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Apprenticeship Skills Pay Off on the Labor Market*

KEY MESSAGES

- **Apprenticeship plans provide the basis for reliably and comprehensively classifying the skills of a large share of Germany's workforce**
- **In total, we classify more than 13,000 different skills and the duration of learning each skill based on the apprenticeship plans**
- **Workers who have acquired higher cognitive, social, or digital skills during their apprenticeship earn higher wages in the short and long term**
- **In particular, the value of digital skills has risen sharply since the 1990s, parallel to the increasing use of computers in the workplace**
- **The speed at which apprenticeship plans are modernized is crucial for how well the German apprenticeship system can prepare its graduates for the future labor market**

Workers' skills are essential to their success on the labor market (Schultz 1961; Becker 1962; Mincer 1974). Higher skills not only have a positive impact on individual labor productivity (Hanushek et al. 2015), but also influence career choices (Deming 2017; Deming and Noray 2020), career trajectories (Arellano-Bover 2022; Adda and Dustmann 2023), and vulnerability to technological change (Cortes 2016; Braxton and Taska 2023). However, the empirical evidence on the economic impact of higher skills is still limited due to how skills are measured. Most existing studies measure skills according to the number of completed years of schooling or test scores. Both are incomplete measures of an individual's actual skill level. First, skills vary considerably among individuals with the same level of formal education. Second, skill assessment tests cover only basic skills (typically in math and reading) and thus comprise only a small part of an individual's entire skill spectrum.

In our research project, we develop novel measures of workers' skills that are comprehensive, highly detailed, and directly relevant to the labor market. To this end, we leverage the characteristics of the German apprenticeship system, which offers three main advantages for measuring skills and analyzing their labor market potential.

First, the qualification requirements are set out in state-approved, nationally standardized apprenticeship plans. This uniform system ensures that a given apprenticeship imparts the same practical and theoretical skills regardless of the training location. In addition, the apprenticeship plans precisely specify the period over which the skills are learned. Second, since about 60 percent of workers in Germany have completed vocational training (IAB 2017), we can measure the skills of a large part of the German labor force. Third, apprenticeships typically commence immediately after secondary education, so apprenticeship plans provide information on what skills individuals have at the beginning of their careers. Measures of workers' skills when entering the labor force are rarely found in the previous literature.

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INSTITUTIONAL BACKGROUND

People usually start an apprenticeship at the age of 16 to 18 years, directly after completing secondary education. The majority of those who complete an apprenticeship have already obtained a lower or intermediate secondary school qualification. Thus, individuals enter the apprenticeship system with very similar levels of education. The length of an apprenticeship varies between two and four years, with most apprenticeships lasting three years. The German apprenticeship system combines theory and practice in the form of a "dual system": one part of the apprenticeship (approx. 3–4 days per week) consists of on-the-job training at a company, while the other part (approx. 1–2 days per week) is made up of courses at a public vocational school.

The skills learned during training at the company and at the vocational school are codified in state-approved apprenticeship plans. Each training occupation is assigned exactly one apprenticeship plan. To ensure that the skills acquired during apprenticeships are relevant to the labor market, apprenticeship plans are developed jointly by employer associations, experts from the vocational training sector, and the Federal Institute for Vocational Education and Training (BIBB) and are authorized by the federal government, making them legally binding (BIBB 2017).

The apprenticeship system is standardized throughout Germany in accordance with the Vocational Training Act. This act stipulates that companies that offer apprenticeships must comply with the requirements set out in apprenticeship plans to ensure the quality of training regardless of where in Germany it is provided (Janssen and Mohrenweiser 2018). In addition, nationally standardized final examinations guarantee that apprentices have acquired the skills specified in the plans. These exams are monitored and graded by the Chamber of Commerce and Industry (IHK) or the Chamber of Commerce (HK), ensuring compliance with nationwide standards. Given these characteristics of the German apprenticeship system, it is reasonable to assume that companies impart the skills outlined in the apprenticeship plans. This enables us to gauge the labor-market-relevant skills of individuals who have completed such apprenticeships.[1]

[1] The approach of using apprenticeship plans to infer worker skills was pioneered by Eggenberger et al. (2018) for Switzerland.

SKILL MEASUREMENT

As discussed in the previous section, apprenticeship plans specify what material apprenticeships cover and how long they last. We analyzed the plans for the 165 largest apprenticeship occupations in Germany, which cover more than 85 percent of those members of the German workforce who have completed vocational training. Each plan consists of, on average, seven pages totaling 850 words. It also contains information on how many weeks apprentices spend learning a particular skill. The plans thus provide information not only about which skills are acquired during the apprenticeship, but also the intensity with which these skills are learned. On average, 120 different skills are listed in each plan. In total, we classified over 13,000 skills that are taught in the German apprenticeship system.

For our further analysis, we group the individual skills into more general skill groups. For this purpose, we take the classification used by Deming and Kahn (2018), which was developed for highly skilled occupations in the United States. After tailoring the classification to fit the German low- and medium-skill apprenticeship context, we identified six distinct skill groups as outlined in Table 1: cognitive, social, digital, manual, management, and administrative.

Cognitive and administrative skills are taught in every apprenticeship, while social and digital skills are more occupation-specific. Manual skills are also strongly occupation-specific, as they are learned particularly in craft apprenticeships (e.g., plumbers, carpenters, or joiners).

DATA

In the next step, we link our skill measures to comprehensive labor market data to investigate how different types of skill are rewarded over individuals' careers after entering the labor market. In the following, we focus on cognitive, social, and digital skills, as these have been discussed as important determinants of labor market success in the previous literature (Weinberger 2014; Hanushek et al. 2015; Deming 2017; Falck et al. 2021).

To analyze the labor market returns to skills, we draw on administrative data in which workers are

Table 1

Skill Classification Based on Apprenticeship Plans

	Keywords and phrases
Cognitive	Math and statistics, critical/analytical thinking, problem solving and decision making, language, creativity, innovation, economics, accounting, business analysis, evaluation
Social	Teamwork, communication, negotiation, presentation, consultation and advice, customer service, service orientation, time management, adaptability, flexibility, stress tolerance
Digital	Basic computer skills, office software, data analysis, data security, software
Manual	Construction, transportation, general physical activities, maintenance, installation, repairing, tools
Management	Management of personnel and financial resources, project management
Administrative	Writing, scheduling, support activities, law and regulations

Source: Authors' own compilation.

tracked throughout their careers. More specifically, we use the Sample of Integrated Labor Market Biographies (SIAB), provided by the Institute for Employment Research (IAB).[2] This is a 2 percent sample of all employees subject to social security contributions in Germany (Antoni et al. 2019; Frodermann et al. 2021). As a consequence of the legal obligation to report the beginning and end of every employment relationship subject to social insurance and the wages paid, the SIAB data is the largest and most reliable source of labor market information in Germany. Furthermore, the SIAB includes information on basic demographic characteristics such as worker age, gender, nationality, and education. Establishment characteristics such as the number of employees, age, and industry affiliation are also part of the SIAB. All of these are important for dealing with worker selection for apprenticeships.

For our study, one crucial detail is that the SIAB provides data on an employee's apprenticeship occupation down to the 5-digit level. Given that apprenticeship plans are also available at this granular level, there is no need for aggregating the apprenticeship skill data when merging them to the worker data in the SIAB.

We focus on full-time employees who have completed an apprenticeship.[3] Our sample contains only workers whom we can observe in full-time employment at least once in each of the four consecutive five-year periods after labor market entry. This allows us to observe the same workers over a period of more than 15 years after the end of their apprenticeship.

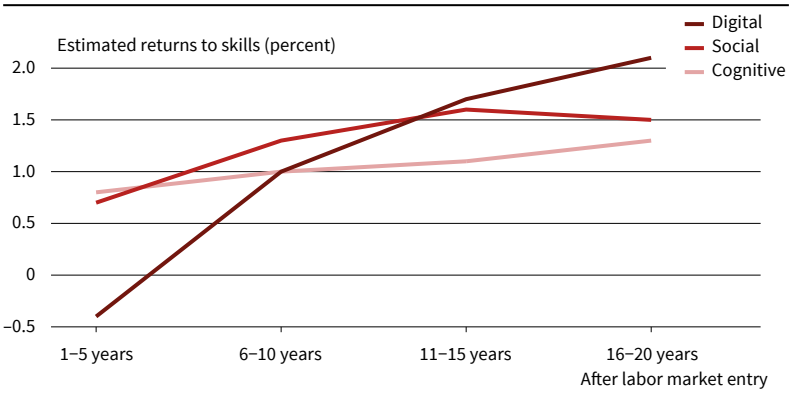
DO THE SKILLS TAUGHT DURING APPRENTICESHIP PAY OFF ON THE LABOR MARKET?

Returns to Skills during a Career

Our results show that employees who have acquired higher cognitive, social, or digital skills during their apprenticeship perform better on the labor market (see Figure 1). While the labor market returns to all three skills are still relatively low in the first few years after completing an apprenticeship, they increase significantly over the course of a career. At the end of our observation period, 16–20 years after entering the labor market, wages increase by 1.3 percent with each additional month of acquiring cognitive skills. This corresponds to additional earnings of about EUR 500 annually. The wage increases associated with an additional month of learning social and digital skills are even higher, at 1.5 percent (approx. EUR 550) and 2.1 percent (approx. EUR 800), respectively. Thus, the wage increases of an additional month of skills acquired in apprenticeship correspond to between 16 percent and 27 percent of the return to an entire additional school year. This illustrates the high value on the labor market of the skills learned during apprenticeship.

Figure 1

Returns to Skills over the Career



Note: The figure shows the percentage increase in earnings for an increase in cognitive, social, and digital skills by one month over the first 20 years after labor market entry. The sample consists of full-time employees with completed apprenticeship education. The estimates account for the other skill groups (manual, management, administrative), demographic factors (gender, nationality, age fixed effects, and pre-apprenticeship educational degree), the year and county of apprenticeship completion, and apprenticeship field (1-digit level).
Source: Sample of Integrated Labor Market Biographies (SIAB); authors' own calculations. © ifo Institute

The wage gradient associated with an additional month of learning skills is most pronounced for digital skills (Figure 1). One explanation for this pattern is that workers with higher digital skills are more likely to obtain a university degree and to participate in on-the-job training later on, possibly because their skills become obsolete more quickly. This has been suggested in recent work by Deming and Noray (2020).

When calculating the relationship between wages and skills, we accounted for wage differences due to gender, age, nationality, and education. Additionally controlling for the year and district of training completion also ensures that our results are not skewed by cohort effects or regional differences in average establishment quality, industry structure, or labor demand. In addition, we compare wages only within occupational groups – i.e., we compare different craft occupations with each other, rather than juxtaposing craft occupations with IT occupations.

In subsequent analyses, we shifted our focus from wage levels to wage growth over workers' careers, relative to the period immediately after labor market entry. While higher cognitive skills are associated with only modest wage increases, wage growth is substantially more pronounced for workers with higher social or digital skills.

[2] Philipp vom Berge, Corinna Frodermann, Tobias Graf, Stephan Grießemer, Steffen Kaimer, Markus Köhler, Claudia Lehnert, Martina Oertel, Alexandra Schmucker, Andreas Schneider and Stefan Seth (2021), *Weakly Anonymized Version of the Sample of Integrated Labor Market Biographies (SIAB) – Version 7519 v1*, Research Data Center of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB), DOI: 10.5164/IAB.SIAB7519.en.v1. The access to the SIAB data was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and subsequently remote data access.

[3] The analysis of full-time employees is a standard procedure, since the SIAB includes daily wages, but no information is available on the daily hours worked by the employees. This limits the comparability of daily wages of part-time workers in the SIAB.

Skill Complementarity

In addition, we examined factors that influence the labor market returns to skills. First, we looked at whether employees who acquire certain combinations of skills during their apprenticeship are paid higher wages. It turns out that the combination of cognitive and social skills is particularly valuable on the labor market. This result corroborates previous findings on the complementarity of cognitive and social skills from the United States (Deming 2017; Deming and Kahn 2018) and Switzerland (Kiener et al. 2023). One interpretation of this finding is that workers who have both cognitive and social skills can take on more complex tasks at work, thereby increasing their productivity (see Deming and Kahn 2018, for a similar argument). In contrast, other combinations of skills acquired during apprenticeship are not associated with a wage advantage.

Moreover, we find that cognitive skills acquired during apprenticeship pay higher returns when they are actually needed in the worker's current job. For this analysis, we determined companies' demand for skills from more than 18 million online job postings provided to us by the US firm Lightcast.

Robustness Checks

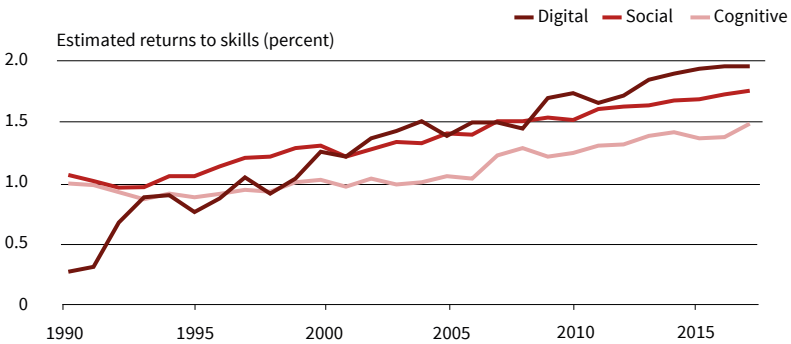
Several further analyses reported in Langer and Wiederhold (2023) illustrate that our results are highly robust. For example, we use supplementary survey data that allow us to account for workers' family background, final high school grades, and non-cognitive skills. The family background controls are particularly important in the context of Germany, which is characterized by a high intergenerational persistence of economic success.[4]

To account for the possibility that our results are explained by the selection of workers into more productive (and thus better paying) apprenticeship establishments, our empirical analysis also controls for establishment characteristics such as size, age, industry affiliation, and overall productivity. Our results remain robust even if we compare only those workers who completed their apprenticeship within the same establishment.

[4] In Germany, it takes 6 generations for those born in low-income families to approach the mean income in their society, longer than in the United States (5) and the OECD average (4.5) (OECD 2018).

Figure 2

Returns Over Time: Prime-aged Males and Females



Note: The figure shows the percentage increase in earnings for a one-month increase in cognitive, social, and digital skills for each year from 1990 to 2017. The sample consists of full-time workers with a completed apprenticeship training aged 35–54 years in a given year. Estimated returns are conditional on the other skill domains (manual, management, admin), worker characteristics (gender, nationality, age fixed effects, and pre-apprenticeship educational degree), and apprenticeship characteristics (year of completion, county of training establishment, and occupational field (1-digit)).
Source: Sample of Integrated Labor Market Biographies (SIAB); authors' own calculations. © ifo Institute

Returns to Skills over Time

Thus far, we have examined how the labor market returns to higher skills evolve over workers' careers. However, to answer the question of how the value of skills is affected by societal and technological change, it is necessary to observe the development of returns over time. Figure 2 shows the returns to skills per year, from 1990 to 2017.[5] The graph illustrates a marked rise in returns to cognitive, social, and digital skills over the past three decades. The surge in the returns to digital skills stands out: by 2017, these returns had increased sevenfold from their 1990 value. Interestingly, the ascent in digital skill returns began in the early 1990s, coinciding with the growing prominence of computers in the workplace. This suggests a complementarity between workplace computer usage and workers' digital skills.

DISCUSSION

We construct novel measures of workers' skills based on apprenticeship plans, which outline apprenticeship requirements in a standardized manner throughout Germany. From these plans, we identified over 13,000 specific skills, which can be categorized into cognitive, social, digital, manual, management, and administrative domains. For each skill, the apprenticeship plans also indicate the learning duration, so that the skill measures can be intuitively interpreted as months of skill acquisition during the apprenticeship.

Workers who acquire higher cognitive, social, or digital skills during their apprenticeship earn significantly higher wages throughout their careers. However, the labor market rewards for various skills differ noticeably. For instance, dedicating an extra month to cognitive skill development during an apprenticeship is related to a 1.3 percent wage increase roughly two decades later. The long-run returns to social and digital skills, however, are even more pronounced, at 1.5 percent and 2.1 percent respectively. When compared to the wage increase from an entire additional year of schooling, which is around 8 percent, it is evident that the labor market highly values all three skills.

Investigating drivers of returns to skills, we find evidence for skill complementarities: workers who simultaneously acquired cognitive and social skills

[5] These estimates are based on a sample of prime-aged workers (35–54 years) in the respective year. Previous evidence indicates that observed wages during prime age are a particularly good proxy for lifetime wages (Hanushek et al. 2015).

during apprenticeship are particularly valuable on the labor market and can maintain this pay advantage throughout their careers. Linking our skill data with job vacancy data, we also provide evidence for skill-technology complementarities. We show that workers with higher cognitive skills earn higher wages when a company's production technology is more likely to require these skills.

Examining long-term patterns, we find that the returns to cognitive, social, and digital skills have increased over the past 30 years. The growth in the returns to higher digital skills is particularly pronounced, suggesting that the increasing diffusion of computer technology is a driving force behind the increased economic value of digital skills.

POLICY CONCLUSIONS

Our study aims to contribute to the understanding of the sources and possible future developments of labor market returns to vocational education. For example, analysis of changes of returns to different types of skills over time may help to forecast the impact of technological change on differently-skilled workers and to determine the feasibility of reskilling. Our finding that cognitive, social, and digital skills acquired through apprenticeships are valued on the labor market also suggests that the German apprenticeship system – which is highly praised internationally (The Economist 2018) – can indeed serve as a role model. In fact, several countries are currently debating whether or not to implement an apprenticeship system. In the US, for instance, apprenticeships have recently been advocated as a means to decrease youth unemployment, increase workforce quality, and provide in-demand skills (Lerman 2022). By offering insights into the suitability of apprenticeship programs to prepare individuals for the demands of the labor market, our results can provide guidance for the design of vocational training curricula.

Our study also shows which skills taught as part of an apprenticeship are mainly responsible for the labor market returns to vocational education. For example, while digital skills are highly rewarded on the labor market, they are taught only for a relatively short period – averaging just two months of a three-year apprenticeship. For the future viability of the German apprenticeship system in times of increasingly rapid technological change, the speed with which apprenticeship plans are modernized is crucial with a view to keeping up with companies' changing skills requirements. Thus, our future research aims to delve into past apprenticeship plans to gauge how effectively the German apprenticeship system equips its graduates for evolving labor market demands.

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