# Vocational education and innovation

## How research from Switzerland is resolving an apparent contradiction

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In Switzerland, vocational education and training (VET) contributes significantly to the innovative capacity of the economy as a whole, of firms and also of individuals. This observation is backed up by recent research findings from the Swiss Leading House on Economics of Education, Firm Behavior and Training Policies at the University of Zurich.

In contrast, the literature – often dominated by Anglo-Saxon scholars – has long since concluded that the only way to drive innovation is through as many higher education graduates from universities and colleges as possible. Vocational education was overlooked – deemed too narrow and retrograde, or confined by outdated knowledge and established technologies. As a result, it was thought that VET could not make a material contribution to innovation; instead, more higher education graduates[1] were called for.

These analyses may well be accurate in the Anglo-Saxon countries, or indeed any country without a high-quality system of dual VET. But the assertions do not ring true for the system in Switzerland (or even Germany). On the contrary, in Switzerland, VET contributes significantly to Switzerland's international position as an innovation leader. It is one of the reasons why Switzerland regularly scores highly in international innovation rankings – despite Swiss labor market entrants having one of the lowest shares of higher education graduates. How then does VET enable innovative capacity in Switzerland?

**Basic vocational education as a driver of innovation**

There are a variety of different mechanisms at work, as recent research for Switzerland shows (and similar effects in Germany's dual education system confirm). First, basic vocational training ensures that the great majority of Switzerland's intermediate-level skilled workforce (i.e. around two-thirds of the labor force with an apprenticeship diploma) has the vocational skills needed for future innovation[2]. Second, VET contributes to knowledge creation and the development of innovative technologies and patents[3]. Third, it provides companies that participate in VET and train apprentices themselves with up-to-date knowledge about emerging technologies (via regularly updated VET curricula)

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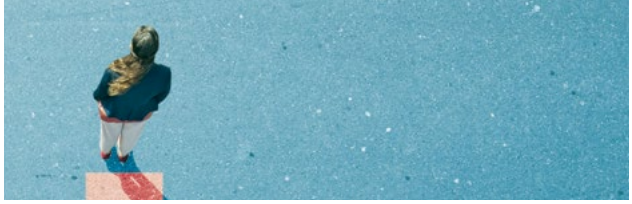
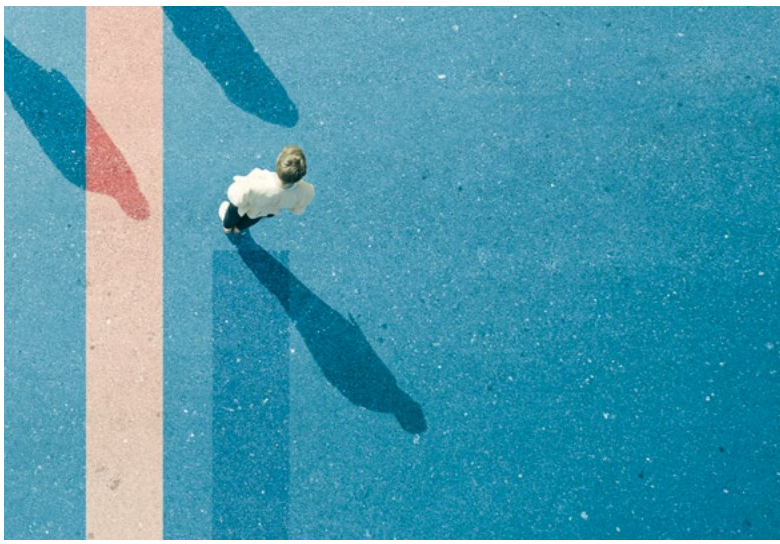
1 Aghion, P. (2008): Higher education and innovation. In: Perspektiven der Wirtschaftspolitik, 9(Special Issue), p. 28-45. Krueger, D., Kumar, K. B. (2004): US-Europe differences in technology-driven growth. Quantifying the role of education. In: Journal of Monetary Economics, 51(1), p. 161–190.

2 Backes-Gellner, U., Pfister, C. (2019): The Contribution of Vocational Education and Training to Innovation – The Case of Switzerland. In: SERI. Research and Innovation in Switzerland 2020. Zürich: Schweizerische Eidgenossenschaft, p. 1-93.

3 Backes-Gellner, U., Kluike, M., Pull, K., Schneider, M.R., Teuber, S. (2016): Human resource management and radical innovation. A fuzzy-set QCA of US multinationals in Germany, Switzerland, and the UK." Journal of Business Economics, 86(2016)7: 751-772 (first published online 07.01.2016, DOI: dx.doi.org/10.1007/s11573-015-0803-3). Meuer, J., Rupietta, C., Backes-Gellner, U. (2015): Layers of co-existing innovation systems. In: Research Policy, 44(4), p. 888–910.





and with the necessary incentives to drive product and process innovation[4]. Fourth, the VET system helps to diffuse new technologies more quickly into the workplace – regardless of whether firms engage in R&D or not. The effect is strongest in companies[5] furthest from the innovation frontier, often SMEs. And fifth, the VET system offers innovation advantages not only to companies but also to vocational graduates. The VET system offers them a wide range of opportunities for occupational mobility and individual upgrading of qualifications through its manifold educational upgrading channels[6].

Through these mechanisms, the VET system creates excellent conditions for navigating innovation-driven change in the labor market. It also promotes the ability and willingness of employees to innovate, and incentivizes individuals and companies to venture into innovation.

**Performance indicators providing evidence for these innovation effects**

Recent studies have examined these effects in more detail and were able to confirm the following specific innovation effects, among others: Firms offering apprenticeship training are 6.8 percentage points more likely to show product or process innovation and 6.3 percentage points more likely to submit patent applications than non-training firms. These effects are strongest in medium-sized firms with 50 to 249 employees. One reason is that innovative knowledge flows indirectly, i.e. via systematically modernized training curricula, from firms that operate at the forefront of innovation to training firms that do not. As a result, all companies that offer apprenticeship training benefit. Curricula are updated regularly with the involvement of highly innovative companies, and such updated training curricula ensure innovative competences in a wide range of companies[7].

In addition, firms employing workers with a broad spectrum of vocational qualifications have been found to exhibit higher levels of innovation than firms with very one-sided qualification structures. The effects can be observed in the early innovation phase (when new ideas and research paths are discovered) but also in incremental, radical or organizational innovations. The strength of the effects varies depending on industry, market dynamics and the HRM systems used in the companies[8]. Moreover, the discussed effects are found not only in SMEs but also in large companies; and they are seen in both traditional segments and high-tech manufacturing.



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4 Rupietta, C., Backes-Gellner, U. (2019): How firms' participation in apprenticeship training fosters knowledge diffusion and innovation. In: Journal of Business Economics (2019) 89:569–597.

5 Schultheiss, T., Backes-Gellner, U. (2021): Updated education curricula and accelerated technology diffusion in the workplace: Micro-evidence on the race between education and technology. In: Swiss Leading House "Economics of Education" Working Paper No. 173.

6 Backes-Gellner, U., Pfister, C. (2019): The Contribution of Vocational Education and Training to Innovation – The Case of Switzerland. In: SERI. Research and Innovation in Switzerland 2020. Zürich: Schweizerische Eidgenossenschaft, p. 1-93.

7 Rupietta, C., Backes-Gellner, U. (2019): How firms' participation in apprenticeship training fosters knowledge diffusion and innovation. In: Journal of Business Economics (2019) 89:569–597.

8 Meuer, J., Rupietta, C., Backes-Gellner, U. (2015): Layers of co-existing innovation systems. In: Research Policy, 44(4), p. 888–910.

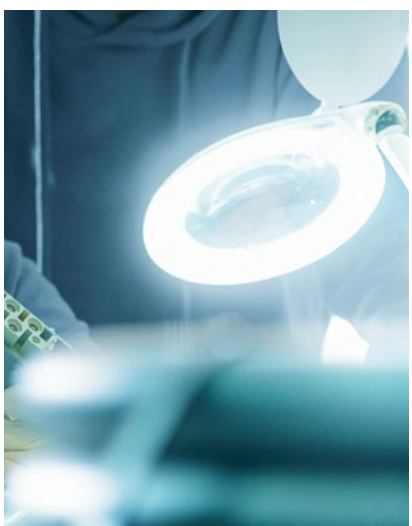
A new study by Schultheiss/Backes-Gellner (2021) also examined the concrete effects of curricula updates on the diffusion of digital technologies in the workplace in Swiss companies. The paper explored the first wave of digitalization in Switzerland in the 1990s, i.e. the use of computer numerical control (CNC), computer-aided design (CAD) and desktop publishing (DP). The study shows that with the updating and introduction of the three digital technologies in the curricula of the different occupations, the diffusion of the new technologies into the workplaces is significantly accelerated (compared to non-updated occupations and compared to the international technology trend). Curricula updates led to an increase in technology use of about 16-18 percentage points, with the effect for "mainstream" firms (those without patents) about twice as high as for "frontier" firms (those with patents). Curricula updates in basic vocational training clearly accelerated the use of new digital technologies – especially in firms without their own R&D activities, i.e. those that face higher hurdles for technology adaptation[9]. Such effects can – and should – also be systematically exploited for further waves of digitalization.

**Universities of applied sciences – career path for VET graduates and drivers of innovation**

Universities of applied sciences (UASs) – traditionally a career step for vocational graduates – also make a significant contribution to innovation, as underlined by various recent studies. When universities of applied sciences were first founded (from the mid-1990s onwards), their graduates and teaching staff formed a powerful new link between vocational and academic qualifications. The positive impact on innovation was clear to see in regions with one of these new UASs. Historically, UAS students were required to have a vocational qualification, which was then enhanced by applied academic knowledge in accordance with the mandate of the universities of applied sciences. Lecturers were expected to have a doctorate from a research university and several years of practical business experience. In addition, UASs were given the mandate to conduct applied research themselves, in collaboration with businesses where possible. This new knowledge combination efficiently bridged between the content and qualification requirements of regular production (or service) processes and the challenges of the R&D process. Again, this was especially true in SMEs engaging in little or no R&D to date, but in high-quality and sophisticated production or services.



[9] Schultheiss, T., Backes-Gellner, U. (2021): Updated education curricula and accelerated technology diffusion in the workplace: Micro-evidence on the race between education and technology. In: Swiss Leading House "Economics of Education" Working Paper No. 173.



**Performance indicators providing evidence for these innovation effects**

Several recent studies confirm multiple positive innovation effects of newly founded UASs with STEM fields. Lehnert/Pfister/Backes-Gellner (2020)[10] show that firms near such institutions employ a significantly higher percentage of workers who perform R&D as their main job activity and also significantly increase their R&D intensity, measured in terms of personnel expenditures. Schultheiss/Pfister/Gnehm/Backes-Gellner (2021)[11] show that after a UAS is founded, firms employ significantly more VET graduates for R&D tasks. In other words, VET graduates are not substituted by UAS graduates but they are also pulled along when R&D is intensified ("a rising tide lifts all boats"). Pfister/Koomen/Harhoff/Backes-Gellner (2021)[12] also noted that the quantity of patenting activities in UAS regions (compared to non-UAS regions) increases significantly. However, it is not only the quantity of patents that increases but also the quality as measured by multiple indicators, i.e. the expansion of patenting activities does not come at the expense of quality. The results of such quantitative, econometric studies are also supported by qualitative case studies, as case studies at Bühler Group AG, maxon or Novartis, among others, clearly illustrate[13].

At the same time, Schlegel/Pfister/Harhoff/Backes-Gellner (2021)[14] demonstrate that such innovation effects are linked to regional preconditions. The UAS effects are significantly stronger in regions that already benefit from sufficient economic conditions, measured, for example, by the size of the labor market or high-tech intensity of a region. The findings of Lehnert/Pfister/Harhoff/Backes-Gellner (2020)[15] in Germany point in the same direction, showing that patenting activities increase in UAS regions in Germany as well, but that the effects are again significantly stronger within coherent regional innovation ecosystems (e.g. alongside research institutes such as the Fraunhofer or Max-Planck Institutes and universities).



[10] Lehnert, P., Pfister, C., Backes-Gellner, U. (2020): Employment of R&D personnel after an educational supply shock: Effects of the introduction of Universities of Applied Sciences in Switzerland. In: Labour Economics, 66.

[11] Schultheiss, T., Pfister, C., Gnehm, A. S., Backes-Gellner, U. (2021): Tertiary education expansion and task demand: Does a rising tide lift all boats? In: Swiss Leading House "Economics of Education" Working Paper No. 154.

[12] Pfister, C., Koomen, M., Harhoff, D., Backes-Gellner, U. (2021): Regional Innovation Effects of Applied Research Institutions. In: Research Policy, 50(4).

[13] Backes-Gellner, U., Pfister, C. (2019): The Contribution of Vocational Education and Training to Innovation – The Case of Switzerland. In: SERI. Research and Innovation in Switzerland 2020. Zürich: Schweizerische Eidgenossenschaft, p. 1-93.

[14] Schlegel, T., Pfister, C., Harhoff, D., Backes-Gellner, U. (2021): Innovation Effects of Universities of Applied Sciences: an Assessment of Regional Heterogeneity. In: The Journal of Technology Transfer.

[15] Lehnert, P, Pfister, C., Harhoff, D., Backes-Gellner, U. (2020): Knowledge Complementarities and Patenting: Do New Universities of Applied Sciences Foster Regional Innovation? In: Swiss Leading House "Economics of Education" Working Paper No. 164.

## Conclusion: (Vocational) education and innovation

Combined, the above findings create a powerful case to state that VET (basic vocational training and subsequent education at universities of applied sciences) is in no way at odds with the innovative capacity of a national economy or individual companies. Indeed, this model of education plays an important role in innovation and in Switzerland's top position in international innovation rankings.

Consequently, the findings of Anglo-Saxon studies are not transferable to Switzerland (nor to Germany) as these countries do not have a high-quality VET system. Thus, Anglo-Saxon countries fight with an increasing number of students and academics against their problem of a shortage of workers with high quality mid-level skills, a problem that does not even exist in this form in Switzerland or Germany due to a well-functioning and high-quality VET system. Accordingly, in Switzerland – unlike in countries without an excellent VET system – education policy must not focus on maximizing the number of academics or university graduates, but on safeguarding and continuously developing the quality of VET. In addition, it is important to maintain a university system that remains competitive at the international research frontier, rather than one where standards are diluted by ever-growing student numbers. Systemically, it is furthermore important to improve the coordination between the vocational and the academic part of the education system.

One acute issue is the lack of applicants for apprenticeships. This has coincided with a significant expansion of high schools (Gymnasium) and universities, a policy that has neither improved the quality of universities nor of VET. Another issue is the risk of diluting the unique profile of UASs, which lately seems to be geared more towards an "academization of UASs" and direct competition with universities rather than their original mandate (with the positive innovation effects mentioned above). A general weakness at present is the topic of lifelong learning, which leaves much to be desired, especially when set against the excellence observed in the VET system. Given the foreseeable demographic developments and increasing digitalization, lifelong learning will become even more crucial for competitiveness and innovation. The focus here must be on the recognition of competences acquired on the job to facilitate occupational mobility and on the development of competences for increasingly digitalized jobs. Contrary to common prejudices, it is not only and not even primarily about programming skills, but also in particular about "digital literacy" or the development of social skills for working in (digital) teams and about self-competence as a prerequisite for increasingly digitalized and also increasingly home-based workplaces.

Resolving these educational policy challenges and acute issues is vital for the innovative capacity of the economy as a whole, of companies and of individuals and ultimately for the contribution of innovation to tackle major societal issues such as climate change and social inequality.

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