CASMIN versus ISCED: Validating Standard Education Variables for German Microdata

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Online Appendix

Appendix 1: Why does education affect outcomes?

Education is related to a wide range of outcomes (Weakliem 2002; Easterbrook et al. 2016). While this paper does not address the precise mechanisms by which educational attainment affects different outcomes, and the relationship between education and outcomes is oftentimes complex, at a general level, for a validation analysis to be plausible, it is necessary to spell out reasons why education may be related to outcomes. At the most basic level, formal education (implicity and explicitly) conveys skills such as reading and reasoning, factual knowledge and information, and attitudes/values. These lead to direct effects of education. Formal education is, however, (self)selective and thus not equally accessible to all members of society, leading to inequalities in education especially by social background. Without controls for social background, we may thus find spurious effects of education, i.e. we need to interpret the effects of education widely to incorporate social background. Furthermore, educational institutions serve as a system of legitimation in the societal distribution of rewards (Meyer 1977). Therefore, we can also expect indirect effects of education, e.g. via income or access to different social networks and neighborhoods.

In social stratification and labor market research, education is expected to affect labour market outcomes, such as employment status and wages, firstly because education enhances skills, which in turn enhance productivity. This is why people invest in their "human capital" (Becker 1964). Competing, more sociological theories (Arrow 1973; Spence 1973) argue that educational attainment, especially when underpinned by some formal qualification, signals cognitive ability, and thereby 'trainability', as well as critical non-cognitive skills such as motivation and discipline rather than skills that are directly relevant for a job. For education to positively influence labour market outcomes, actual learning is not a prerequisite; it suffices if education is an effective screening device for employers, and in this respect, low education can become a stigma. Conflict theory (Collins 1971; Kerckhoff 1976) finally states that educational attainment is a means for higher social classes to transfer social privilege from one generation to the next, and to exercise social closure: higher-status groups have more resources to invest in the education of their children, ranging from language skills to financial assets supporting extended university studies. In this case, apparent education effects are rather social background (i.e. spurious) effects.

Educational attainment is easier to measure than occupation or income and it is positively related to success in the labour market. Therefore, educational attainment is also commonly used as a proxy indicator for socioeconomic status (e.g. in much of health research, see e.g. Eikemo et al. 2008; von dem Knesebeck et al. 2006) even though socioeconomic status is conceptualised as resulting from the combination of education, occupational status, and income. Consequently, variables related to social status (and occupation and income) are also commonly *indirectly* (but still causally) related to education.

When interested in social attitudes and opinions, the socialising role of education, rather than education as an allocation device, is often at the forefront of the argument, but there are again multiple explanations. The enlightenment hypothesis (Davis and Robinson 1991; Hyman and Wright 1979; Stouffer 1955) assumes that education generally strengthens liberal values, leading to lower support of traditional authorities and higher support for norms of equal treatment and minority rights. The higher skills of the more highly educated contribute to this in that "cognitive sophistication" has been shown to lead to more political tolerance (Bobo and Licari 1989). Weakliem (2002) theorises that education enables people to trust their own abilities so that traditions may be perceived as hindering them from leading their lives as they wish. The core values approach, in contrast, expects different societies to stress different "official" values and attitudes in their educational curricula (Phelan et al. 1995; Selznick and Steinberg 1969), leading to a reproduction of societal values across generations via

education, with no effects of skills. So, while education is expected to be related to attitudes everywhere, the direction of the relationship may differ across societies.

Finally, in contrast to both these approaches stressing socialisation and learning, using longitudinal data, Lancee and Sarrasin (2015) found no intra-individual change in attitudes as individuals pass through education, pointing at selection effects. Ultimately, parental education is a joint (partial) cause of educational success *and* attitudes, and the same may apply to cognitive ability and personality characteristics such as openness. With regard to the latter two, the causal effects may run both ways though, and it is unlikely for these third variables to be responsible for the entire association (Emler and Frazer 1999).

In summary, while there are different and often complex explanations for education effects brought forward for various outcomes in the literature, these can be subsumed under the headers of *learning* (direct effects), *allocation* (indirect effects) and *selection (spurious effects)*. Concerning the latter, it means that education is not necessarily causally relevant for the observed outcomes, but a third variable related to both education and the outcome in question is the underlying cause for both, most importantly, social background. In the (often inevitable) absence of controls for such variables, we thus need to be aware that educational attainment inevitably measures factors beyond the individual educational experience and the ensuing status attainment and network processes, and that education effects will thus include third-variable effects in addition to genuine (direct and indirect) education effects.

Appendix 2: The German educational system

The German school system is highly stratified (e.g., Allmendinger 1989), with different school-leaving qualifications going along with different levels of general basic skills (Maehler et al. 2013; Rammstedt 2013). While schooling is regulated by the 16 federal states, a standing federal body (the "Kultusministerkonferenz" or KMK) ensures some degree of coordination across Germany as a whole. There is a strong differentiation between schooling and vocational education (König et al. 1988). Like in general schooling, there are hierarchical differences between different levels and types of programs and qualifications within post-school vocational education as well (Protsch and Solga 2016). In contrast to general schooling and higher education, vocational education is regulated centrally though.

While compulsory full-time general education lasts nine years since 1964, pupils in Germany since 1920 only spend the first four years (or six years in Berlin and Brandenburg) in the same school type, "Grundschule" (primary school). Following "Grundschule", pupils are sorted into different school types originating in the early history of formal schooling (König et al. 1988; Döbert 2007), depending on teacher recommendations and—depending on the federal state—parental preferences (Füssel et al. 2010). The available options were traditionally the non-selective "Hauptschule" (lower track) with grades five to nine (with its predecessor "Volksschule" lasting eight years), the intermediate "Realschule" with grades five to ten, and the academically selective "Gymnasium" with grades five to (depending on state and cohort) twelve or 13. While the lower and intermediate tracks prepare mostly for vocational training in dual system apprenticeships and full-time vocational schools, the Gymnasium, with its high-status "Abitur" examination, prepares for traditional university education. Finishing the "Gymnasium" a year earlier leads to the entrance qualification for universities of applied sciences ("Fachhochschulreife", see below). While upward transfer across school types is rare, all general school-leaving certificates can also be obtained in specialized vocational or evening schools if a student wants to upgrade their certificate after having obtained a first schooling-leaving certificate, and this opportunity is used quite often (Orr and Hovdhaugen 2014; Jacob and Tieben 2010). The 1970s saw the introduction of comprehensive schools ("Gesamtschule") on a 'trial basis' across Germany. While federal states with mostly sociodemocratic governments established these on

a permanent basis, leading to a parallel existence of a tripartite and comprehensive system, federal states with mostly conservative governments abolished these schools again.

Following German reunification, all eastern German states introduced the Gymnasium but most kept one alternative track of lower secondary education instead of implementing two, corresponding to "Haupt-" and "Realschule" (Weiss and Weishaupt 1999) and called e.g. "Regelschule", "Mittelschule" or "Sekundarschule". Since "Hauptschule" became more and more unpopular, some West German states followed suit and integrated these two tracks into a new school type, which has different names in different federal states (e.g. "Realschule plus" or "Sekundarschule"). In all federal states, these schools, like the older comprehensive schools, nevertheless are required to offer the school-leaving certificates of "Hauptschule" and "Realschule", which thus remain important in determining youth's later learning opportunities.

More and more higher education institutions have started operating in Germany to respond to the economy's increased need for a higher-educated workforce since the 1960s. "Fachhochschulen" ("universities of applied sciences", abbreviated "FH") were introduced, and existing engineering schools upgraded to this status (e.g. Gellert and Rau 1992; Hüther and Krücken 2018). Before the onset of the 'Bologna reforms' in the early 2000s, traditional universities used to offer "Diplom" (in the natural and social sciences), "Magister" (in the humanities) and "Staatsexamen" (in fields preparing for regulated professions such as medicine, law, and teaching) degrees after nine semesters (but usually rather five or more years of study). In the 2000s, bachelor's and master's degrees were introduced in both types of higher education institutions, with FH diploma being equivalized with the bachelor's level and traditional university degrees with the master's level (e.g. Schomburg 2011). Furthermore, an even more vocationally oriented "Berufsakademie" (vocational academy) was introduced, offering tertiary education in combination with an apprenticeship for holders of the Abitur. In a few states, these have been upgraded to "Duale Hochschulen" (dual system higher education establishments, e.g. Graf and Powell 2022; Bachsleitner 2020).

Germany has a third large sector of education, vocational education and training (VET), which facilitates the transition from school to work for youth not bound towards higher education and ensures a well-qualified workforce in occupations for which higher education is not required (Solga et al. 2014). Initial vocational training mostly takes place in the so-called "dual system" where apprentices work for pay under an apprenticeship contract with an employer while attending vocational school part-time. This type of VET is notably not limited to crafts occupations but extends to business, banking, public service and other non-manual occupations (König et al. 1988). For social and health-related occupations, vocational training rather takes place in full-time vocational schools (Protsch and Solga 2016). For many occupations, it is possible to either take additional vocational schooling after some years of work experience to reach higher occupational positions (e.g. technicians) and/or take additional exams to qualify as "Meister" (master craftsperson) (see e.g. OECD 2013). This is often referred to as advanced VET.

Appendix 3

Table 1: Mapping official ISCED 3-digit codes to German educational qualifications based on response options in the Demographic Standards (Hoffmeyer-Zlotnik et al. 2016)

highest vocational qualification:			***highest school-leaving qualification:***					
	Vocational qualifications not covered in ALLBUS in italics, likely category chosen by affected respondents in F057 (see Figure 2):		Still in school	Finished school without qualification	Lower track school-leaving qualification or 8 or 9 grades of lower secondary in former GDR	Intermediate track or 10 grades of lower secondary in former GDR	University entrance qualification ("Abitur") or University of applied sciences entrance qualification	missing
1	*noch in Ausbildung*	M	-*	100**	244		344	100
2	No vocational qualification							
3	Vocational internship, traineeship			254 (10 in ALLBUS)				254 (10 in ALLBUS)
4	Vocational training on-the-job with final certificate, but no apprenticeship, *pre-vocational training year*	M		254 (35 in ALLBUS)	244 (35 in ALLBUS)		344 (45 in ALLBUS)	254
5	Semi-skilled worker qualification, *Preparatory service for the intermediate level in public administration*	C or D		353			454	353
6	*Completion of a one-year programme at a training centre/school for health and social professions*	F						
7	*Completion of a two-to-three-year programme at a training centre/school for health and social professions*	F		453				453
8	Apprenticeship			354				354
9	Vocational school qualification							
10	*Abschluss einer Fachschule der DDR*	G		650***				
11	Master craftsperson, technician, or equivalent technical college qualification							
12	*Abschluss einer Ausbildung zum Erzieher/zur Erzieherin*	F or G						
13	Bachelor, Diploma from a university of applied sciences (including engineering school)*, Diplom Berufsakademie*	G or J		640				
14	Master, University Diploma, "Magister", state examination			740				
15	Doctoral degree			840				
	missing		missing	100**	244		344	missing

Notes: * To avoid that general school pupils are coded as "missing" in ISCED, the category can be omitted from the questionnaire. In this case, the category 'Left school without a school-leaving certificate' must be reformulated as 'No school-leaving certificate (yet)'. Some pupils may, in fact, have obtained a school-leaving certificate already. Current school attendance should be recorded in a separate question on main status.

** Based on the assumption that primary school was completed. As it is rarely asked in Germany whether primary school was completed, it is usually not possible to differentiate between ISCED 0 and 100 in Germany.
*** Master craftspersons are officially classified here if the preparatory course took at least 880 hours; all others are assigned to ISCED 550. In practice, this differentiation can only be implemented if the main specialization of the training is asked for, which most studies do not do. Since most cases attend a longer course, all cases end up in ISCED 650 and ISCED 550 is empty in Germany.

Appendix 4: Theoretical arguments for linking education to selected outcome variables (20 empirically most relevant variables, section 4.3)

4.1 Socio-structural variables

isei08c: ISEI combined (c): Current and past occupation. The "International Socio-Economic Index" (ISEI, Ganzeboom and Treiman 1996; Ganzeboom et al. 1992) is a commonly used indicator of occupational status. It measures "the attributes of occupations that convert a person's education into income" (Ganzeboom and Treiman 1996, p. 212) by maximizing the indirect effects of education on income via occupation and minimizing the direct effects. At a theoretical level, education is expected to positively relate to occupational status because education is closely related to access to occupations with higher skill requirements (see Appendix 1). These often also are related to higher incomes, so that individuals will also compete for these jobs, again giving a further advantage to more highly educated people. Given education was used in the derivation of the ISEI (because of the theoretical relationship), a close relationship is expected for methodological reasons as well. The measure was validated in the original study.

siops08c: SIOPS combined (c): current and former occupation. Treiman's "Standard International Occupational Prestige Scale" (SIOPS, Treiman 1977) indicates occupational prestige. It was derived based on subjective occupational prestige evaluations in about 60 countries. "Prestige, then, is the approval and respect members of society give to incumbents of occupations as rewards for their valuable services to society (Treiman 1977, pp. 16-22). Since prestigious occupations also usually have high skills requirements and people will also need to compete for them (see Appendix 1), education is expected to facilitate access to more prestigious occupations. In fact, occupational status (see above) has been thought of as a cause of prestige (Ganzeboom et al. 1992, p. 9). Prestige was also used to validate competing education measures by Braun and Müller (1997).

iscd11scp: ISCED current spouse or partner (scp), isei08scp: ISEI current spouse or partner (scp); siops08scp: SIOPS current spouse or partner (scp). Partner's education, occupational status and occupational prestige is expected to be linked to respondents' education because of the tendency to choose partners of a similar social background, education, and status (homogamy). This is again explained by a variety of factors: people of similar social status and education have similar tastes, values and lifestyles; and high-status and thus also highly educated partners are attractive because of the resources they contribute to a couple (e.g. Kalmijn 1998).

inc: R.: Monthly net income – open+closed. Education is expected to be linked to (personal) income because of 1. the higher skills and thus higher productivity of more highly educated people and 2. because individuals compete for well-paying jobs, and employers screen them based on their educational credentials (see Appendix 1). Personal income was also used to validate competing education measures by Braun and Müller (1997).

hhinc: Monthly net household income – open+closed Q, di07: Per capita income, net monthly, di08: Equivalent income OECD-modified scale. Household income, also when re-calculated to per-capita or equivalized income, is expected to be related to respondents' education because of firstly the relationship between respondent education and respondent income (see variable "inc" above) on the one hand, and because of the tendency of partners to be socially similar (see variables "iscd11scp", "isei08scp", "siops08scp" above) on the other.

id03: Top-bottom-scale: self-classification, S16_1: Making ends meet with household income. We can expect people's subjective vertical self-classification and capability to make ends meet to somewhat follow objective social criteria (see variables "isei08c", "siops08c", "inc", "hhinc" above). Also, more highly educated individuals will perceive their education alone as a reason for higher self-classification.

4.2 Political and attitudinal variables

pa02a: Political interest (ordinal), I006: Have no influence on the government, pa23: Left-right party assessment: CSU, pt02: Trust: Federal Constitutional Court: Political interest, efficacy and knowledge as well as institutional trust (in a mostly trustworthy political system) are expected to be related to education because formal education conveys information about how societies work, including civics as part of the school curriculum, and because it facilitates further learning and cognitive sophistication (see Appendix 1). Research has also shown that less literate individuals assess their own civic skills as rather low (Dutz 2020). In addition, pedagogical style and governance (e.g. giving pupils opportunities to participate in how a school is run) affect adults' political attitudes (Emler and Frazer 1999). Political interest was also used to validate competing education measures by Braun and Müller (1997).

pa32: Political compromise is a betrayal of principles. This item measures fundamentalism or black-and-white thinking, an anti-liberal and anti-democratic attitude and component of right-wing populism, which is strongly related to education as well as anti-immigrant attitudes (Giebler and Wagner 2019). These correlations can be explained primarily by the "enlightenment thesis" and the greater capacity for complex thinking and weighing up perspectives among more highly educated people (see Appendix 1). It has also been shown that low political self-efficacy results in populist attitudes, which would result in an indirect effect of education, but in addition to that, the social stigma coming about with low education in "knowledge societies", and grievance with the political dominance of the higher educated triggers populist attitudes (Spruyt et al. 2016).

px06: Dangerously many immigrants in Germany, pa19: Stopping the immigration of refugees. Education is one of the strongest predictors of anti-immigrant attitudes. Two explanations for this effect are suggested in the literature: the enlightenment thesis (see Appendix 1) and the group conflict theory. The latter argues that more educated individuals are less affected by economic competition (e.g. for jobs or housing) than less educated individuals and thus develop less hostile attitudes towards them (e.g. Lancee and Pardos-prado 2010).

pa14: Stiffer sentences for offenders. This item measures punitiveness in respondents, which is related to conservative, authoritarian and populist (including anti-immigrant) attitudes (Roberts and and Indermaur 2007), which are related to education. Some studies have found a negative relationship between punitiveness and education (Grasmick and McGILL 1994; Rich and Sampson 1990; Spiranovic et al. 2012; Hesselbart and Schuman 1976), but they do not often theorize this relationship. We can formulate several hypotheses regarding the relationship between education and punitiveness: First, it can be expected that lower educated individuals more strongly stress the retributive rather than preventative nature of punishment to assert the rule of law in society (Reuband 2007), which appears to be mediated via fear of crime and authoritarianism or political ideology (Langworthy and Whitehead 1986; Hanslmaier 2013; Kamenowski and Baier 2020). Second, they may have a stronger belief than more educated respondents in the personal responsibility of offenders and thus the effectiveness of punishment of criminals to prevent crime (rather than more complex measures aiming to address the causes of criminal behaviour and re-socialise offenders) and believe that harsh punishments are more effective than weaker ones. Third, as another indirect effect, media consumption patterns differ across education groups, with lower-educated individuals consuming more tabloid and commercialised content than more highly educated individuals, and this media consumption pattern is linked to punitiveness (Spiranovic et al. 2012; Kamenowski and Baier 2020).

J006: Man earns money, woman does housework. This is an indicator of conservative, stereotypical gender-role attitudes. The individualism acquired through education (see Appendix 1) is expected to reduce the adherence to traditional gender roles, which has repeatedly been shown in empirical research (e.g. Weakliem 2002). Gender-role attitudes were also used to validate competing education measures by Braun and Müller (1997).

Appendix 5: Standard coding scheme for CASMIN and its derivation from ALLBUS education questions

A hierarchical coding system was developed to allow coding all CASMIN versions into one variable, shown in Table 8. Depending on the availability of specific pieces of information in the data (especially whether sectors or degree levels in higher education are distinguished), different categories can be used within the three broad levels. The first digit distinguishes general elementary education and less (code 1) from intermediate and secondary (code 2) as well as tertiary education (code 3).[1] At the second digit, sub-levels are distinguished: code 1 indicates that the higher sub-level within the digit-1-level was not completed while code 2 indicates that it has been completed. For example, in intermediate and secondary education, 211 and 212 correspond to completion of intermediate general education but non-completion of full secondary/maturity, while 221 and 222 correspond to completion of full secondary/maturity. At the third digit, general or more academic education is distinguished from vocational or more applied education. Up to secondary education, code 1 corresponds to general education in the absence of subsequent vocational education and code 2 to vocational education or the combination of general and vocational education at this level. At the tertiary level, code 1 corresponds to applied tertiary education and code 2 to traditional university education.

This hierarchical coding scheme has, in order to provide standard codes for dealing with missing or vague information ("nfs" or "not further specified"-categories), many more categories than the usual CASMIN scheme and all those containing a 0 in the code will only need to be used when information is missing (e.g., when information on the level of an applied tertiary degree is missing, corresponding to CASMIN 3a, code 301 would be used, while for applied bachelor's and master's degrees, there would be codes 311 and 321 respectively). At the elementary and intermediate levels, codes containing 0s will normally not be used in Germany since all surveys differentiate the different levels of school-leaving certificates as required by CASMIN and ask whether vocational education was completed; such codes may however be useful when post-coding open responses in semi-open questions. A differentiation of the level of vocational education is not needed for the derivation of CASMIN, leading to lower requirements for questionnaire items when CASMIN needs to be derived (in contrast to ISCED).

[1] Note that while in ISCED in Germany, tertiary education includes advanced vocational education, in CASMIN, tertiary education in Germany is limited to higher education at universities and unviersities of applied sciences.

Table 2: A hierarchical education coding scheme based on and extending CASMIN (2003)

Code	Value labels	Description	German qualifications (ALLBUS categories)	
			F056	F057(F057A/B)
100	1_nfs < intermediate	1_nfs less than intermediate education	B or C unknown	missing
101	1ab_nfs < intermediate, no voc	1ab_nfs Less than intermediate education, no vocational training	B or C unknown	M
102	1c_nfs < intermediate with voc	1c_nfs Basic vocational training with less than intermediate education	B or C unknown	A, B, C, D, F, G, H
111	1a no elementary gen, no voc	1a Inadequately completed general education, no vocational training	B	M
112	1ac no elementary gen but voc	1ac Basic vocational training with inadequately completed general education	B	A, B, C, D, F, G, H
121	1b elementary gen, no voc	1b General elementary education (compulsory schooling), no vocational training	C	M
122	1c elementary gen with voc	1c Basic vocational training above and beyond compulsory schooling	C	A, B, C, D, F, G, H
200	2_nfs intermediate or maturity	2_nfs intermediate secondary education or maturity with or without vocational training	D, E or F unknown	missing
201	2bcgen_nfs intermediate or maturity gen, nfs	2bcgen_nfs intermediate general qualifications with or without maturity, nfs	D, E or F unknown	M
202	2acvoc_nfs intermediate or maturity voc, nfs	2acvoc_nfs intermediate vocational qualification with or without maturity, nfs	no answer, don't know, G	A, B, C, D, F, G, H
210	2ab_nfs intermediate, nfs	2ab_nfs intermediate education without maturity certificate with or without vocational training	D	missing
211	2b Intermediate gen	2b Intermediate general qualification	D	M
212	2a Intermediate voc	2a Intermediate vocational qualification or secondary programmes in which general intermediate schooling is combined with vocational training	D	A, B, C, D, F, G, H
220	2c_nfs Maturity, nfs	2c_nfs Maturity certificate, nfs	E, F	missing
221	2c_gen gen maturity, no voc	2c_gen General maturity certificate, no vocational qualification	E, F	M
222	2c_voc voc maturity	2c_voc Vocational maturity certificate/General maturity certificate and vocational qualification	E, F	A, B, C, D, F, G, H
300	3_nfs Tertiary degree, nfs	3_nfs Tertiary degree, nfs	any	J or K unknown (no answer, don't know)
301	3a_nfs applied degree, nfs	3a_nfs Lower tertiary degree (applied), nfs	any	J (no answer, don't know)
302	3b_nfs traditional degree, nfs	3b_nfs Higher tertiary degree (traditional), nfs	any	K (no answer, don't know)
310	3_low bachelor's degree, nfs	3_low Lower-level tertiary degree (bachelor's level), nfs	any	J or K unknown(A)
311	3a_low applied bachelor's	3a_low Lower-level lower tertiary degree (bachelor's level, applied)	any	J (A, C)
312	3b_low traditional bachelor's	3b_low Lower-level higher tertiary degree (bachelor's level, traditional)	any	K(A)
320	3_high >= master's degree, nfs	3_high Higher-level tertiary degree (master's level), nfs	any	J or K unknown(B)
321	3a_high >= applied master's	3a_high Higher-level lower tertiary degree (master's level, applied)	any	J(B)
322	3b_high >= traditional master's	3b_high Higher-level higher tertiary degree (master's level, traditional)	any	K (B, C, D, E, F)
-1	no answer		no answer don't know no answer	no answer no answer don't know
-2	don't know		don't know	don't know
-6	cannot be generated/coded		no answer, don't know, G B, C, D, E, F any	L, M L J or K unknown(C)