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ABHANDLUNGEN
Berufe – Theorien und Messkonzepte

Occupation-Based Measures—An Overview and Discussion

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Abstract Occupational information is among the most versatile categories of information about a person available in quantitative data. The goal of this paper is to provide an overview of occupation-based measures in different topic areas. These include not only measures for analyzing social stratification, such as prestige scales, socioeconomic indices and class schemes but also measures of workplace tasks, occupation-specific health risks, gender segregation, and occupational closure.

Moreover, as the quality of such data depends on the quality of the underlying occupational information, we also provide an overview of how to collect occupational information in surveys, how to code this information, and how occupational classifications are commonly used. By doing so, we hope to increase researchers' awareness of the potential of occupation-based analyses, as well as their knowledge of how to properly handle such measures in empirical analyses.

Keywords Occupational classifications · Occupational prestige · Class schemes · Workplace tasks · Occupational closure

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Berufsbasierte Maße – Überblick und Diskussion

Zusammenfassung Berufsbezogene Angaben gehören zu den vielseitigsten personenbezogenen Informationen, die in quantitativen Datensätzen zur Verfügung stehen. Ziel dieses Beitrags ist es, einen thematisch möglichst umfassenden Überblick über berufsbasierte Skalen und Instrumente zu geben. Im Mittelpunkt der Ausführungen stehen nicht nur die weit verbreiteten berufsbasierten Instrumente zur Analyse sozialer Schichtung, wie z. B. Prestigeskalen, sozioökonomische Indizes oder Klassenschemata, sondern wir behandeln auch Instrumente zur Erhebung beruflicher Tätigkeitsinhalte sowie Indikatoren zur Erfassung berufsspezifischer Gesundheitsrisiken, beruflicher Geschlechtersegregation oder beruflicher Schließung.

Da die Qualität und Aussagekraft solcher Maßzahlen auch von der Qualität und Art der zugrunde liegenden Berufsinformationen abhängt, geben wir außerdem einen Überblick darüber, wie Berufe in Umfragen erfasst und codiert werden und welche Berufsklassifikationen dabei typischerweise zum Einsatz kommen. Wir hoffen, dadurch das Bewusstsein unserer Leserinnen und Leser für das Potenzial berufsbezogener Analysen zu schärfen sowie ihr Wissen über den richtigen Umgang mit berufsbasierten Skalen bei der Anwendung in empirischen Forschungsprojekten zu erhöhen.

Schlüsselwörter Berufsklassifikationen · Berufsprestige · Klassenschemata · Berufliche Tätigkeitsinhalte · Berufliche Schließung

1 Introduction

Even though it has become almost commonplace in sociology to consider a person's occupation—as Treiman (1977) once famously stated—to be the single best clue available on who this person is, extensive overviews on how and for which purposes this information might actually be used in empirical analyses are still somewhat scarce. While some comprehensive overviews are available for occupation-based stratification measures (e.g., Connelly et al. 2016; Lambert and Bihagen 2014; Rose 2005), and a few overviews covering other topic areas can also be found (e.g., Rohrbach-Schmidt and Tiemann 2013; for task measures), synopses covering occupation-based measures from different topic areas are hard to find.

Moreover, we think that many papers discussing occupation-based measures actually do not sufficiently highlight the role of occupational classifications, especially with regard to how these classifications and their characteristics might influence the scales and measures drawing upon them (for exceptions see, e.g., Connelly et al. 2016; Rose 2005). For this reason, the goal of this article is twofold: first, to give an overview of different types of occupation-based measures, and second, by providing a detailed discussion of the technical aspects of classifying and coding occupations at the beginning, to allow the interested reader to more proficiently judge the pros and cons of occupation-based measures.

Therefore, the second section covers occupational classifications. In this section, we discuss what occupational information quantitative surveys usually collect, how this information is coded, what alternatives are available for this coding procedure, and what the advantages and disadvantages of these alternatives are.

In the third section, we give an overview of occupation-based stratification measures. These measures, such as prestige scales, socioeconomic indices, and class schemata, are—at least in sociology—likely the most commonly used occupation-based measures.

With the increasing prominence of the task-based approach (e.g., Autor 2013; Autor et al. 2003) in economics as well as sociology and other social sciences, occupation-based task measures have become increasingly popular. While some of these task measures have been around for a while, the growing popularity of the topic has also spawned new developments. We give an overview of these measures in the fourth section.

In the fifth section, we discuss occupation-based measures that provide information on occupational segregation, health, or the institutional characteristics of occupations. The scales focusing on the latter topic for the most part cover the degree to which legal regulations, licensing, or comparable provisions apply to an occupation.

While we try to give an overview that is as comprehensive as possible, it is obvious that given the number of occupation-based measures available, we had to make some selections. There are, for example, a large number of nation-specific measures for various countries and describing them all would go far beyond the scope of this article (and, quite frankly, in many cases would also be beyond the limits of our knowledge). Therefore, we limit the discussion to measures that are either relevant in the national context or that are (or have been) of great relevance to the development of a specific type of measure.

2 From Occupations to Occupation Codes

Occupations are related to a variety of inequality dimensions such as wages, social status, and health. The quality of measures that capture occupation-specific characteristics and inequalities in empirical analyses necessarily depends on the quality of the occupational information available in the data. Therefore, technical questions regarding the collection and coding of occupational information or the technical features of occupational classifications are highly relevant—from a technical point of view but also substantively. In the remainder of this section we discuss such technical but nevertheless essential foundations of occupation-based measures.

2.1 Coding Occupations

To use information on occupations as well as occupation-based measures in empirical analyses, one needs to obtain valid and reliable data on occupations first. This implies that researchers have to transfer detailed occupational information into a system of more or less detailed occupation codes. A particular difficulty of this

procedure is the conceptual ambiguity of occupations. This ambiguity results not least from the fact that occupations are a social construct (Meyer 2015) and they might refer to different things in different contexts. Thus, the same person might in different situations use different terms to describe her or his occupation (e.g., sociologist, scientist, or professor).

An additional difficulty is that in some occupations the link between qualification and occupational activity is rather loose, i.e., what someone can do (by means of her or his qualification) does not necessarily coincide with what the person actually does at work.[1] Thus, people with the same qualifications might work in different occupations, and people with different qualifications might work in the same occupation.[2] Moreover, people often tend to respond to the question about their occupation in terms of their qualifications rather than in terms of their actual occupational activity.[3] As a result, the link between the occupational information provided by survey respondents and their actual occupational activities may, in some cases, be rather weak.

This implies that collecting codable occupational information is challenging because doing so, researchers have to meet different, sometimes contradicting requirements. On the one hand, the survey instrument should capture the dimensions of interest as precisely as possible. On the other hand, data collection should be sufficiently easy so that respondents can complete the questionnaire without (major) problems. The established practice for dealing with this problem is to ask three consecutive questions instead of just one to capture the occupation that the respondent actually works in (see StatBA 2016).[4]

While for a long time the standard way of collecting occupational information from survey data has been to use open-ended questions to collect information for later manual coding, computer technologies have opened up new options at all stages of this process.

In most cases the actual coding—i.e., the assignment of open text information on occupations to occupation codes—still takes place after the survey is conducted. However, several techniques are available to (at least partially) replace or complement traditional manual coding procedures. As a result, coding methods vary

[1] Note that in terms of the four perspectives on occupation distinguished by Haupt and Ebner (2020) earlier in this volume, the coding procedures described here—and therefore also the measures building on these codes—always imply a demand-side perspective. This is so because the focus of questions asking for respondents' occupations is on what people actually do in their working lives, i.e., a person's occupation is defined by what s/he has been hired to do (or does as a self-employed worker), not by what s/he has been trained for.

[2] Thus, e.g., computer programmers often come from diverse courses of education. In other occupations, though, the link between qualification and occupational activity is rather strong, for example, because specific qualifications are required to enter the occupation.

[3] Thus, they might, e.g., refer to themselves as sociologists even if they are actually working in public relations or a statistics department.

[4] The first is a rather general question about one's occupational activity ("What is your occupational activity?"), the second asks for a detailed description ("Please describe your occupational activity in detail!"), and the third asks for the specific denomination ("Does this occupation or activity have a special name?"). For an overview of international practices, see Tijdens (2014).

strongly with respect to the intensity of computer usage, from (almost) fully automated approaches to traditional manual ones.

The methods most commonly used are, first, automatic coding, i.e., the automatic assignment of occupation codes to occupation titles by specialized software.[5] Automatic coding usually relies on lists of occupational titles that the program matches with occupational information from the survey. Second, as automatic coding currently only works satisfactorily for the rather easy-to-handle cases that include clear occupational information, researchers or coding institutions often combine automatic coding with other coding methods—most notably manual coding.[6] A common term for referring to such a combination of methods is semi-automatic coding (e.g., Züll 2016). Third, instead of using software to code automatically, coders can use software to suggest potential codes for the coders to choose from, to speed up (manual) coding procedures (computer-assisted coding). Fourth and last, traditional manual coding is still common, particularly as a more reliable option for handling cases that are otherwise difficult to code.[7]

Especially for manual coding, using additional information can be helpful. Paulus and Matthes (2013), for example, recommend drawing on the following additional information: the differentiated occupational position (Stellung im Beruf, see StatBA 2016), industry or sector, the number of employees, employment history, and education.

In addition to these "classic" coding procedures, advanced, computer-assisted methods for coding occupations during the interview have recently been developed. There are two major approaches to such in-survey coding: search trees and semantic matching, or a combination thereof (see, e.g., Tijdens 2015). Search trees refer to a method in which interviewers present a sequence of survey items to the respondent, allowing her or him to select increasingly specific job titles—ranging from a rather general job category in the first item to a specific job title in the last item. Hoffmeyer-Zlotnik et al. (2006) and Tijdens (2015) provide examples for this method.

In contrast, semantic matching means that the job title provided by the respondent is entered into the survey instrument (either by her/himself such as in a web survey or by an interviewer) and a matching algorithm identifies a number of potentially matching job categories from a database. Subsequently, the program or the interviewer presents these as response categories to the respondent. Schierholz and his colleagues provide an example of this method (Schierholz 2019; Schierholz et al. 2018; Bethmann et al. 2014). Schierholz's approach is particularly relevant in the German context as it allows coding into the German Occupational Classification 2010 (KldB 2010) as well as into the International Standard Classification of Occupations 2008 (ISCO 08).

[5] A well-known tool for performing different types of automatic or computer-assisted coding is, for example, CASCOT, developed by the IER in Warwick (Elias et al. 2014).

[6] A well-documented example in which researchers combine automatic coding with additional manual coding procedures is the occupation coding in the German Census 2011 (Loos et al. 2013).

[7] For details on manual coding, see, e.g., Geis and Hoffmeyer-Zlotnik (2000) or Geis (2011).

2.2 Occupational Classifications

Occupational classifications systematically reduce the diversity of occupations by dividing them into categories that are as homogeneous as possible internally and as heterogeneous as possible between different categories. In the following, we provide a short introduction to such schemes.

Until 2010, there were two different *national classification schemes* available in Germany. These were the German Classification of Occupations of the Federal Employment Agency (BA) from 1988 (KldB 88) and an alternative version provided by the Federal Statistical Office in 1992 (KldB 92). In 2010, there was a complete revision of the two classification schemes in a joint effort by both issuing institutions, which resulted in a single, updated version, the KldB 2010. The KldB 2010 allows for an up-to-date mapping of current occupational structures and provides an easier crosswalk to ISCO 08 than the earlier versions did. Beyond that, it also constitutes a structural break with the "old" national classifications of occupations, making it difficult to compare with its predecessors (Bundesagentur für Arbeit 2011a, b).

The KldB 2010 (see Paulus and Matthes 2013) is a hierarchical five-digit classification. It consists of 1286 occupational types (five-digit code), 700 occupational subgroups (four-digit code), 144 occupation groups (three-digit code), 37 main occupation groups (two-digit codes), and 10 occupational areas (one-digit code).

The KldB 2010 structures occupations according to two dimensions. The primary dimension is occupational expertise. The criteria for measuring occupational expertise are the skills, abilities, and knowledge required for typical activities in the given occupation. The first three digits of the five-digit code of the KldB 2010 provide increasingly detailed information on occupational expertise. The fourth digit mainly serves to further differentiate occupations in terms of their incumbents' activities. However, some codes serve as indicators to mark specific cases (Bundesagentur für Arbeit 2011a, p. 17; Paulus and Matthes 2013, pp. 8 f.).[8]

The fifth digit of the KldB 2010 code represents the second dimension, the requirement level. The requirement level refers to the complexity of the occupation performed and distinguishes between the following: unskilled occupations (level 1); skilled occupations (level 2), which usually require vocational training; specialist occupations (level 3), which usually require either further vocational training (e.g., a master craftsman's qualification) or a bachelor's degree; and expert occupations (level 4), which require an advanced tertiary degree, such as a master's degree, university diploma, or state examination.

An often-ignored fact is that the indication of the requirement level in the fifth digit of the KldB 2010 code has some undesirable consequences. In particular, unlike in the ISCO or earlier versions of the KldB, it is not possible to generate meaningful aggregates of the KldB 2010 just by eliminating the last (depending on the level of aggregation one, two, three, or four) digits of the code numbers, as this would

[8] A "0" indicates subgroups without further specialization (compared to the three-digit occupation); "8" indicates occupations that, despite having a specialization, are not coded separately; and "9" indicates supervisory or leadership personnel.

merge occupations with quite diverse qualification requirements into the same code.[9] Thus, an adequate aggregation procedure would be to add the fifth digit again after aggregating at the two-digit level, for example.

However, as the 37 two-digit codes are rather detailed (especially after adding the fifth digit) and the ten one-digit codes are too crude to validly reflect the occupational segmentation of the German labor market, alternative aggregations have been developed. One example comes from Matthes et al. (2015), who provide an aggregation of the 37 two-digit codes into 14 "occupational segments," which are both much more suitable analytical categories than one-digit codes and significantly more parsimonious than two-digit codes.

The major alternative to these national classifications is using *international classification schemes*, namely the different versions of the International Standard Classification of Occupations (ISCO).[10] The most recent version, the ISCO 08, is a four-digit, hierarchically structured classification. It consists of 436 occupational groups (four-digit code), 130 minor groups (three-digit code), 43 sub-major groups (two-digit codes), and 10 major groups (one-digit code).

The two structuring dimensions of the ISCO are the skill level required for the job and skill specialization. The first digit of the ISCO 08 indicates the skill level in terms of the categories of the International Standard Classification of Education (ISCED 2011, cf. UNESCO 2012). The ISCO distinguishes among four skill levels: major group 2 covers occupations that typically require an academic degree (ISCED levels 6, 7, and 8). Major group 3 occupations usually require a master craftsman's or technician's degree or the equivalent (ISCED level 5). Major groups 4–8 include occupations that require vocational training (ISCED levels 2 and 3). Major group 9 comprises unskilled occupations, i.e., occupations that do not require any formal vocational training (ISCED level 1). Major groups "0" (military occupations) and "1" (managerial occupations) are an exception insofar as they do not imply any specific educational requirement, but might include occupations at different skill levels.

The second dimension—skill specialization—reflects the tasks performed at work. The criteria for specifying skill specialization are the field of knowledge required, the tools and machinery used, the materials worked on or with, and the kinds of goods and services produced. For further information, see ILO (2012).

In summary, both the national and international classification schemes have advantages and disadvantages. The major advantage of the KldB is that it reflects the occupational structures of the German labor market in a much more differentiated manner than the ISCO does. In particular, the KldB provides much more detail, distinguishing 1286 occupation groups at the five-digit level, which is almost three times as many as the 436 occupation categories distinguished by the four-digit ISCO.

[9] Thus, for example, the aggregate code 3210 (building construction) includes occupations that are as diverse as unskilled construction workers (32101), skilled construction workers (32102), building technicians (32103), and civil engineers (32104).

[10] For a detailed description of ISCO 08, as well as of earlier versions of ISCO (ISCO 58, ISCO 68, and ISCO 88), see ILO (2020). Crosswalks between the different versions of ISCO are available from the ILO website (ILO 2020) or from Ganzeboom (2020a). Crosswalks between the KldB 2010 and ISCO 08 as well as between different versions of the KldB are available from the website of the Federal Employment Agency (Bundesagentur für Arbeit 2019).

Moreover, while both classifications use comparable criteria for classifying occupations (namely occupational expertise [KldB] versus skill specialization [ISCO] and requirement level [KldB] versus skill level [ISCO]), the KldB is more precise in implementing these criteria. This is mainly due to the occupations in major group 1 (and 0) of the ISCO. Although occupations in all other major groups (as well as occupations in the KldB) have a clearly defined skill level (or skill requirements), it is not clear which level of skills the occupations in major group 1 of the ISCO require. Especially when using occupation codes as a basis for stratification measures, such as the ones introduced in the next section, this is a relevant disadvantage of the classification.

However, the major advantage of the ISCO is that almost all sociologically meaningful measures that rely on occupational information are available for one or several versions of the ISCO, whereas they are not necessarily available for the KldB. Moreover, internationally comparable measures are almost exclusively available for the ISCO. Thus, although probably not preferable from a conceptual perspective, using the ISCO is often the more pragmatic choice.

3 Occupation-Based Stratification Measures

Occupation-based stratification measures are aimed at capturing the relevant dimension(s) of social inequality that are in some way connected to the labor market and/or the economic domain of a society. Such measures are probably the most-well known and frequently used type of measure that builds on occupational information. Examples for the application of these measures are in the operationalization of parental and/or offspring social status in analyses of intergenerational social mobility or stratification (e.g., Blau et al. 1967; Erikson and Goldthorpe 1993; Ganzeboom et al. 1989; Hertel and Groh-Samberg 2019) or in education research (e.g., Jacob and Klein 2019). Further examples are their use as an alternative or complementary measure for returns to education (e.g., Klein 2016; Neugebauer and Weiss 2017) or as an instrument to measure intragenerational status changes during the life course. In the latter case, measuring status change after specific events such as unemployment (Gangl 2004) or career interruptions following motherhood (e.g., Aisenbrey et al. 2009; Gangl and Ziefle 2009; Grunow et al. 2011) is of particular importance. The following section gives an overview of the most important types of measures, their theoretical foundations, and the actual measures or scales available for data analysis.

The most basic distinction made in papers discussing different types of stratification measures is to classify them by their level of measurement, i.e., to distinguish between continuous (sometimes also called gradational) and categorial approaches (e.g., Schneider et al. 2016; Ganzeboom et al. 1992). An alternative way of classifying stratification measures is to distinguish different types of measures by the construct they capture, such as reputation/prestige or socioeconomic status (e.g., Connelly et al. 2016; Rose 2005; Wegener 1985, 1988). In practice, this means that one can distinguish between reputation scales, interaction scales, and socioeconomic indices among the continuous measures. Categorial scales—on the other

Table 1 Occupation-Based Stratification Measures: An Overview

Level of measurement	Scale Type/ Construct measured	Conceptual Background	Measure	Available for	Main Reference(s)
Continuous	*Reputation Scales*	Functionalism	SIOPS (Treiman Scale)	ISCO 68 ISCO 88 ISCO 08	Treiman (1977) Ganzeboom and Treiman (1996, 2010)
			MPS	ISCO 68 ISCO 88 KldB 75 KldB 92	Wegener (1985, 1988) Frietsch and Wirth (2001) Christoph (2005)
			Berufliches Ansehen in Deutschland	KldB 2010	Ebner and Rohrbach-Schmidt (2019)
	Socio-economic Indices	Functionalism	(Duncan) SEI	Only US Classifications	Duncan (1961) Hauser and Warren (1997) Hout et al. (2016)
			ISEI	ISCO 68 ISCO 88 ISCO 08	Ganzeboom et al. (1992) Ganzeboom and Treiman (1996, 2010)
	Interaction Scales	Weber (status groups)	Laumann/ Guttman Scale	Only US Classifications	Laumann (1966) Laumann and Guttman (1966)
			CAMSIS	ISCO 88 KldB 75	Stewart et al. (1973, 1980) Prandy (1990) Prandy and Lambert (2003)
			Chan/ Goldthorpe Status Scale	Only UK Classifications	Chan and Goldthorpe (2004, 2005)
			ICAMS	ISCO 88	Meraviglia et al. (2016)
Categorial	*Class Categories*	Weber (class)	EGP/ESeC	ISCO 68 (EGP) ISCO 88 (EGP, ESEC) ISCO 08 (ESEC) KldB 92 (EGP)	Erikson et al. (1979) Erikson and Goldthorpe (1993) Müller et al. (2006) Rose and Harrison (2007)
		Marx	Wright	Not based on occupational classifications	Wright (2000)
		Durkheim	Micro Classes	SOC 1970 ISCO 68 ISCO 88 ISCO 08	Weeden and Grusky (2005) Grusky and Galescou (2005)
	Pragmatic Measures	–	European Socio-Economic Groups (ESeG-2014)	ISCO 08	Meron et al. (2014)
			Blossfeld's Classification of Occupations	KldB 70/75 KldB 92 ISCO 68	Blossfeld (1983, 1985, 1987)

hand—are for the most part class categories, even though the underlying concept of class might differ with respect to its theoretical foundations.

In addition, there are measures that do not refer to a particular conceptual background, but appear to rely on pragmatic decisions of the researcher responsible for constructing the scale. Table 1 provides an overview of these different types of measures, their conceptual background, the most relevant measures of this type, occupational classifications that they are available for, and some of the core references.[11]

3.1 Reputation Scales and Socioeconomic Indices

Among the most popular continuous stratification measures are *reputation scales* and *socioeconomic indices (SEIs)*. Both these measures implicitly assume that the social hierarchy consists of a continuous sequence of positions that are ordered vertically and are characterized by status differences that are often incremental. As a result, the social hierarchy lacks any characteristic breaks or cleavages and thus the positions in this hierarchy should—at least in principle—allow for a substantial amount of mobility between them.

There is a close link between both measures and the functional theory of stratification (Davis and Moore 1945), as the measures used in these scales directly relate to core concepts of the theory (see, e.g., Hatt 1950; Rose 2005). The basic functionalist idea of stratification is that—in order to guarantee its proper functioning—every society needs to fill social positions that require certain prerequisites regarding ability, education, or talent. To make sure that for demanding positions, sufficient candidates are willing to undergo the lengthy education required, there are rewards—such as income or prestige—attached to these positions. To scale occupations, both scales rely on either the reward dimension alone or on both the prerequisites and the reward dimension: reputation scales rely on prestige and socioeconomic indices on income and formal qualifications.

As *reputation scales* rely on prestige judgments provided by survey respondents, a core assumption connected to this type of scale is that there is general knowledge of the prestige "value" associated with individual occupations. Moreover, scholars from this tradition also assume that there is a consensus about prestige judgments both within and between different societies (see, e.g., Treiman 1977; Hauser and Warren 1997; for recent criticism of this assumption see, e.g., Lynn and Ellerbach 2017; Goyder 2009).

While there have been earlier examples of reputation scales (for overviews, see Davies 1952; or Nam and Powers 1983), the first "real" reputation scale whose construction relied on a nationwide representative sample for the US was developed by the National Opinion Research Center (NORC) in 1947 (North and Hatt 1953). It served as a blueprint for numerous US (e.g., Hodge et al. 1964; Siegel 1971; Stevens and Hoisington 1987; Nakao and Treas 1990, 1994; Smith and Son 2014;

[11] Due to format restrictions, we cannot cover older national measures for Germany such as the socioeconomic index by Handl (1977), or Mayer's (1977) interaction-based status scale. Wolf (1995) provides an overview of these measures.

Hout et al. 2016) and international studies (e.g., Pineo and Porter 1967; Najman and Bampton 1991; Tsai and Chiu 1991).

The most influential and most commonly used reputation scale is, however, Treiman's (1977) Standard International Occupational Prestige Scale (SIOPS). Part of this scale's success results from the fact that Treiman constructed it using an international database (for details, see Treiman 1977, p. 29 ff.) to allow for international comparisons as well as the application to national data from various countries. Moreover, the scale is consistently updated to match the most recent version of the ISCO—the original version used ISCO 68, then ISCO 88 (Ganzeboom and Treiman 1996, 2003), and the most recent one uses ISCO 08 (Ganzeboom and Treiman 2010).

A reputation scale specifically constructed for the German context is Wegener's (1985, 1988) Magnitude Prestige Scale (MPS). Originally developed for the ISCO 68, there are versions of the MPS for the KldB 75 and the KldB 92 (Frietsch and Wirth 2001), as well as for the ISCO 88 (Christoph 2005). Unlike in the standard approach, where respondents judged occupations using a nine-rung ladder (see Nakao and Treas 1994 for a detailed description), Wegener used magnitude measurement to collect empirical information on prestige ratings (see Wegener 1984 for details).

A particularity of magnitude measurement is that it allows respondents to freely choose numeral values or line length as they see fit. This also allows respondents to individually define the distance between the lowest and the highest object on the underlying dimension (in this case, the prestige continuum).[12] Consequently, there are neither the bottom nor the ceiling effects that occur in the standard approach. Moreover, respondents are able to make much more fine-grained judgments. Thus, they are able to express differences that might be lost when using a categorial response scale—as the prestige of both occupations being judged is sufficiently close for them to fall into the same scale category.

Currently, Ebner and Rohrbach-Schmidt are developing a new reputation scale for Germany that will be available for the KldB 2010. Regarding technical procedures, this scale is similar to the US scales, measuring reputation using an eleven-category response format ranging from very low reputation (0) to very high reputation (10). The first descriptive results, including a description of occupations in the different deciles of the reputation distribution, as well as a technical documentation of scale development, are available in Ebner and Rohrbach-Schmidt (2019).

In contrast to reputation scales, which are based on survey respondents' judgments, *socioeconomic indices* (SEI) are usually constructed by calculating weighted averages of several indicator variables considered to be pointing to a person's high (or low) socioeconomic status. The decision regarding which indicators to use is at the discretion of the researcher constructing the scale. The most common indicators are education and income.

[12] In fact, Wegener has shown elsewhere (Wegener 1990, 1992) that by applying this measurement method, one can show that the perception of the prestige continuum is indeed status dependent. Although high- and low-status respondents put different occupations in the same prestige order, high-status respondents tend to extend the prestige continuum, whereas low-status respondents tend to compress it.

While choosing indicators is usually straightforward, the real problem when constructing an SEI is deriving relative weights for these indicators. When constructing the "original" SEI, Duncan (1961) solved this problem by regressing the prestige ratings of North and Hatt's (1953) prestige scale on income and education and using the regression estimates for predicting SEI scores. Even though this procedure might have originated as a makeshift solution to address the problem of the North and Hatt scale not covering the entire range of occupations in the US, SEI scores often outperformed prestige measures in empirical models (Featherman and Hauser 1976, p. 405). For later versions of the NORC-prestige scales, it was standard procedure to calculate updated SEIs (for older prestige scales, see Hauser and Warren 1997; for the most recent scale, see Hout et al. 2016).

Apart from the fact that it is necessary to conduct a prestige survey to derive relative weights for the indicator variables included in an SEI—which involves substantial cost and effort—another downside of the Duncan procedure is that the resulting index has no clear conceptual interpretation (e.g., Hodge 1981; Ganzeboom et al. 1992). Thus, when Ganzeboom and his colleagues developed the International Socio-Economic Index (ISEI), they returned to Duncan's original conception of occupation as the activity that links income and education. On this basis, they developed their idea of the SEI as an intervening variable between education and income that "measures the attributes of occupations that convert a person's main resource (education) into a person's main reward (income)" (Ganzeboom et al. 1992, p. 9).

Not least because of this conceptual clarity, the ISEI has developed into the most popular continuous stratification measure. Other factors that might contribute to this popularity are its broad applicability, which results from its construction based on international data and its reliance on the ISCO for occupation coding, as well as the fact that Ganzeboom and his colleagues update the ISEI more or less regularly. Thus, while originally developed for the 1968 version of the ISCO (Ganzeboom et al. 1992), it is also available for the ISCO 88 (Ganzeboom and Treiman 1996, 2003) and the ISCO 08 (Ganzeboom and Treiman 2010).

3.2 Interaction Scales

While reputation scales and SEIs both share a common theoretical background, there is a close link between the third type of continuous measure, *interaction scales*, and the Weberian concept of status groups (*Stände*).[13] For Weber (1978), status particularly finds its expression in close interaction (commensality) and marriage relations (connubium). In a comparable manner, interaction scales draw for their construction upon friendship or marriage data and assume that those who frequently share such relations also share a common position in the social order.

[13] Status groups are one of the two concepts provided by Weber (1978, especially p. 302 ff. and p. 926 ff.) that are relevant from an inequality perspective (the other being class, which we discuss below). Due to format restrictions, we cannot provide a detailed discussion of the Weberian concepts of class and status groups here. See, e.g., Groß (2015) for an overview.

Despite this seemingly close connection to the Weberian concept of status, scholars constructing interaction scales do not agree on whether these scales should indeed be characterized as "Weberian".

Laumann and Guttman (Laumann 1966; Laumann and Guttman 1966) were the first to develop an interaction scale that fits our current understanding of this type of measure. While earlier approaches of measuring social position by means of social interaction usually relied on subjective preferences for interaction, the major contribution of their work was that their new scale relied on actual interaction patterns instead. Laumann and Guttman (1966, p. 170) consider their index to be one that refers not to status but to social class. However, their notion of class, which defines classes as groups that originate from "such associational relationships as consanguineal and affinal kinship, friendship, and common residence" is quite reminiscent of Weber's concept of status.

The next important step in the development of interaction scales was the introduction of the Cambridge Social Interaction and Stratification Scales (CAMSIS).[14] Stewart et al. (1973, 1980) first introduced this type of scale in the late 1970s. Based on friendship (and later on marriage) data, they used correspondence analysis to identify dimensions underlying the association patterns expressed by these data and interpreted the first of the dimensions identified as representing the inequality structure.

There have been several replications of and updates to the scale (e.g., Prandy 1990; Prandy and Lambert 2003), as well as an increasing number of national versions for a variety of countries. Among those are two versions for Germany based on Microcensus data from the 1990s, which cover either the KldB 75 (data from 1991) or the ISCO 88 (data from 1995) (see CAMSIS 2020).

What is notable about the position of the scholars working on the CAMSIS scale is that they reject the idea that interaction scales build on the Weberian tradition (e.g., Lambert and Griffiths 2018; Bottero and Prandy 2003; Stewart et al. 1980). Instead, they argue that the association patterns observed should not be influenced by (specific features of) the stratification order, but that these patterns should—quite to the contrary—actually constitute the stratification order (Lambert and Griffiths 2018, p. 87).

In contrast, while technically following the same approach to constructing an interaction scale as CAMSIS, Chan and Goldthorpe (2004) argue that the scale operationalizes status in the Weberian sense. Accordingly, they use the scale to distinguish empirically between the Weberian concepts of class (operationalized using the EGP discussed below) and status (see Chan and Goldthorpe 2005, 2007a, b, c, d, e).

A third group of researchers working on interaction scales comprises De Luca, Meraviglia, and Ganzeboom. In addition to jointly developing an interaction scale for Italy based on CAMSIS procedures (De Luca et al. 2012), their major contribution has been that they also developed an internationally comparable version of the

[14] Lambert and Griffiths (2018, p. 83 ff.) provide a short overview of further interaction scales not covered here.

CAMSIS scale. This international version of CAMSIS is called ICAMS and is available for the ISCO 88 (Meraviglia et al. 2016).

While Meraviglia and her colleagues also hold the position that interaction scales following the CAMSIS procedures should refer to "status groups in the Weberian sense" (De Luca et al. 2012, p. 31), their empirical results point in another direction. Including ICAMS in a joint model with the SIOPS and the ISEI, Meraviglia et al. (2016) argue that despite the clear conceptual differences between the three scales, there is a common latent construct that underlies all of them.

3.3 Categorial Scales

In contrast to continuous approaches, which represent the status dimension in a way that implicitly assumes that the social hierarchy consists of a continuous sequence of positions and that the status differences between these positions are often incremental, *categorial scales* tend to pronounce the differences between the groups, which define the categories of the scheme. The latter point is particularly true for class schemes—the most common type of categorial scale. Another important difference between these scale types is that for continuous scales, researchers usually identify the stratification order represented by the scales ex post, i.e., the order is a result of the scaling enterprise. In contrast, researchers define class schemes usually ex ante, based on theoretical considerations (Breen 2005; Breen and Rottman 1995).

From a conceptual perspective, class schemes assume that society consists of rather distinct groups of people that differ in some core aspects of their life chances in general and/or their economic conditions in particular. Moreover, some class schemes assume that beyond this, the members of a particular group might share some common characteristics, such as similar cultures, mindsets, or interests. In any case, what characterizes classes are clear delineations between each other and the fact that—in most cases—more than a small, incremental change in one's condition will be required to cross class lines. However, in contrast to the continuous scales discussed above—which arrange occupations in a strict hierarchy—at least between some of the classes in a particular scheme, the hierarchical order might be unclear (see, e.g., Goldthorpe 2000, p. 228).

Depending on the principles guiding the differentiation between individual classes, one can distinguish different types of classification schemes. The most common distinction in the literature is that between Weberian, Marxian, and Durkheimian class schemes (for a detailed discussion of these and some further class approaches see, for example, the contributions in Wright 2005).

3.3.1 Weberian Class Schemes

Presumably, the class schemes most widely used are the EGP class scheme developed by Goldthorpe and his colleagues (Erikson et al. 1979; Erikson and Goldthorpe 1993; Goldthorpe 2000) and the closely related European Socio-economic Classification (ESeC) (Rose and Harrison 2007). The former distinguishes between eleven different class positions, the latter between nine, although especially for the EGP, the use of more aggregate versions of the scale is common. A particular advantage of the ESeC

is that in addition to the more standardized coding procedures, different teams of researchers have successfully conducted country-specific validation studies to test the scheme (for Germany, see Müller et al. 2006 and Wirth et al. 2009). Standard codes for the EGP are available for the ISCO 68, ISCO 88 (Ganzeboom 2020b, c), and KldB 92 (Brauns et al. 2000; Gesis 2020). The ESeC is available for the ISCO 88 (Harrison and Rose 2006) and ISCO 08 (Harrison 2020; Gesis 2020; or Herter and Wirth 2016).

Conceptually, the EGP (and the same holds for the ESeC) is usually considered a (neo-)*Weberian* class scheme (Breen 2005).[15] What characterizes classes from a Weberian perspective is primarily common life chances that arise from the shared market situation of their members. There might be different bases for a shared market situation such as "possession of goods" or "opportunities for income" (Weber 1978, p. 927). Accordingly, one can distinguish different types of classes by identifying what provides the basis for the class members' common market situation.

In the EGP and ESeC, the main points of reference are commercial classes (*Erwerbsklassen*), i.e., the focus is on shared aspects of the classified persons' labor market situation. Technically, the labor market situation is defined by two criteria: employment status (self-employed persons without employees versus employers versus employees) and—among employees—employment relations.

In turn, what defines employment relations is the type of labor contract employees are working on, which is considered indicative of the type of work they perform: those whose work is easy to monitor and does not require specific human capital are hired on a labor contract. The main characteristics of the latter are, first, that employees' payment will be equivalent to the amount of work they perform (e.g., per piece) and, second, that the contract lacks features that aim to bind the employee to the employer. In contrast, the service relationship aims to bind those whose work is difficult to monitor and who need to have specific human capital to the firm, not only to secure their commitment but also to facilitate investments in firm-specific human capital. The service relationship does so by offering employees a contract that is not only long-term but also provides them with prospects in terms of career chances and/or salary progression (for a detailed discussion, see Goldthorpe 2000, pp. 206–229; Breen 2005).

[15] Interestingly, the (neo-)Weberian character of the EGP scheme seems to have evolved over time: early on—as Breen (2005, p. 42) also notes—the authors seem to have been reluctant to identify their class scheme as Weberian and instead referred to both Marx and Weber as relevant sources (Erikson and Goldthorpe 1993, p. 37). Moreover, Tåhlin (2007), who describes the historical development of the EGP scheme in detail, argues that the reference of the scheme is merely a post-hoc rationale for which empirical analyses provide no empirical support. Instead, he argues that occupational skill requirements (relevant for distinguishing classes in the SEI scheme by Erikson and others—one of the ancestors of the EGP) would provide a more useful basis for differentiating the classes of the EGP scheme.

3.3.2 Marxian Class Schemes

The most prominent class scheme in the *Marxist tradition* was developed by Wright (2000).[16] At first sight, the point of departure for Wright's scheme is more or less the same as it is for the EGP: a distinction between employers (capitalists), self-employed persons without employees (petit bourgeoisie), and employees (working class). Moreover, as in case of the EGP, Wright had to solve the "problem of the 'middle class'" (Wright 2000, p. 15). This means that he had to deal with the fact that in modern societies, a vast majority of the population are employees; thus, further distinctions within this group seem reasonable to allow for more detailed analyses.

However, the conceptual background of Wright's classification is rather distinct from the approach of Goldthorpe and his colleagues. For Wright, the difference between capitalists and employees, in particular, is not merely one of holding differential resources, which provide those holding them with a specific (and distinct) set of opportunities. What is essential is that these differential resources constitute a (conflict-laden) social relationship between the two groups (exploitation). This allows the capitalists to appropriate (a substantial) part of the value the employees generate by means of their labor.[17]

In a comparable fashion, Wright draws a distinction between different types of employees along the dimensions of authority (e.g., that held by managers) and skill. As employers cannot secure these employee groups' full commitment just by exerting hierarchical control, they have to do so by granting them privileges, which allows managers and skilled employees to extract what Wright terms "loyalty rents". The latter also appears to be—as Wright (2000, p. 19) himself concedes—quite close to Goldthorpe's concept of the service relationship. The major difference from Wright's perspective is again the conceptual background. Moreover, he criticizes that Goldthorpe's service class actually combines capitalists, managers and professionals, which, while all privileged, are privileged for completely different reasons. It is actually the distinction between the three dimensions underlying these groups' privilege that constitutes the backbone of Wright's own classification.

Wright's classification comes in two variants: the first is a basic class typology, which, in addition to two groups of owners (capitalists and petite bourgeoisie), differentiates between four employee groups. While employee groups are categorized by the two dimensions just introduced (i.e., skill and authority), Wright distinguishes capitalists and petite bourgeoisie by their hiring or not hiring of labor. The second is an elaborated class typology in which he adds intermediate categories to all three dimensions[18]. This results in a twelve-class scheme differentiating between three owner categories and nine employee categories.

[16] Over the years, Wright has actually developed different versions of his class scheme. For earlier versions, see, e.g., Wright and Perrone (1977) or Wright (1985).

[17] For a detailed discussion, see Wright (2000, pp. 27 ff.).

[18] These are owners that hire only a few (i.e., less than ten) employees; employees that only hold supervisory power but are not involved in decision-making processes; and specialized employees at a medium level of qualification.

From a technical perspective, Wright's class scheme constitutes an exception among the measures discussed here, as it does not build directly on detailed information on occupations (in the sense captured by occupational classifications). Instead, it relies on information about those characteristics of the persons in the dataset, which are relevant for operationalizing the differences between class positions, in particular ownership, authority (e.g., supervisory power), and education (skill).[19]

3.3.3 Durkheimian Class Schemes

In contrast, microclasses, which were developed by Grusky and his colleagues (Sørensen and Grusky 1996; Grusky and Sørensen 1998; Grusky and Weeden 2001; Weeden and Grusky 2005; Grusky and Galescou 2005), focus on rather small occupational groupings; thus, detailed information on occupations is essential for the construction of microclass schemes. Grusky and his colleagues refer to this as a *Durkheimian approach to class analysis* because of its strong references to the technical division of labor.

The starting point for the development of microclasses was a critique of the existing schemes, which—as the class schemes of the Weberian or Marxist fashion discussed above—aggregate occupations into a comparatively small number of "big classes". Grusky and his colleagues argue that this focus on large aggregate classes is problematic. The reason for this is that most of the processes that link classes to class-specific outcomes "operate more directly and decisively at the level of detailed occupations" (Weeden and Grusky 2005, p. 154) rather than at the level of "big class" groupings. The reason for this is, in Weeden and Grusky's view, the higher internal homogeneity of occupations in comparison to "big class" aggregates. This, in turn, should be so because the mechanisms generating within-group homogeneity[20] should have a much stronger effect at the occupation level than at the "big class" level (see Weeden and Grusky 2005, p. 149 ff. for details).

The actual number of microclasses distinguished varies between different publications. Thus, while Sørensen and Grusky (1996) distinguish 70 "middle-range occupational titles", Weeden and Grusky (2005) distinguish 126 different classes, and Jonsson et al. (2009) distinguish 82. Coding tables for transferring occupational information into microclass codes are available for the US SOC 1970 and for the ISCO 68, ISCO 88, and ISCO 08.[21] In addition, detailed descriptions of the coding scheme are available in the appendices to Weeden and Grusky (2005, 2012; 126-class scheme) or Jonsson et al. (2009; 82-class scheme).

[19] On the practical operationalization of Wright's scheme, see, e.g., Wright (1997, pp. 74 ff.) or Rose (2005).

[20] Namely, selection into occupations, social conditioning, for example, by similar training or interaction with persons that have similar interests and similar training, and similarity of working conditions.

[21] Microclass codes for the SOC 1970 are available at Kim Weeden's website (Weeden 2020). Coding schemes for the different versions of the ISCO are available for download from the website of the "Social Networks and Occupational Structure" (SoNOcS) project (see SONOCS 2020).

3.3.4 Pragmatic Measures

Beyond that, there are also measures that try to capture some hierarchical aspect of occupations without explicitly relying on any theoretical tradition. We refer to this type of measure as *pragmatic measures*. The most recent measure of this type is the European Socio-Economic Groups (ESeG-2014) classification scheme developed by Meron et al. (2014; for a detailed discussion, see also Tijdens 2016). Although formally commissioned by Eurostat as a successor to the ESeC, the ESeG is conceptually distinct. In particular, it abandons the ESeC's theoretical conception, most notably the concept of employment relations. Instead, to distinguish between the categories of the scheme, it solely relies on recoding the two-digit ISCO 08 codes and gathering information on employment status (employed versus self-employed).[22] Thus, it follows a rather pragmatic approach, which is why we classified it among the pragmatic measures. The ESeG distinguishes seven employee categories and two additional categories for the non-employed. Moreover, a further subdivision into 30 employee and twelve non-employed categories is possible.[23]

The most popular pragmatic measure in Germany is Blossfeld's Classification of Occupations (Blossfeld 1983, 1985, 1987). This scheme distinguishes between twelve groups of occupations. Blossfeld constructed these groups by combining information on the field of occupational activities (production, service, and administration) with a hierarchical dimension. To capture this hierarchical aspect of occupations, groups were constructed "with the objective of making these groups as homogeneous as possible in their average general and vocational training requirements as well as in their occupational activities" (Blossfeld 1987, p. 98). Blossfeld originally developed his Classification of Occupations for the KldB 70/75. Moreover, the classification is also available for the ISCO 68 (Blossfeld 1987) and KldB 92 (Schimpl-Neimanns 2003).[24]

3.4 Summary and Evaluation

In summary, there are numerous occupation-based stratification measures that relate to different strands of sociological theory and carry—not least through their functional form—different methodological implications. Thus, which one of these is appropriate to use in a particular situation should—in addition to pragmatic reasons such as the availability of a measure for a particular occupational coding scheme—for the most part, be a decision that is driven by theoretical considerations. In our opinion, this should hold true even in situations where empirical results obtained with one measure do not differ much from those obtained when using another.

[22] Moreover, for coding the unemployed persons' categories, age and unemployment status (e.g., student, retired) are required.

[23] SPSS code to generate ESeG is available from Tijdens (2016); SPSS and Stata code are available from Herter and Wirth (2016).

[24] Further information as well as setup files one can apply to Microcensus data are available from Gesis (2020).

It is also important to note that stratification measures might "inherit" weaknesses from the underlying schemes for coding occupations and that these weaknesses might imply restrictions for particular applications of the stratification measures. A somewhat unfortunate feature of many classification schemes is, for example, that typical career paths in the non-tertiary sector (e.g., from skilled worker to master craftsman) much more commonly imply occupational changes than do career paths within the tertiary sector (e.g., from assistant professor to associate professor to full professor). Thus, despite the fact that the latter path might imply a considerable improvement in one's social position, the measures presented here might not reflect this development, as it is already absent in the classification underlying the measure.[25] Although this might not be a problem in many situations, in some—such as monitoring career development over time—it might be just that. Thus, in any case, it is a good idea to reflect on the conceptual as well as the formal properties of the measure before its empirical application.

4 Measuring Occupation-Specific Tasks

In their seminal paper, Autor et al. (2003) shifted the focus onto what is now called "the 'task approach' to labor markets" (Autor 2013) or simply the task-based approach (TBA). Since then, measuring and analyzing occupation-specific tasks has increasingly become a focus of attention in scientific discussions. In particular, by applying task-based analyses, researchers have tried to explain the wage and employment polarization in recent decades.

For the US labor market, Autor et al. (2003) showed that changes in job requirements, which resulted from the increasing use of programmable machines, can explain the lower employment growth among medium-skilled workers compared with high- and low-skilled workers. Similar findings were made for other industrialized countries (e.g., Goos et al. 2014).

Other examples of the successful application of task-based analyses are wage development (Autor et al. 2008), outsourcing (e.g., Jensen and Kletzer 2010; Blinder 2009), the transfer of occupation-specific human capital when changing jobs (e.g., Kracke et al. 2018; Gathmann and Schönberg 2010), and the potential replacement of human labor by computers or computer-controlled machines (Frey and Osborne 2017; Dengler and Matthes 2018).

It is important to note that the perspective of the task-based approach is genuinely one of occupation research in that it considers an occupation not merely to be a placeholder for a particular position in the social structure—which, for example, the occupation-based stratification measures discussed earlier often do. Instead, it is deeply rooted in workplace activities. This is so because from the TBA perspective, there is a strong link between occupations and tasks, with occupations being defined

[25] In contrast, measures such as income reflect career development in both cases. In practice, the problem described should mainly apply to the continuous measures rather than to the categorial ones, because, due to the stronger aggregation of the latter, categorial measures might not be appropriate for the type of detailed analyses that give rise to the problem anyway.

as "a bundle of tasks" (e.g., Acemoglu and Autor 2011; Autor and Handel 2013), whereas tasks are considered "a unit of work activity that produces output (goods and services)" (Acemoglu and Autor 2011, p. 1045). Thus, according to this definition, tasks are activities that individuals in a particular occupation are required to perform in a particular workplace.

Task measures are available at the occupation level as well as at the worker or person level (Autor and Handel 2013). From a technical perspective, however, occupation-level measures might either be aggregated from the personal level, or they might be genuinely constructed on the occupation level. In the latter case, occupation-level measures usually rely on expert knowledge regarding job profiles and the typical tasks performed in an occupation. In contrast, person-level measures usually rely on surveys to collect information on tasks performed at a workplace. Throughout the following pages, we provide a more detailed description of the two approaches.

4.1 Expert-Based Task Operationalizations

While expert-based task operationalizations might in specific cases also rely on input from sources such as survey data (as, e.g., in the case of the Occupational Information Network [O*NET]), in most cases, they are—as their name suggests—based on judgments by occupational experts. Consequently, they provide genuine occupation-level information—a characteristic that, in some cases, might reduce their predictive power compared with person-level information (see Autor and Handel 2013 for an example).

Even though it has been succeeded by the O*NET, the US Department of Labor's *Dictionary of Occupational Titles (DOT)* is probably still the most well-known source of expert-based task data, not least since Autor et al. (ALM) used it in their 2003 paper. The first edition of the DOT appeared in 1939, and the original release of its fourth and most recent edition was in 1977; the last revision was in 1991. The DOT contains detailed information on 12,000 occupational titles, including detailed information on different job requirements (for a more detailed description of the DOT, see, e.g., Autor et al. 2003; Handel 2016a; or Rohrbach-Schmidt and Tiemann 2013).

The *O*NET*[26], which succeeded the DOT in 2001, was established in response to methodological criticism of the latter. A major point of that criticism was that a large part of the occupational information in the DOT was, in fact, not updated in later editions, but simply copied from earlier ones.[27] In contrast to the DOT, the O*NET uses a mix of different data collection methods, surveys of jobholders, and expert ratings from job analysts. However, similar to the DOT, the O*NET database only provides mean values for occupations, whereas the original microdata are not available.

[26] For further information, see https://www.onetonline.org/.

[27] For a comprehensive review of these issues, see Handel (2016a); for details, see Cain and Treiman (1981) or Spenner (1990).

O*NET data have been used frequently to answer different research questions, and—despite having been constructed for the US labor market—O*NET data have also been applied to other countries. An example of the latter is Goos et al. (2014), who apply task categories constructed using O*NET data to investigate trends in employment polarization for selected European countries.

An alternative expert-based database providing detailed information on occupations in Germany is BERUFENET. BERUFENET is an online database provided by the Federal Employment Agency (BA). Although its main functions are to provide vocational guidance to jobseekers and to support employment services, the database also covers detailed information on occupational tasks, which is available for scientific research. One advantage of BERUFENET over the DOT and O*NET is that it has more frequent updates and quality controls. Thus, at least once a year, new occupations and tasks are added or old ones deleted. Moreover, it is determined for all occupations whether the task descriptions have remained constant or changed.

Dengler et al. (2014) assigned the task information included in the BERUFENET to the five task types distinguished by ALM: non-routine analytic, non-routine interactive, routine cognitive, routine manual, and non-routine manual tasks. To do so, they used BERUFENET's requirement matrix, which describes approximately 8000 different tasks that might be relevant to BERUFENET's approximately 4000 core occupations.[28]

To assure the quality of the task categorization, three coders independently assessed the tasks and coded them to the ALM categories. Afterwards, Dengler and colleagues calculated the share of the five task types in the total number of core tasks[29] for each occupation. Moreover, they generated task profiles for occupational aggregates. These data are currently available for the KldB 88 and KldB 2010[30] and will be available soon for the ISCO 08.[31] In addition to the 2013 data, the authors will provide data for 2016 and 2019 soon and will supplement them with additional data at three-year intervals. These will be part of a larger dataset (Dengler et al. 2020) combining occupational information from different sources (as, e.g., also the scales by Vicari presented in the section "Occupational Segregation, Institutions, and Health").

4.2 Survey-Based Task Operationalizations

The BIBB-IAB and BIBB-BAuA employment surveys were the first surveys in Germany to collect comprehensive data on workplace tasks to allow analyses to

[28] The term "core occupation" refers to the most recent job title for a particular occupation. For example, the occupation "motor vehicle mechatronic" has older job titles such as "motor vehicle mechanic" and more specific job titles such as "motor vehicle mechatronic—focus on car bodywork technology." These alternative job titles are linked to the core occupation; thus, the requirements of the core occupation can be assigned to the alternative job titles as well.

[29] Tasks are generally assigned to an occupation if they are typically necessary for the exercise of the occupation. The core tasks are indispensable for the exercise of the occupation, whereas the other tasks are only required at certain workplaces.

[30] It is available for download at http://doku.iab.de/fdz/reporte/2014/MR_12-14_data.zip.

[31] Currently, the data for ISCO 08 are only available upon request.

be performed in the context of the task-based approach.[32] They are repeated cross-sectional surveys. The 1979, 1985/1986, 1991/1992, and 1998/1999 waves of these surveys were conducted jointly by the German Federal Institute for Vocational Education and Training (BIBB) and the Institute for Employment Research (IAB). The later survey waves, conducted in 2006, 2012, and 2018, were commissioned by the BIBB in cooperation with the Federal Institute for Occupational Safety and Health (BAuA).[33]

The surveys have been important for research on the task-based approach, not least because the first publication using survey-based task measures (Spitz-Oener 2006) relied on these data and many others followed suit (e.g., Antoncyzk et al. 2009; Black and Spitz-Oener 2010; Cassidy 2017; Fedorets 2019; Gathmann and Schönberg 2010; Geel et al. 2011; Geel and Backes-Gellner 2011; Romeu Gordo and Skirbekk 2013).

However, although the data from the employment surveys are commonly used, there has also been some criticism regarding particular features of the data. The most serious of these is that—not least because the items used for measuring tasks were originally developed for a completely different purpose—there is no clear standard of assigning items to task categories. For example, Rohrbach-Schmidt and Tiemann (2013) have shown that this is not without consequences since the results obtained for the effects of technological change in Germany are extremely sensitive to the classification of tasks into routine or non-routine. Moreover, the number and wording of items have changed considerably over time, and items often do not refer to a single task but rather to a number of tasks.[34]

These problems mean that researchers should be cautious when using the data—especially when making comparisons over time. On the other hand, at least for Germany, they are the only data source available actually allowing analyses spanning extended periods of time. For this reason, the BIBB-IAB and BIBB-BAuA employment surveys are—despite the weaknesses just mentioned—some of the most important sources of task data for Germany.

In contrast to the BIBB-IAB and BIBB-BAuA employment surveys, the Survey of Workplace Skills, Technology, and Management Practices (STAMP) was developed by Handel (2007, 2008, 2016b) specifically for measuring workplace tasks. Even though STAMP exclusively focuses on the US, it has been influential for different measurement efforts that provide data for Germany.

There are two main features that distinguish STAMP from earlier efforts of survey-based task measurement. First, instead of trying to fit the items available to

[32] Although the German Microcensus of 1969 was actually the first survey to collect any information on workplace tasks (for a detailed historical account and description of the relation between items in the Microcensus and the early BIBB/IAB studies, see Rohrbach-Schmidt and Tiemann 2013), the task information collected in the Microcensus is genuinely unsuited for task-based analyses, as discussed here. The main reason for this is that the Microcensus merely collects information on respondents' main task, thus ignoring the fact that there is usually a variety of workplace tasks or—in Acemoglu and Autor's (2011) words—a bundle of tasks that have to be performed within any particular occupation.

[33] See, e.g., Rohrbach-Schmidt and Tiemann (2013) for a description of the surveys up to 2012 and Hall et al. (2020) for the 2018 survey.

[34] Such as "accommodating, serving, or caring" or "advertising, public relations, marketing, acquisitions".

a framework developed much later, STAMP started from the categories of the framework, such as cognitive, interpersonal, and physical job requirements, and tried to adequately measure these by developing specific items. Second, instead of asking questions that combine several tasks, Handel tends to break down individual constructs into a sequence of simple yes/no questions[35] that are "objective, concrete, correspond directly to the target of interest, and have absolute meanings for respondents" (Handel 2016a, p. 170). Particularly for the different cognitive dimensions (e.g., mathematics or reading), this is, in our opinion, a very suitable approach.

STAMP's concept of measuring workplace tasks has influenced two major survey efforts with regard to how they measure workplace tasks. One is the Programme for International Assessment of Adult Competencies (PIAAC), and the other is the German National Educational Panel Study (NEPS). The Organization for Economic Cooperation and Development (OECD) conducted the PIAAC in 31 countries, including Germany. There were two survey waves; the first was conducted in 2011/2012, and the second was conducted in 2014/2015. The data set provides internationally comparable information on work content at the workplace level, thus taking into account the heterogeneity of work tasks within occupations. One drawback, however, is that the occupational information is available only at the two-digit level of the ISCO 08.

The second survey that borrows from STAMP is the Adult Cohort of the German National Educational Panel Study (NEPS). Matthes et al. (2014) provide a detailed description of this survey's module for capturing workplace tasks. In line with STAMP, Matthes et al. (2014) start from ALM's distinction of different task categories and try to develop specific items to measure these tasks. In particular, their measures for analytic and interactive tasks draw heavily on the STAMP questionnaire. What is unique about the approach of Matthes et al. (2014) is the way that they try to capture the routine dimension. They start from the premise that everyday concepts of routine will often not be in accord with ALM's concept of routine (which means, in fact, substitution by technical means) and thus capturing routine in the latter sense in a survey might be error prone (see also the related discussion in Autor 2013, p. 192). Instead, Matthes et al. (2014) proposed capturing two elements that characterize non-routine occupations, namely, task complexity and autonomy, assuming that occupations that do not score high on these constructs should consequentially be considered routine.

4.3 Summary and Evaluation

The main difference between expert-based and survey-based task operationalizations is that the latter provide individual-level information. Thus, researchers might use survey-based task operationalizations to analyze task variation within occupations. In contrast, expert-based task operationalizations provide aggregate information that only allows analyses at the occupation level. In practice, this is even true in cases in which parts of the expert-based scores rely on survey measures (as in the O*NET) or are generated relying on information from different experts (which would provide

[35] See Handel (2016b, p. 195) for examples.

at least some information on task variation), as in the DOT. This is due to the fact that even in these cases, where more detailed information would be available, only aggregate information is made available to the scientific community.

Moreover, survey data are faster at measuring changing workplace requirements. This is so not only because they rely on the knowledge of workers actually working at these workplaces. A second reason is that including job requirements that have changed in an expert database relies on time-consuming procedures. Thus, consultations with experts need to take place or changes in training regulations or other publicly available job descriptions need to occur before these changes can be included in the next round of updates to the database.

On the other hand, occupational experts are aware of the purpose of evaluating different occupations. In addition, they are trained to collect or generate such complex information. Both characteristics should help experts to make more adequate judgments. Moreover, information on rare occupations is often unavailable in surveys, as no respondents with these particular occupations participate in the survey or their number is too small to provide reliable information. Expert data, on the other hand, provide reliable information on all occupations.

In sum, both ways of collecting task data have their particular advantages and disadvantages, and which of the two types of measures is better suited to answer a particular research question largely depends on the question at hand.

5 Occupational Segregation, Institutions, and Health

Although stratification and task measures are probably the most prominent among the occupation-based measures, there are other topic areas for which occupation is equally relevant. Thus, in the following, we discuss occupation-based measures, focusing on three such topic areas: (1) occupational segregation, (2) institutional characteristics of occupations, and (3) occupation-specific health risks. We describe these three areas in more detail and give examples of occupation-based measures available for these domains.

5.1 Occupational Segregation and Composition

In general, the concept of segregation describes the state of a social group (e.g., women, migrants, academics, unemployed persons) being concentrated in certain segments of society (e.g., certain regions or occupations) while being underrepresented in others. A particularly important form of occupational segregation—i.e., the concentration of individuals in certain occupational segments—is occupational gender segregation. It refers to the unequal gender composition of occupations and has severe implications for the wages of both men and women (England and Folbre 2005).

While there are many data sets and databases that allow for the analysis of the socio-demographic compositions of occupations at the micro-level, databases that comprise comprehensive information on the occupation level are still scarce. Hausmann et al. (2015a) provide an example for such a comprehensive database for

Germany, the Occupational Panel (OccPan). The original aim of the OccPan was to analyze occupational gender segregation and its consequences. The OccPan includes data on the composition of 254 occupations according to socio-demographic characteristics, such as the proportion of women and men, average age, average education, and average wage in the occupation. The panel relies on data from the Sample of Integrated Labor Market Biographies (SIAB) and includes data for Western Germany for the years 1976–2010, which Hausmann and her colleagues aggregated at the occupation level. Occupational information in the OccPan is available for the KldB 88. Data from the OccPan are available from the website of the Institute for Employment Research (IAB).[36] For more detailed analyses using OccPan data, see also Hausmann and Kleinert (2014) and Hausmann et al. (2015c).

5.2 Institutional Characteristics of Occupations

Moreover, occupations might have institutional characteristics that, for example, restrict the provision of certain services to incumbents of a particular occupation or limit access to certain occupations. Such regulations exist in the education system as well as in the labor market. One of the results of such regulations is usually that incumbents of an occupation to which such regulations apply can extract rents beyond those that they might receive in a market situation.

With regard to education systems, internationally comparative research on school-to-work transitions has produced three concepts that relate to these systems' institutional structures and can be useful in categorizing such systems: standardization, differentiation, and vocational specificity. The first of these concepts, standardization, is defined as "... the degree to which the quality of education meets the same standards nationwide." It is measured by "variables such as teachers' training, school budgets, curricula, and the uniformity of school-leaving examinations" (Allmendinger 1989, p. 233).

The second concept, the differentiation of educational systems (e.g., van de Werfhorst 2011), refers to the degree to which students are sorted into different levels and tracks in the education system. There is usually a distinction between horizontal differentiation and vertical differentiation. The German education system is typically considered to show high vertical differentiation, i.e., it is stratified (Allmendinger 1989).

In addition to standardization and differentiation, another dimension in which education systems can differ remarkably is vocational specificity (e.g., Müller and Shavit 1998). This concept implies that in some countries young people acquire general skills during vocational training, but in others (e.g., in Switzerland and Germany), they receive highly occupation-specific training.

While for general education, there is usually no direct link to specific occupations, the concepts described for classifying education systems can also be useful for the analysis of vocational education. This seems particularly reasonable in countries where vocational training is highly occupation-specific, for example, in Germany, Austria, Denmark, and Switzerland. For Switzerland, Grønning et al. developed

[36] See Hausmann et al. (2015b).

a scale that provides detailed data on the institutional characteristics of training occupations within upper secondary vocational training (Grønning et al. 2018). The main source of data used for constructing this scale is occupational information from Swiss training ordinances.

After collecting occupation-specific data, Grønning and her colleagues classified occupations along the three dimensions as follows:

1. Standardization: the measure of standardization applied by Grønning et al. is the centralization of final exams. High standardization means that training occupations have a standardized practical exam set by cantonal authorities and graded by experts. Standardization is low if the apprenticeship trainer prepares and grades the exam, if the type of practical exam differs between regions, or if there are oral instead of written exams.
2. Differentiation: there is a horizontal as well as a vertical dimension of differentiation. Horizontal differentiation describes the sorting of students into different fields and subjects. Vertical differentiation refers to the difference between basic and advanced levels of training, as well as in the duration of training programs (2-year Vocational Education and Training (VET) programs versus 3- to 4-year programs).
3. Specificity: the specificity of VET depends on the "type of skills" acquired (general versus occupation-specific) and the "manner of skill acquisition" (practical versus theoretical). Data are available for the eight-digit codes of the Swiss Standard Classification of Occupations 2000 (SSCO2000).

Eggenberger et al. (2018) provide another example that focuses on vocational specificity. Relying on information from Swiss training ordinances as well, they calculate occupation-level specificity measures based on the skill bundles required in individual training occupations. The specificity measure ranges from 0.669 (least specific: hotel management clerk) to 0.971 (most specific: paper technologist) and is available for SSCO2000 codes at the five-digit level. Using this measure, Eggenberger and his colleagues show that the institutional characteristics of training occupations influence not only the individual acquisition of skills but also the labor market careers of graduates.

Institutions also shape processes and inequalities in the labor market. Theories of occupational closure emphasize that recruitment processes strongly rely on certificates (Weeden 2002). The exclusion of candidates without an appropriate certificate from certain occupations limits occupational supply and hence generates rewards ("rents") for incumbents of these occupations if they are able to organize into occupational associations. Exclusion processes can be either informal or formal (e.g., Haupt and Ebner 2020; in this volume). Informal recruitment (credentialism) means that firms are not obliged to hire people with certain certificates, but that it is nevertheless common practice to do so, particularly in order to reduce training costs. For some occupations, on the other hand, governments define which certificate(s) an employee has to hold in order to legally perform a particular occupational task (licensing). In Germany, licensing mainly occurs among occupations in the social sphere that provide basic goods (see Haupt 2016, p. 135). Examples are health (e.g., medical doctors), education (e.g., teachers), and security (e.g., police officers).

There are several measures that try to capture credentialism and licensing for various occupations in Germany. Vicari (2014) developed the first of these measures, which provides two indicators at the occupation level: (1) the degree of standardized credentials and (2) the degree of regulation. The first indicator shows whether those trained in an occupation usually receive a standardized training certificate that relies on uniform federal or state-level curricula or federal or state-level final examinations. If this is the case for a particular occupation, Vicari considers this occupation standardized. The second indicator captures occupational licensing. According to Vicari, licensing occurs if there are laws and administrative provisions that govern access to an occupation, working in the occupation, and the use of a specific occupational title and make them contingent upon holding a specific qualification or license. In addition to both these indicators, Vicari provides a combined indicator, "Degree of standardized certification" that joins the information of indicators 1 and 2. All three indicators are available for the two- and three-digit versions of the KldB 1988 and KldB 2010. Their values range between "0" and "1", with "0" indicating a very low degree of standardized certification and "1" indicating a very high degree of standardized certification.

Haupt (2016) provided the second measure. It includes two indicators: (1) the index of occupational closure and (2) the index of occupational licensing. The first indicator measures the extent to which occupational skills are important for recruitment decisions. If recruitment in an occupation relies exclusively on one occupation-specific skill profile, Haupt classifies the occupation as a closed occupation. The values of this indicator range between "0" (very low level of closure) and "3" (very high level of closure). The second indicator covers occupations that are subject to a statutory obligation to recruit only applicants holding a state permit to practice that particular occupation. Thus, the indicator relies on a rather narrow concept of licensing. In particular, it does not cover occupations with title protection (e.g., engineers) or in which a master craftsman's certificate is required to carry on the trade. The indicator is dummy-coded (license yes/no). Both indicators are available for the KldB 1988 and KldB 2010 as well as for the ISCO 88 (each at the three-digit level). They are available at the SowiDataNet Datorium (Haupt et al. 2018).

In a third approach, Stuth (2017) analyses the connection between occupations and temporary employment. In this context, he develops several measures to operationalize occupational closure.

1. To measure credentialism, Stuth calculates a "credential inflation index (CIX)" as the number of all newly awarded occupation-specific credentials in proportion to the number of employees in the respective occupation.
2. His measure of standardization indicates whether there are standardized credentials at the school/university level, at the level of the federal states, or at the federal level.
3. Licensing: Stuth distinguishes two different forms of licensing: first, the licensing of tasks, i.e., only certain occupations may provide certain services. His licensing measure captures this type of licensing.
4. The second form of licensing is the legal protection of occupational titles. A separate indicator for title protection covers this second dimension of licensing.

5. There are two measures of occupational specificity. The first, uniqueness, indicates whether the incumbents of an occupation perform tasks that those working in other occupations only rarely perform or whether they perform tasks that are common for most occupations. The second measure, variety, indicates whether the incumbents of an occupation perform highly specialized tasks or whether they are generalist and perform a wide range of different tasks.
6. Moreover, there are two indicators showing whether an occupation is represented either by an association that lobbies on the behalf of its members or an occupation-specific trade union. While Stuth originally developed his indicators for the KldB 1992, he also transferred them to KldB 1988 and KldB 2010. All three versions are available at SowiDataNet Datorium (Stuth 2020).

5.3 Occupation-specific Health Risks

Working in a particular occupation not only provides access to valuable resources such as income or prestige but also often involves occupation-specific health risks, burdens, or strains—which are not distributed equally between occupations. However, while such occupation-related inequalities—for example, in health- or work-related stress—are a common subject of scientific interest, empirical research on the topic mostly relies on individual-level measures. These cover such diverse topics as chronic morbidity, injuries, subjective health, stress, cognitive demands at work, and burnout and have been implemented in national and international comparative surveys (see Burr et al. 2019; Verschuuren et al. 2013; for overviews).

In contrast, studies that provide aggregate information on health at the occupation level are still comparatively rare. Kroll (2011), for example, uses data from the BIBB/BAuA Employment Survey to generate indices that address physical, psychosocial and general workloads at the occupation level for the ISCO 88 and KldB 92. Moreover, Kroll (2015a) also provides an updated version for the ISCO 08 and the KldB 2010, as well as correspondence tables and setup files (Kroll 2015b).

In addition, there are studies that are not aimed at constructing specific indices but nonetheless provide information at the occupation level. These studies usually focus on specific health-related risks. An example of this type of study is that of Liebers et al. (2016). Using data from German statutory health insurance funds, they provide information on disease-related incapacity to work for detailed three-digit codes of the KldB 88 as well as aggregate information for Blossfeld's Classification of Occupations (see the section "Occupational-Based Stratification Measures" above). However, other studies only provide results that refer to aggregate occupational information. In some cases, these results relate to specific medical conditions such as dorsal pain or cardiovascular disease (e.g., Brendler et al. 2013, 2019; Liebers et al. 2013). In others, they relate to more general constructs, such as self-reported health (Burr et al. 2013) or mental well-being (Thielen and Kroll 2013). In both cases, the results are available for Blossfeld's Classification of Occupations.

6 Summary and Conclusion

While we probably have to leave open the question of whether a person's occupation is indeed the *single best* clue on who this person is, what we have shown in this article is that occupational information—properly surveyed and coded—provides researchers with the opportunity to enrich their data with numerous occupation-based measures. These measures, in turn, allow researchers to examine a plethora of different research questions from quite different topic areas.

In addition to the "classic" occupation-based measures applied in stratification research, such as prestige scales, SEIs, and class schemes, occupation-based measures covering many other topic areas are available. Among these are measures for different types of workplace tasks and measures capturing occupation-specific health risks, gender segregation, or occupational closure. All of these measures relate to a specific—and in some cases extensive—body of literature and trying to give only a short overview of these different strands of literature would go beyond the scope of this paper.

Nevertheless, we hope that those who were not aware of the variety of these measures before have, by reading this paper, obtained a general impression of the potential of occupation-based analyses, while the others have hopefully found one or another aspect or measure covered in this paper that is new to them. In any case, we hope that both groups of readers will agree with us that independent of whether a person's occupation is indeed the single best clue about who this person is, occupational information is quite likely the single most versatile type of information about a person available in quantitative data.

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