The Skill Landscape of Germany

Evidence from Apprenticeship and Job Vacancy Data

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Motivation and Main Findings

- According to recent surveys, many employees feel unprepared for the requirements of the labor market (Economist, 2017)
- **Does the German apprenticeship system prepare its graduates adequately for the challenges of the modern labor market?**
  - → We analyze standardized apprenticeship plans to objectively measure skill supply for a highly relevant part of the German labor force – around 60% of German workers completed an apprenticeship program (Source: IAB, 2017)
  - → We relate the skills supplied through the German apprenticeship system to workers' numeracy skills and labor market success
  - → In ongoing work, we link apprentices' skills to employers' skill requirements derived from online job vacancy data and explore the consequences of skill mismatch
- Our descriptive results suggest that the labor market rewards the skills developed through the apprenticeship system
- Conditional on a large set of controls (e.g., non-cognitive skills, family background), we find that workers who completed an apprenticeship in occupations with higher cognitive and ICT skill intensities have substantially higher cognitive skills and earn higher wages

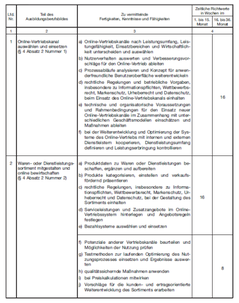
Skill Supply Side

Institutional Setting of the German Apprenticeship System

- Most apprenticeships take 3 years to complete
- Dual system: apprenticeship training includes education at public vocational schools and on-the-job training in firms
- Unique setting:
  - → Requirements of apprenticeship training are codified in state-approved apprenticeship plans
  - → These are standardized across the whole country by the *Vocational Training Act*
  - → The same practical and theoretical skills are developed in a particular apprenticeship regardless of the training location
- Training content formulated in the apprenticeship plans represents mandatory minimum standards every training company needs to cover
- Skill data derived from apprenticeship plans do not suffer from drawbacks of worker task surveys (e.g., U.S. O*NET, German BIBB), such as self-reported task-content assessments

Apprenticeship Plans

- We derive skills from plans of the 42 largest apprenticeship occupations in Germany, representing more than 50% of the German workforce with completed apprenticeship training (data collection ongoing)
- Each plan:
  - Represents one occupation and allows us to derive a precisely measured set of skills developed during the apprenticeship
  - Exhibits on average 7.2 pages describing the imparted skills in high detail
  - Contains columns containing the occupational skill content with a profound description of competences provided at all stages of the apprenticeship



Notes: Plan for the apprenticeship occupation e-commerce Salesperson

Classification of Occupational Skills

- We assign labels to each skill mentioned in an apprenticeship plan
- Skill labels are based on the classification by Deming and Kahn (2018), slightly adapted to fit the German apprenticeship context
- Relative skill measure: Share of a certain skill in all skills trained in an apprenticeship occupation (shares add up to 100%)

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

Occupational Skill Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Cognitive	1.000							
(2) ICT	0.451	1.000						
(3) Social	0.025	–0.059	1.000					
(4) Manual	–0.683	–0.346	–0.523	1.000				
(5) Character	0.393	0.230	0.262	–0.604	1.000			
(6) Management	–0.003	–0.192	0.143	–0.277	–0.012	1.000		
(7) Baseline	–0.269	–0.076	0.012	–0.005	0.085	–0.029	1.000	
(8) Admin	0.331	–0.038	0.209	–0.653	0.393	0.063	–0.197	1.000

Top and Bottom Apprenticeships (Occupational Skill Shares)

Panel A: Top 3 Apprenticeships

Cognitive Skills			ICT Skills		
Occupation	Cognitive Share	ICT Share	Occupation	ICT Share	Cognitive Share
Tax Assistant	48.53	4.40	Media Designer	27.61	41.20
Media Designer	41.20	27.61	Metal Cutting Mechanic	17.79	21.63
Techn. Product Designer	39.94	12.24	e-Commerce Salesperson	16.28	34.88

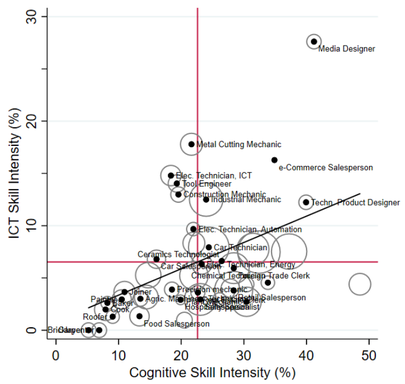
Panel B: Bottom 3 Apprenticeships

Cognitive Skills			ICT Skills		
Occupation	Cognitive Share	ICT Share	Occupation	ICT Share	Cognitive Share
Cook	7.92	1.98	Farmer	0.96	20.51
Carpenter	6.91	0.00	Carpenter	0.00	6.91
Bricklayer	5.21	0.00	Bricklayer	0.00	5.21

Notes: Table shows the ranking of the top and bottom three apprenticeships according to their cognitive and ICT skill shares. Sample is restricted to the 42 largest apprenticeship occupations in Germany.

Occupational Skills in Germany

Figure: Cognitive and ICT Skill Shares in German Apprenticeship Plans

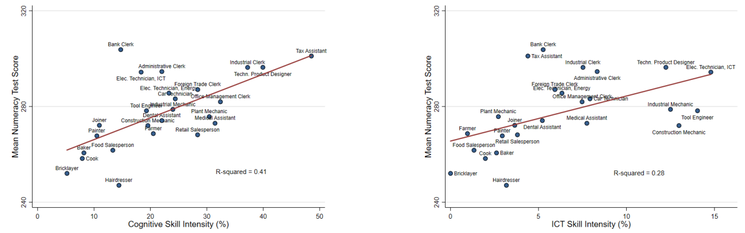


Notes: Figure plots ICT and cognitive skill shares in 42 German apprenticeship plans, weighted by the number of new apprentices in 2017. Apprenticeships whose titles are shown are represented by filled dots; the size of the hollow circles around the filled dots is proportional to the number of new apprentices in 2017. Regression line shown in black. Averages of ICT and cognitive skill shares shown as red lines.

PIAAC Data

- Data from the Programme for the International Assessment of Adult Competencies (PIAAC) and its follow up study provide test scores and labor market outcomes for adults aged 16-65
- PIAAC data contain information on the completed apprenticeship (five-digit occupational level)
- Used to quantify impact of skills developed through the apprenticeship system on workers' cognitive skills (numeracy test scores) and labor market success (hourly wages)

Occupational Skill Intensities and Individuals' Numeracy Skills



Notes: Occupation-level correlations of cognitive/ICT skill intensities and numeracy test scores. Sample consists of PIAAC participants with a completed apprenticeship training. Correlations shown in this graph are based on apprenticeship occupations with more than 30 observations in PIAAC.

Occupational Skill Intensities and Individuals' Numeracy Skills/Wages

	Numeracy			Log Hourly Wages		
	(1) Cognitive Skills	(2) ICT Skills	(3) All Skills	(4) Cognitive Skills	(5) ICT Skills	(6) All Skills
Cognitive	0.010** (0.004)		0.013*** (0.003)	0.006** (0.002)		0.009*** (0.002)
ICT		0.031*** (0.006)	0.039*** (0.006)		0.015*** (0.005)	0.018*** (0.004)
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Non-cognitive skills	Yes	Yes	Yes	Yes	Yes	Yes
Final school grades	Yes	Yes	Yes	Yes	Yes	Yes
Family background	Yes	Yes	Yes	Yes	Yes	Yes
Other Skills	No	No	Yes	No	No	Yes
F-statistic (cogn. and ICT)			39.40			14.15
F-statistic (all skills)			19.69			6.01
R^2	0.29	0.30	0.33	0.25	0.25	0.29
N	1496	1496	1496	1467	1467	1467

Notes: Sample consists of PIAAC participants with a completed apprenticeship training. Dependent variables are PIAAC numeracy test scores (Columns 1–3) and log hourly wages (Columns 4–6). All regressions contain basic controls (age, age^2, gender and migrant status) as well as controls for individuals' non-cognitive skills (Big 5, grit, locus of control, risk attitude, trust), final high school grades (math and German), state of finishing high school , and the two-digit occupation of mother/father when the person was 15 years old. Robust standard errors, shown in parentheses, are clustered at the occupational level. When all skills are included in Columns 3 and 6, reference category is manual skills. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

A 10pp increase in an occupation's cognitive skill intensity (e.g. from bricklayer to bank clerk) increases numeracy test scores by 0.1 SD and wages by 6%

A 10pp increase in an occupation's ICT skill intensity (e.g. from plant mechanic to technical product designer) increases numeracy test scores by 0.31 SD and wages by 15%

- We also report F-statistics for the cognitive and ICT skill variables and for the full set of skills. For both numeracy skills and wages we can strongly reject that these groups of coefficients are equal to 0 (p<0.001)

Skill Demand Side

- Demand side refers to employers' skill demand expressed in job vacancies posted online
- Data from online job vacancies provide a unique source of variation in skill requirements between and within detailed occupations

We use two data sources to measure employers' skill demand:

Burning Glass Technologies (BGT)

Joint work by Langer, Wiederhold and O'Kane (BGT)

- Near-universe of online job vacancies in Germany, in total more than 48 million vacancies
- BGT scrapes 207 online sources, pre-processes the data and uses ML algorithms to classify skill requirements
- Time period: January 2014 - July 2020

Case Study IT Jobs

- Over 550,000 web-crawled online job vacanies in the IT sector
- Scraped from Federal Employment Agency and other job boards
- Time period: June 2014 - September 2018

Next Steps

- Derive occupational skill content for all 328 state-approved apprenticeships
- Use administrative panel data of the German workforce available since 1975 (SIAB) to quantify labor market success of apprenticeship graduates
- Analysis of occupational skill changes over time using apprenticeship plan updates
- Linking apprentices' skill supply measures to employers' requirements on the demand side and investigate the economic consequences of mismatch between skill supply and demand

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