

Skill provision concerns in the knowledge economy: training firms' perspective

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The rise of the knowledge economy has created new and higher skill demands on the labour market, posing challenges collective skill formation systems, traditionally catering to manual, mid-level skills. We examine how firms involved in apprentice training experience skill provision challenges in the knowledge economy, engaging with the political economy literature and with scholarship on 'skill gaps' and 'skill shortages'. We explore factors predicting firms' skill provision concerns, using novel survey data with over 1'650 participating Swiss training firms. Our findings lend support for scholarship emphasizing the primacy of digitalization and upskilling for a good adaptation to the knowledge economy, also in the context of dual vocational education and training systems. However, we identify issues of 'skill gaps' for firms in high-digitalized occupational fields, where the increasing attractiveness of general education at the expense of vocational education and training, and a lacking quality of applicants are prevalent. For firms in lower digitalized occupational fields, on the other hand, 'skill shortage' problems such as a loss of occupational popularity dominate.

Key words: dual VET, training firms, digitalization, knowledge economy, skill gaps, skill shortages, survey data

1. Introduction

With increasing digitalisation and general trends towards occupational upskilling and skill-biased technological change (Acemoglu, 2002; Diessner et al., 2022), favouring "skilled over unskilled labour by increasing its relative productivity and, therefore, its relative demand" (Violante, 2016, p. 1), policy makers face the challenge to secure the provision of high skills while ensuring education for a broad share of the population (Introduction to this special issue). This development has ramifications for countries' successful adaptation to the knowledge economy and the 'twin transition', where skill provision challenges may impede innovation and productivity, dampen growth (Horbach & Rammer, 2022) and exacerbate existing inequalities between the high and the low skilled (Hope & Martelli, 2019).

How countries adapt to these challenges are furthermore determined by the economic, industrial and institutional make-up (Açemoglu and Pischke, 1998; Hall and Soskice, 2001; Busemeyer and Trampusch, 2012). One central scholarship to understand skill provision in times of structural transformations of the labour market and the economy is the skill formation literature, placing the different involvement of the state and the private sector at the centre of the creation of human capital (Bonoli and Emmenegger, 2022; Antonazzo et al. 2023). In collective skill formation systems (CSFSs), characterized by a high public and private commitment to education and training, firm-provided apprenticeships are cornerstones (Busemeyer and Trampusch, 2012). CSFSs are generally associated with a high level of matching between skill demand and supply on the labour market and a balance of economic efficiency and social inclusion goals (Di Maio et al., 2019; Bonoli and Emmenegger, 2021; Carstensen and Ibsen, 2020).

Recently, however, firms in countries with established dual apprenticeship systems, such as Germany, Austria and Switzerland, face a pronounced lack of adequately skilled workers compared to firms in countries with statist (e.g., France) or liberal (e.g., United Kingdom) skill formation systems, according to their own statements (ECS, 2019). The historical *raison d'être* of CSFSs was to cater to employers' skill demands by providing workers in artisan and crafts sectors, expanding to industrial production workers with the Fordist economy (Gonon & Maurer, 2012; Busemeyer & Trampusch, 2012). Currently, employment in the traditional core sectors of CSFSs are declining and face simultaneously a loss of interest from the younger generation due to academic drift (Eurofund and Cedefop, 2020, pp. 62-63; Thelen, 2014; Protsch & Solga, 2016; Brunello & Rocco, 2017; Graf, 2018).

At the same time, service and technological sectors, also provided through vocational training programs, demand higher more knowledge-oriented (Açemoglu & Restrepo 2016). With increased premia on higher (STEM) skills on the labour market, and the slow adaptability of coordination between central actors in CSFSs, including state, business and unions, training-providing firms may struggle to keep their mode of skill provision relevant (Iversen and Soskice, 2019; Busemeyer et al., 2022; Durazzi, 2023). Policy makers and firms alike thus face uncertainty about their futures as economic actors and as training providers (Rodrik, 2022; Beckert, 2014), and their courses of action (e.g. expansion of the state as training provider, increased investment

in or exit from training for firms, see Durazzi and Geyer, 2019; Wilson and Bajka, 2024).

While firms as providers of education and training are central to CSFSs, firm perspectives are often missing in the literature (or limited to cost-benefit studies (Wolter and Schweri, 2002; Wolter et al., 2006; Aepli et al., 2024) or small-n studies (Baumeler and Lamamra, 2019; Imdorf, 2017)). With growing importance of technology and digitalization in the transition to the knowledge economy, firms' exposure to and adaptation of digitalization across sectors and occupations (Calvino et al., 2018) has plausible implications for their perspective on their roles and relevance as training-providers (Comin & Mestrieri, 2013; Acemoglu & Restrepo, 2016). Still, to our knowledge, no study has yet attempted to use training firms' perspectives to understand skill provision challenges in transitioning to the knowledge economy and their political implications. Whereas skill provision problems are decidedly felt in most economic sectors, the nature of these challenges for different firms (nested in occupations) and their potential remedies are largely unknown.

To address this gap, we 'look under the hood' on training firms to gauge their situation in the knowledge economy. We ask, *what are the main challenges training firms face in the knowledge economy? To what extent can the level of digitalization in sectors explain training firms' experience of 'skill gap' and 'skill shortage' problems?* Grasping the complexity of occupational and firm-level particularities with a recent and novel survey with a focus on skill provision with over 1'600 training-providing firms, we contribute to the growing skill formation literature and its yet under-explored firm-dimension with an explorative study, drawing on theoretical concepts from labour economics.

We target Switzerland as a typical case of a CSFS (Emmenegger & Seitzl, 2019) but among others (such as Austria, Denmark, Germany, and the Netherlands) a 'least likely' case for malcontent with the dual vocational education and training (VET) system (Seawright & Gerring, 2008; George & Bennett, 2005). In Switzerland, the economy relies strongly on dual VET, and it is known for its high level of firm involvement (Busemeyer & Trampusch, 2012). Switzerland has a high participation of apprentices (ca. 60 percent of each school-leaving cohort choose the VET track) and offers over 240 dual training programs across the skill spectrum (SKFB, 2023; Wettstein et al., 2017). The level of skill match on the labour market is balanced there is neither a large oversupply nor undersupply of skilled workers (Pusterla et al., 2018) and

the system enjoys high political support (Emmenegger et al., 2023). This sets the scene for a conservative estimate of firms' skill provision challenges in a CSFS context, which are likely to be more severe in less well-matched systems.

The paper is organized as follows. In section 2 we review the literature on the transition to the knowledge economy, and skill gaps and skill shortages and the relation to dual VET and derive hypotheses. In section 3 we discuss the data and methods used in this paper, and we present our results in section 4. A discussion and conclusion follow in section 5.

2. The knowledge economy and collective skill formation systems

For a smooth transition and adaptation to the knowledge economy, CSFSs have been shown to benefit from an orientation towards technological advancement and the rapid update of training curricula catering to the needs in the economy (Diessner et al., 2022; Emmenegger & Haslberger, 2023; Autor et al., 2003). Training for such occupations, has undergone important upskilling (Oesch & Rodríguez Menés, 2010; Deissinger, 2019) with strong political consensus—across different CSFSs—underpinning such developments. In Germany, the expansion of the tertiary sector and the decline in the industrial, production-sector, has engendered an increased interest and need for workers with higher cognitive skills and thereby an upshoot in enrolment in higher education and recruitment of university graduates (Baethge & Wolter, 2015; Durazzi, 2023). This has posed a dilemma for dual initial VET: firm involvement in training-provision is declining with the employment rates in mid-skilled sectors, while aspirations and career-choices among compulsory-school leavers have shifted towards general and higher education (Baethge & Wolter, 2015; Anderson & Hassel, 2013). With the movement of highly qualified students towards higher education, and a loss of interest in training from the employers' side, the status of VET has decreased in favor of higher education (Jacob & Solga, 2015; Deissinger & Ott, 2016). At the university-level, dual studies were integrated to cater to these developments in the labor market in Germany (Graf, 2013). In Switzerland, however, adaptations within the existing dual VET system for upskilling and the advancement of higher skilled vocational programs have taken precedence over changes oriented towards integrating vocational elements into the sphere of higher education, as in Germany (Emmenegger et al., 2023; Graf, 2016).

At the same time, employment in care, retail, and hospitality—less affected by technological change and digitalization (Autor, 2022)—is expanding and increasing the

pressure on CFSFs to maintain a high level of learners to cater to future skill needs (Culpepper & Thelen, 2008; Oesch & Rodríguez Menés, 2010). Similarly, manual work, such as construction and production manufacturing, economic cornerstones in the industrial era, continues to play a role in the Swiss political economy (Oesch, 2023). However, given the economic premia to and political support for work in high-skilled and highly digitalized services in the overall economy and the growing role of the knowledge economy also in VET (Oesch & Rodríguez Menés 2010; Oesch, 2023; Emmenegger & Haslberger, 2023; Durazzi, 2023; Busemeyer et al., 2022; Iversen & Soskice, 2019), employers (and training firms) in less digitalized sectors and occupations may carry a double burden. First, in the transition to the knowledge economy, where demographic changes and international competition make domestic skill supply more challenging to secure. And second, in the context of dual VET, ascertaining an adequate level of skill supply (apprentices) to cater to the skill demand, lest alternatives to dual VET would be more efficient, yield higher productivity gains and in-firm training abandoned (Wolter et al., 2006; Wolter & Schweri, 2002; Powell & Snellman, 2004).

Considering the growing scholarship on preferences for education, tendencies on the supply-side of labor, namely prospective students and apprentices (and their parents), hold preferences for education tracks and occupations that are associated with strong cognitive and general skills (Autor et al., 2003; Durazzi & Benassi, 2020; Krueger & Kumar, 2004), high earnings and flexible work (Powell & Snellman, 2004) and that enjoy a high social prestige (Abrassart & Wolter, 2020; Lynn & Ellerbach, 2017). For training firms, these streams have set off a ‘battle for apprentices’ (Deissinger, 2019, p. 294) where burdensome, manual and low-prestigious work attracts fewer apprentices in favor of programs in fields of typically knowledge-intensive, digital and ICT-gearred occupations (Deissinger & Ott, 2016). Although recent work has shown a less pessimistic future for dual VET in terms of earnings and social mobility for VET-degree holders (Haslberger, 2021; Emmenegger & Haslberger, 2023; Durazzi & Tonelli, 2024) other studies confirm the trade-off of higher entry earnings but diminishing income returns and employment outcomes over the life course for vocational compared to general education graduates (Korber & Oesch, 2019; Decker et al., 2024; Hanushek et al., 2017). Streams of academic drift and shifting educational preferences for high-skilled work in knowledge-intensive sectors (Baethge & Wolter, 2015; Benassi & Durazzi, 2020; Durazzi, 2023; Herrigel, 2015), fueled by the positional

value of general education diplomas (Di Stasio et al., 2016; Scholz et al., 2023) pose tangible challenges for firms in general, and training firms in CSFSs in specific. These challenges should however be more likely to manifest themselves in the less-digitalized, less-skilled occupational fields that face an uphill battle in the transition to the knowledge economy in general and are plagued with popularity problems among school-leavers (Deissinger & Ott, 2016; Deissinger, 2019).

H1a: Firms in low-digitalized occupational fields are more likely to express skill provision concerns than firms in high-digitalized occupational fields.

H1b: Firms in low-digitalized occupational fields are more likely to express skill provision concerns that are *related to dual VET* than firms in high-digitalized occupational fields.

In the following section, we discuss the different natures of skill provision issues in a dual VET context.

2.1 Skill gaps and skill shortages in modern dual VET systems

Given the range of structural changes on the labour market and in education of recent years, we expect various impact on sectors and occupations given their position in the knowledge economy. Specifically, we will argue that firms in higher digitalized occupations (Calvino et al., 2018) are more likely to experience ‘skill gaps’ problems, and firms in less digitalized occupations to experience ‘skill shortage’ problems.

In its plainest form, ‘skill gaps’ “[...] measure the extent to which workers lack the skills necessary to perform their current job” (McGuinness et al., 2018, p. 990), and is “usually measured by collecting information from the employer on the perceived skill deficiencies of workers” (Ibid.) Despite recent criticism directed towards employers for inflating ‘skill gap complaints’ (Cappelli, 2015; McGuinness et al., 2018), scholars and cross-country studies maintain that the gap is real. This phenomenon hurts single firms, entire industries, as well as individuals whose skill sets do not match labour market demands (Brunello et al., 2007; Brunello & Wruuck, 2021; Somers et al., 2017; Healy et al., 2015).

If ‘skill gaps’ capture the unmet demand of employers for a certain type of skilled worker (McGuinness et al., 2018), the issue incorporates further nuance. The reason for the ‘skill gap’ may be the “unfilled or hard-to-fill vacancies that have arisen as a consequence of a lack of qualified candidates for posts” (McGuinness et al., 2018, p. 991). This phenomenon is usually referred to as ‘skill shortage’ which “arise when

employers are unable to recruit staff with the required skills in the accessible labour market and at the ongoing rate of pay” (Brunello & Wruuck, 2021, p. 1147; Quintini, 2011). Thus, as put by McGuinness et al. (2018), “Skill gaps describe the situation whereby the employer believes that workers do not possess the adequate competencies to successfully discharge their current role. ‘Skill shortages’ relate to a situation whereby employers are unable to fill key vacant posts due to a lack of suitably qualified candidates” (2018, p. 986). Although ‘skill shortage’ issues are viewed as a subset of ‘skill gaps’ issues in the literature (McGuinness et al., 2018; Brunello & Wruuck, 2021), we treat these as two separate—albeit not mutually exclusive—categories that cater to different types of skill provision problems that firms may experience.

From the vantage point of the skill gaps and skill shortage literature, the streams of upskilling in the economy and increased interest in general education cast specific doubts over the effectiveness and viability of CSFSs over liberal systems (Autor et al., 2003; Cappelli, 2015; Graf, 2018; Oesch & Rodríguez Menés, 2011; Durazzi, 2023; Jaik, 2020). Dual VET programs often prioritize practical skills over academic knowledge, which potentially limits individuals’ ability to pursue higher education or adapt to rapidly changing technological advancements, (particularly in knowledge-intensive sectors (Thelen, 2020)). There is also a perceived social prestige gap, where dual VET programs carry a lower status compared to academic education pathways, leading to biases and stigmatization (Iannelli & Raffe, 2007; Shavit & Müller, 1998; Abrassart & Wolter, 2020).

For firms involved in dual training, the latter issue relates both to the issues of skill gaps *and* skill shortages. The move of high-qualified candidates into general education on the high-skilled end of VET programs, while the demands on technical and cognitive skills are on the rise on in the same sectors, is observed in many systems (Deissinger, 2019, Busemeyer & Thelen, 2022, Schulz et al., 2023 for Germany; Pusterla et al., 2018 for a multi-country comparison). However, although the skill needs have increased among the knowledge intense sectors, the needs in the economy often align with the skills learnt through high-skilled initial VET programs in highly digitalized sectors (Seitzl, 2020; Seitzl & Unterweger, 2022; Damelang & Ruf, 2023; Hassel & Palier, 2020; Calvino et al., 2018). Furthermore, in CSFSs, vocational degrees are valued as high if not higher by employers compared to liberal systems (Di Stasio et al., 2016). Thus, although valued by employers, dual VET suffers from a popularity deficit both in more and less knowledge-intensive and digitalized sectors, potentially

creating mismatches when the system's ability to attract suitable and qualified candidates for the programs is failing.

In specific, we posit that 'skill gaps' are likely to occur in dual VET where certain apprenticeships are in high demand by apprentice candidates, but these candidates lack the required training in knowledge-intensive and highly digitalized fields. At the same time, among firms in sectors that are less digitalized and that offer training in mid- and low-skilled occupations, there is a concern for non-college-bound youths having shifted preferences from the traditional blue-collar jobs towards knowledge-intensive white-collar jobs (SKBF, 2023; Jaik, 2020; Durazzi, 2023; Graf, 2018; CEDEFOP, 2018). This would be an example of 'skill shortage' related to dual VET, occurring where there are not *enough* potential learners interested in taking up jobs due to the unattractiveness of certain types of work, due to poor working conditions, low wages, and career prospects (CEDEFOP, 2018).

Hypothesis 2a: Skill gap issues are more likely among firms in high-digitalized occupational fields.

Hypothesis 2b: Skill shortage issues are more likely among firms in low-digitalized occupational fields.

In the following, we discuss the materials and methods used in this paper.

3. Materials and methods

3.1 Survey and data

We independently collected the contact details of Swiss training firms from the open recruitment platform berufsberatung.ch (orientation.ch) between January 2021 and October 2022 and obtained a total number of 10'632 firms in various economic sectors. In June and July 2022, we carried out ten interviews with firm representatives to inform and our survey questionnaire (Table A15 in the appendix). The project was waived by the University of St. Gallen ethics committee.

We reached out to all firms via email at the end of November 2022. In the invitation to participate in the survey, we addressed the email to employees who are involved with the recruitment of apprentices in the firm (either in the capacity of manager, HR worker, VET professional, or other). We declared the aim of the survey as being to understand the state of shortage of skilled workers in Swiss training firms. We

explained that we would do this by looking at strategies that the firms pursue to solve skill provision issues and the overall role of vocational education and training. After two reminders we had in total 2'738 responses. After removing cases with missing values from the relevant variables (see section 3.2), we had a working sample of 1'653 firms, which represents ca. 15,5% of the total number of contacted firms.

The firms that responded were offering their main VET programmes in 34 different vocational fields¹, out a total of 38 (SBFI, 2023). In our sample, healthcare and manufacturing was the largest, followed by the construction sector (see Table 1). However, in sectors such as electricity, also with known skill provision problems, the share of non-participating firms was twice as high as the participating firms. Compared to the most popular occupations in Switzerland during 2022 (i.e., commercial employee, healthcare worker, retail clerk, social care worker, electrician, etc., see SBFI (2022), the respondents in each of these occupations correspond well with this list, except for the high representation of occupations in the construction field (see table A13 in the Appendix).

Since we highlighted in the invitation email that our aim was to understand skill provision and firms' strategies to secure their skill supply in Switzerland, there is a possibility that firms in sector touched by these issues decided to participate. For example, there is a higher share of firms participating in construction and healthcare, where the lack of skilled workers is well-documented (CEDEFOP, 2023) (see Figure A1 in the Appendix). It is therefore possible that our findings overstate the presence of skill provision concerns, as well as its relation to dual VET. Our conclusions are cautious in response to this possible selection bias.

Regarding participation across the cantons in Switzerland we observe a slightly higher participation of firms in German-speaking cantons, a slightly lower participation of firms in French-speaking cantons, and a roughly equal participation of firms in Italian-speaking cantons compared to the non-participating firms (see Figure A2 in the Appendix).

¹ Due to the proximity of some vocational branches, we combined Databases, network design and administration; Software and application development; and Computer use to ICT, and Interdisciplinary programs and qualifications with health and social care; Nursing and midwifery; Medical diagnostics and treatment technology; Pharmacy; and Social work and counselling to Health and social work. After the re-grouping, we used 30 vocational fields in the analysis (Table 1).

The respondents who agreed to take the survey were presented with an online questionnaire that asked questions about the firms and the respondents, the firms' skill provision strategies, approaches, experiences, and challenges related to dual VET, and the firms' affiliations and activities with organizations of the working world.

Table 1. Vocational fields

<i>Vocational fields</i>	<i>n firms</i>
Construction	297
Human health care and social work	271
Secretary and office work	149
Machines and metal industry	130
Electricity and energy	106
Wholesale and retail	86
Hospitality	82
Vehicles, ships and airplanes	71
Food production	56
Architecture and urban planning	50
Materials	43
Transport services	37
ICT	36
Crop production and animal breeding	32
Gardening	31
Hairdressing and beauty	30
Dentistry	30
Electronics and automation	27
Domestic services	21
ICT	35
Forestry	21
Arts and crafts	12
Chemistry	12
Audio-visual technique	8
Textile production	8
Fashion and industrial design	7

Veterinary medicine	4
Recycling	2
Library services	1
Total	1653

3.2 Variables and estimation strategy

We use a logistic regression model with binary dependent variables (concern for the firms' skill provision; firms' skill provision concerns related to dual VET; and reasons for VET-related skill provision concerns) (Hosmer & Lemeshow, 2000; Long, 1997).

In the first step of the analysis, we first used the survey question whether the firms' thought that a skill shortage within the firm is likely within the next five years as the dependent variables. We used the term 'skill shortage' to convey a general lack of skills and skilled workers within the firm, since it is the commonly used term among laymen and in media when discussing this issue (although in this article we use the term to denote a 'lack of suitable workers', following McGuinness et al. (2018) and Brunello and Wruuck (2021)). The answer categories ranged from 'highly likely', 'rather likely', 'neither', to 'rather unlikely' and 'unlikely' on a Likert scale. We recoded this item into a binary variable, where the 'highly likely' and 'rather likely' categories were coded 1, and 'neither', 'rather unlikely' and 'highly unlikely' were coded 0. We used this variable as a dependent variable in the first step of the analysis.

In the second step of the analysis, we asked the firms that had indicated that they thought a skill shortage in the firm within the next five years was 'rather likely' or 'highly likely', if their skill shortage concern was related to dual initial vocational training². We coded the answers 'no' as 0, and 'yes, in-house training might not keep up with future skill demands in this establishment' *and/or* 'Yes, the dual form of vocational training might not be flexible or adaptive enough in general', *and/or* 'Yes, other' as 1.

² Due to a programming error, intercepted and addressed early in the data collection, a few respondents who did not indicate a skill shortage concern were still asked whether their skill shortage problems were related to dual VET. In our analysis, this accounts for n=48 observations. Only n=2 of these went on to indicate that their (presumed) concern was related to dual VET, which we do not believe influences the results.

In all the logistic models, we use a predictor variable relating to the occupational field (in which the firms offer their main apprenticeship) according to its *level of digitalization*. We rely on Calvino et al. (2018) and their digitalization taxonomy³ of economic sectors and score the vocational field according to the economic sector they are sorted under. High digital-intensive vocational fields were given a score of 4 and the lowest digital-intensive occupational fields were scored 1 (see table A16 in the Appendix). In our dataset, we also have a variable detailing the skill requirements in the different occupational fields in the sample, which correlates to the digitalization variable at 0.9403, showing almost a complete overlap between the two. Since this paper aims to abstract to the overall needs in different occupational groups given the pervasiveness of digitalization as a concept covering multiple aspects of sectoral advancement in the knowledge economy, we chose to use this variable, but sometimes use the terms ‘digitalized’, ‘knowledge-intense’ or ‘high-skilled’ occupational groups interchangeably.

As control variables⁴ we included items from the survey that, on the level of individual firms, may influence their outlook on their skill supply provision (both in general and related to dual VET) but that are independent of the main predictor variable (digitalization of occupational field) and not directly related to the research question in focus. Previous works have shown that the firms that are using dual VET for long-term economic goals (as supposed to as a substitute low-cost labour) are more likely to offer employment (i.e. retain) their graduated apprentices as workers (Wolter et al., 2006; Mohrenweiser and Backes-Gellner, 2010). Firms that employ this strategic orientation plausibly have a higher investment and entrenchment in dual VET, compared to non-retention-oriented firms that often generate net-benefits from their training (Wolter et al., 2006; Wolter and Schweri, 2002), which may make them more vulnerable to dysfunctions of the dual VET system (to the extent to which they are prevalent) (Culpepper and Thelen, 2008). Therefore, we include this survey item as a control variable.

In the similar vein, assuming a greater level of concern about the future skill provision and a dissatisfaction with the functioning of the dual VET system is be related

³ The authors use indicators both capturing technological components (ICT investment, purchases of ICT intermediates, Robot use, Online sales) and human capital components (ICT specialists) to construct the digitalization taxonomy for sectors.

⁴ Full list and details available in Table A1 in the Appendix.

to the difficulties filling apprentice vacancies and thus meet the skill demands in the organization (Le Barbanchon et al., 2023), we control for firms' reported difficulties to hire apprentices the last 12 months.

Since the enrolment in general education has expanded overall in Switzerland (Emmenegger et al., 2023; BFS, 2022), but not equally in all cantons, we included a binary variable for an above or below average (13.7 per cent) relative change in general education enrolment at the upper secondary level between 2010 and 2022. Further, we controlled for firm size, membership in professional associations (in Switzerland, these are called Organizations of the working world, *Oda* (Wettstein et al., 2017)); and language region (as explained in section 3.2). Lastly, we estimated the travel duration from the responding firms⁵ to the closest Higher Education Institute (HEI), to account for the (potential) competition training firms are facing from the possibility to pursue general (higher) education in the local area where the firm is located. Our assumption is that the closer the distance (measured in travel duration by public transport) between the firm and a HEI, the more likely that young school-leavers in the same area are to consider an academic track rather than dual VET.

For the second step of the analysis, we used the follow-up questions asked to the firms who had indicated that their skill provision concern was related to dual VET. We asked the respondents to indicate, firstly, the reason(s) for which their concerns were dual VET related. We chose to focus on the categories that both were the most pertinent for the firms and that relate closest to the issue of *skill gaps*: 'General education is increasingly attracting potential VET candidates', 'Apprentice candidates are less and less qualified for the dual VET in the concerned occupation' and "The VET curriculum is not up to date with the rising skill requirements in the concerned occupation", and for *skill shortages*: 'The occupation is increasingly losing popularity'. We coded these answers into binary variables.

We then used each reason given for dual-VET related skill provision concern as dependent variable and ran separate analyses, with controls⁶.

To estimate the effects of the predictor variables on the outcome, we used linear logistic regression models and calculated the average marginal effects (AME) following Long (1997) and Hosmer and Lemeshow (2000). The formula for the logistic regression model is written:

⁵ Details on the operationalization is available in table A1 in the appendix.

⁶ The full models of the analyses are available in Tables A5-6 and A8-12 in the Appendix.

$$P(Y = 1 | X_1, X_2, \dots, X_k) = \frac{1}{1 + e^{-(\beta_1 \text{Digitalization} + \beta_2 \text{Retention} + \beta_3 \text{Hiring difficulties} + \beta_4 \text{Firm size} + \beta_5 \text{OdAmember} + \beta_6 \text{Language} + \beta_7 \text{HEI duration})}}$$

We ran post-estimation tests for multicollinearity between the predictor variables, calculating Variance Inflation Factors (VIF) (Kohler & Kreuter, 2012), and did not detect any multicollinearity (see tables A3 and A4 in the Appendix).

4. Results

4.1 Skill provision concerns across occupational fields

In table 2 below we list the sectors and the answer distribution on the “Skill shortage is likely within the next 5 years” question. The mean value is ca. 67% in the sample.

Table 2. Skill provision concerns across occupational fields (by level of digitalization)

	<i>Likely</i>	<i>Not likely</i>	<i>n</i>	<i>%</i>
<i>Skill shortage likely within the next five years</i>				
High-digitalized occupational field	232	138	370	62.7
Architecture and urban planning	34	16	50	68
Electricity and energy	78	28	106	73.6
Electronics and automation	18	7	25	72
ICT	22	13	35	62.9
Library services	1	0	1	100
Secretary and office work	77	72	149	51.7
Veterinary medicine	2	2	4	50
Medium-high-digitalized occupational field	197	111	308	64
Arts and crafts	7	5	12	58.3
Audio-visual technique	5	3	8	63.5
Machines and metal industry	91	39	130	70
Vehicles, ships and airplanes	48	23	71	67.6
Wholesale and retail	45	41	86	52.3
Medium-low-digitalized occupational field	276	92	379	74.7
Chemistry	6	6	12	50

Dentistry	11	16	27	40.7
Fashion and industrial design	4	3	7	57.1
Human health care and social work	213	58	271	78.6
Material production	38	5	43	88.4
Textile production	4	4	8	50
Low-digitalized occupational field	403	204	655	66.4
Construction	206	91	297	69.4
Crop production and animal breeding	10	21	31	32.3
Domestic services	11	10	21	52.4
Food production	41	15	56	73.2
Forestry	14	7	21	66.7
Gardening	21	10	31	67.7
Hairdressing and beauty	17	12	29	58.6
Hospitality	56	26	82	68.3
Recycling	0	2	2	0
Transport services	27	10	37	73
Total	1108	545	1653	67.03

Note: The measure of digitalization of sectors is taken from Calvino et al. (2018).

From Table 2, we see that firms in the lower digitalized groups in general are more concerned about their future skill provision compared to the higher digitalized groups, the medium-low group having the highest mean value of 74.7%.

Table 3. Skill provision concern related to dual VET: descriptive data

<i>Skill provision concern</i>			
<i>related to dual VET</i>	<i>Freq.</i>	<i>Percent</i>	<i>Cum.</i>
Is not related	814	70.42	70.42
Is related	342	29.58	100
Total	1156	100	

In the following step, we ran two logistic regression models where we used ‘skill provision concerns’ (Figure 1a) in the first as a dependent variable, and ‘relating the skill provision concerns to dual VET’ (Figure 1b) as dependent variable in the second,

including the predictor variables. We omitted the control variables from the first model ‘change in general education enrolment’ and ‘shortest travel duration to HEI’, since we do not assume that these aspects are related to the extent to which firms view their skill concerns as being related to dual VET per se.

Figure 1a: Logistic regression model over firms’ skill provision concerns

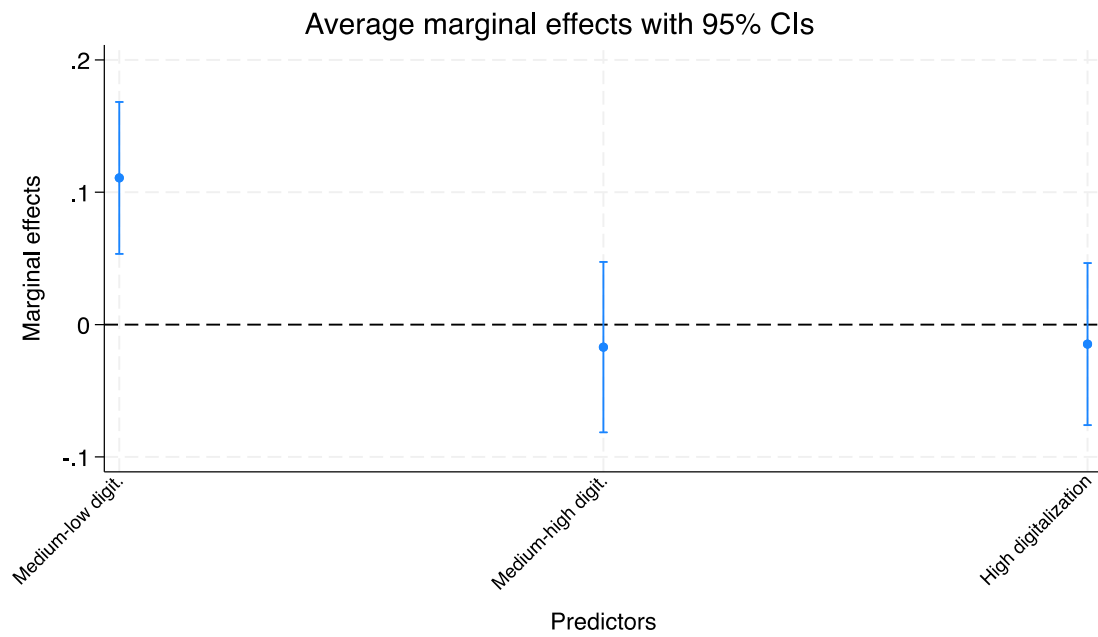
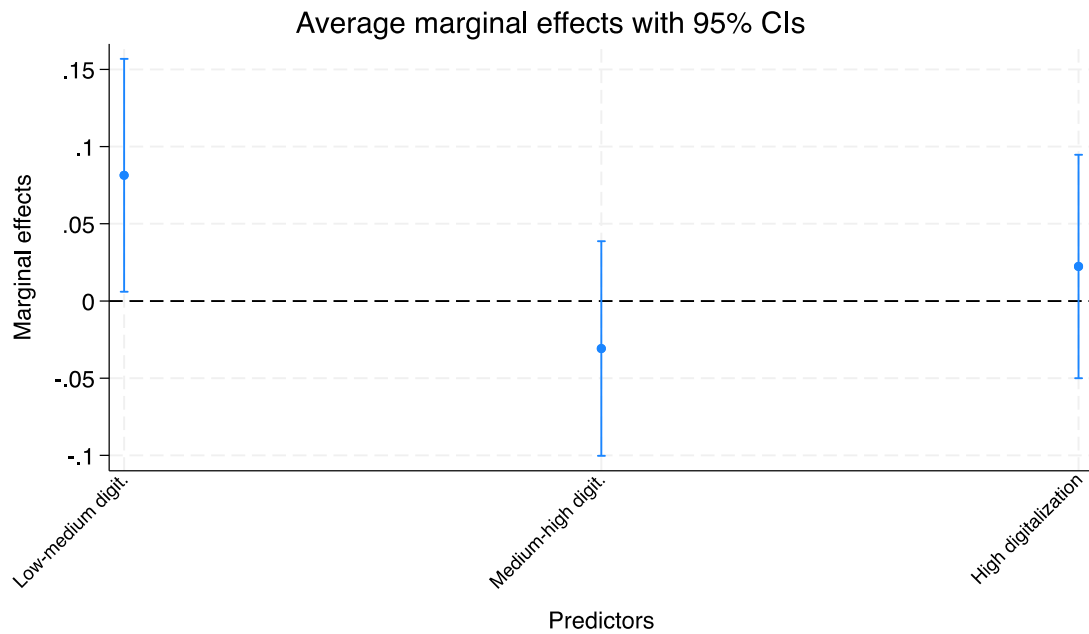


Figure 1b: Logistic regression model over firms’ skill provision concerns being related to dual VET



From Figure 1a, we see that firms in medium-low digitalized occupational group, driven by the healthcare and social work occupations and material production, are significantly more likely to be concerned of a future skill provision problem (supporting H1a). Hiring difficulties as well as having a retention-oriented training strategy also associate with skill provision concerns in general (see table A5 in the appendix).

In the follow-up question for the firms that were indeed concerned of the future skill provision, it was similarly firms in medium-low digitalized occupational fields that tended to relate these concerns to the dual VET system (Figure 1b). We thereby also find support for H1b, where firms in medium-low digitalized occupational fields were more likely than firms in higher digitalized occupational fields to attribute their skill provision concerns to VET.

Among the control variables (Table A6 in the Appendix), the effect of hiring difficulties is greater than the effect of medium-low digitalization, suggesting the importance of firm-level factors influencing the outcome. Furthermore, firms that are members of OdA are slightly more likely to attribute their skill provision concerns to the dual VET system.

In the following steps, we look at the firms' likelihood for citing different reasons to the dual VET-related skill provision concerns, given the digitalization of the occupational fields in which the training programs are located.

4.2 Reasons to VET-related skill provision concerns

When we asked the firms to indicate the main reasons for why VET should be related to their skill provisions issues, the following grievances were frequently mentioned: that general education is increasingly attracting potential VET candidates, that the candidates are not qualified enough, that the VET curricula are not up to date, and that the occupation is losing popularity. We classify the former two as 'skill gap'-related, the latter as 'skill shortage'-related issues.

We estimated the average marginal effects on the different reasons for VET-related skill provision concerns given digitalization of the occupational field, with the controls (Figures 2-4 below).

Figure 2: Skill gap reasons: 'General education is increasingly attracting potential VET candidates' (left-hand panel) and 'Candidates are not qualified for VET' (right-hand panel)

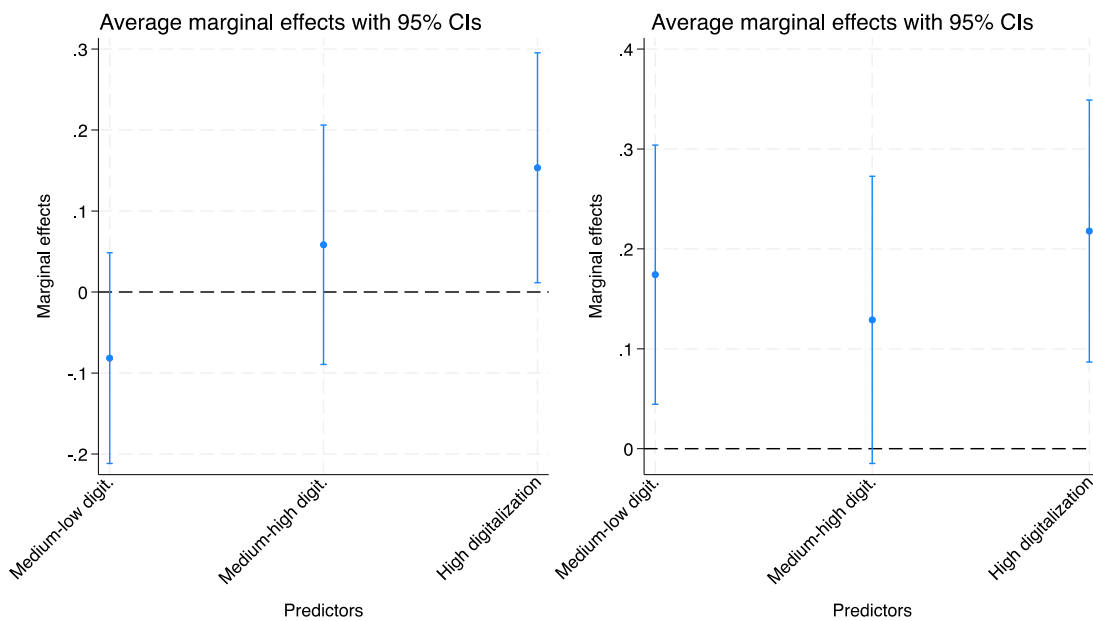


Figure 3: Skill gap-reason: 'VET curricula are not up to date'

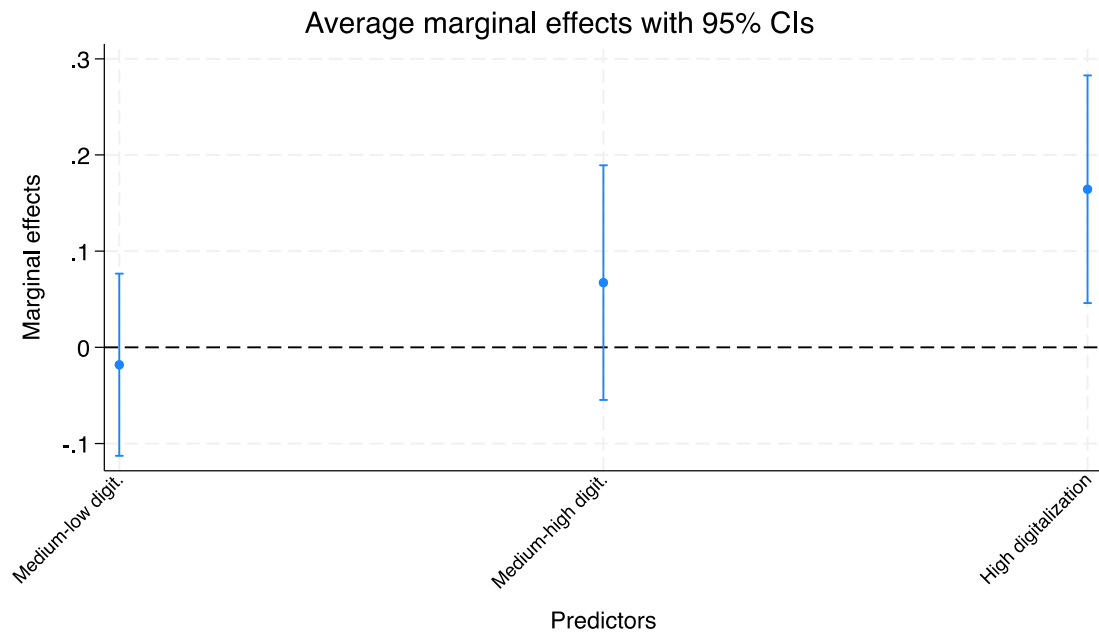
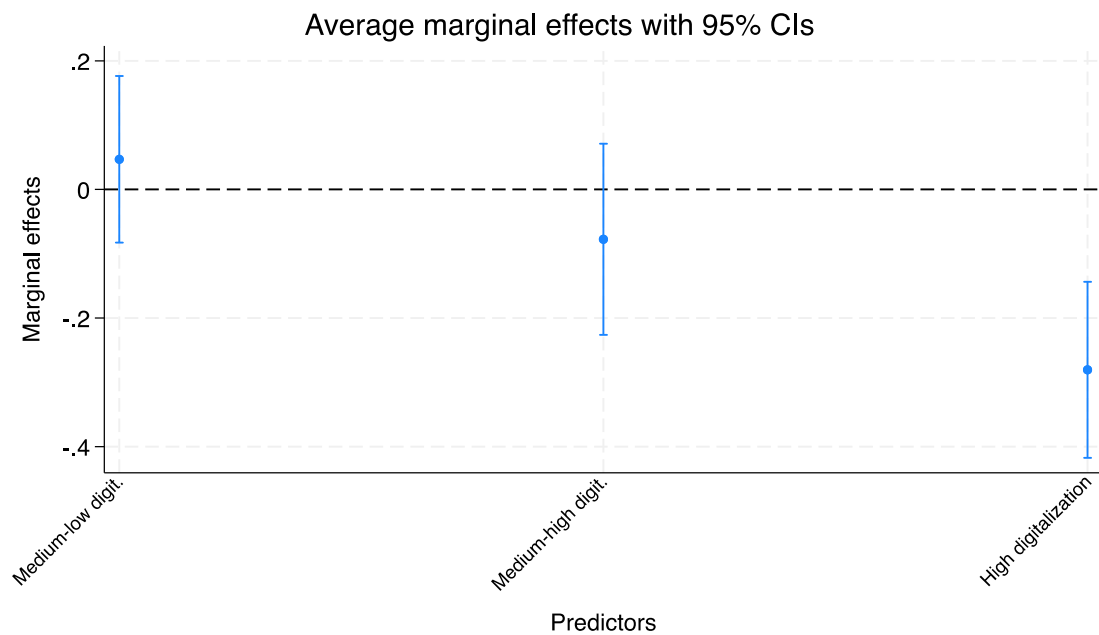


Figure 4: Skill shortage-reason: ‘Occupation is losing popularity’



Looking at ‘skill gaps’-reasons, we see that firms in the high-digitalized occupational fields are more likely than firms in the low- and medium-digitalized groups to cite reasons such as ‘general education is increasingly attracting potential VET candidates’ and ‘VET curricula are not up to date’ issues in relation

to their VET-related skill provision problems (Figures 2 and 3). On the other hand, firms citing ‘Candidates are not qualified for VET’ pertain both to the medium-low and high digitalized occupational fields, showing that the issue of ‘skill gaps’ relating to an unreadiness of today’s school-leavers exists both in mid- to high-level occupations.

Regarding the ‘skill shortage’-reason (Figure 4), the ‘loss of popularity’ of the occupation, firms in highly digitalized occupational fields are less likely (with a substantial effect) to cite this as a VET-related skill provision problem. This means that the low-digitalized occupational fields are more likely to experience such issues as the source of their VET-related skill provision concerns (see figure A11 in the Appendix for analysis with a recoded digitalization variable, with high-digitalized as reference category). In sum, we find mixed support for H2a, where also firms in medium-low-digitalized occupational fields experience a lack of candidate quality, along with the firms in high-digitalized occupational fields. We also find support for H2b, where the medium-low digitalized occupational group cites a loss of popularity as a source for VET-related skill provision concerns.

5. Discussion and conclusion

In this study, we find that around two thirds of all the firms in the sample were worried about a future skill provision, aligning well with other recent large scale economic reports (CEDEFOP, 2023). However, only about one third of those who *do* worry attribute their concerns mainly to the functioning of the dual VET system, which they are all a part of. In sum, around 19% of all surveyed training firms stated that they are worried that the dual VET system is not adequately addressing their skill needs. This descriptive finding paints a rather positive overall picture of a prototypical CSFS’s fulfilment of its purposes. Surveying firms across levels of digitalization and skill requirements (by occupational field), catering to low- as well as high-qualified learners, and despite the presence of difficulties attracting candidates, the satisfaction with the involvement as providers of education and training is high. This finding supports scholarship stipulating that goals of economic efficiency and social inclusion of a broad share of the population is possible within the boundaries of collective skill formation (Bonoli and Wilson, 2019; Di Maio et al., 2019; Bonoli and Emmenegger, 2021), not

only as a political goal but also a lived reality for key actors in dual VET.

However, the picture is more fine-grained when taking a closer look. We found that lower levels of digitalization in the occupational fields associated with a stronger likelihood to worry about the future skill provision. This underscores the comparative advantages of shoring up on technological capacities in the transition to the knowledge economy and the difficulties adapting to the same for the crafts, services and the (less digitalized) production sectors (Autor et al., 2003; Diessner et al., 2022). Hence, firms in CSFSs with their traditionally high ability to solve collective action problems and providing mid-skilled sectors with qualified workers, face similar struggles as liberal systems (Autor & Dorn, 2013)⁷.

Of the firms attributing their skill provision concerns to the functioning of the dual VET system, those in lower digitalized occupational fields stood out. This finding underlines the tendency observed previously, that more highly digitalized sectors are faring well in the knowledge economy and are neither constrained as private providers of education as a collective good. It also adds a new perspective on previous studies expressing pessimism of VET systems' capability to adapt to the challenges of the knowledge economy and the increased importance of higher education over VET (Baethge & Wolter, 2015; Schmidt, 2010; Anderson & Hassel, 2013) and aligns with Emmenegger et al. (2023) underscoring Switzerland's successful route to upskilling *within* dual VET.

However, firms in the traditional VET-sectors, fostering mid-skilled service and crafts workers, with lower digitalization, are facing the biggest challenges both securing the skill supply in the general economy and within the dual VET context (Horbach & Rammer, 2022). This finding calls for concern, given the (still strong) reliance on dual apprenticeship training in these sectors in Switzerland (Oesch, 2023; Oesch & Rodríguez Menés, 2011, however less so in Germany (Diessner et al., 2022)).

The further findings when inquiring the *reasons* for dual VET-related skill provision concerns corroborate these insights. For firms in high-digitalized occupational

⁷ Another factor associated with a higher likelihood for skill provision concerns was firms' retention-oriented strategy. Firms that more often offer employment to their apprentice graduates were generally more concerned about the future skill provision but did not refer their concerns specifically to the dual VET system compared to non-retention-oriented firms. One tentative explanation for this finding is that although the dual VET system itself might not be seen as culpable, a strong-orientation of not only training but also hiring VET graduates—potentially at the expense of other (parallel or alternative) skill supply strategies—makes firms more vulnerable to the rapidly changing demands in the economy.

fields, the key reasons for which were the increasing attraction of general education to—in the eyes of the firms— suitable VET candidates; the lacking qualifications among existing VET candidates; and the lagging update of the VET curricula to correspond to their skill needs. These aspects relate to a *skill gap* issue (McGuinness et al., 2018). Thus, firms in highly digitalized sectors are not immune to skill provision concerns, despite their advantageous position in the economy, but may face issues attracting candidates with the right qualifications for the type of skills and tasks that they will need to be productive in the firm (see Horbach & Rammer, 2022).

One other related aspect raises concern among the surveyed firms in this study regarding the vitality of dual VET: the loss of popularity of occupations. This represents the *skill shortage* aspect of skill provision problems in the literature (McGuinness et al., 2018; McGuinness & Ortiz, 2016; Brunello & Wruuck, 2021) and is most prominent among firms primarily in low-digitalized occupations. Thus, firms training for occupations that are generally less digitalized, more manual (and sometimes routinized) struggle to keep up in the transition to the knowledge economy (Autor, 2022; Horbach & Rammer, 2022). With lower wages and cumbersome work, these sectors that still are maintaining or increasing their work demand struggle to attract candidates (despite these having adequate qualifications).

This tendency possibly inflates the *skill gaps* problem: candidates who are not qualified for, or interested in, general education or even higher-skilled VET programs are neither interested in training programs that are within their ‘range’. The changing landscape of professional aspirations and preferences among the young is confirmed in other surveys and studies of career and education choice (Combet, 2023; SKBF, 2023; Wettstein et al., 2017; Haasler, 2020) and underscore a potential cause and effect of skill gaps on the labour market: the jobs that are needed, fewer are qualified for or want. However, firms in high-digitalized, knowledge-intensive, occupations do not only cite inadequate compulsory education as a problem, but also direct their grievances to the VET curricula. These occupational fields are not concerned with a lack of interest from young people per se, given the high popularity of such training programs (SBFI, 2022), but are also dissatisfied with the VET curricula not corresponding to the rapid skill changes in the field (see Emmenegger & Setizl, 2019, for a case of collective action from larger firms in the clerical training field to reform the VET curriculum to suit their needs). This underscores the inherent slowness of CSFSs to rise to the rapid

developments in the knowledge economy (Introduction to this special issue) and prompts collective actors' swift responses.

Considering diverging employer grievances and the constellations and strength-relationship of political actors involved in VET (Trampusch, 2010), traditional VET occupations (found in the lower digitalized occupational groups) usually leverage their professional associations' role in advocating their needs, given the Swiss collectivist configuration (Trampusch, 2010; Emmenegger et al., 2023). However, being affiliated with an *OdA* is positively associated with a tendency to attribute skill shortage concerns to the functioning of the dual VET system. The paramount impact of macro-trends in the economy, with shifting educational preferences and compressed wages in the less digitalized and knowledge-intensive sectors, are exerting pressure even in highly collectivized sectors (Graf et al., 2021; Hope & Martelli, 2019). This underscores further the importance of cooperation and coordination among collective actors in VET to pursue reforms that target the specific nature of skill gap and skill shortage concerns, felt by its constituents.

The political solutions to both skill gaps and skill shortages in VET are however not simple. For the supply-side, the future workforce, increased information and promotion about certain occupations and careers could help overcome wrongful assumptions or indeed prejudices shaping negative attitudes towards said jobs – albeit not specifically highlighted by any group in our study. However, efforts from the demand side, that of the employers, are equally essential: improved working conditions, settings that appeal and are amenable also to untypical candidates (for example, women in typically male occupations such as construction or electricity work, or to men in healthcare or social work), and permeability to higher studies could be favourable for a balanced skill match (Stevens, 2007). Similarly, for the healthcare sector (as well as retail, hospitality and other lower skilled service-occupations), typically populated by women, with lower wages and inconvenient work hours, where an increased demand for labour is imminent (Autor & Dorn, 2013), making work more attractive is already a priority among the involved professional associations and state actors in Switzerland (DFE, 2010; OdASanté, 2015; SECO, 2016). Although, in view of the salience and prosperity of knowledge-intensive, digitalized sectors in the new economy (Oesch, 2023; Cappelli, 2015), it is uncertain whether political coordination to shore up support and implement reforms to close the attractiveness deficit in concerned sectors will be adequate.

Whereas persistent skill gap problems can cause long-term harm to the economy, these challenges are also likely to have a slow onset leaving policy makers and actors involved in skill formation enough time to adapt to rising challenges and prevent them (McGuinness & Ortiz, 2016). For skill shortages, the problems are often immediate and disruptive with direct effects on firms' productivity (Brunello & Wruuck, 2021), as well as commitment to training-provision in general (see Wilson & Bajka, 2024). Solutions may be time-consuming and ineffective, both from policy makers, sectors and firms, creating productivity losses that may not readily be overcome in the short-term (Cappelli, 2015). Thus, filling the popularity deficit of occupations, strong coordination between state and social partners as well as continued political commitment will be necessary.

CSFSs are often regarded as advantageous in the institutionalist and comparative political economy literature (Emmenegger & Haslberger, 2023; Bonoli & Emmenegger, 2022; Durazzi & Tonnelli, 2024). Employers in these systems are an active part and a strong voice (through professional associations) in the political discussions shaping and determining policies and overall direction of the economy and the formation of skills (Busemeyer & Trampusch, 2012; Bonoli & Emmenegger, 2022). The pressure from globalization and technological change, the polarization of skills, and the rising interest in general education over VET (Baethge & Wolter, 2015; Diessner et al., 2022), are, however, rendering certain firms more vulnerable to an increasing skill provision problem (see Horbach & Rammer, 2022). Our firm study confirms similar and worrisome trends among healthcare and material production, facing both 'skill gap' and 'skill shortage' problematics. This points to the relevance of future studies on skill provision and the transition to the knowledge economy targeting these vulnerable sectors.

A few limitations to this paper should be mentioned. Due to the modest response rate, although not different from other similar employer surveys (Liechti et al., 2017), and our lack of information on the non-participants, we cannot readily assume that our sample is representative for the whole population of 60'000 Swiss training firms (KOF 2024). However, for occupational fields and the language regions, our sample is comparable to Swiss averages.

Furthermore, since the level of digitalization, ICT stock investment, investment in technology and equipment may well differ from one firm to the other even within the same occupational field, it is possible that we miss variation on the firm-level with our

measurement of digitalization. However, by using control variables capturing the firm size, their hiring situation, and retention-strategy, we reduce the likelihood of some other factors that may be confounded with high (or low) levels of digitalization influencing the outcome. Further research with finer measures on the firm-level and a longitudinal perspective could delve deeper into the mechanisms of training firms' successful resolution of challenges related to the knowledge economy.

Data availability statement: The data that support the findings of this study are openly available in OSF at <https://doi.org/10.17605/OSF.IO/MEX9H>.

References

- Abrassart, A. (2013) 'Cognitive Skills Matter: The Employment Disadvantage of Low-Educated Workers in Comparative Perspective', *European Sociological Review* 29(4): 707–19.
- Acemoglu, D. (2002). Technical Change, Inequality, and the Labor Market. *Journal of Economic Literature* 40(1): 7–72. doi:10.1257/0022051026976.
- Acemoglu, D. and Pischke, J-S. (1998). Why Do Firms Train? Theory and Evidence, *The Quarterly Journal of Economics*, Volume 113, Issue 1, February 1998, Pages 79–119, <https://doi.org/10.1162/003355398555531>
- Acemoglu, D. and P. Restrepo (2016), "The Race Between Machine and Man: Implications of Technology for Growth, Factor Shares and Employment", *NBER Working Paper*, No. 22252, National Bureau of Economic Research, Cambridge, MA, <http://dx.doi.org/10.3386/w22252>.
- Anderson, K. M., & Hassel, A. (2013). Pathways of Change in CMEs: Training Regimes in Germany and the Netherlands. In Wren, A. (ed), *The Political Economy of the Service Transition*, (pp. 171-194). Oxford University Press: Oxford.
- Antonazzo, L., D. Stroud, and M. Weinel. 2023. "Institutional Complementarities and Technological Transformation: IVET Responsiveness to Industry 4.0 – Meeting Emerging Skill Needs in the European Steel Industry." *Economic and Industrial Democracy*, <https://doi.org/10.1177/0143831X211059227>.

- Autor, D. and D. Dorn. 2013. “The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market.” *American Economic Review* 103(5):1553–97.
- Autor, D. H., Levy, F., & Murnane, R. J. (2003). The Skill Content of Recent Technological Change: An Empirical Exploration. *The Quarterly Journal of Economics*, 118(4), 1279–1333. DOI: <https://www.jstor.org/stable/25053940>.
- Autor, D. (2022). The Labor Market Impacts of Technological Change: From Unbridled Enthusiasm to Qualified Optimism to Vast Uncertainty. *Working Paper 30074, National Bureau of Economic research, Cambridge (MA)*.
- Baethge, M. & Wolter, A. (2015). The German Skill Formation Model in Transition: From Dual System of VET to Higher Education? *Journal for Labour Market Research* 48(2): 97–112. doi:10.1007/s12651-015-0181-x
- Beckert, J. (2014). Imagined Futures: Fictional Expectations in the Economy. *Theory and Society* 42(3): 219-240.
- Bonoli, G., & Emmenegger, P. (2022). *Collective Skill Formation in the Knowledge Economy*. Oxford: Oxford University Press.
- Brunello, G., Garibaldi, P., & Wasmer, E. (2007). *Education and Training in Europe*. Oxford: Oxford University Press.
- Brunello, G., & Rocco, L. (2017). The labor market effects of academic and vocational education over the life cycle: Evidence based on a British cohort. *Journal of Human Capital*, 11(1), 106–166. DOI: <https://doi.org/10.1086/690234>.
- Brunello, G., & Wruuck, P. (2021). Skill shortages and skill mismatch: A review of the literature. *Journal of Economic Surveys*, 35, 1145-1167. DOI: <https://doi.org/10.1111/joes.12424>.
- Busemeyer, M. R. (2015). *Skills and Inequality: Partisan Politics and the Political Economy of Education Reforms in Western Welfare States*. Cambridge University Press: Cambridge.
- Busemeyer, M. R., & Trampusch, C. (2012). *The Political Economy of Collective Skill Formation*. Oxford: Oxford University Press.
- Busemeyer, Marius R., and others (eds), *Digitalization and the Welfare State* (Oxford, 2022; online edn, Oxford Academic, 21 Apr. 2022), <https://doi.org/10.1093/oso/9780192848369.001.0001>

- Cappelli, P. (2015). Skill Gaps, Skill Shortages, and Skill Mismatches: Evidence and Arguments for the United States. *ILR Review* 68(2), 251-290. DOI: <https://doi.org/10.1177/0019793914564961>.
- Calvino, F., C. Criscuolo, L. Marcolin and M. Squicciarini (2018), “A taxonomy of digital intensive sectors”, OECD Science, Technology and Industry Working Papers, No. 2018/14, OECD Publishing, Paris, <https://doi.org/10.1787/f404736a-en>.
- CEDEFOP (2018). The changing nature and role of vocational education and training in Europe. Volume 3: the responsiveness of European VET systems to external change (1995-2015). *Cedefop research paper, No 67*. Luxembourg: Publications Office. DOI: <http://data.europa.eu/doi/10.2801/621137>.
- (2020). On the way to 2020: data for vocational education and training policies. Indicator overviews: 2019 update. *Cedefop research paper No 76*. Luxembourg: Publications Office of the European Union.
- (2023). *Skills forecast*. Available at: <https://www.cedefop.europa.eu/en/tools/skills-forecast> [Accessed 22.08.2023].
- Combet, B. (2023). Women’s aversion to majors that (seemingly) require systemizing skills causes gendered field of study choice. *European Sociological Review*, early access: <https://doi.org/10.1093/esr/jcad021>.
- Comin, D and M. Mestieri (2013), “If Technology Has Arrived Everywhere, Why Has Income Diverged?” *NBER Working Paper*, No. 19010. National Bureau of Economic Research, Cambridge, MA, <http://dx.doi.org/10.3386/w19010>.
- Culpepper, P.D. & Thelen, K. (2008). Institutions and collective actors in the provision of training: Historical and cross-national comparisons. In K.U. Mayer & H. Solga (eds), *Skill formation: Interdisciplinary and cross-national perspectives*. New York: Cambridge University Press.
- Damelang, A. & Ruf, K. (2023). Once outside, always outside? The link between overeducation persistence and training systems throughout the employment career.” *Social science research* 109.
- Deissinger, T. (2019). The Sustainability of the Dual System Approach to VET. In Guile, D. and Unwin, L. (eds.). *The Wiley Handbook of Vocational Education and Training*, First Edition. New York (NY): John Wiley & Sons, Inc.
- Deissinger, T., & Ott, M. (2016). Tertiariation of vocational education and training and its implications—problems and issues in Germany and France. In S. Bohlinger,

- T. K. A. Dang, & M. Glatt (Eds.), *Education policy: Mapping the landscape and scope* (pp. 267–296). Frankfurt, Germany: Peter Lang.
- DFE (Département fédéral de l'économie) (2010). Du personnel qualifié pour la Suisse. *Une initiative du Département fédéral de l'économie*.
<http://www.news.admin.ch/NSBSubscriber/message/attachments/24189.pdf>
 [Accessed 12.04.2024].
- Diessner, S., Durazzi, N. & Hope, D. (2022). 'Skill-Biased Liberalization: Germany's Transition to the Knowledge Economy'. *Politics & Society* 50(1): 117–55.
- Di Stasio, V., Bol, T., & Van de Werfhorst, H. G. (2016). What makes education positional? Institutions, overeducation and the competition for jobs. *Research in Social Stratification and Mobility*, 43, 53-63.
- Durazzi, N. & Benassi, C. (2020). 'Going Up-Skill: Exploring the Transformation of the German Skill Formation System'. *German Politics* 29(3): 319–38.
- Durazzi, N. (2023). Engineering the expansion of higher education: High skills, advanced manufacturing, and the knowledge economy. *Regulation & Governance*, 17(1), 121-141. DOI: <https://doi.org/10.1111/regg.12439>.
- Emmenegger, P. & Haslberger, M. (2023). Yesterday's Model for Tomorrow's Economy? The Effect of Dual VET on Wage Inequality in the Knowledge Economy. *Conference paper, RC28 Summer Meeting, University of Michigan, Ann Arbor, USA, 15.08.2023*.
- Emmenegger, P., Graf, L., & Trampusch, C. (2019). The governance of decentralised cooperation in collective training systems: a review and conceptualisation. *Journal of Vocational Education and Training*, 71(1): 21–45.
- Emmenegger, P. and Seitzl, L. (2019), Collective Action, Business Cleavages and the Politics of Control: Segmentalism in the Swiss Skill Formation System. *British Journal of Industrial Relations*, 57: 576-598. <https://doi.org/10.1111/bjir.12426>
- Emmenegger, P., & Seitzl, L. (2020). Social partner involvement in collective skill formation governance. A comparison of Austria, Denmark, Germany, the Netherlands and Switzerland. *Transfer: European Review of Labour and Research*, 26(1), <https://doi.org/10.1177/1024258919896897>.
- Emmenegger, P., Bajka, S. & Ivardi, C. (2023). How Coordinated Capitalism Adapts to the Knowledge Economy: Different Upskilling Strategies in Germany and Switzerland. *Swiss Political Science Review*, 29(4): 355-378.

- Estevez-Abe, M., Iversen, T. & Soskice, D. (2001). Social Protection and the Formation of Skills: A Reinterpretation of the Welfare State. In Hall, P.A. & Soskice, D. (eds). *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*. Oxford: Oxford University Press.
- Eurofound and Cedefop (2020), *European Company Survey 2019: Workplace practices unlocking employee potential*, European Company Survey 2019 series, Publications Office of the European Union, Luxembourg.
- European Company Survey (2019). European Company Survey. Available at: <https://www.eurofound.europa.eu/en/data-catalogue/european-company-survey> [Accessed 03.05.2024].
- George, A.L., & Bennett, A. (2005). *Case Studies and Theory Development in the Social Sciences*. Cambridge, MA: The MIT Press.
- Gonon, P., & Maurer, M. (2012). Educational policy actors as stakeholders in the development of the collective skill system: The case of Switzerland. In Bussemeyer, M. R. & C., Trampusch (Eds.) *The comparative political economy of collective skill formation*, (pp. 126–149). Oxford: Oxford University Press.
- Graf, L. (2013). *The hybridization of vocational training and higher education in Austria, Germany, and Switzerland*. Opladen, Berlin and Toronto: Budrich Unipress.
- (2016). The rise of work-based academic education in Austria, Germany and Switzerland. *Journal of Vocational Education & Training*, 68(1), 1–16. <https://doi.org/10.1080/13636820.2015.1107749>
- (2018). Combined modes of gradual change: the case of academic upgrading and declining collectivism in German skill formation. *Socio-Economic Review*, 16(1): 185–205. DOI: doi.org/10.1093/ser/mww044.
- Graf, L., Strebel, A., Emmenegger, P. (2021). State-led bricolage and the extension of collective governance: Hybridity in the Swiss skill formation system. *Regulation & Governance*, 17, 103-120.
- Haasler, S. R. (2020). The German system of vocational education and training: challenges of gender, academisation and the integration of low-achieving youth. *Transfer*, 26(1), 57–7. DOI: <https://doi.org/10.1177/1024258919898115>.
- Hassel, A., & Palier, B. (eds) (2020). *Growth and Welfare in Advanced Capitalist Economies: How Have Growth Regimes Evolved?* Oxford: Oxford University Press.

- Healy, J., Mavromaras, K., & Sloane, P. (2015). Adjusting to skill shortages in Australian SMEs. *Applied Economics*, 47(24), 2470–2487.
DOI: [10.1080/00036846.2015.10008764](https://doi.org/10.1080/00036846.2015.10008764)
- Hope, D. & Martelli, A. (2019). The Transition to the Knowledge Economy, Labor Market Institutions, and Income Inequality in Advanced Democracies. *World Politics* 71(2): 236-288.
- Horbach, J., & Rammer, C. (2022). Skills shortage and innovation. *Industry and Innovation*, 29(6), 734–759. <https://doi.org/10.1080/13662716.2021.1990021>.
- Hosmer, D. W., & Lemeshow, S. (2000). *Applied Logistic Regression*. John Wiley & Sons: Hoboken, NJ, USA. DOI:10.1002/0471722146
- Iannelli, C., & Raffe, D. (2007). Vocational Upper-Secondary Education and the Transition from School. *European Sociological Review*, 23(1), 49–63. DOI: <https://doi.org/10.1093/esr/jcl019>.
- Iversen, T., & Soskice, D. (2019). *Democracy and Prosperity: Reinventing Capitalism through a Turbulent Century*. Princeton University Press.
- Jacob, M., & Solga, H. (2015). Germany’s vocational education and training system in transformation: Changes in the participation of low- and high-achieving youth over time. *European Sociological Review*, 31, 161–171.
- Jaik, K. (2020). Brain drain from vocational to academic education at upper-secondary level? An empirical analysis for Switzerland. *Empirical Research in Vocational Education and Training*, 12(10). DOI: <https://doi.org/10.1186/s40461-020-00095-8>.
- Kohler, U., & Kreuter, F. (2012). *Data Analysis Using Stata* (3rd ed.). College Station, TX: Stata Press.
- Korber M, Oesch D. (2019). Vocational versus general education: Employment and earnings over the life course in Switzerland. *Adv Life Course Res.* 40:1-13. doi: 10.1016/j.alcr.2019.03.003.
- Lassnigg, L. (2023). *Sustaining Dual Apprenticeship systems: Similarities and Differences in Austria, Germany, and Switzerland*. In Ye, J-H. & M., Jiang. (eds.), *Technical and Vocational Education and Training*. IntechOpen.
DOI: [10.5772/intechopen.112561](https://doi.org/10.5772/intechopen.112561)
- Le Barbanchon, T., Ronchi, M., & Sauvagnat, J. (2023). "Hiring Difficulties and Firm Growth. *CEPR Discussion Papers 17891*, C.E.P.R. Discussion Papers.

- Liechti, F., Fossati, F., Bonoli, G. and Auer, D. (2017). The Signalling Value of Labour Market Programmes, *European Sociological Review*, Volume 33, Issue 2, April 2017, Pages 257–274, <https://doi.org/10.1093/esr/jcw061>
- Long, J.S. (1997). *Regression Models for Categorical and Limited Dependent Variables*. Thousand Oaks, CA: Sage Publications.
- Lynn, F.B. and Ellerbach, G. (2017) ‘A Position with a View: Educational Status and the Construction of the Occupational Hierarchy’, *American Sociological Review* 82(1): 32–58.
- McGuinness, S. and Ortiz, L. (2016). Skill gaps in the workplace: measurement, determinants and impacts. *Industrial Relations Journal* 47(3): 253–278.
- McGuinness, S., Pouliakas, K., & Redmond, P. (2018). Skills mismatch: concepts, measurement and policy approaches. *Journal of Economic Surveys*, 32(4), 985-1015. DOI: <https://doi.org/10.1111/joes.12254>.
- Mohrenweiser, J., Backes-Gellner, U. (2010). Apprenticeship Training, what for: Investment or Substitution? *International Journal of Manpower*, 31, 545-562.
- OdASanté. (2015). Une étude montre que la Suisse dépend du personnel étranger dans le domaine opératoire. *Communication de presse*, 18.05.2015. https://www.odasante.ch/fileadmin/odasante.ch/docs/Kommunikation_Public_Relations/Medien/Medienmitteilungen/150518_MM_Studie_OP-Personal_f.pdf [Accessed 12.04.2024].
- Orientation.ch (2024). *Le portail officiel suisse d'information de l'orientation professionnelle, universitaire et de carrière*. Available at: [orientation.ch](https://www.orientation.ch) [Accessed 26.06.2024].
- Oesch, D. (2013). *Occupational change in Europe: How Technology and Education Transform the Job Structure*. Oxford: Oxford University Press.
- Oesch, D. (2023). The Structural Shifts in Switzerland's Economy and Society, 2000-2020. In Emmenegger, P., Fossati, F., Häusermann, S., Papadopoulos, I., Sciarini, P., Vatter, A. (eds). *Handbook of Swiss Politics*. Oxford: Oxford University Press, ch. 5.
- Oesch, D., & Rodríguez Menés, J. (2011). Upgrading or polarization? Occupational change in Britain, Germany, Spain and Switzerland, 1990–2008. *Socio-economic Review* 9(3), 503-531. DOI: <https://doi.org/10.1093/ser/mwq029>.
- Powell, W. W., & Snellman, K. (2004). The knowledge economy. *Annual Review of Sociology*, 30, 199–220. <https://doi.org/10.1146/annurev.soc.29.010202.100037>

- Protsch, P., & Solga, H. (2016). The social stratification of the German VET system. *Journal of Education and Work*, 29(6), 637–661. <https://doi.org/10.1080/13639080.2015.1024643>
- Pusterla, F., Oswald-Egg, M.E., Bolli, T., & Renold, U. (2018). Disentangling Skills Mismatch : Fifth Release of the KOF Youth Labour Market Index. *KOF Studies, No 123*. Zürich : ETH-KOF. Available at: <https://edudoc.ch/record/134623> [Accessed 12.12.23].
- Quintini, G. (2011). Over-qualified or under-skilled: A review of existing literature. *OECD Social, Employment and Migration Working Paper 121*. Organisation for Economic Co-operation and Development: Paris.
- Rodrik, D. (2022). An Industrial Policy for Good Jobs. Policy Proposal. The Hamilton Project.
- SBFI (Staatssekretariat für Bildung, Forschung und Innovation) (2022). Baromètre des transitions 2022 : Principaux résultats Mars/Avril 2022. *SBFI, Bern*. Available at: <https://cockpit.gfsbern.ch/fr/cockpit/nahtstellenbarometer-2022/> [Accessed 26.01.2023].
- (2023). Berufsbildung. Available at: <https://www.becc.admin.ch/becc/public/bvz/beruf/grundbildungen> [Accessed 18.04.2023].
- Schulz, W., Solga, H. & Pollak, R. (2023). Vocational education, tertiary education, and skill use across career stages, *European Sociological Review* 39(5), 741–758, <https://doi.org/10.1093/esr/jcac074>.
- Schmidt, N. (2010). Auswirkungen des Strukturwandels der Wirtschaft auf den Bildungsstand der Bevölkerung. *Wirtschaft und Statistik*, 6, 537–551.
- Seawright, J., & Gerring, J. (2008). Case-Selection Techniques in Case-Study Research: A Menu of Qualitative and Quantitative Options. *Political Research Quarterly*, 61(2), 294–308. DOI: <https://doi.org/10.1177/1065912907313077>.
- SECO (Secrétariat d’Etat à l’économie). (2016). Pénurie de main-d’œuvre qualifiée en Suisse. Système d’indicateurs pour évaluer la demande en personnel qualifié. *Analyse du marché du travail*. https://www.seco.admin.ch/seco/fr/home/Publikationen_Dienstleistungen/Publikationen_und_Formulare/Arbeit/Arbeitsmarkt/Fachkraeftebedarf/indikatorensysteme-m-zur-beurteilung-der-fachkraeftenachfrage.html [Accessed 12.04.2024].

- Seitzl, L. (2020). *How Corporatist Economies Innovate*. Working paper, University of St. Gallen.
- Seitzl, L. and Unterweger, D.F. (2022). 'Declining Collectivism at the Higher and Lower End: The Increasing Role of Austrian State in Times of Technological Change. In Bonoli, G. and Emmenegger, P. (eds). *Collective Skill Formation in the Knowledge Economy*. Oxford: Oxford University Press.
- Shavit, Y. & Müller, W. (1998). *From School to Work: A Comparative Study of Educational Qualifications and Occupational Destinations*. Oxford: Clarendon Press.
- SKBF (Swiss coordination centre for research in education). (2023). *Swiss education report: 2023*. Aarau: SKBF CSRE.
- Solga, H., Protsch, P., Ebner, C., Brzinsky-Fay, C. (2014). The German Vocational Education and Training System: its Institutional configuration, Strengths and Challenges. *WZB Discussion Paper, No. SP 2014-52*.
- Somers, M., Cabus, S., Groot, W., & van den Brink, H. (2019). Horizontal Mismatch between Employment and Field of Education: Evidence from a Systematic Literature Review. *Journal of Economic Surveys*, 33(2), 567–603. DOI : <https://doi.org/10.1111/joes.12271>.
- Stevens, P. A. (2007). Skill shortages and firms' employment behaviour. *Labour Economics*, 14(2), 231-249. DOI : <https://doi.org/10.1016/j.labeco.2005.09.002>.
- Thelen, K. (2014). *Varieties of Liberalization and New Politics of Social Solidarity*. Cambridge: Cambridge University Press.
- (2020). Transitions to the Knowledge Economy in Germany, Sweden, and the Netherlands. In Hassel, A. & B., Palier. (eds), *Growth and Welfare in Advanced Capitalist Economies. How Have Growth Regimes Evolved?* Oxford: Oxford University Press. DOI: <https://doi.org/10.1093/oso/9780198866176.003.0006>
- Trampusch, C. (2010). Employers, the state and the politics of institutional change: Vocational education and training in Austria, Germany and Switzerland. *European Journal of Political Research* 49: 545–573.
- Violante, G.L. (2016). Skill-biased Technological Change. In: *The New Palgrave Dictionary of Economics*. London: Palgrave Macmillan.
- Wettstein, E. E., Schmid., & Gonon, P. (2017). *Swiss Vocational and Professional Education and Training (VPET)*. Bern: hep Verlag.

- Wilson, A. and Bajka, S. (2024). 'Exit, Voice and Loyalty' in collective skill formation: a study of Swiss training firms. *Working paper, IDHEAP, University of Lausanne*.
- Wolter, S.C., Mühlemann, S. and Schweri, J. (2006), Why Some Firms Train Apprentices and Many Others Do Not. *German Economic Review*, 7: 249-264. <https://doi.org/10.1111/j.1468-0475.2006.00155.x>
- Wolter, S.C., Schweri, J. (2002). The Cost and Benefit of Apprenticeship Training: The Swiss Case. *Applied Economics Quarterly* 48(3 – 4), 347 – 67.