-reported in literature that small firms tend to invest in training less frequently, reflecting higher fixed costs of identifying skill needs or organizing suitable training offers and greater (perceived) risks of poaching due to their inability to pay competitive wages (Brunello and Wruuck, 2020). Poorer management competencies and practices in mostly smaller-sized firms, which translate in lower job complexity and skill needs (Pouliakas and Russo, 2015), may also inhibit training investments. The same holds for an overall inability to shift a firm's business and product market strategy towards a high-investment/high-skill equilibrium (Booth and Snower, 1996).

Firms' external operating environment also influences training activities as it affects costs and expected benefits. For instance, country differences in corporate training activity tend to be influenced by differential institutions, product and labour market regulations, industrial structures, innovation activities and skills supply (Cedefop, 2015). Brunello and Wruuck (2020) examine country patterns based on data from the Eurostat Continuing Vocational Training Survey (CVTS) and the EIBIS. They find considerable heterogeneity but, overall, the countries with the lowest shares of firms providing training are all located in Southern and Eastern Europe. Similarly, investment in training per employee tends to be lower on average in these countries compared to North-Western European neighbors. Reasons for the inherently lower commitment to in-company training by countries in this group include weaker institutional foundations that build on social partner partnerships, greater liquidity constraints, lack of in-company training culture but also business structures such as differences in firm size.

An established body of literature suggests that training investments made especially by the private sector tends to be suboptimal relative to the social planner's equilibrium, feeding skill shortages (Haskel and Holt, 1999). Differences among firms and countries in training investments are influenced by the hold-up problem inhibiting firms' and workers' decisions to commit to training. Credit constraints, information asymmetry, overall economic uncertainty affecting the long-term payoff of human capital investments, market imperfections and other matching externalities are also factors distorting the efficient provision of training (Almeida et al., 2012; Leuven, 2005; Acemoglu and Pischke, 1999; Stevens, 1994). The latter justify the case for government intervention (e.g. via firm subsidies and training levies or other policies to promote skill needs identification and company-worker cost sharing), although it is generally difficult to arrive at unambiguous policy recommendations and to identify the exact source of labour market imperfection underpinning training inefficiency (Leuven, 2005; Stevens, 2001).

2.2. Corporate training and skill shortages/gaps

The relationship between firms' difficulties to source or retain talent and their reactivity in terms of corporate training provision remains insufficiently explored. However, it has been indirectly examined through analysis of the linkage between training and business cycle movements, given the typical procyclicality of skill shortages (Cedefop, 2010).

An economic upturn should work to support corporate investment in human capital via several channels, namely (i) a labour market channel, i.e. more firms hiring new staff to accommodate business demands, increasing need for newcomer training. The latter is necessary especially if some firms, faced with a shrinking applicant pool and heightened adverse selection, compromise their recruitment and hire workers with lower skills than required (ibid., 2010). Tightening labour markets arguably make training more important to retain and attract staff, as they raise the cost of reliance on external talent, (ii) a profitability channel, i.e. firms being in a better position to pay for training, (iii) an investment channel, for example purchase of new capital equipment requiring new competencies and skills for operation (capital-skill complementarity), and (iv) an expectations channel, i.e. a more positive outlook for the future should increase businesses' confidence that they will be able to amortize training investments or swiftly accommodate any staff poaching and turnover.

Reflecting such economic mechanisms, several empirical studies have confirmed that training investments and skill shortages are strongly procyclical and inversely related to rising unemployment rates (Cedefop, 2015; Mendez and Sepulveda, 2012; Frogner, 2002).

By contrast, strong labour markets may also imply enhanced labour mobility and turnover, diluting firms' incentives to invest in staff's acquisition of general human capital (Becker, 1962). It has also been argued that recessions are associated with a 'cleansing' of inefficient organizational capital that includes reorientation of firms' workplace training towards incumbents. The opportunity cost of investment in skill tends to fall relative to work during recessions, further explaining why workplace training may be counter-cyclical (Brunello, 2009). Brunello and Wruuck (2020) fail to find a statistically significant relationship between training investments and unemployment rates using two main EU datasets (CVTS, EIBIS), although their analysis may be inhibited by low frequency data limitations.

As with training, skill shortages/gaps are underpinned by structural elements linked to, inter alia, slow adaptiveness of (vocational) education systems to labour market needs (Haskel and Martin, 2001), technological change, institutional constraints (including sluggish wage bargaining systems or stringent employment protection legislation, inhibiting labour market mobility) and the overall regulatory shift towards labour market flexibility. Geographical barriers to talent sourcing and retention, non-market clearing wage offers, unattractive working conditions are also usual culprits for firms' (perceived) difficulties to find suitably-skilled workers (Cedefop, 2015). The conflating of desired behavioral and personality traits with the technical skillset demanded by job applicants (Green et al., 1998), inefficient human resource management practices (including algorithmic recruitment) (Cappelli, 2015) and low-cost product market strategies (Mason, 2010) further point to organizational deficiencies underpinning skill shortages.

Training provision of firms is nonetheless one of the multiple avenues that firms may use to respond to skill shortages/gaps, and the preferred one for most EU firms.[6] Others include the increasing use of overtime, output reductions, use of subcontracted or casual labour, capital-labour substitution etc. (Healy et al., 2015). Bennett and McGuinness (2009) showed, for instance, that 58% of employers in technologically-intensive sectors in Northern Ireland adjusted to the problem of skill shortages by training and upskilling their existing staff and 47% chose to recruit staff from other backgrounds and train them up. Backes-Gellner and Tuor (2010) further illustrated that companies signaling to potential candidates that they offer good continuing training programs were less likely to experience recruitment difficulties. However, due to its investment nature and institutional factors, training is more likely to entail higher adjustment costs and inertia relative to other ways of overcoming

[6] Based on data from the EIB special survey on digitalization and skills (2018) for services and manufacturing firms.

recruitment bottlenecks (Richardson, 2007). It is also less likely to be deployed relative to other options, such as cutting output, to counteract more complex, intractable skills-related bottlenecks (Healy et al., 2015). It is therefore reasonable to anticipate a sluggish sensitivity of training investments to skill shortages/gaps. Their relationship is also likely to be dynamic, for instance firms increasing their training investments should over time have a lower need to search for skills from the outside labour market and hence experience fewer recruitment difficulties.

3. EU firms' investment in workforce training – recent trends

3.1 The European Investment Bank Investment Survey

This report uses unique company-level (longitudinal) data made available as part of the European Investment Bank (EIB) Investment Survey.

The EIBIS dataset contains extensive information on firms' investment decisions, investment financing and the obstacles they face in their investment activity[7]. The EIBIS is a telephone survey of about 13,5 thousand firms carried out annually mainly in all 27 EU Member States, with additional interviews carried out in the UK and the US. Representativeness in terms of country distribution, as well as firm size classes (micro to large) and 4 main sectors (infrastructure, construction, manufacturing and services), is achieved by using a stratified sampling methodology. Respondents to the survey comprise of senior persons within companies with responsibility for investment decisions and how these are financed (e.g. owner, Finance manager, Finance Director or Head of Accounts, Chief Financial or Executive Officer). The survey collects data on a wide range of firm characteristics (e.g. firm age, main sector of activity, firm size) and performance, past investment activities and future plans, sources of finance, financing issues and challenges that businesses face in their investment decisions.

For this paper, we focus on two key questions of interest on training and skill shortages/gaps.

First, we use information on how much businesses invested in the last financial year in the *training of employees*, as opposed to other tangible and intangible resources, to maintain or increase their future earnings. A core part of the questionnaire asks respondents to think about their investment activities and associated expenditure, if any, in all of their company's locations. It subsequently asks them about their investment activities in several areas ("In [ADD AS APPROPRIATE 2020 OR the 2020/21 OR the 2019/20 financial year, how much did your business invest in each of the following with the intention of maintaining or increasing your company's future earnings? (a) land, business buildings and infrastructure (b) machinery and equipment (c) research and development (d) software, data, IT networks and website activities (d) training of employees (e) organisation and business process improvements.")

While the option referring to employee training does not explicitly refer to the type of education and training activities financed via investment expenditures, by its nature it should capture firms' expenditures on formal and non-formal forms of staff learning. This encapsulates any outlays made by companies on education and training courses (within- or outside of the firm), conferences, workshops, seminars but also guided/instructor-led on-the-job training, which could be accompanied or not by a specific certification process. Such investment activities are not expected by contrast to cover any informal learning processes and associated opportunity costs endured by firms.[8] Data based

[7] Further details about the EIBIS survey methodology are available at EIB Investment Survey (Details) and in the methodology report.

[8] Formal learning is learning that occurs in an organised and structured environment (such as in an education or training institution or on the job) and is explicitly designated as learning (in terms of objectives, time or

on the Continuing Vocational Training Survey in enterprises (CVTS) shows that EU firms use a mix of training types and providers. Training courses, however, tend to be the most popular compared to workshops/conferences or guided on the job training. For example, some 60% rely on CVT courses to train their workforce with external courses on average more popular than internal provision[9].

Second, we use a question assessing a firm's perception of the obstacles it faces to its investment activities in general. Companies are asked whether a range of different factors constitute a major or minor obstacle or no obstacle at all to their investment activities, as follows (example for the 2021 survey wave) "thinking about your investment activities in [ADD COUNTRY OF INTERVIEW], to what extent is each of the following an obstacle? Is it a major obstacle, a minor obstacle or not an obstacle at all?". The list of factors includes (a) the demand for products and services, (b) energy costs, (c) access to digital infrastructure, (d) labour market regulations (e) business regulations (e.g. licenses, business permits, bankruptcy) and taxation, (f) availability of adequate transport infrastructure, (g) availability of finance and (h) uncertainty about the future. Crucially for the purposes of our analysis, one additional option is (i) the *availability of staff with the right skills*. Compared to previous literature investigating different proxies of firms' skill shortages/gaps[10], the value-added of the EIBIS measure is that it explicitly aims to demarcate skill-based constraints with tangible impacts on firms' investment activities[11].

In investigating the relationship between the two aforementioned variables, one needs to pay particular attention to their time frame. The question on employee training investment is clearly framed in terms of the last, fully finalised, accounting year (t-1), the one on skill gaps does not have a clearly-stated reference period. It may hence be possible that some respondents have reflected on the extent to which skill gaps constitute an impediment to their current (t), as well as previous (t-1), corporate investment activities. However, it should also be noted that respondents were asked to focus on their previous year investment activities throughout most of the questionnaire and, in fact, in the questions immediately preceding the one on their investment barriers. It is therefore likely that

resources). Formal learning is intentional from the learner's point of view. It typically leads to certification. Non-formal learning is learning which is embedded in planned activities not explicitly designated as learning (in terms of learning objectives, learning time or learning support), but which contain an important learning element. Non-formal learning is intentional from the learner's point of view. It typically does not lead to certification. Informal learning (also referred to as experiential, or incidental/random learning) is learning resulting from daily activities related to work, family or leisure. It is not organised or structured in terms of objectives, time or learning support. Informal learning is in most cases unintentional from the learner's perspective. Informal learning outcomes may be validated and certified. For definitions of non-formal and informal learning, see Cedefop's glossary https://www.cedefop.europa.eu/en/projects/validation-non-formal-and-informal-learning/european-inventory/european-inventory-glossary.

[9] Based on CVTS 2015 (latest wave available) some of EU firms 54% provide training in the form of formal courses, and 34% provide courses internally.

[10] Such measures have typically ranged from the less precise (e.g. firms having 'difficulty filling jobs' as in the so-called Manpower Talent surveys), to the more general (e.g. firms with 'difficulties finding staff with the right skills' as in the European Company Surveys) or to simply capturing labour shortages (e.g. manufacturing firms in which 'labour is a factor limiting production' as in the European Commission Business surveys). Others have more accurately aimed to measure hard-to-fill vacancies explicitly due to the absence of skills, qualifications and work experience (e.g. UK employer skills survey) or the duration of unfilled vacancies (Haskel and Martin, 1993). More recent attempts have also aimed at predicting occupational skill shortages based on a series of underlying labour market indicators (e.g. Dawson et al., 2020; OECD, 2017).

[11] We also acknowledge however the notable challenges of the EIBIS measure, such as the fact that it is not clear if the lack of availability of staff with the right skills refers mostly to firms' external recruitment difficulties or in-house skill gaps affecting the proficiency of existing workers. See Brunello and Wruuck (2021) for further discussion on measurement.

their responses to the question about investment obstacles would mostly anchor on their investment activities from the preceding year (t-1). Such timing issues would not affect the direction of the estimated, contemporaneous, relationship between the two variables in the pooled sample. We also show in the analysis below that training investment tends to be a more sluggish variable across time compared to skill gaps, rendering it likely that changes in the latter are more likely to affect the former. Nonetheless, we have sought to investigate further the direction of their relationship in the panel sample by including lagged values of the skill gap variable in the empirical specification. We also address potential reverse causality issues by estimating a dynamic model of training investment that uses lags of the variables as instruments. Such analysis provides some reassurance to our hypothesis that movement in corporate skill gaps are significant determinants of firms' persistent training investments.

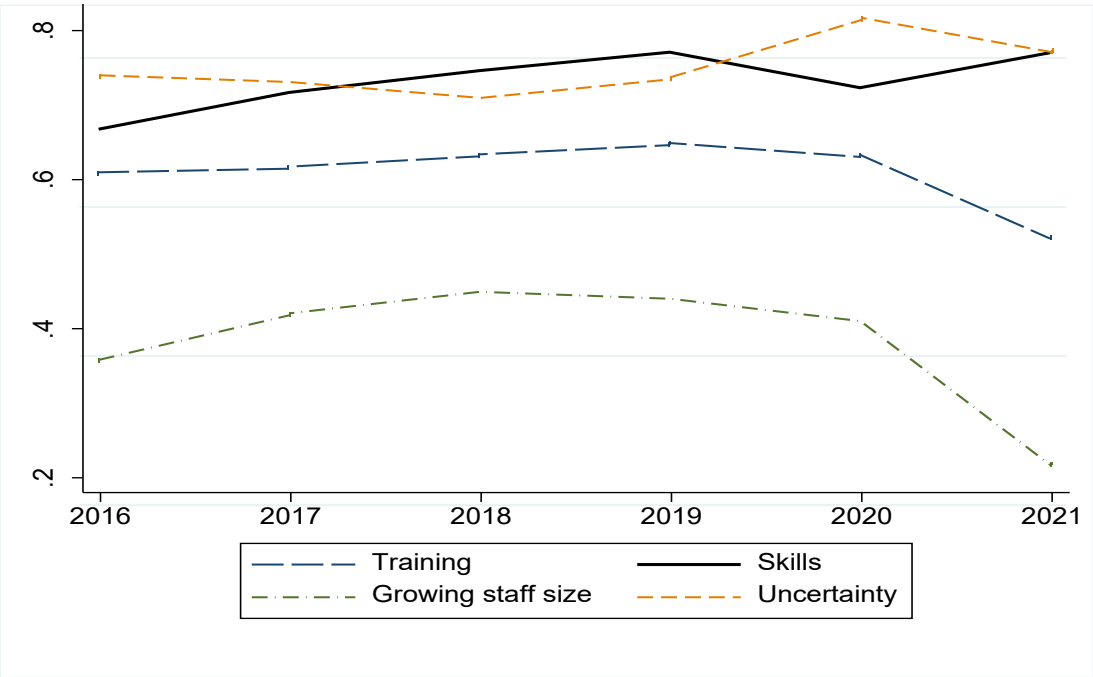
The first wave of EIBIS was carried out between April-August 2016 and by now the dataset consists of six consecutive waves in total (referring to the periods 2015/16, 2016/17, 2017/18, 2018/19, 2019/20, 2020/21). Pooling together the six waves of data hence results in a pooled dataset that contains a total of 77,350 European companies.

A significant value of the EIBIS data is that it also allows tracing a subset of firms over time and hence the deployment of (dynamic) panel data methods. About 15,374 firms can be observed in one or more waves of the survey over the time period under analysis in this report (2015/16-2020/21), with at least a quarter of those providing follow-up information for at least three years.

3.2 Trends in training and skill shortages/gaps

The limited availability of staff with the right skills is a key structural obstacle for firms in Europe. As described before, reasons are structural (demographics, changing skill needs, emigration in some parts of the EU) and cyclical. Reflecting the labour market recovery and increasingly tight labour markets in some EU economies in the years following the Great Financial Crisis, companies experienced increasing difficulties in finding suitably skilled staff (Figure 1). In fact, the EIBIS data reveal that out of the list of all investment impediments faced by European firms, the limited availability of skills has been the most frequently named concern. It was only superseded in the fifth wave (2019/20) by the factor 'uncertainty about the future', given the evolving coronavirus pandemic, but returned to the top in the latest wave. Skill-related obstacles to investment have also exhibited an upward trend over time, cited by 69% of firms in 2015/16 but rising to about 79% in 2018/19 and 2020/21, with a temporary drop to 74% in 2019/20. In the pooled sample, an average of about 75% of firms consider that skills are a bottleneck for their investment activities, with 46% identifying them as a major obstacle.

Figure 1 **Corporate skills gaps and training investment, 2016-2021**



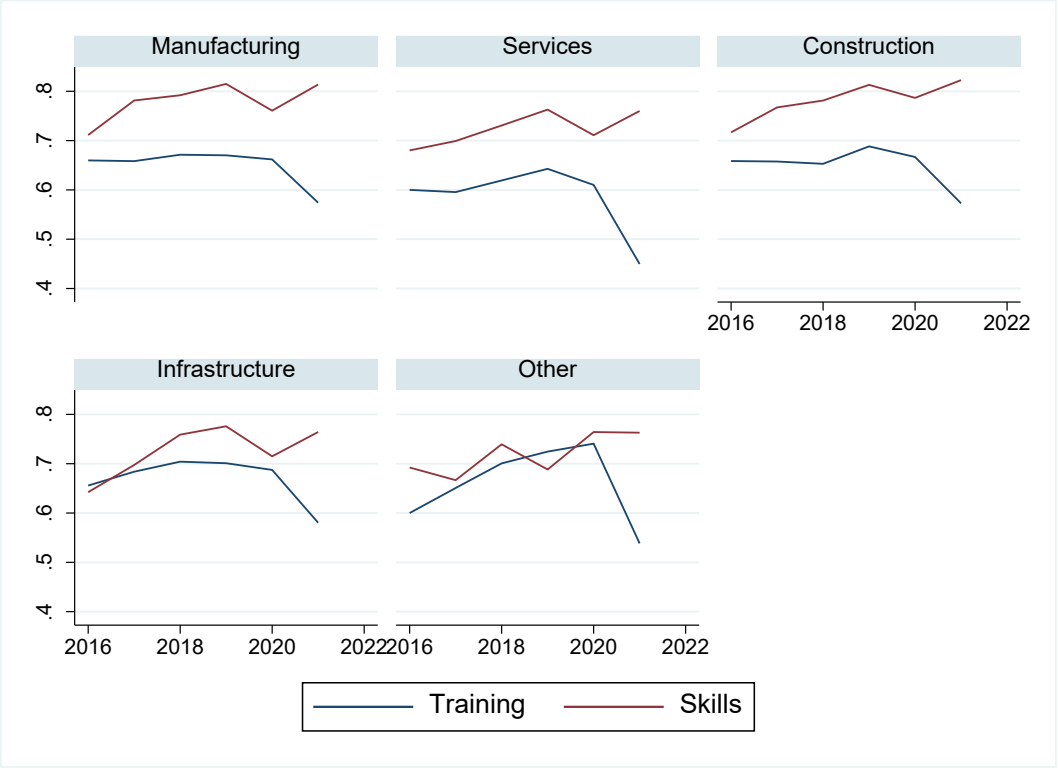
NB: 'Training' = share of companies in the sample that invested in employee training in the last financial year. 'Skills' = share of companies for which the 'availability of staff with right skills' is an obstacle to investment. 'Growing staff size' = share of companies with increasing staff size in last 3 years. 'Uncertainty' = share of companies for the 'uncertainty about the future' is an obstacle to investment.
Source: European Investment Bank Investment Survey (EIBIS)

Skills-related investment impediments tend to be highest among firms based in Central and Eastern European countries and the Baltics but less pronounced in some Southern European Member States (EIB, 2020, 2021). They are also more prevalent among firms in the construction and manufacturing sectors while small-sized companies are more likely to face major skill gaps.

In line with the business cycle upturn and growing hiring difficulties pre-dating the COVID-19 shock, the EIBIS sample also reveals a small yet sustained increase in training activity up until 2019. The share of European firms diverting part of their investment towards employee training increased from 64% in 2015/16 to 67,5% in 2018/2019. However, training fell markedly to 65.6% in 2019/20 and collapsed to 54% in 2020/21, reflecting increasing uncertainty and economic constraints following the onset of the COVID-19 crisis. During this period the pandemic facilitated a stark decline in in-person forms of formal and non-formal education and training activities that was not fully compensated by rising patters of online learning (OECD, 2021).

Figure 1 further reveals that training investments increased at a relatively slower pace than reported skill gaps. Skill bottlenecks in turn mirror employment growth, although a significantly smaller share of firms experience growing staffing numbers. This potentially reflects the rising adjustment costs of hiring from a shrinking pool of job applicants, when labour markets become tight and skill shortages intensify (Stevens, 2007). In addition, it could be related to cobweb effects whereby structural shifts in skill demand, such as those linked to emerging digital technologies, cannot be accompanied by slowly adjusting skill supply, hence constraining realized employment.

Figure 2 **Corporate skills gaps and training investment, by economic activity**



Source: European Investment Bank Investment Survey (EIBIS)

The link between skill gaps firms experience and their training activity is evident over time for the whole EU economy but also at sectoral level. Firms in all four main economic sectors covered in EIBIS (manufacturing, construction, infrastructure and services) increasingly experienced skills-sourcing difficulties and more invested in training compared to the first wave (see Figure 2).[12] Training investments in the manufacturing sector appear to be somewhat less responsive compared to other economic activities, potentially reflecting the higher automation risk and greater inclination to invest in labour saving technologies in this sector (Frey and Osborne, 2017; Pouliakas, 2018). By contrast, the COVID-19 shock seems to have exacerbated the decline in workforce training in the services sector.

Despite the upward trend in training investment that was in sync with rising skill gaps in the pre-pandemic era, more strongly so in Southern and Central Eastern European countries, this was not enough to achieve convergence in training levels across EU regions. North-Western European countries have the highest share of firms investing in employee training (60%) compared to Southern and Central Eastern European countries (53.8% and 54%), respectively (Figure A1.1). The former group of countries also experienced a faster rebound in economic activity that resulted in higher levels of skill gaps pre-pandemic, but these were somewhat muted with the onset of COVID-19 and dropped in 2020. By contrast, Southern European countries had a relatively slower labour market recovery following the global economic sovereign crisis, which was reflected in lower levels of skill gaps. But

[12] Manufacturing based on NACE classification of economic activities in group C, Construction based on NACE classification of economic activities in group F, Services based on NACE classification of economic activities with firms in group G (wholesale and retail trade) and group I (accommodation and food services activities) and Infrastructure based on NACE classification of economic activities in group D and E (utilities), group H (transportation and storage) and group J (information and communication).

the COVID-19 pandemic does not appear to have put a dent in firms' difficulties in sourcing skill in this region (Figure A1.2).

4. Empirical relationship between training investment and skill gaps

4.1 Pooled relationship between training and skill gaps

The time series data shown above indicate that there is a positive, yet imperfect and lagged, relationship between European firms' training investments and their inability to find or retain suitably-skilled staff. The raw data confirm that companies where skills constitute an impediment to their investment activities are contemporaneously more likely to divert part of their investment outlays to staff training. While 59% of European firms that experienced skill gaps invested in training, only 49% of those without them did so. Reversely, 79% of training companies indicated that the availability of skills is an obstacle to investment activities, whereas the same holds for 71% of non-training firms (Table 1).

Table 1 **Firm characteristics by training investment status**

	Training	**No training**	**two-sample t-test (equal variance)**
Skill gaps			
Availability of skills an obstacle	79% (0.410)	71% (0.454)	-24.08***
Availability of skills a major obstacle	48% (0.499)	44% (0.496)	-10.55***
Economic sector			
Manufacturing	30% (0.456)	28% (0.451)	-3.51***
Services	23% (0.420)	28% (0.449)	16.22***
Construction	22% (0.413)	21% (0.405)	-4.34***
Infrastructure	25% (0.431)	22% (0.415)	-8.02
Age			
Less than 5 years	4% (0.190)	5% (0.216)	7.83***
5-9 years	9% (0.292)	12% (0.321)	9.98***
10-19 years	24% (0.424)	26% (0.437)	7.33***
20+ years	63% (0.481)	58% (0.494)	-15.99***
Size: SME	83% (0.378)	87% (0.339)	15.01***
Innovation	44% (0.496)	21% (0.408)	-67.74***
Subsidiary	29% (0.455)	21% (0.405)	-27.24***
Profit	80%	71%	-28.65***

	(0.403)	(0.455)	
Employment increased in last 3 years	47% (0.499)	34% (0.474)	-35.77***
Linking individual pay with performance	70% (0.456)	61% (0.486)	-19.07***
Expectations: improved business prospects in sector/industry	42% (0.493)	38% (0.486)	-9.60***

Source: European Investment Bank Investment Survey (EIBIS)

Table 1 shows that this relationship is likely to be underpinned by both cyclical and structural conditions, including firm characteristics, firms' positive business outlook and future expectations and rising skill demands associated with technological innovation or growing staff size linked to improved profitability. Firms with higher skill demands that are reflected in their job postings and overall work organization are also likely to simultaneously employ specific bundles of human resource management and workplace practices, training being one component of them (Ichiniowski et al., 1997; Cedefop, 2012).

The above highlights that it is necessary to account for a range of possible confounding factors to detect the underlying association between European companies' training investments and skill gaps. Our basic analysis therefore employs a multivariate regression probit approach, with Hubert-White robust standard errors, that aims to uncover the partial correlation between the probability that firms engage in training investment and their difficulty in finding or retaining workers with the right skills (see Annex 2 for further methodological details).

We do so by first including as control variables a set of relatively standard/exogenous firm characteristics, namely firm age, size (specifically, a dummy variable identifying small and medium-sized firms) as well as the main sector of economic activity. We subsequently include a more extensive set of regressors that capture whether establishments are a subsidiary of another company, if they are innovative, if the size of the workforce grew in the last three years, if the firm invested in other tangible or intangible assets, other non-skill-related obstacles to investment activities and also a measure of the average wage bill per employee (appropriately winsorized to remove outliers). Proxies of managerial quality within the firm, such as years of experience of the company's CEO/head of firm, as well as the use of high-performance workplace practices, such as a strategic business monitoring system or performance-related pay schemes (PRP), are also considered although such variables are only available in the last two EIBIS waves. In the final, main, specification, we retain statistically significant variables from the aforementioned options. In all instances country and time dummies are included in the specification to account for cyclical conditions and institutional differences across the countries in the sample. Annex 1 describes the main variables used in the analysis and provides descriptive statistics.

Table 2 shows the estimated regression coefficients following the estimation of the above-described basic and extended specifications using the pooled sample. It is confirmed that the partial correlation between firms' training investment and skill-related impediments is positive and statistically significant, other things equal. European companies that are challenged in finding or retaining workers with the right skills have, on average, a 9.2% higher probability of investing in employee training, when only a relatively exogenous set of control variables is considered. In the full specification, this probability falls to 4.6% but remains statistically significant[13]. An interesting finding is that the

[13] Although a measure of training 'intensity' in the firm, captured by the degree of training investment expenditures per employee, is available in the data, it is highly skewed due to a significant number of zero values. We have therefore preferred to use as main dependent variable for the analysis a discrete measure of training

sensitivity of training investment is less among firms experiencing 'major' skill deficiencies. The probability of such firms investing in the training of employees is about 2.7%. In line with Healy et al. (2015), this may reflect the fact that companies faced with more 'complex' skill shortages may be more inclined to explore alternative ways of addressing their human capital problem, including a shift towards automation or capital-intensive production methods or reducing output altogether.

Table 2 **Determinants of training investment, probit regressions**

	(1) *Basic*	(2) *Basic & innovation*	(3) *Extended (no wage)*	(4) *Full*	(5) *Full & workplace practices*	(6) *Full – major skill gap*
Investment obstacle: availability of staff with right skills	0.25***	0.21***	0.15***	0.16***	0.17***	0.09***
	(0.011)	(0.011)	(0.014)	(0.014)	(0.020)	(0.012)
Company sector						
services	-0.11***	-0.04***	0.05***	0.06***	0.07***	0.06***
	(0.013)	(0.013)	(0.016)	(0.017)	(0.023)	(0.017)
construction	0.07***	0.20***	0.30***	0.30***	0.33***	0.30***
	(0.013)	(0.014)	(0.017)	(0.017)	(0.024)	(0.017)
infrastructure	0.08***	0.18***	0.28***	0.25***	0.27***	0.25***
	(0.013)	(0.013)	(0.016)	(0.017)	(0.023)	(0.017)
other	0.15***	0.19***	0.27***	0.26***	0.30***	0.25***
(Manufacturing)	(0.051)	(0.052)	(0.062)	(0.063)	(0.080)	(0.063)
Company age						
<5 years	-0.19***	-0.21***	-0.21***	-0.17***	-0.18***	-0.17***
	(0.023)	(0.024)	(0.030)	(0.031)	(0.046)	(0.031)
5-9 years	-0.14***	-0.16***	-0.17***	-0.15***	-0.15***	-0.15***
	(0.016)	(0.016)	(0.019)	(0.020)	(0.029)	(0.020)
10-19 years	-0.07***	-0.09***	-0.09***	-0.08***	-0.09***	-0.08***
(20+ years)	(0.011)	(0.012)	(0.014)	(0.014)	(0.020)	(0.014)
sme	-0.19***	-0.07***	-0.05***	-0.06***	-0.07**	-0.06***
	(0.014)	(0.014)	(0.019)	(0.019)	(0.028)	(0.019)
innovation		0.62***	0.19***	0.18***	0.17***	0.18***
		(0.010)	(0.014)	(0.014)	(0.019)	(0.014)
subsidiary		0.22***	0.28***	0.24***	0.23***	0.24***
		(0.012)	(0.015)	(0.015)	(0.021)	(0.015)
ln (wage bill per employee)				0.15***	0.15***	0.16***
				(0.009)	(0.013)	(0.009)
Changed company size in last 3 years						
same			0.02	0.00	-0.02	0.01
			(0.015)	(0.016)	(0.021)	(0.016)
increased			0.16***	0.16***	0.13***	0.16***
(decreased)			(0.014)	(0.014)	(0.020)	(0.014)
Investment activities (other)						
organization and business process improvement			0.51***	0.51***	0.49***	0.51***
			(0.014)	(0.015)	(0.020)	(0.015)
machinery and equipment			0.38***	0.38***	0.41***	0.38***

investment. Regressing the continuous training intensity variable on skill shortages reveals that firms faced with greater skill bottlenecks spend, on average, about 28 EUR more per employee on training, other things equal.

			(0.013)	(0.014)	(0.019)	(0.014)
R&D			0.31***	0.30***	0.29***	0.30***
			(0.016)	(0.017)	(0.023)	(0.017)
software, data, IT networks and website			0.55***	0.54***	0.51***	0.54***
			(0.012)	(0.013)	(0.018)	(0.013)
land, buildings and infrastructure			0.16***	0.15***	0.13***	0.15***
			(0.013)	(0.014)	(0.019)	(0.014)
Investment obstacle: availability of finance			-0.05***	-0.04***	-0.05***	-0.03***
			(0.012)	(0.012)	(0.017)	(0.012)
Expectations: improved business prospects in sector/industry			0.03**	0.03**	-0.00	0.03**
			(0.012)	(0.013)	(0.018)	(0.013)
HRM/workplace practices						
Use of formal strategic business monitoring system					0.20***	
					(0.018)	
PRP (individual)					0.13***	
					(0.018)	
Time dummies						
2017.wave	0.06***	0.07***	-0.06***	-0.06***		-0.06***
	(0.016)	(0.017)	(0.021)	(0.022)		(0.022)
2018.wave	0.05***	0.05***	-0.05**	-0.06***		-0.06***
	(0.016)	(0.017)	(0.021)	(0.022)		(0.022)
2019.wave	-0.01	-0.02	-0.04**	-0.06***		-0.06***
	(0.016)	(0.016)	(0.021)	(0.022)		(0.022)
2020.wave	0.03*	-0.00	-0.07***	-0.10***	-0.04*	-0.09***
	(0.016)	(0.016)	(0.021)	(0.022)	(0.021)	(0.022)
2021.wave	-0.22***	-0.23***	-0.31***	-0.35***	-0.29***	-0.34***
(2016.wave)	(0.016)	(0.016)	(0.020)	(0.021)	(0.021)	(0.021)
Country dummies	x	x	x	x	x	x
Constant	-0.08***	-0.43***	-0.69***	-2.20***	-2.29***	-2.16***
	(0.030)	(0.031)	(0.044)	(0.106)	(0.147)	(0.106)
Observations	76,733	76,725	62,245	58,535	30,549	58,535

NB: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Probit regressions with dependent variable a 0-1 dummy indicating if a firm has positive employee training investment or not in last financial year. Col (6) includes as independent variable if the availability of staff with the right skills constitutes a 'major' obstacle to investment activities.
Source: European Investment Bank Investment Survey (EIBIS)

Considering the impact of other firm characteristics, it is evident that firms in the construction and infrastructure sectors typically invest more often in workforce training, while those in manufacturing are the least likely to do so. In general, younger and small and medium-sized firms (SMEs) are found to invest significantly less in employee training. Subsidiary firms by contrast have a higher probability of financing staff training, as they potentially benefit from training resources from their parent companies. The same holds for innovative and higher wage/productive firms, as well as those that recently experienced employment growth.

Training investments also tend to be accompanied by complementary investments in intangible assets (e.g. organization and business process improvements; software, data, IT networks and websites), more so than tangibles. Such organizational improvements include the utilization of performance-related pay schemes and the use of formal strategic business monitoring systems, which are found to be more prominent among training establishments. Overall, the decision of European companies to

invest in human capital is constrained by the lack of availability of finance. Moreover, in alignment with theories of bounded rationality affecting companies' skills decisions, namely that companies tend to engage in relative comparisons with their immediate sectoral or local group (Green, 2013), training investments are found to be influenced by business prospects in a firm's own sector. The time dummies further confirm that training investments increased in a concerted fashion since 2015/16. The COVID-19 period (2019/20 and especially 2020/21) halted this positive trend.

The above findings indicate that it is mostly expanding, innovative and high-productivity companies that realise the value of systematically engaging in human capital investments, conditional on adequate financing. Such investments are also critically determined by the general economic outlook and immediate business prospects of rival firms. When such dynamism and rising skill needs translate into increasing difficulties to find desired skillsets, the EIBIS data confirm that firms also tend to divert part of their investment outlays towards staff training.

There is however marked heterogeneity in the sensitivity of training investments with skill gaps (see Table A3.1). While there is a statistically significant relationship between the two variables in all regions, the sensitivity is larger in North-Western European countries (and in the more flexible Anglosaxon labour markets of US/UK) and lowest in the South. A stronger effect is also present for SMEs and those in the services sector, in contrast to those in the secondary sector (manufacturing/construction). The reaction of training investment to skill bottlenecks is more easily facilitated for firms with sufficient buffer of internal funds, as opposed to those reliant on external financing sources. Skills-driven sensitivity of training is also greater among firms that invested more than in the past or plan to invest more in the future, especially if such investment is made for capacity expansion and innovation purposes.

4.2 Dynamic relation between training and skill shortages/gaps

The positive relationship between training investment and skill gaps, found in the pooled sample, is likely to be biased by unobserved firm heterogeneity. Despite the inclusion in the empirical specification of several important correlates capturing observable firm characteristics, investment activities and barriers, workplace practices and business expectations, the EIBIS data provide limited insight into the level of skill intensity characterizing companies and their sociodemographic profile (e.g. workforce age, gender and skills composition). There is also no information about firms' track record with regards to their recruitment and retention strategy, reasons for and type of skill deficiencies, turnover rates (by staff skill levels), most common recruitment channels used (e.g. online or offline) and other such important mediating variables that could provide insight into the underlying mechanism linking company training decisions with skills constraints.

To mitigate the effect of unobserved omitted variable bias, we therefore exploit the longitudinal dimension of the EIBIS dataset. As mentioned above, about 15,374 unique companies (of the original 77,350) have been followed-up in subsequent survey waves. The panel element of the data allows us to explore in more depth the transitions of companies between training and non-training states and relate this to movements in and out of a skill gap state at present time and in lagged periods.

Examining the transition patterns of firms across different skill gap states over time (Table 3), there is substantial persistence among those faced with skill bottlenecks. More than 8 out of 10 companies (84%) that have a skill gap in earlier waves continue to do so in subsequent years. Only 16% of firms that face skills-related impediments at a given wave move to a non-skill-gap state at another wave. By contrast, more than a half (54%) of no-skill-gap firms report that skills became an important obstacle to investment activities in following years. Such movements however tend to be predominantly towards minor skill gaps, as making the leap towards a major skill gap tends to be rare (reversely, it is also easier for firms to move out of a situation of a major skill gap). The persistence of skill gaps is greatest among manufacturing and construction establishments, while moving to a situation where the availability of skilled staff is no longer an impediment is more frequently observed in micro-sized

companies in the services sector (see Table A3.2). SMEs are generally less likely to state that skills constitute an obstacle to investment when this is not the case in previous periods, and more prone to remaining in a no-skill-gap state, compared to larger-sized companies, which may experience more frequent changes in skill demands over time.

The raw transition probabilities also reveal marked state dependence in training investments among companies. 76% of firms that invested in employee training in earlier waves of the sample continued to do so in later periods, while about 1 in 5 companies (24%) move out of a training state. Transitions are more frequent among companies that decide to invest in training, even though they did not do so in the past (about 38%). Such companies making a leap towards training are concentrated in Southern and Central-Eastern European countries, indicative of some convergence taking place among EU Member States that are traditionally training laggards. SMEs and non-innovative companies in the services sector are less likely to move to a training state and, reversely, more likely to move out of it than other companies[14]. This could indicate that some types of firms face particular difficulties to overcome fixed costs, coordination issues or a lack of a suitable training infrastructure in some parts of the EU.

Table 3 further confirms that 8 in 10 companies that continuously invest in training across two periods (TT = training to training) face skill gaps, as do three-quarters of those that engage in employee training even though they did not previously do so (NT = no training to training). By contrast, for those that become non-training companies over time (TN = training to no training) and, especially, those remaining in this state (NN = no training to no training), the availability of skills constitutes a less pressing obstacle. Despite this reinforcing association between skill gaps and training investment, the transition data fail to provide compelling evidence that firms facing skill impediments (either in current or lagged time periods, or when considering major or minor gaps) are more likely to change their training investment state between periods (in particular, move to an NT state). This confirms that training investment is a slow-moving variable that depends more on structural corporate factors (e.g. firm training culture) and long-term planning decisions (dependent on immediate business outlook and expectations) but responds less to short-term business cycle movements.

Table 3 **Dynamics of corporate training investment and skill gaps**

(a) Transitions between different skill gap and training investment states

	No skill gap	***Skill gap***
No skill gap	46%	54%
Skill gap	16%	84%
	No major skill gap	***Major skill gap***
No major skill gap	71%	29%
Major skill gap	32%	68%
	No training	***Training***
No training	62%	38%
Training	24%	76%
No training (COVID-19 period)	71%	29%
Training (COVID-19 period)	32%	69%

(b) Relationship between training investment transitions and skill gaps (current and lagged)

	NN	**NT**	**TN**	**TT**
No skill gap (t)	30%	15%	16%	39%

[14] Results are available from the authors upon request.

Skill gap (t)	22%	14%	14%	50%
No skill gap (t-1)	30%	16%	15%	39%
Skill gap (t-1)	21%	14%	15%	50%
No skill gap (t-2)	28%	16%	15%	42%
Skill gap (t-2)	21%	12%	16%	51%
Training transition group shares	24%	14%	15%	47%
Mean skill shortage by training transition group	70%	76%	74%	80%

NB: NN = transition from no-training to no-training state. NT = no-training to training. TN = training to no-training. TT = training to training. COVID-19 period refers to the 2019/20 and 2020/21 EIBIS waves.
Source: European Investment Bank Investment Survey (EIBIS)

The transition analysis above highlights the need for estimating a dynamic model linking corporate training investment and skill gaps, one that allows for state dependence of the main dependent variable while also correcting for the contemporaneous endogeneity between training and skill-related investment obstacles. Table 4 therefore displays the empirical output following the estimation of a random effects logit regression applied to the EIBIS panel data that includes Mundlak terms within the specification to strip out time-invariant (unobserved) effects (Wooldridge, 2010; Hsiao, 2014)[15]. It also includes estimates of an Arellano-Bond dynamic GMM panel data model (Arellano-Bond, 1991). Hubert-White standard errors that are robust to heteroscedasticity are computed in all regressions.[16] A Mundlak test, which computes the joint significance of all the Mundlak terms added to the specification, confirms that the estimated coefficients of a pooled regression, as shown in Table 2, should be biased due to the presence of unobserved heterogeneity.[17]

The empirical estimation confirms that the statistically significant positive relationship between firms' training investment and the occurrence of (major) skills gaps is robust to unobserved heterogeneity. The size of the skill gap effect when such fixed effects estimation is applied remains close to 3,6% (falling to 2% for major skill obstacles), highlighting that the positive contribution of skill gaps to training is relatively immune to the presence of unobserved firm-specific factors. To overcome concerns about the lack of clarity in the reference period underlying the skill gap variable, the analysis also includes its lagged values in the empirical specification. The results (see Annex Table A3.4) confirm that the positive effect of skill-related investment impediments holds also when they precede firms' decision to invest in staff training, given that the skill gap variable lagged one and two periods also has a statistically significant positive impact on training[18].

Table 5 further displays the output of a dynamic GMM panel data model estimation that allows for dynamics in the dependent training variable and aims to tackle the endogeneity of skill gaps in the specification by using lagged differences (and levels) of the exogenous variables in the model as

[15] Such an empirical methodology should yield estimates that control for time-invariant unobserved characteristics (same as if a fixed effects panel regression was executed) but accommodates the non-linearity of the dependent variable and allows for the inclusion of variables that do not have any within-group variation into the specification.

[16] As a robustness check, we have also estimated a fixed effects linear probability model. The estimated coefficients on skill gaps and their first lag remain positive and statistically significant at the 5% level of significance. Results are available from the authors upon request.

[17] The Mundlak test reveals a statistically significant $\chi^2(14)$ value of 303.93***, rejecting the null hypothesis that the Mundlak terms are jointly equal to zero.

[18] Nevertheless, the two-period lagged model significantly reduces the sample size and available longitudinal information of the dataset. Future research could revisit the issue when the accumulation of further waves of the EIBIS panel dataset permits a more robust analysis.

instruments. It demonstrates that the availability of skills is a significant obstacle to investment that reinforces training provision in companies. This effect holds over and above the significant and strong state dependence of training investments in firms.[19]

Table 4 **Corporate training investment and skill gaps, logit panel data estimation with random effects and Mundlak terms**

	(1) *Major and minor skill gap*	(2) *Major skill gap*
Investment obstacle: availability of staff with right skills	0.34*** (0.046)	0.16*** (0.041)
Control variables (as Table 2)	x	x
Mundlak terms	x	x
Observations	31,469	31469
Number of respondents (panel)	14,272	14,272

NB: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Panel data logit regressions with random effects. Dependent variable is a 0-1 dummy indicating if a firm has positive employee training investment or not in last financial year. Mundlak terms (within-group mean value of independent variables for the time periods an individual is present in the longitudinal sample) included in control set, in addition to all explanatory variables as in Table 2. Full regression output available in Table A3.3 in Annex.
Source: European Investment Bank Investment Survey (EIBIS)

Table 5 **Corporate training investment and skill gaps, Arellano-Bond dynamic GMM estimation**

Training (lagged)	0.07*** (0.018)
Investment obstacle: availability of staff with right skills	0.04*** (0.012)
Control variables (as Table 2)	x
Observations	8,000
Number of respondents (panel)	5,006

NB: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Arellano-Bond dynamic GMM linear model. Dependent variable is a 0-1 dummy indicating if a firm has positive employee training investment or not in last financial year. Specification with control variables as shown in Table 2. Full regression output available in Table A3.5 in Annex.
Source: European Investment Bank Investment Survey (EIBIS)

5. Impact of coronavirus pandemic on firm training

5.1. COVID-19, workplace adjustments and investment expectations

The preceding analysis has shown that while firms constrained by the absence of suitably skilled staff are also more likely to invest in human capital development, corporate training decisions exhibit strong state dependence and react sluggishly to cyclical fluctuations and signals of skills scarcity. However, the COVID-19 crisis and related restrictions put firms in an extraordinary situation, with the

[19] After applying the Sargant test of overidentifying restrictions, we fail to reject the null hypothesis that the overidentifying restrictions are valid, so our instrument set satisfies the exogeneity condition ($\chi^2(9) = 8.87$). The Arellano-Bond test for zero autocorrelation in first-differenced errors also reveals that the instrumental variables satisfy the necessary conditions, namely we reject evidence of 1st order serial correlation (z = -16.4, p-value = 0.000) but fail to reject 2nd order serial correlation (z = -1.067, p-value = 0.285).

marked economic and social shock it entailed for organisations impacting on training decisions. COVID-19 contributed to the widening of pre-existing labour market inequalities for both vulnerable populations and firms (Pouliakas and Branka, 2020; EIB, 2022) and accentuated the digital divide due to remote working arrangements and social distancing practices (Sostero et al., 2021). In alignment with the downward trend in training investment demonstrated by the last two (COVID-19 affected) EIBIS waves, the OECD (2021) and van Loo et al. (2021) have also shown that COVID-19 lockdowns and social distancing practices significantly curtailed non-formal and, especially, informal learning at the workplace.

To obtain a first assessment of the impact of the coronavirus shock on companies, the 2020 and 2021 waves of the EIBIS included several COVID-19-related questions. Specifically, the survey enquired about the impact of the COVID-19 pandemic on employment, i.e. whether firms put staff on leave or were made redundant, let go or reduced working hours as a reaction to the pandemic as well as expectations about permanent employment reductions. Furthermore, the survey focused on current and likely long-term impacts of the coronavirus pandemic on firms' service or product portfolio, supply chains, innovation capability and use of digital technologies. Firms were also asked if the health shock altered their investment plans and access to credit and debt/equity position for 2020/21. This allows one to assess if there was a structural break in firms' overall economic outlook and environment for the 2020-2021 period relative to the past. In addition, the latest wave (2021) contains information on the impact and magnitude of the COVID-19 pandemic on company's sales or turnover compared to the beginning of 2020 (see Table 6).

The EIBIS data indicate that non-training firms were more likely to have put a significant fraction (over a half) of their staff on temporary leave, make them redundant or unemployed or reduce work hours in 2020 in reaction to the coronavirus shock, or to say that they do not intend or need to take any action, compared to their training counterparts. In contrast, training companies were instead more likely to have increased staff numbers, or their work hours, compared to before the pandemic. Nevertheless, there is a statistically insignificant difference in the use of temporary staff reduction channels between training and non-training companies, ceteris paribus[20]. What is more, training firms are significantly less likely to think that the pandemic shock will lead to a structural reduction in employment (especially those in the manufacturing and infrastructure sectors).

Similarly, training firms are more likely to expect that the COVID-19 outbreak will lead to a long-term increase in the use of digital technologies (including for instance to prevent business continuity or improve communication with customers, suppliers or employees). Training firms appear to be more adaptive, reacting to the pandemic and trying to position in the new normal. As a response to the coronavirus pandemic, they are more likely to have taken actions or to have made investments to develop new products, services or processes, transform their supply chain (bring more stages to the same location or closer to the businesses' home country) or become more digital (e.g. move to online service provision).

Table 6 **Impact of COVID-19 on corporate investment by training status**

	No training		***Training***	
	Mean	*Std.Dev.*	*Mean*	*Std.Dev.*
Change in investment expectations for [year] due to Coronavirus				
Abandon investment plans	0.156	0.363	0.119	0.324
Delay investment plans	0.676	0.468	0.699	0.459

[20] Probit regression results that include the COVID-19 variables in the basic and extended specifications as in Table 2 are available from the authors upon request. The discussion in this section refers to statistically significant, ceteris paribus, relationships between the COVID-19 variables and training investment.

Continue investment plans with different or reduced scale or scope	0.410	0.492	0.461	0.499
Labour adjustment: Had to put staff temporarily on leave, make staff redundant or unemployed or reduce the number of hours they work compared to before the coronavirus pandemic				
Yes, up to a quarter	0.203	0.402	0.223	0.416
Yes, up to half	0.100	0.300	0.108	0.310
Yes, up to three quarters	0.068	0.251	0.064	0.244
Yes, over three quarters	0.137	0.344	0.119	0.324
No, but will start to take action in next 3 months	0.037	0.189	0.044	0.204
No, and don't need/intend to take any of these actions	0.429	0.495	0.408	0.491
No, we have increased staff numbers and/or hours worked	0.026	0.158	0.033	0.179
Expectations of Coronavirus long-term impact				
Service or product portfolio	0.334	0.472	0.336	0.472
Supply chain	0.351	0.477	0.376	0.485
Increased use of digital technologies	0.381	0.486	0.499	0.500
Permanent reduction in employment	0.262	0.440	0.242	0.428
Impact of COVID-19 on company sales or turnover compared to beginning of 2020 (ordinal index from 1-3, where 1-increased, 2-same, 3-decreased)	2.333	0.773	2.232	0.790
Covsales (cardinal index from 1-7, where 1 = decreased over 50% and 7 = increased over 50%)	3.354	1.375	3.610	1.249
Receipt of financial support in response to COVID-19				
Access to new subsidised or guaranteed credit	0.143	0.350	0.141	0.348
Deferral of payments	0.191	0.393	0.183	0.386
Subsidies or other	0.427	0.495	0.429	0.495
Any other financial support	0.077	0.267	0.072	0.258
Not received any financial support	0.406	0.491	0.413	0.492
Actions taken as a result of COVID-19				
Increased its debt position	0.161	0.367	0.152	0.359
Raised new equity (market)	0.024	0.154	0.027	0.163
Raised new equity (current owners)	0.059	0.236	0.059	0.236
Made changes to investment plans	0.247	0.431	0.273	0.446
Revised investment plans upwards	0.137	0.344	0.188	0.390
Taken actions or made investments as response to COVID-19				
develop new products, services or processes	0.198	0.398	0.257	0.437
transform your supply chain	0.094	0.292	0.118	0.323
become more digital	0.300	0.458	0.417	0.493

Source: European Investment Bank Investment Survey (EIBIS)

Companies that invest in staff training are more likely to have made changes to their investment plans in 2020/2021 as a result of the coronavirus crisis and to state that they have revised them upwards. They are less likely to abandon their investment plans; instead, they are more likely to delay or change their scale and scope, in comparison to non-training companies.

Overall, the latest survey wave (2021) highlights that firms that invested in training in the previous financial year are also more likely to have increased their sales and turnover compared to the start of 2020, when the COVID-19 pandemic began to unfold across the globe. In the absence of longitudinal data, it is not possible to ascertain the causality of such a relationship and it is plausible that unobserved variables (e.g. corporate resilience, managerial quality or other such factors not available in the standard control set of the EIBIS dataset) could confound trends in corporate training investment and financial performance. But in view of the persistence of training investments it is plausible that past training investments could have contributed towards strengthening the resilience of European firms against the unanticipated economic and social shock of the pandemic.

5.2. COVID-19 and training transitions

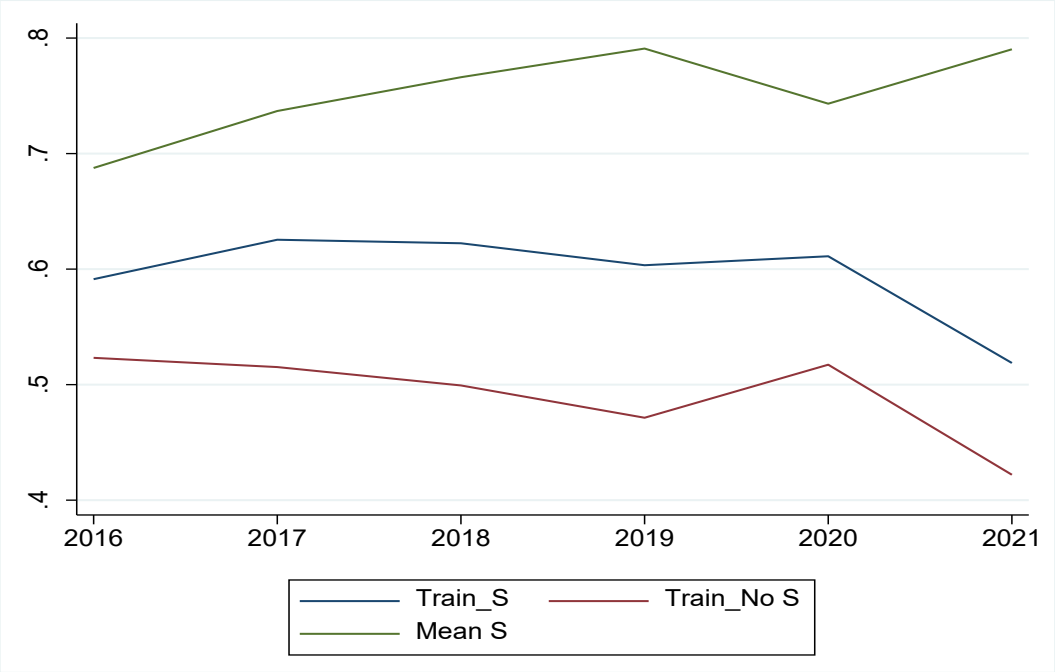
Given the sharp drop in firms' training investment activity with the pandemic, we investigate further which firms were more likely to continue or exit from training. The COVID-19 pandemic had a significant impact on firms' transition probabilities from and towards training. In particular, the probability of remaining in a training state, i.e. a firm that had invested in training in the previous year(s), declined markedly to 69% in the COVID-19 period, from 78% in the pre-pandemic era (Table 3(a)). This resulted in about 32% of firms moving out of a training state in the pandemic period (compared to 22% in the previous waves). Significantly fewer non-training firms made an investment in staff training in the pandemic waves, as compared to the previous years (29% vs. 39%, respectively). Subsequently, 71% of companies remained in a no-training state throughout the pandemic waves, in contrast to 61% in the previous period.

In contrast to such significant deviations in the transition probabilities of training, the data reveal that there were muted transitional effects in firms' skill gaps. The probability of firms remaining in a skill-gap state slightly rose from 85% in the pre-COVID-19 period to 86% in the last two survey waves (2019/2020-2020/21); whereas the respective share of firms moving out of a skill gap state declined only from 15% to 14% in the COVID-19 period. While the COVID-19 shock does not therefore seem to have had a significant effect on firm's skill gaps, it has provoked marked adjustments in training commitments.

Figure 3 illustrates this wedge in the relationship between skill gaps and training investments during the COVID-19 period. While the average share of firms faced with skill impediments declined in 2019/20, it rebounded in 2020/21. The reverse trend took place in the training investments of firms regardless of skill gap status[21]. The deviation is marked in the latest survey wave, in which respondents' survey answers are more likely to reflect the full impact of COVID-19 compared to the 2019/20 wave, where the pandemic was still in its early stages.

[21] A differences-in-differences probit regression in which we interact the skill gap variable with an indicator of the COVID-19 period (2020 onwards) fails to reveal any statistically significant difference in mean training investments between skill gap and non-skill-gap companies. There is therefore no evidence to suggest that firms faced with skill impediments reacted differently in their training decisions compared to non-skill-gap companies, following the onset of the pandemic.

Figure 3 **Corporate skills gaps and training investment, pre- and COVID-19 periods**



NB: 'Train_S' = mean training investments of skill-gap firms. 'Train_No S' = mean training investment of non-skill-gap firms. 'Mean S' = mean share of companies with skill gaps. COVID-19 period refers to the latest two waves of the EIBIS (2019/20, 2020/21).
Source: European Investment Bank Investment Survey (EIBIS)

Given the significant transitions into and out of training as a result of the COVID-19 outbreak, Table 7 aims to provide insight into specific characteristics associated with the probability of firms making training investment shifts during the recent tumultuous period. The table displays the estimated regression coefficients of two separate probit models that use the same specification and control variables as in Table 2. The first (*T→NT*) uses as dependent variable an indicator of whether companies stopped making any investments in employee training in the COVID-19 period (2020 onwards), even though they previously did so. While the second regression (*NT→ T*) uses as dependent variable a dummy indicator of firms that moved from a state of no training in the pre-COVID-19 era to one of training in the pandemic years.

Table 7 **Determinants of training transitions, pre- and COVID-19 period**

	T → NT	**NT → T**
Investment obstacle: availability of staff with the right skills	-0.08	0.06
	(0.057)	(0.069)
Company sector		
services	-0.08	0.04
	(0.066)	(0.08)
construction	-0.26***	0.28***
	(0.07)	(0.085)
infrastructure	-0.27***	0.16*
	(0.067)	(0.086)
other	-0.18	0.12

(manufacturing)	(0.131)	(0.206)
Company age		
<5 years	0.39**	-0.23
	(0.179)	(0.190)
5-9 years	0.27***	-0.09
	(0.083)	(0.105)
10-19 years	0.02	-0.14*
(20+ years)	(0.058)	(0.075)
sme	0.14*	-0.23**
	(0.077)	(0.104)
innovation	-0.12**	0.23***
	(0.054)	(0.07)
subsidiary	-0.11*	0.36***
	(0.056)	(0.08)
ln(wage bill per employee)	-0.15***	0.11***
	(0.042)	(0.043)
Changed employment in last 3 years		
same	0.15**	-0.00
	(0.059)	(0.073)
increased	-0.10*	0.18**
	(0.058)	(0.073)
Investment activities (other)		
organization and business process improvement	-0.48***	0.59***
	(0.056)	(0.077)
machinery and equipment	-0.35***	0.27***
	(0.057)	(0.067)
R&D	-0.18***	0.38***
	(0.066)	(0.085)
software, data, IT networks and website	-0.56***	0.52***
	(0.050)	(0.063)
land, buildings and infrastructure	-0.18***	0.14**
	(0.052)	(0.07)
Investment obstacle: availability of finance	0.08*	0.01
	(0.049)	(0.062)
Expectations: improved business prospects in sector/industry	0.03	-0.02
	(0.053)	(0.069)
2020.wave	-0.30***	0.19***
(2021.wave)	(0.050)	(0.065)
Country dummies	x	x
Constant	1.83***	-1.94***
	(0.484)	(0.502)
Observations	4,456	2,425

NB: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Probit regressions with dependent variables (0-1) dummies indicating if a firm made a transition from training to no training investment (**T → NT**), or from no training to training (**NT → T**), between the pre-COVID-19 (2016/19) and COVID-19 period (2020/21). The reference category for the NT→T regression is firms that did not invest in training pre-COVID-19 and did not change their status in the COVID-19 period (NT→NT). The reference category for the T→NT regression is firms that invested in training pre-COVID-19 and did not change status in the COVID-19 period (T→T).
Source: European Investment Bank Investment Survey (EIBIS)

The findings in Table 7 indicate that, compared to manufacturing companies, those in the construction and infrastructure sectors were overall more likely to shift towards investing in training after the

COVID-19 outbreak. Younger firms were more likely to discontinue their training investments, relative to their older counterparts. SMEs were also less inclined to move towards training than larger-sized establishments and prone to exiting an existing training state in the pre-pandemic era, while firms faced with finance constraints also had higher chances of stopping past training commitments. By contrast, innovative, growing and high-wage companies and those that are subsidiaries of parent organisations have a positive probability of commencing staff training investments, or of refusing to halt their previous commitments, despite the challenging pandemic environment. The results confirm that in the latest survey wave (2020/21), companies were on average characterized by lower chances of transitioning to a training state and were also more likely to exit from it.

6. Conclusions

As European countries slowly exited from the protracted economic crisis in the previous decade, significant differences in corporate training investments between them persisted, even though some convergence took place between Southern and Central Eastern European and their North-Western neighbours. With the broadening labour market recovery that preceded the pandemic, more European companies slowly stepped up their training investment activities, notably those experiencing rising skill deficiencies in available talent pools. We show that with the onset of the COVID-19 pandemic at the beginning of 2020, this slow upward trend in companies' training investments has been significantly reversed. What is more, the impact of the pandemic on firms' training provision is uneven across firms and European countries, raising the risk of stalling convergence.

With respect to persistent divergences, the empirical analysis shows that firms' training investments respond to needs, and those facing skill shortages are more likely to invest in the training of their staff. This relationship is robust to unobserved heterogeneity and dynamic effects. It is underpinned by both cyclical and structural conditions, including firm characteristics, firms' business outlook and rising skill demands associated with technological innovation or growing profitability. On average, it is mostly expanding, innovative and high-productivity companies that realise the value of systematically engaging in human capital investments, conditional on adequate financing. Such investments are also critically determined by the general economic outlook and immediate business prospects of rival firms. Firms that are more confident of being well-positioned to realise opportunities are also more inclined to invest in their staff. This also suggests that firms highly performing firms play a crucial role in helping to adapt skills supply, through creating jobs incentivizing training and providing more training activities themselves.

We find that firms' reactivity to skill gaps varies across geographies, possibly mediated by institutional and labour market conditions as well as existing training infrastructure and ecosystems. Skill-based constraints are more likely to provide a stronger signal for training in North-Western European firms, Here, it might point to firms more inclined to act in 'high training equilibria'. Complementary investment in education and training systems might also play a role. As for sectoral differences, we find greater reactiveness in the services sector where some of the less complex shortages might be easier for firms to address with training provision. By contrast, companies in the secondary sector may be prone to the deployment of labour-substituting strategies. Firms faced with 'complex' or 'major' skill gaps may in general be more inclined to consider alternative means of mitigating them than workforce training. Those driven by innovation are by contrast more sensitive to the availability of skilled human resources.

The transition analysis confirms that training investment is a slow-moving variable that depends more on structural corporate factors (e.g. firm training culture) and long-term planning decisions

(dependent on immediate business outlook and expectations) and responds less to short-term business cycle movements.

We find that some pre-existing inequalities in training provision and access to it are likely to have been exacerbated by the pandemic. Manufacturing firms, as well as younger-aged companies and SMEs, are found to be more likely to have exited from a training state in the pandemic period. By contrast, innovative, growing and high-wage subsidiaries of companies commenced staff training investments despite the challenging pandemic environment, accentuating pre-existing trends. This raises risks of increasing divergences across firms, workers and geographical areas. It also points to the need to focus on a mix of measures to strengthen training ecosystems in the longer term and step up training support and options, for example through certified digital courses, that can help revert the drop in training triggered by the COVID-19 shock. At the same time, support for training could help firms to reposition in the new normal.

While training investments declined markedly in the COVID-19 period for all firms, training firms have been less affected by a need to engage in significant workforce adjustments. They seem more ready to advance with the digital transformation in the emerging new normal and to improve product and service provision. By contrast, significantly fewer non-training firms made new investments in employee training in the pandemic period compared to previous years, indicative of COVID-19 putting companies' potential training decisions on hold and adding to risks of lagging behind in the post-pandemic environment.

Our findings on firms' training provision over recent years and the differentiated reaction to the COVID-19 shock point to several challenges for EU policy. First, that the availability of skills has remained a pressing issue for many firms, while training investment has been heavily disrupted, points to a challenging constellation. The fact that perceived skill gaps persisted at very high level points to the significance of structural drivers behind them, notably technological transformation and ageing, that come increasingly to the fore. EU firms will have to react to these to remain competitive. Critically, our results also indicate that the firms less advanced with the digital transformation are also less likely to train. Similarly, while skill gaps can induce firms to train, an ageing workforce might provide some disincentives to training investment at firm level.[22]

Second, while policy support during the pandemic has provided a lifeline to many hard-hit firms, there is a risk that as Europe is moving into recovery some resources might be trapped with workers (remaining) in non-training firms. Such workers have fewer opportunities to enhance their skillsets in firms less likely to transform. Given the non-negligible number of non-training firms, this risks slowing down structural transformation and technology adoption, particularly in parts of the EU where training investment is less prevalent and training ecosystems not well developed. One option for policy response in this situation could aim to facilitate individuals' access to training, e.g. through subsidies or making training an individual right. However, evidence on individual-based approaches to support training is mixed and there is a risk that those groups most in need of (re)training, to improve their opportunities in a changing labour market, are least likely to benefit. This points to the need to improve information on training, ensure quality training offers and workplace conditions that allow individuals to pursue training even if not part of their work.

Third, our results point to specific challenges for SMEs in the current situation, arguably linked to a need for policy action to mitigate risks of rising divergences. SME's were more likely to cut their training investment during the pandemic. Despite being more reliant on a quality training infrastructure and a large pool of qualified workers, they face challenges in accessing these. At the

[22] The EIBIS data does not include information on worker characteristics and a matched employer employee dataset would be needed to further investigate the relationship between workforce age and firms' propensity to train.

same time, they are in a more difficult position to compete on wages when trying to attract skilled labour moving out of the pandemic.

Finally, our results show that geographic differences in training are very persistent and catch-up tends to be slow. Firms train when they see a need for it and when they seem more confident to be in a position to reap the benefits. This points to the need to tackle investment bottlenecks, including – but not limited to – the availability of skills and improve the investment environment to entice more firms to invest in the training of their workforce to support economic convergence and cohesion in Europe.

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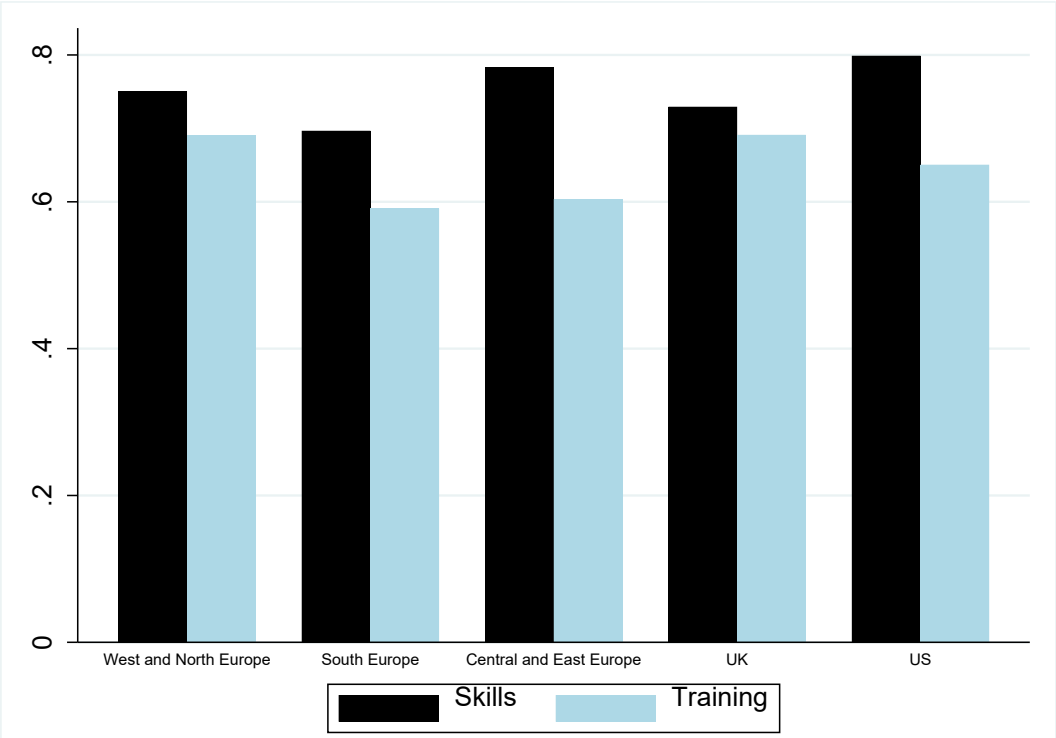
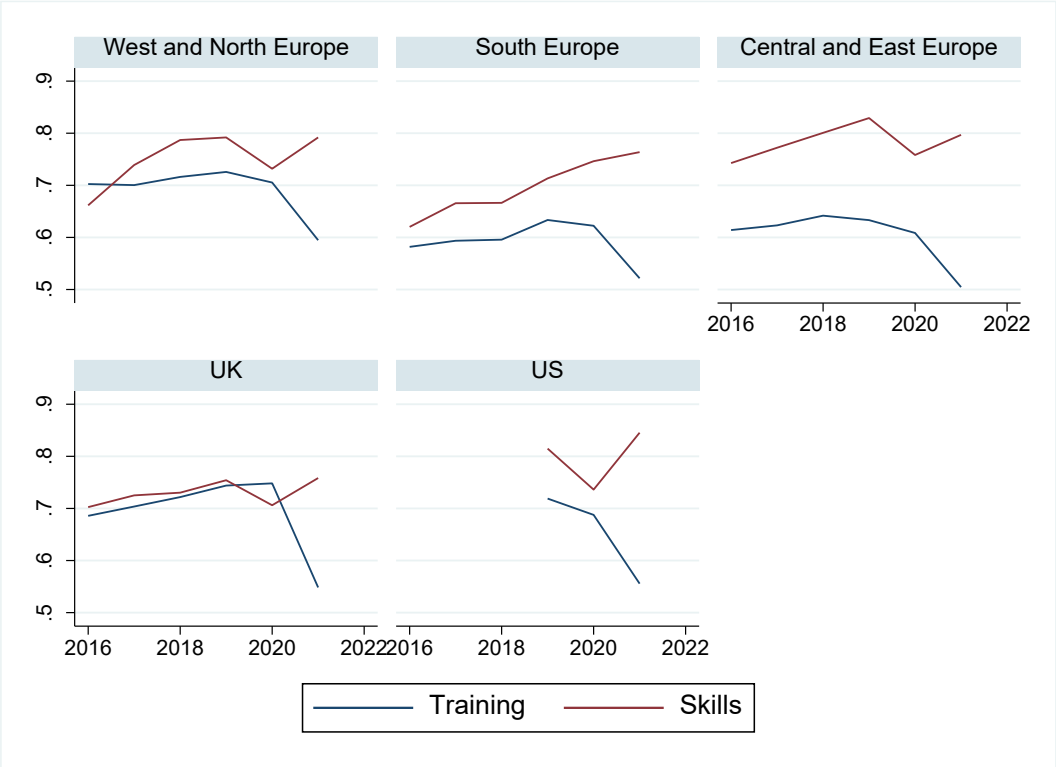
Annexes

Annex 1 Descriptive statistics





Source: European Investment Bank Investment Survey (EIBIS)

Table A1.1 **Summary statistics – all EIBIS sample**

Variable	Obs	Mean	Std.Dev	Min	Max
Training investment (dummy)	77,350	0.567	0.495	0	1
Investment obstacle					
Availability of staff with the right skills	76,757	0.753	0.431	0	1
Availability of finance	76,027	0.490	0.500	0	1
Company sector					
Manufacturing	77,350	0.291	0.454	0	1
Services	77,350	0.251	0.434	0	1
Construction	77,350	0.214	0.410	0	1
Infrastructure	77,350	0.235	0.424	0	1
Other	77,350	0.009	0.093	0	1
Company age					
less than 5 years	77,326	0.043	0.202	0	1
5-9 years	77,326	0.104	0.305	0	1
10-19 years	77,326	0.245	0.430	0	1
20+ years	77,326	0.608	0.488	0	1
SME	77,350	0.844	0.363	0	1
Innovation (dummy)	77,350	0.339	0.474	0	1
Employment changed in last 3 years					
same	73,547	0.236	0.425	0	1
increase	73,547	0.417	0.493	0	1
HRM/workplace practices					
Use of formal strategic business monitoring system	26,601	0.686	0.464	0	1
Reward individual performance with higher pay	39,607	0.664	0.472	0	1
Investment activities (other)					
Organisation and business process improvement	68,937	0.294	0.456	0	1
Machinery and equipment	68,937	0.739	0.439	0	1
R&D	68,937	0.229	0.420	0	1
software, data, IT networks and website	68,937	0.612	0.487	0	1
Land, buildings and infrastructure	68,937	0.311	0.463	0	1
Expectations: improved business prospects in same sector/industry	73,410	0.404	0.491	0	1
Wage bill per employee	69,911	27.827	21.129	0.0000167	150
Ln(wage bill per employee)	69,911	9.896	0.929	0.016	11.918
Profit	77,350	0.758	0.429	0	1

Source: European Investment Bank Investment Survey (EIBIS)

Annex 2 Empirical methodology

To test the ceteris paribus relationship between firms' training investments and skills gaps, the following discrete choice multivariate regression model is estimated:

$$T_i^* = \alpha + \beta_1 S_i + \beta_2 \mathbf{X}_i + u_i \qquad [A1]$$

where T_i^* is a binary dependent variable indicating whether firm i spends part of its investment budget on the training of employees. S is the main explanatory variable distinguishing firms according to the degree to which skill gaps impede their investment activities. $\mathbf{X}$ is a (1xk) vector of $\{\boldsymbol{x_1}, \boldsymbol{x_2}, \dots, \boldsymbol{x_k}\}$ control variables that affect the propensity of firms to encounter skills-related investment barriers and are correlated with their ability to finance staff training, while $u \sim i.i.dN(0, \sigma^2)$ is the unobserved error term.

The EIBIS also collects longitudinal information tracing the same firms across the six waves of the survey. This allows for the implementation of panel-based estimators in order to control for any unobserved heterogeneity affecting the regression coefficients of equation [A1], derived from the pooled sample i.e. $E(u_i/S_i) \neq 0$. Considering the discrete nature of the training dependent variable and the limited within-group variation of several key explanatory variables, a Mundlak random effects panel regression has been implemented as follows:

$$T_{it}^* = \alpha + \beta_1 S_{it} + \beta_2 \mathbf{X}_{it} + \beta_3 \overline{\mathbf{X}}_i + \epsilon_{it} \quad [A2]$$

where $\bar{X}$, a vector containing the Mundlak effects, namely the mean of the regressors, has been added into the specification as a proxy for the unobserved relationship between the error term and S, to ensure that $E(\varepsilon_i/S_i) = 0$.

Furthermore, to allow for the state dependence and endogeneity of the dependent and explanatory variables in different time periods, we estimate a dynamic Arellano-Bond GMM model as follows:

$$T_{it}^* = \alpha + \gamma T_{it-1} + \beta_1 S_{it} + \beta_2 \mathbf{X}_{it} + \epsilon_{it} \quad [A3]$$

Annex 3 Additional empirical findings

Table A3.1 **Sensitivity of training investment to skill gaps**

	beta
Region	
West and North Europe	.173***
South Europe	.100***
Central and East Europe	.108***
United Kingdom	.167**
US	.345***
Sector	
Manufacturing	.108**
Construction	.130***
Services	.186***
Infrastructure	.142***
Age	
less than 5 years	.144*
5-9 years	.089*
10-19 years	.141***

20+ years	.153***
Size	
SME	0.145***
Non-SME	0.116**
Innovation	
Not innovative	.155***
Innovative	.093***
Profitability	
Break-even or loss	.192***
Profit	.125***
Investment priority	
Replacing capacity (including training to keep skill levels same)	.096***
Capacity expansion for existing products/services (including training for increasing productivity)	.158***
Developing or introducing new products, processes or services	.185***
No investment planned	.124***
Investment finance	
Internal funds or retained earnings (e.g. cash, profits)	.154***
External finance (e.g. financing from banks, private or public equity)	.096***

NB: beta is the estimated coefficient of separate probit regressions of training investment occurrence on an indicator of firm's skill gap for each subgroup, with control variables as in the full specification of Table 2.
Source: European Investment Bank Investment Survey (EIBIS)

Table A3.2 **Transitions of skill gaps by firm characteristics and waves**

	No skill gap	*Skill gap*
Sector		
Manufacturing		
No skill gap	46%	54%
Skill gap	14%	86%
Construction		
No skill gap	42%	58%
Skill gap	14%	86%
Services		
No skill gap	48%	52%
Skill gap	18%	82%
Infrastructure		
No skill gap	48%	52%
Skill gap	17%	83%
Firm size: SME		
No skill gap	47%	53%
Skill gap	16%	84%
Firm size: non-SME		
No skill gap	44%	56%
Skill gap	15%	85%
2020/21 waves (COVID-19)		
No skill gap	46%	54%
Skill gap	14%	86%
2016/19 waves (Pre-COVID-19)		
No skill gap	46%	53%
Skill gap	15%	85%

Source: European Investment Bank Investment Survey (EIBIS)

Table A3.3 **Corporate training investment and skill gaps, random effects logit panel data estimation with Mundlak terms**

	(1) *Major and minor skill gap*	(2) *Major skill gap*
Investment obstacle: availability of staff with right skills	0.34***	0.16***
	(0.046)	(0.041)
Company sector		
services	0.05	0.04
	(0.097)	(0.096)
construction	0.34**	0.34**
	(0.159)	(0.158)
infrastructure	0.06	0.05
	(0.227)	(0.225)
other	0.06	0.04
(manufacturing)	(0.253)	(0.250)
Company age		
<5 years	-0.11	-0.11
	(0.187)	(0.186)
5-9 years	-0.08	-0.08
	(0.127)	(0.127)
10-19 years	-0.05	-0.05
(20+ years)	(0.073)	(0.073)
sme	-0.18	-0.18
	(0.252)	(0.249)
innovation	0.29***	0.30***
	(0.058)	(0.058)
subsidiary	0.13	0.13
	(0.134)	(0.135)
ln (wage bill per employee)	0.07	0.08
	(0.049)	(0.049)
Changed employment in last 3 years		
same	-0.16***	-0.16***
	(0.054)	(0.054)
Increased	0.13**	0.13**
(decreased)	(0.062)	(0.062)
Investment activities (other)		
organization and business process improvement	0.88***	0.88***
	(0.062)	(0.062)
machinery and equipment	0.41***	0.41***
	(0.065)	(0.065)
R&D	0.77***	0.77***
	(0.084)	(0.083)
software, data, IT networks and website	0.90***	0.90***
	(0.057)	(0.057)
land, buildings and infrastructure	0.30***	0.30***
	(0.062)	(0.062)
Investment obstacle: availability of finance	-0.04	-0.01
	(0.057)	(0.057)
Expectations: improved business prospects in same sector/industry	0.08*	0.09*
	(0.052)	(0.051)
Time dummies		
2017.wave	-0.10	-0.08
	(0.067)	(0.067)
2018.wave	-0.01	0.01
	(0.070)	(0.070)
2019.wave	0.07	0.09
	(0.074)	(0.074)

2020.wave	-0.07	-0.05
	(0.079)	(0.079)
2021.wave	-0.69***	-0.66***
(2016.wave)	(0.076)	(0.076)
Mundlak terms		
mean_sector	0.22***	0.22***
	(0.076)	(0.075)
mean_age	0.12*	0.13*
	(0.066)	(0.066)
mean_size	0.05	0.04
	(0.263)	(0.260)
mean_innovation	0.08	0.08
	(0.093)	(0.093)
mean_subsidiary	0.33**	0.33**
	(0.148)	(0.148)
mean_change_employment_3years	0.13***	0.14***
	(0.046)	(0.046)
mean_ln(wage bill per employee)	0.38***	0.38***
	(0.066)	(0.066)
mean_organisation&business process	0.62***	0.63***
	(0.097)	(0.097)
mean_machine	0.71***	0.72***
	(0.094)	(0.094)
mean_rnd	-0.14	-0.14
	(0.115)	(0.114)
mean_software	0.57***	0.58***
	(0.086)	(0.086)
mean_land	0.11	0.11
	(0.091)	(0.091)
mean_financial_constraint	-0.14*	-0.14*
	(0.081)	(0.082)
mean_exp_business_prospects	-0.05	-0.04
	(0.081)	(0.081)
Constant	-7.44***	-7.32***
	(0.597)	(0.597)
Observations	31,469	31,469
Number of respondents	14,272	14,272

NB: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Panel data logit regressions with random effects. Dependent variable is a 0-1 dummy indicating if a firm has positive employee training investments or not in last financial year. Mundlak terms (within-group average value of independent variables across time periods an individual is present in the longitudinal sample) included in control set.
Source: European Investment Bank Investment Survey (EIBIS)

Table A3.4 **Corporate training investment and lagged skill gaps, logit panel data estimation with random effects and Mundlak terms**

	(1) *Current and one lag*	(2) *One lag*	(3) *Two lags*
Investment obstacle: availability of staff with right skills	0.29***		
	(0.062)		
Investment obstacle: availability of staff with right skills (t-1)	0.18***	0.23***	0.19**
	(0.059)	(0.058)	(0.087)
Investment obstacle: availability of staff with right skills (t-2)			0.16*
			(0.08)
Control variables (as Table 2)	x	x	x
Mundlak terms	x	x	x
Observations	19,216	19,216	9,095
Number of respondents (panel)	10,873	10,873	5,660

NB: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Panel data logit regressions with random effects. Dependent variable is a 0-1 dummy indicating if a firm has positive employee training investment or not in last financial year. Mundlak terms (within-group mean value of independent variables for the time periods an individual is present in the longitudinal sample) included in control set, in addition to all explanatory variables as in Table 2. Full regression output available upon request.
Source: European Investment Bank Investment Survey (EIBIS)

Table A3.5 **Corporate training investment and skill gaps, Arellano-Bond dynamic GMM estimation**

Training (lagged)	0.07***
	(0.018)
Investment obstacle: availability of staff with right skills	0.04***
	(0.012)
Company sector	
services	0.06
	(0.051)
construction	0.02
	(0.064)
infrastructure	-0.03
(manufacturing)	(0.062)
Company age	
<5 years	-0.11**
	(0.046)
10-19 years	-0.02
	(0.029)
20+ years	0.01
(5-9 years)	(0.019)
sme	0.02
	(0.053)
innovation	0.05***
	(0.011)
Wage bill per employee	0.01
	(0.011)

Changed employment in last 3 years	
same	-0.03*
	(0.013)
increased	0.01
(decreased)	(0.012)
Investment activities (other)	
organization and business process improvement	0.10***
	(0.011)
machinery and equipment	0.03**
	(0.013)
R&D	0.11***
	(0.015)
software, data, IT networks and website	0.12***
	(0.011)
land, buildings and infrastructure	0.04***
	(0.012)
Investment obstacle: availability of finance	-0.01
	(0.011)
Expectations: improved business prospects in same sector/industry	0.02
	(0.010)
Time dummies	
2017.wave	-0.03**
	(0.014)
2018.wave	-0.01
	(0.011)
2020.wave	-0.02*
	(0.012)
2021.wave	-0.11***
(2019.wave)	(0.014)
Constant	0.27**
	(0.123)
Observations	8,000
Number of respondents	5,006

NB: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Arellano-Bond dynamic GMM linear model. Dependent variable is a 0-1 dummy indicating if a firm has positive employee training investments or not in last financial year.
Source: European Investment Bank Investment Survey (EIBIS)

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