PART II
Who catches the eye?
Quantifying job autonomy in service work

6. Objective

Measuring job autonomy as part of employment quality has come to the fore in recent research attempts (overview in Warhurst et al., 2017). Though analyzing the job autonomy of workers has been explored in economics, social science, or psychology long before (e.g., Breaugh, 1985; Hackman & Oldham, 1975; Sims et al., 1976). The aim of this section is to model and quantify the previously defined autonomy dimensions to determine the status quo of the job autonomy available to workers, to establish comparability across different branches based on a uniform scale, and to identify changes in job autonomy over the past years. The underlying assumption is that ADM systems have increasingly found their way into the world of work. Although no causalities between using ADM systems and changes in job autonomy are established, the aim is to identify branches in which job autonomy is particularly strong (or weak) and which individual dimensions of job autonomy have changed.

The BIBB/BAuA-Employment Survey (BIBB/BAuA-ETB)[45] is particularly suitable as a data basis for this analysis as it provides extensive data on German working environments from the point of view of workers. The central objective of the analysis is to quantify job autonomy for the German service sector, the branches falling under it, and selected characteristics of their employees (e.g., educational attainment or sex). For this purpose, an overall value for job autonomy, the *Autonomy Index*, and a breakdown of the previously defined seven autonomy dimensions are presented. Furthermore, the corresponding data sets of the BIBB/BAuA-ETB from 2018 and 2012 are compared to identify changes in job autonomy. These findings may provide indications of the penetration of ADM systems into the world of work.

45 As a representative cross-sectional survey, the BIBB/BAuA-ETB is conducted every six years. The targeted audience is employed persons aged 15 and older who work at least 10 hours a week in a paid job. The survey is supervised by the Federal Institute for Vocational Education and Training (BIBB) and the Federal Institute for Occupational Safety and Health (BAuA). The current wave dates from 2018 and includes 20.012 respondents. The corresponding dataset from 2012 includes a total of 20.036 employed people. Both datasets are harmonized. The data analysis is based on the questionnaires of the surveys, see Hall and Siefer (2011, 2017), and the associated method reports, see Gensicke and Tschersich (2018), Gensicke et al. (2012), Rohrbach-Schmidt and Hall (2013, 2020). For the present analysis, the Scientific Use Files of the 2018 and 2012 surveys were acquired.

Since the BIBB/BAuA-ETB does not contain any explicit items to map the use of ADM tools, an approximation of this content is attempted by means of combining selected skill- and task-related items following Pfeiffer (2020, p. 473) (e.g., knowledge of mathematics and statistics, extent of computer usage). Although these work demands are not equivalent to the actual use of ADM systems, they do illustrate workers' potential capacities for handling them.

Part II is mainly intended to establish comparability within the service sector and, thereby, provide a comprehensible basis for the selection of branches for the qualitative, in-depth analysis. Thus, this section is an intermediate step in this thesis, which also considers gaps in previous research regarding the expression of selected autonomy dimensions, socio-economic characteristics of workers, or job-related attributes. This overall process concludes with the identification of service branches that are particularly striking examples of job autonomy cases, i.e., that show peculiarly high or low levels, and those mostly affected by changes in the degree of job autonomy between 2012 and 2018. Two of the selected branches serve as objects for an in-depth analysis of ADM systems influencing job autonomy in the qualitative Part III.

Part II is thus structured as follows: A description of the method applied (Chap. 7) is followed by the analysis chapter, which examines the calculated autonomy scales according to branches and task types (Chap. 8.1), selected socio-economic characteristics of the respondents or their organizations (Chap. 8.2), as well as other aspects connected with the use of ADM (Chap. 8.3). This cross-sectional analysis of the 2018 survey year is followed by a qualitative longitudinal comparison with the 2012 data (Chap. 8.4). The consideration of the limitations in the analysis conducted is essential for a reliable evaluation of the results (Chap. 9). Concluding remarks (Chap. 10) close Part II, summarize it, reflect on previous findings, and lead into the next section.

7. Method: constructing the Autonomy Index

There are four preliminary considerations for measuring the quality of work (Lepperhoff, 2011, pp. 32–33), some of which are applied to the following analysis of job autonomy. These conceptual preliminaries include: (1) how work is defined in the present case; (2) which functions of work or dimensions are included in the analysis and to what extent they are hierarchically ranked; (3) to what extent existing inequalities in quality concepts are reproduced and how these principles are taken into account in the analysis and interpretation of the data; and (4) to what extent the complexity of work and work quality are taken into account in terms of both objective-structural and subjective perceptions of workers. These requirements for a measurement concept for work quality serve as a point of orientation for the analysis of job autonomy in the following:

1) The definition of work includes the paid work of dependent employees (blue-collar and white-collar workers, civil servants) in the German service sector (Chap. 7.3).
2) The analysis draws on the theoretical definition of seven autonomy dimensions: Task, Method, Criteria, Scheduling, Working Time, Locational and Interactional Autonomy (Chap. 4.1). Weighted equally, no hierarchical ranking is assumed between the dimensions.
3) Socio-economic differences among the respondents are partly considered by including educational attainment, sex, working hours, or duration of employment.
4) The Autonomy Index includes both objective and subjective aspects of work, depending on the dimension considered. The BIBB/BAuA-ETB mainly reflects the subjective impressions of the employees. For a lack of appropriate measures, some items deviate from this approach (specifically Working Time and Locational Autonomy).

In addition to these quality requirements, the construction of autonomy scales and the summarizing Autonomy Index are initially based on a critical examination of previous attempts to operationalize job autonomy, with a particular focus on the use of the BIBB/BAuA-ETB (Chap. 7.1). It emerges quickly that the existing concepts need to be considerably expanded to do justice to a multidimensional concept of job autonomy, which is the foundation of this thesis (Chap. 7.2). The calculation of the autonomy scales is followed by a brief description of the sample and the variables used for further analysis (Chap. 7.3). The extensive Appendix | Part II breaks down individual construction and analysis steps to achieve the highest possible reproducibility and transparency of the results.

7.1. A question of operationalization

The central question in the analysis of job autonomy based on the BIBB/BAuA-ETB is the operationalization of the concept, i.e., the selection of items that are to fill job autonomy with substance and meaning. In this regard, it is remarkable that current operationalization and measurement approaches to job autonomy hardly differ from early concepts, e.g., job redesign research in the 1970s and 1980s. Rather, earlier approaches to determining job autonomy show more multidimensional concepts. In particular, reference to the job redesign frameworks for analyzing motivational potential (Hackman & Oldham, 1975; Sims et al., 1976) and the conceptual approach of Breaugh (1985) is useful (Chap. 1.3 and 4.2): Reconsidering the Hackman and Oldham (1975, p. 162) definition of autonomy in the JDS ("The degree to which the job provides substantial freedom, independence, and discretion to the employee in scheduling the work and in determining the procedures to be used in carrying it out"), the authors use three items to operationalize job autonomy (Hackman & Oldham, 1974, pp. 72–79):

- *How much autonomy is there in the job? That is, to what extent does the job permit a person to decide on his or her own how to go about doing the work?*
- *The job gives a person considerable opportunity for independence and freedom in how he or she does the work.*
- *The job denies a person any chance to use his or her personal initiative or discretion in carrying out the work.*

Building on the work of Hackman and Oldham (1975) and using a similar definition of job autonomy ("The extent to which employees have a major say in scheduling their work, selecting the equipment they will use and deciding on procedures to be followed", Sims et al., 1976, p. 197), Sims et al. (1976, pp. 200–208) formulate another operationalization attempt within the JCI:

- *How much are you left on your own to do your own work?*
- *To what extent are you able to do your job independently of others?*
- *The freedom to do pretty much what I want on my job.*
- *The opportunity for independent thought and action.*
- *To what extent do you receive information from your superior on your job performance?*
- *To what extent are you able to act independently of your supervisor in performing your job function?*
- *The control I have over the pace of my work.*

Finally, Breaugh's (1985) operationalization closes this first canon of past analytical approaches to job autonomy. As already prominently listed in the seven dimensions of job autonomy, the author considers three dimensions of autonomy, each based on three items (Breaugh, 1985, p. 570):

Work Method Autonomy
- *I am allowed to decide how to go about getting my job done (the methods to use).*
- *I am able to choose the way to go about my job (the procedures to utilize).*
- *I am free to choose the method(s) to use in carrying out my work.*

Work Scheduling Autonomy
- *I have control over the scheduling of my work.*
- *I have some control over the sequencing of my work activities (when I do what).*
- *My job is such that I can decide when to do particular work activities.*

Work Criteria Autonomy
- *My job allows me to modify the normal way we are evaluated so that I can emphasize some aspects of my job and play down others.*
- *I am able to modify what my job objectives are (what I am supposed to accomplish).*
- *I have some control over what I am supposed to accomplish (what my supervisor sees as my job objectives).*

The approaches to operationalizing autonomy according to Hackman and Oldham (1975), Sims et al. (1976), and Breaugh (1985) have in common that they define job autonomy by means of methodical degrees of freedom and components of time allocation while executing tasks. In addition, Hackman and Oldham (1975) and Sims et al. (1976) include independence from other people at work in their approaches. Furthermore, the subjective part in the execution of work is emphasized (e.g., personal initiative or judgment in Hackman & Oldham, 1975) as well as the availability of information (e.g., receiving information from superiors in Sims et al., 1976). Breaugh (1985) stands out with his definition of Criteria Autonomy, which is one of the few approaches that includes the influence over work goals and the evaluation of performance as part of job autonomy. What is missing from these approaches, however, are job autonomy aspects that explicitly deal with time and place of work – these gaps are presumably due to their lesser relevance at the time.

Other studies that also operationalize job autonomy but do not use the BIBB/BAUA-ETB have already been discussed in the research status

of Part I and are therefore not dealt with again in detail. An example of this is S.-C. Meyer et al. (2022, p. 328), who address learning systems and their connection with selected criteria of quality of work. Using the DiWaBE survey (Digitalization and Employment in Transition), they define job autonomy as a concept that includes independent work scheduling, determining the pace of work, freedom of decision-making, working oneself into new tasks, and influencing the amount of work or the frequency of monotonous work processes (S.-C. Meyer et al., 2022, p. 321). Gensler and Abendroth (2021, p. 526), on the contrary, are guided by Breaugh's (1985) definition of job autonomy and, using the LEEP dataset (Linked-Employer-Employee-Panel) for an operationalization of job autonomy, refer to the items of autonomous determination of when a task is completed, methodical degrees of freedom, and the possibility of defining work goals themselves. In addition, Giering and Kirchner (2021, p. 562), using the SOEP-IS data set (Socio-Economic Panel Innovation Sample), take up similar operationalization elements: the possibility of deciding independently how work is to be carried out, the pace at which it is to be done, and the extent to which the sequence of tasks can be determined.

This selection of studies clearly shows that even in the current research context, there is hardly any agreement on the definition and operationalization of job autonomy. Although overlaps in terms of content are recognizable, they do not go beyond the standard understanding of quantitative approaches to job autonomy. This may be due in part to the construction of the respective data sets, but there is also a lack of critical engagement with the limited formulation of job autonomy. As will become clear, this criticism can be applied to a number of studies that use the BIBB/BAuA-ETB to deal with job autonomy. This list is intended as an excerpt of the study landscape with reference to quantitative approaches to digitalization and does not claim to be exhaustive.

Drawing on the more complex operationalization approaches of job redesign research in the 1970s and 1980s, today's understanding of job autonomy in attempts based on the BIBB/BAuA-ETB has become more limited. The studies in the following overview mostly use the 2018 dataset (Table 5). The operationalization of job autonomy is not always an explicit goal but a component of the respective research approach. In addition to the very narrow definitions of job autonomy within these studies, all other items used to answer the given research question are listed. According to the definition of job autonomy in this thesis, these items also include a wide range of autonomy-related aspects: organizational possibilities (influence on work quantity, working time, planning), work intensity (perception of pressure, contradictory demands, interruptions, lack of information, quality cuts), working time situation (work

outside traditional working hours), as well as some individual criteria (bringing in ideas, support from colleagues, timely information). The following overview of items used not only provides an insight into the different approaches to the concept of job autonomy and the content depth of the BIBB/BAuA-ETB but also marks an important orientation towards operationalizing the Autonomy Index.

It becomes clear that recent studies attribute little dimensionality to the concept and are concentrated on elements of the methodical and scheduling dimensions: Kirchner et al. (2020, p. 8) operationalize job autonomy via the frequency with which the execution of work is prescribed down to the last detail and the extent to which one's own work can be planned and scheduled. S.-C. Meyer et al. (2019, p. 215) even restrict themselves to the latter item when depicting job autonomy. In addition, a series of studies by the BAuA determine the characteristics of selected job resources by task type. They subdivide according to the task types of leadership and management (Ribbat et al., 2021, pp. 10–11), person-related (Schlicht et al., 2021, p. 11), object-related (Terhoeven, 2021, p. 7), and information-related (Tegtmeier, 2021, p. 8), and refer to task-specific resources and job autonomy. The authors define job autonomy as the ability to plan and schedule one's own work, to choose break times, and to influence workload.

Accordingly, there is a consensus among the studies examined as to how job autonomy should be operationalized. Components of flexibility in terms of working time or location, or of interaction work, are not included. Similarly, there is no focus on aspects that describe the objectives of work or task diversity. For the construction of an Autonomy Index based on the job autonomy dimensions already defined, the operationalization of job autonomy is considerably expanded. Though the studies listed help identify further suitable items: The resources include support from colleagues and superiors, which is generally considered to promote job autonomy. The same applies to the items listed under interaction demands. Factors relating to working time and place of work are used as guidelines for constructing Working Time and Locational Autonomy. Selected items of the categories intensity/demand and learning/problem solving demand are transferable to the dimensions Task, Method, and Criteria Autonomy. The reasoning of why these items are included in the construction of the Autonomy Index follows in the next chapter.

Table 5: Recent operationalization attempts of job autonomy using BIBB/BAuA-ETB

	Description	Item	Kirchner et al. 2020	Meyer et al. 2019	Ribbat et al. 2021	Schlicht et al. 2021	Terhoeven 2021	Tegtmeier 2021
Job Autonomy	Prescribed how to perform work down to the last detail*	F411_02	×				×	
	Planning and scheduling work independently*	F700_02	×	×	×	×	×	×
	Deciding when to take a break*	F700_06			×	×	×	×
	Influencing amount of work*	F700_03			×	×	×	×
Resource	Feeling that task is important	F700_07			×	×	×	×
	Perception of being part of a collective	F700_10			×	×	×	×
	Support from colleagues*	F700_12			×	×	×	×
	Support from superiors*	F700_13			×	×	×	×
	Appreciation by superiors	F700_14			×	×	×	×
Time/ location	Excessive working time	AZ, F206			×	×	×	×
	Taking family and private interests into account*	F208			×	×	×	×
	Work outside 7am-7pm*	F209			×	×	×	×
	Weekend work*	F220, F223			×	×	×	×
	Work at home*	F228, F229			×	×	×	×
Intensity/ demand	Working under intense deadline or performance pressure*	F411_01			×	×	×	×
	Repeating work processes down to the last detail*	F411_03			×	×	×	×
	Experiencing disruptions or interruptions*	F411_06			×	×	×	×
	Prescribed number of pieces, certain min. output, or time*	F411_07			×	×	×	×
	Tracking of different types of work or processes*	F411_09			×	×	×	×
	Reaching the limits of performance*	F411_12			×	×	×	×
	Very fast work required	F411_13			×	×	×	×

Learning/problem solving demand	Responding to and solving problems	F327_01	×	×	×	×
	Making difficult decisions independently	F327_02	×	×	×	×
	Identifying and closing knowledge gaps*	F327_03	×	×	×	×
	Thinking about and familiarizing with new tasks*	F411_04	×	×	×	×
	Improving existing processes or trying something new*	F411_05				×
	Unlearned skills required	F411_08	×	×	×	×
	Not receiving all the necessary information	F700_09	×	×	×	×
Interaction demand	Organizing, planning, and preparing work processes of others	F310	×			
	Taking responsibility for other people*	F327_04	×	×	×	×
	Convincing others and negotiating compromises*	F327_05	×	×	×	×
	Communicating with other people professionally	F327_06	×	×	×	×

Notes: Own translation, collection, and item assignment. *Items used for the construction of the Autonomy Index.
Source: Collected items from Kirchner et al. (2020), S.-C. Meyer et al. (2019), Ribbat et al. (2021), Schlicht et al. (2021), Terhoeven (2021), Tegtmeier (2021).

7.2. Item selection

In the theoretical part of this thesis, a total of seven dimensions of job autonomy are identified. These dimensions are described in detail (Chap. 4.2) and serve as a starting point for modeling dimensions that are as congruent as possible using the BIBB/BAuA-ETB 2018 and 2012. A brief description of the defined dimensions of job autonomy may provide a reminder:

- Task Autonomy: possibility to choose work tasks from task set; task variability; composition of work quantity; completeness of tasks and information.
- Method Autonomy: selection of procedures, methods, and tools to perform work tasks; possibility to build up competencies.
- Criteria Autonomy: ability to modify or choose the criteria used for evaluating work performance; taking responsibility for work performance; possibility to set work goals and to pursue them consciously and intentionally.
- Scheduling Autonomy: ability to decide on sequence, prioritization, timing, and speed of task completion; break determination; independent handling of disruptions and uncertainties.

- Working Time Autonomy: possibility to determine beginning and end of working time; determination of total working time and overtime; on-call duty.
- Locational Autonomy: possibility to determine the place where work tasks are executed within (micro-locality) or outside (macro-locality) the usual workplace.
- Interactional Autonomy: dependency on third parties; relation to team autonomy; possibility to determine extent of collaboration with third parties.

In the following compilation of the Autonomy Index, particular importance is given to a broad definition and thus to the best possible representation of the defined dimensions of job autonomy. In this way, the requirements of a modern concept of job autonomy, which goes beyond purely methodical and scheduling characteristics, are considered. Table 6 provides an overview of the respective number of items assigned to a dimension, the content of the assigned questions, and the effect of the selected question on the dimension.

For example, the answer *frequently* to the first question *How often does it happen in your work that one and the same work process is repeated down to the last detail?* has a negative effect on the calculation of the index value of the dimension Task Autonomy. The underlying question is always whether job autonomy is strengthened. If an item promotes job autonomy (+), answering the question with *frequently* or similar has a positive effect on the calculation of the Autonomy Index. If an item is rated as autonomy-reducing (–), answering the question with *frequently* or similar reduces the overall Autonomy Index.

Table 6: Construction of Autonomy Index with selected BIBB/BAuA-ETB 2018 items

Autonomy Dimension	No.	Question	Effect
Task Autonomy	1	How often does it happen in your work that one and the same work process is repeated down to the last detail?	–
	2	How often does it happen in your work that you improve on existing procedures or try something new?	+
	3	How often does it happen that you have influence over the amount of work assigned to you?	+
	4	How often does it happen that you are not informed in time about important decisions, changes, or plans for the future?	–
	5	Do you perform your tasks mainly according to instructions or mainly independently?	–
Method Autonomy	1	How often does it happen in your work that you have to identify and close your own knowledge gaps?	+
	2	In your work, how often do you find yourself being told how to perform the work down to the last detail?	–
	3	How often in your work do you find yourself faced with new tasks that you first have to think about and familiarize yourself with?	+
Criteria Autonomy	1	How common is it in your work that you are prescribed an exact number of pieces, a certain minimum output, or the time to complete a certain job?	–
	2	How often does your work require you to push yourself to the limit?	–
	3	How often does your job involve working under intense deadline, or performance pressure?	–
Scheduling Autonomy	1	How often do you experience disruptions or interruptions in your work, e.g., due to colleagues, bad material, machine malfunctions, or telephone calls?	–
	2	How often does your work require you to keep track of different types of work or processes at the same time?	–
	3	How often does it happen that you can plan and schedule your own work?	+
	4	How often does it happen that you can decide for yourself when to take a break?	+
Working Time Autonomy	1*	How often do you manage to take your family and private interests into account when planning your working hours?	+
	2	Are your working hours normally between 7 a.m. and 7 p.m.?	+
	3*	Have you arranged the following in your job? (on-call duty, work on demand, etc.) – none of the above	+
	4*	Do you usually work on Saturdays, at least once a month?	–
	5*	Do you usually work on Sundays, at least once a month?	–

Autonomy Dimension	No.	Question	Effect
Locational Autonomy	1*	Do you work for your company – even if only occasionally – from home?	+
	2*	How often does this occur?	+
		If your company gave you the option of working at home at times, would you accept this offer?	
Interactional Autonomy	1	How often does your job require you to take responsibility for others?	–
	2	How often does your work involve convincing others and negotiating compromises?	–
	3	How often do you get help and support for your work from colleagues when you need it?	+
	4	And how often do you get help and support for your work from your direct supervisor when you need it?	+

Notes: Own translation, collection, and item assignment. *Marked questions indicate deviations in the definition of a dimension in 2018 from the equivalent in 2012. These differences are due to changed items in the 2018 dataset. A detailed listing of the items used in both datasets and the composition of the individual dimensions are prepared in Table 18 and Table 19 | Appendix.

Task Autonomy

If individual work processes are repeated down to the last detail for employees (item 1), it is assumed that there is little autonomy due to the low task variability. Accordingly, the item is included negatively in the calculation. In contrast, higher Task Autonomy is expected if existing processes can be improved or new things at work can be tried out independently (2). The possibility to influence one's own workload (3) not only has the potential to increase task variability but may also enable employees to select tasks from a set and thus contribute to the holistic nature of work tasks. If workers are not informed about important decisions (4), their ability to act may be limited, and the holism of tasks may be restricted. Finally, working predominantly under instructions (5) also falls under this dimension because it influences the task content and task variability of employees.

Method Autonomy

The need to recognize and close one's own knowledge gaps (1) is interpreted as promoting job autonomy, as it contributes to the development of competence and thus enables the use of new methods, procedures, or tools for carrying out work. On the contrary, if individual instructions are given as to how a task is to be carried out in detail (2), a reduction in

job autonomy is assumed in the methodical sense as the decision-making competence of performing tasks is minimized. If, however, it is necessary to constantly work on and think about new tasks (3), it is associated not only with the development of competence but also with the possibility of working on these new tasks with a free choice of methods.

Criteria Autonomy

This dimension is linked to setting one's own work goals and taking responsibility for them. Accordingly, the specification of exact quantities, results, or time targets (1) reduces job autonomy, according to this understanding. In contrast, frequently being forced to the limits of performance (2) has a more indirect effect on reducing job autonomy. What is intended is that the limits of performance capacity are more likely to be reached when work goals are determined by supervisors, i.e., cannot be set by oneself. Working under pressure to meet deadlines (3) is likewise evaluated in this context. This item assumes that work pressure and deadlines, whether directly or indirectly imposed, have the effect of reducing job autonomy.

Scheduling Autonomy

If this dimension is about being able to freely organize working time and work content, then being interrupted in one's work, whether for example by colleagues or by technical malfunction (1), is at odds with this form of job autonomy. Similarly, the need to monitor several work processes simultaneously (2), in the sense of intensified work, is regarded as reducing job autonomy. The formulation of the question makes it a compulsion and not a degree of freedom ("required to"). The possibility of planning and scheduling one's own work independently (3) has a clearly beneficial effect on dimensions. The same applies to the scheduling of breaks, which is decided by the employees themselves (4).

Working Time Autonomy

This dimension can only be mapped indirectly with the given items. The strongest item is the question of how often private interests can be considered when planning work (1). The remaining items reflect the extent to which deviations from traditional working hours in the form of evening and night work (2), work on call (3), or weekend work (4, 5) are present. All of them are linked to unhealthy, intense, and burdensome work. Work on call reflects the unplannability of work schedules as an element of heteronomous work. Saturday and Sunday work are included separately in the

analysis, as Saturday, in contrast to Sunday, is considered a regular working day under the Working Time Act, despite its weekend status. Thus, structural peculiarities regarding Working Time Autonomy are captured. It has been proven that these forms of temporally atypical work have a stressful effect on employees, so a negative effect on job autonomy is assumed.

Locational Autonomy

This dimension can only be mapped in relation to the possibility and frequency of working from home (1). Both items are associated with an autonomy-promoting effect on employees. The more frequently employees work from home, the more positive the effect on job autonomy. In addition, and due to a lack of other data, the potential possibility and perception of employees working from home (2) are included in the calculation of the Autonomy Index. With this dimension, however, it must be clearly pointed out that interpretations must be made with the greatest caution.

Interactional Autonomy

This dimension describes the dependency on other people at work, be they service recipients, colleagues, or superiors. Since the need to take responsibility for others (1) interferes with one's own work sphere, it is rated as reducing job autonomy. Finally, there tends to be little influence that can be exerted on the behavior or work performance of other people. Convincing others and negotiating compromises (2) also fits into this logic as an interactional demand. There is a dependence on third parties that cannot be influenced entirely by the employees themselves. In contrast, support at work from colleagues (3) or superiors (4) is regarded as conducive to job autonomy. A decisive role is played by the fact that these persons, in their supportive role, may help with work demand, be it with the gathering of information or in the actual performance of work tasks.

7.3. Calculation, sample, and variable description

In addition to the targeted selection of suitable items for the content mapping of job autonomy, the calculation of the values for the overall index and autonomy dimensions, as well as the sample and variables, is described below.

The Autonomy Index and the individual dimensions are presented on a scale from 0 to 100. To achieve this, adjustments are necessary

regarding the direction as well as the length of the response spectrum of the selected items. The correction of the direction refers to a recoding of the response spectrum of all items that would enter the index negatively, according to the above explanations. Example: The first item in the dimension Task Autonomy is *How often does it happen in your work that one and the same work process is repeated down to the last detail?*. The answer spectrum includes the possibilities frequently (F411_03=1), sometimes (=2), rarely (=3), never (=4), and not stated (=9). The recoding is frequently (=0), sometimes (=1), rarely (=3), never (=4), and not stated (=missing value). This item thus contributes positively to the Autonomy Index, provided that a work process is repeated as rarely as possible, down to the last detail. The breakdown of the recoding can is presented in Table 18 and Table 19 | Appendix.

The problem of different *lengths* of the response spectra (e.g., four vs. five response scales) is overcome by means of z-transformation, i.e., the data are standardized to establish comparability (also z-standardization). The conversion of these z-scores into the cumulative standard normal distribution leads to the representation of the data spectrum from 0 to 1. To increase reader friendliness, the values are multiplied by 100, i.e., transformed linearly.

The calculation of the index values for dimensions and the total index follows the logic of classical sum indices, i.e., the average index score across all selected items for a dimension forms the dimension score:

$$Autonomy\,Dimension = \frac{100}{n}\sum_{i=1}^{n} Item\,score_i$$

$$n - No.\ of\ items\ in\ dimension$$

All items are *weighted equally* in the calculation of the index value of a dimension. In order to obtain findings that are as representative as possible, the *product of design weight and drop-out weight* is taken into account (Gensicke & Tschersich, 2018, pp. 34–43; Rohrbach-Schmidt & Hall, 2013, p. 18, 2020, pp. 26–27). The purpose is to consider the selection probabilities of households and respondents caused by the sample design (design weight) as well as the selective failures due to refusals (drop-out weight) in the calculations. In particular, socio-economic characteristics are taken into account in the weighting approach (e.g., employment, occupational status, federal state, education, gender, marital status). Orientation is provided by the distribution of the population, according to Mikrozensus 2017 and 2011. Finally, the Autonomy Index is calculated as a simple average of the individual dimensions:

$$Autonomy\ Index = \frac{1}{m}\sum_{j=1}^{m} Autonomy\ Dimension_j$$
$$m - No.\ of\ dimensions$$

The test for reliability and internal consistency of the Autonomy Index, including all 26 items, is satisfactory with a Cronbach's alpha of 0.69.

This procedure is repeated for the 2012 wave of the BIBB/BAuA-ETB. However, there is a particularity in the comparison of the 2012 and 2018 observation years: Although both surveys are largely harmonized, there are some differences in the wording of individual items or their range of responses. However, these differences have only a minor impact on the comparison of the index values of 2012 and 2018. A problem arises from the inclusion of added items in the 2018 questionnaire or their absence in the 2012 survey. This applies primarily to items dealing with the locality or mobility of employees, i.e., the dimension of Locational Autonomy. The items assigned from the 2018 dataset are completely missing from the previous dataset, so the Locational Autonomy dimension is not calculated for 2012. As a result, an Autonomy Index that differs from the method presented is provided within Chap. 8.4. Instead of the originally defined seven autonomy dimensions, this index contains only the six calculated comparative values. Thus, a distinction is made between the two values *Autonomy Index* and *Autonomy Index w/o Locational Autonomy*.

The following sample and variable descriptions are preceded by several steps of data cleaning. In an initial step, the data is reduced by all respondents who are not in dependent employment, i.e., blue-collar workers, white-collar workers, or civil servants. Thus, self-employed persons[46] were excluded from the analysis. Likewise, all respondents not working in the service sector are excluded from the analysis. According to the Federal Statistical Office (Destatis, n.d.), the service sector comprises sections G to S according to WZ 2008 (Table 14 | Appendix). Following the data reduction, the datasets used for analysis include a total of 11.738 and 10.896 observations for the years 2018 and 2012, respectively (Table 20 | Appendix).

46 The employment status is mapped in the data set via the variable *position in occupation* (Stib). The following characteristics are excluded from the analysis: self-employed persons (Selbstständige/r), freelance workers (Freiberuflich tätig), freelancers (Freier Mitarbeiter/Freie Mitarbeiterin), contributing family members (Mithelfende/r Familienangehörige/r), and missing answers.

In line with the representative character of the BIBB/BAuA-ETB, the respondents are distributed predominantly among the sectors of human health and social service (Q), education (P), public service (O), and wholesale and retail trade (G) in 2018. This distribution differs only slightly from that in the 2012 survey year. Nevertheless, the case numbers for relatively low-employment branches are quite small. This applies to the real estate (L) and arts, entertainment, and recreation (R) sectors. When interpreting the results at a later stage, it is therefore necessary to focus on the branches that present higher case numbers.

For a more in-depth analysis of job autonomy, generated variables are used to explain the socio-economic and ADM-related characteristics of the respondents. The selected variables are available for both years under review. Table 21 | Appendix gives a brief overview of the selected generated variables, the source variable, the number of observations by year, and the share of each expression. Detailed breakdowns of the generated variables *task type*, *ADM knowledge,* and *changes in work environment* are listed in Table 22, Table 23, and Table 24 | Appendix.

Accordingly, a wide variety of task types are distributed across the respondents, also reflecting the great task-side heterogeneity of the service sector. Several task types could be assigned to one respondent. Accordingly, 30 % of respondents perform management tasks in the form of personnel responsibility. Information-related and people-related tasks are likewise frequent task types. Purely object-related tasks are performed less often.

Furthermore, the present sample mainly comprises people with vocational training or a university degree. In the period under review from 2012 to 2018, the increase in the proportion of workers with a university degree (+11 pp), the decrease in the proportion of employees without a vocational qualification (-2 pp), and those with a vocational qualification (-9 pp) indicate a certain trend toward academization. Gender ratios have remained relatively stable. Just under two-thirds of those represented in the sample are women. The respondents work in roughly equal numbers at large, medium, and small companies[47]. Only a small proportion are employed by micro-enterprises. Most of the employees surveyed work 31 to 40 hours a week. Another 30 % work part-time (10 to 20 hours or 21 to 30 hours). Around one-third of the sample is made up of employees who work particularly long hours, i.e., more than 40 hours a week. More

47 Classification of enterprise sizes according to Eurostat (2016): micro-enterprises (less than 10 employees), small enterprises (10 to 49), medium-sized enterprises (50 to 249), large enterprises (more than 250).

than half of the respondents have been employed by the same employer for more than 10 years. A further 19 % have worked for the same employer for up to 10 years in 2018. This relationship is very welcome in that process-related changes in the company may be perceived over a longer period of time.

Of those respondents who already have ADM knowledge, as an indicator of the potential for dealing with ADM applications, it is predominantly basic knowledge that is indicated. Knowledge-intensive services (KIS)[48], although the ratio has fallen compared with 2012 (-12 pp), account for most respondents, at around three-quarters. In addition, most respondents work in environments that have changed little over the past two years. Around 16 % of respondents work in environments that have undergone considerable changes in many areas in the recent past. This may also be where the users and developers of ADM applications are likely to be. Almost half of all respondents frequently must make difficult decisions, which may be perceived as evidence of particularly intensive and responsibility-loaded work.

For the generated variables *task type*, *ADM knowledge*, and *changes in work environment*, definitional explanations are provided below: The idea of distinguishing between different *task types* originates from research conducted by the BAuA. A distinction is made between leadership and management (Ribbat et al., 2021), information-related (Tegtmeier, 2021), object-related (Terhoeven, 2021), and person-related (Schlicht et al., 2021) tasks to describe the digital transformation of these areas. The definition of the task types used is superficially based on the reports mentioned above but differs from the originals (Table 22 | Appendix): (1) Management describes persons who exercise supervising responsibility. (2) An information-related task describes activities such as handling data and computers, searching for and collecting information, and planning processes or research activities. (3) An object-related task describes the handling of objects in everyday work. This can include the handling/supervision of machines, the transport of goods, or cleaning activities. (4) A person-related task places a person at the center of the activity. A person is the recipient of a service, as in teaching, caring, or hosting. A

48 Knowledge intensity is assigned based on the demand profile of a job and measures whether a job is filled by an above-average proportion of highly qualified employees. The definition includes not only university graduates but also all employees who have completed further training in the form of a technical, master craftsman, or specialized school education. Knowledge-intensive occupations provide information, in particular, on the extent to which the use and provision of scientific and technological knowledge is part of a job (Hall, 2007).

job may, of course, consist of several of these tasks. Accordingly, some respondents are also assigned several task types. The differentiation according to task type ultimately serves the purpose of simplification.

Since the BIBB/BAuA-ETB does not include items related to the specific use of ADM in work environments, the goal of introducing the variable *ADM knowledge* is to approximate the use of ADM systems at work. It is assumed that it is fundamentally possible to use ADM if selected skills and tasks are used at work. These essentially include information gathering, working with computers, knowledge of mathematics and statistics, and the usage of computer application programs. Advanced ADM knowledge is additionally assumed if the computer use goes beyond pure application (Table 23 | Appendix). The approach goes back to Pfeiffer (2020, p. 467), who does not ask which tasks can be replaced by machines, since this depends on much more than pure technical feasibility, but approaches the topic of what potential workers bring to the table for shaping AI and ML in companies – a concept that appears largely applicable to ADM.

Pfeiffer (2020, p. 472) maps these potentials in terms of competencies that are necessary for utilizing these systems and draws on the following selection of items from the BIBB/BAuA-ETB: frequent collection, research, and documentation of information; professional knowledge of mathematics, specialist arithmetic and statistics; professional knowledge of PC application programs; application or use of IT systems that goes beyond pure application. The latter variable determines the extent to which *basic* (application only) or *advanced* knowledge (beyond application) is assumed.

The variable *changes in work environment* describes changes in the direct work environment within two years before the survey. These may include the introduction of new computers, machines, or services, but also organizational changes and new products (Table 24 | Appendix). The assumption is that the use of ADM systems can translate into all these forms of change. *High changes in work environment*, in this sense, describe changes at (almost) all these levels. *Low* is more likely to be interpreted as a marginal change in the immediate working environment. This variable thus serves as an approximation of the degree of change in the immediate work environment that may be associated with technological innovation, e.g., the use of ADM systems.

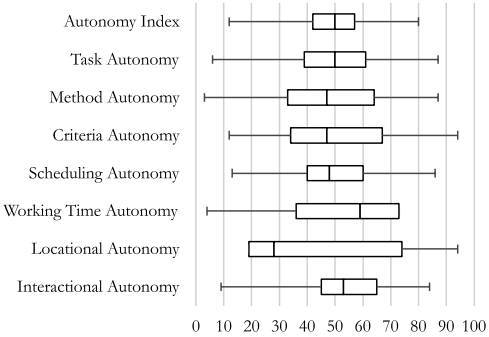
8. Results: Autonomy Index

The analysis of the Autonomy Index begins with a first overview of the sum index for the entire service sector and, at the same time, serves as an interpretation aid and reading example for the following analyses: Figure 4 initially shows the box plot results for the Autonomy Index on a scale of 0 to 100. Boxplots generally provide information about the distribution and statistical variability of data. The end of the lower whisker shows the minimum value of the underlying sample (N=11.738). Correspondingly, the upper whisker shows the maximum value. Within the box are the middle 50 % of the data. The boundaries of the box show the upper and lower quartiles. The median is usually displayed within the box as a continuous line, separating the entire chart into the lower and upper 50 % of the data.

The supplementary data table lists the mean (M) and the standard deviation (SD). Unless otherwise explained, the following considerations refer primarily to the mean value. However, it is worth taking a closer look at the median and the further distribution to statistically assess the quality of this mean value. For example, the mean value of the overall index is 49. However, the median of 50 and the position of the box indicate that there are some outliers in the lower field. Detailed summary statistics are provided in Table 25 | Appendix.

The average index value of 49 fundamentally suggests that employees are well below the maximum value and experience restrictions in their work at many levels. Even in this highly aggregated presentation, differences between individual dimensions become clear. Method and Locational Autonomy in particular are below average, indicating that many employees experience constraints in the way they perform their tasks and are also tied to a specific place of performance. Working Time Autonomy is the most pronounced dimension. This result reflects the fact that only in certain branches is it necessary to work at weekends, on call, or in shifts – again, this would apply more to low-wage branches or particularly person-related services. Interactional Autonomy makes a positive first impression. Seemingly many employees in the service sector have support at work and can work relatively independently of compromises with others.

Figure 4: Autonomy Index (Total, service sector), 2018



N=11.738	M	*SD*
Autonomy Index	49	*11*
Task Autonomy	50	*16*
Method Autonomy	48	*20*
Criteria Autonomy	50	*23*
Scheduling Autonomy	50	*16*
Working Time Autonomy	52	*20*
Locational Autonomy	42	*30*
Interactional Autonomy	52	*17*

Source: BIBB/BAuA-ETB 2018. Own calculations.

However, the heterogeneity of the service sector at this level allows only superficial interpretations. In addition, the conceptual difficulties of Working Time and Locational Autonomy become clear: In the first case, the top 50 % of workers have stable and similar freedoms regarding working time. The bottom 50 %, by contrast, are spread over a wide range of seemingly quite different degrees of Working Time Autonomy. The opposite is the case for Locational Autonomy. This clear separation of the data situations will apply throughout the analysis.

A differentiated analysis of these aggregated autonomy dimensions is the aim of the following chapters. The question being clarified is for which employees, in which branches, and which tasks, particularly striking autonomy characteristics are apparent. For further interpretation, two method-related aspects are important: On the one hand, not the distance to the maximum value of 100 (or minimum value of 0) of the Autonomy Index should be used as an interpretation reference, but possible deviations from the mean value of the dimension. This shows more clearly, for example, which branches, or socio-economic factors are to be considered in connection with different degrees of autonomy. On the other hand, the composition of the index values for individual dimensions allows for an interpretation of the results within dimensions rather than between dimensions, for example, which branches deviate particularly clearly from the mean value within the dimension Task Autonomy.

Ultimately, the aim of this analysis is to uncover relative proportions or disproportions in the expression of job autonomy according to selected characteristics of employees, associated companies, working conditions, and branches. This approach does not show causal relationships. Based on the theoretical considerations, the following also applies here:

Low levels of autonomy must be questioned just as much as high levels, because even work environments that are conducive to job autonomy can create intensive and stressful work situations.

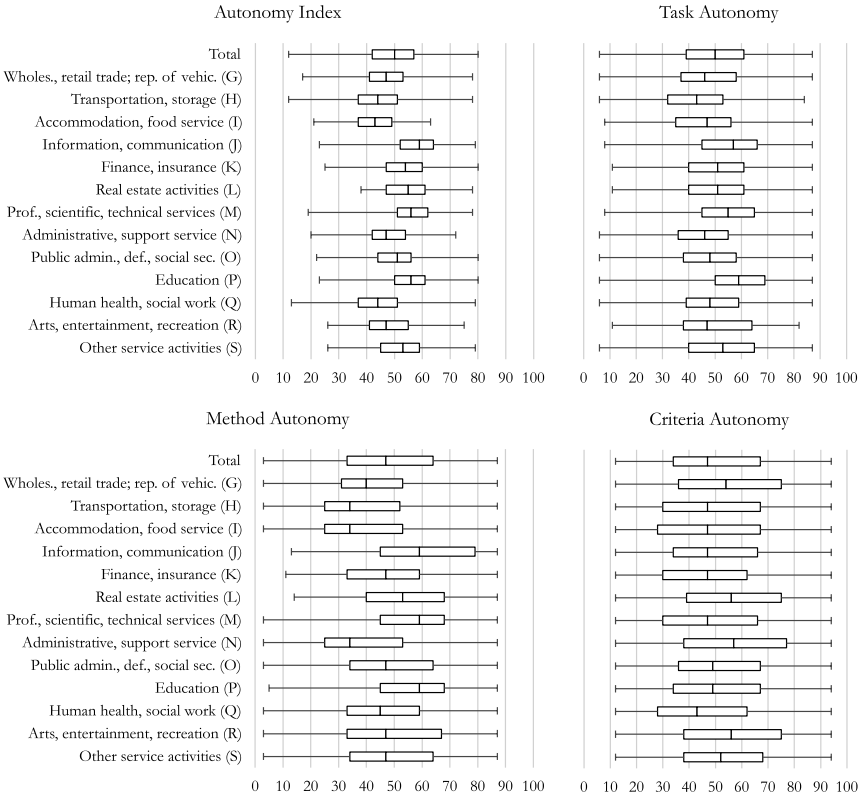
8.1. By service branch and task type

The Autonomy Index aims to quantify the degree of job autonomy in the service sector and thus realize the comparability of branches and other selected variables. The breakdown according to the predefined job autonomy dimensions is intended to show which dimensions are particularly strongly or weakly pronounced: Clearly, the broad heterogeneity of the service sector is reflected in the range of the Autonomy Index by *branch* (Figure 5). The index values confirm the previous assumption of a division into stronger and weaker expressions of job autonomy in certain branches. Information and communication, finance and insurance, real estate, other professional, scientific, and technical services, as well as education, lead the field of high-autonomy branches (also HAS). Trade, logistics, accommodation and food services, or healthcare and social services show negative deviations from the mean in the perceived job autonomy of their employees (also LAS).

Interestingly, however, this division can only be identified in relation to certain autonomy dimensions. As described above, the average index value for job autonomy in the service sector is 49. Differentiation by service branch already reveals clear deviations from this average value in some cases, which suggests that the degree of job autonomy can differ depending on the content and type of task. In turn, the group of branches that employ the most people overall but also have the highest social relevance, often performing direct person-related interaction work, is found to have less perceived job autonomy at work than the few branches with many highly qualified workers that perform less direct interaction work.

Further analysis of the branches according to the individual autonomy dimensions shows that this distinction can only be applied to selected autonomy dimensions: These include Task and Method Autonomy. This implies that the distinction between LAS and HAS is transferred in particular to the freer choice and arrangement of work tasks, a higher level of information, task variability, and influence on the amount of work in the latter group. In contrast, many employees working in LAS tend to work in prescribed work settings, have less job autonomy in their work tasks, and may have to perform more monotonous work. However, when examining Task and Method Autonomy it becomes clear that some

Figure 5: Autonomy Index by service branch (1/2), 2018



branch differences seem to be converging. For example, finance and insurance no longer stand out among the supposedly more autonomous branches, whereas healthcare and social services are more in line with the entire service sector. For these examples, autonomy-establishing or restricting factors must therefore lie elsewhere.

Branch groupings are also less clear-cut in relation to other job autonomy dimensions. For example, the Criteria Autonomy dimension is less pronounced across branches. This suggests that the entire service sector is subject to economic performance and control principles. Pressure to perform at work is considered high, and there are supposedly precise targets for the performance of work. Many employees must go to the limits of their performance to achieve them. These findings also

Figure 5 (continuing)

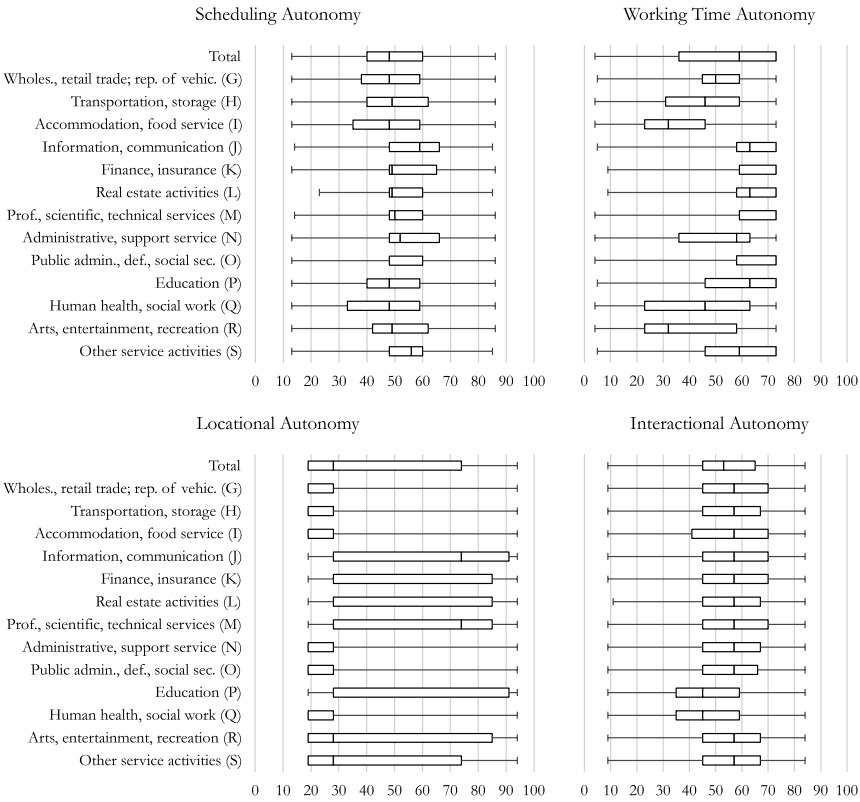
		Autonomy Index		Task Autonomy		Method Autonomy		Criteria Autonomy	
	N	M	*SD*	M	*SD*	M	*SD*	M	*SD*
Total	11.738	49	*11*	50	*16*	48	*20*	50	*23*
Branch									
Wholes., retail trade, rep. of vehic. (G)	1.242	47	*9*	46	*15*	42	*19*	53	*24*
Transportation, storage (H)	785	44	*10*	42	*15*	39	*19*	48	*24*
Accommodation, food service (I)	323	43	*8*	47	*15*	40	*17*	48	*24*
Information, communication (J)	746	58	*9*	55	*15*	60	*20*	49	*21*
Finance, insurance (K)	647	54	*9*	50	*15*	49	*18*	49	*21*
Real estate activities (L)	113	54	*9*	51	*14*	54	*18*	55	*23*
Prof., scientific, technical services (M)	800	56	*8*	54	*15*	58	*19*	49	*21*
Administrative, support service (N)	444	48	*9*	46	*15*	40	*20*	56	*25*
Public admin., def., social sec. (O)	1.714	50	*9*	48	*14*	50	*19*	52	*21*
Education (P)	1.809	56	*8*	59	*14*	58	*18*	50	*21*
Human health, social work (Q)	2.583	45	*10*	49	*15*	47	*19*	45	*23*
Arts, entertainment, recreation (R)	181	49	*10*	50	*16*	49	*20*	55	*23*
Other service activities (S)	351	52	*9*	52	*16*	49	*20*	53	*22*

Source: BIBB/BAuA-ETB 2018. Own calculations.

speak for a high degree of control over work, which has become established across the board in services, irrespective of the content and type of task. However, it is reasonable to assume that the economization and control mechanisms differ from branch to branch. What is noticeable overall regarding Criteria Autonomy is that supposedly autonomy-strong branches underperform, and the trade sector, for example, stands out positively. This may be due to the great heterogeneity within the sector, which covers large and complex corporate structures as well as the smallest economic units. Furthermore, while human health and social services still showed stronger autonomy tendencies in Task and Method Autonomy, the branch comparatively sags in Criteria Autonomy, which again speaks for strong economization tendencies that affect healthcare and social workers.

Regarding Scheduling Autonomy as a proxy for the intensity of work, which reflects the extent to which one's own work can be planned and is characterized by interruptions, the distinctions between autonomy-restricted and autonomy-enhanced branches are again apparent. However, it is less clear-cut (Figure 6). Apparently, work is perceived as very

Figure 6: Autonomy Index by service branch (2/2), 2018



intensive across branch boundaries. It is striking that particularly person-related services show a low level of Scheduling Autonomy, i.e., are particularly burdened in this sense. The possibility to plan one's own work independently and free of interruptions is more feasible, especially in the information and business-related branches. Again, these are the branches with a higher average level of qualification, wages, and overall better quality of work.

The most pronounced branch differences refer to the dimensions Working Time und Locational Autonomy. This is due to the different structuring of work and the degree of direct interaction work. Less Locational and Working Time Autonomy are particularly relevant for those branches that provide person-related services. In the case of Working

Figure 6 (continuing)

		Scheduling Autonomy		Working Time Autonomy		Locational Autonomy		Interactional Autonomy	
Total	11.738	50	*16*	52	*20*	42	*30*	52	*17*
Branch									
Wholes., retail trade, rep. of vehic. (G)	1.242	48	*16*	51	*15*	32	*23*	56	*17*
Transportation, storage (H)	785	51	*17*	43	*20*	32	*24*	55	*17*
Accommodation, food service (I)	323	47	*15*	35	*18*	29	*22*	54	*20*
Information, communication (J)	746	56	*13*	62	*15*	67	*27*	56	*16*
Finance, insurance (K)	647	54	*13*	66	*10*	51	*29*	56	*16*
Real estate activities (L)	113	54	*13*	63	*13*	49	*29*	54	*17*
Prof., scientific, technical services (M)	800	54	*13*	63	*14*	56	*29*	57	*16*
Administrative, support service (N)	444	55	*15*	51	*18*	31	*23*	56	*16*
Public admin., def., social sec. (O)	1.714	53	*14*	61	*17*	38	*25*	53	*17*
Education (P)	1.809	49	*15*	58	*15*	70	*31*	47	*16*
Human health, social work (Q)	2.583	46	*16*	45	*22*	34	*25*	48	*17*
Arts, entertainment, recreation (R)	181	52	*16*	38	*20*	44	*31*	54	*19*
Other service activities (S)	351	54	*14*	57	*17*	44	*30*	54	*17*

Source: BIBB/BAuA-ETB 2018. Own calculations.

Time Autonomy in particular, there are, by definition, major differences regarding the need for weekend and shift work, as well as on-call duty and the limited ability to plan working hours. The results are unsurprising in this respect, as task content and work requirements can be clearly linked to the results. However, the subsequent comparison of the extent of Working Time Autonomy between 2012 and 2018 (Chap. 8.4) is particularly exciting, as it points to an autonomy-restricting tendency in recent years.

Finally, the dimension of Interactional Autonomy also shows a leveling out across branches. Most rate this form of job autonomy similarly, i.e., the degree of (in-)dependence on colleagues and superiors is rated similarly. This suggests that the basic cooperation of employees, the degree of support, or the need to compromise are independent of the branch. Education as well as healthcare and social services differ considerably. Since both branches are characterized by a high degree of interactional work, it could be assumed that it is also more necessary to frequently take responsibility for others or to make compromises. The complexity of the interaction dependencies between superiors, col-

leagues, and, above all, service recipients imply particularly demanding work and require a lot of coordination.

It is important to keep in mind that high levels of autonomy do not automatically have a positive effect on employees. High levels of Task and Method Autonomy among highly qualified employees are characteristic of the ideal type of the Entreployee who achieves performance through the utilization of subjectivity. Low levels of these dimensions also speak for a standardization and formalization of work that aims to keep the subjective part of work as small as possible. All these aspects should be viewed in close connection with Criteria and Scheduling Autonomy, in that they reflect high performance pressure and intensive work – which, however, is transferred differently to employees in the sense of methodical or task-related scope for action depending on the branch.

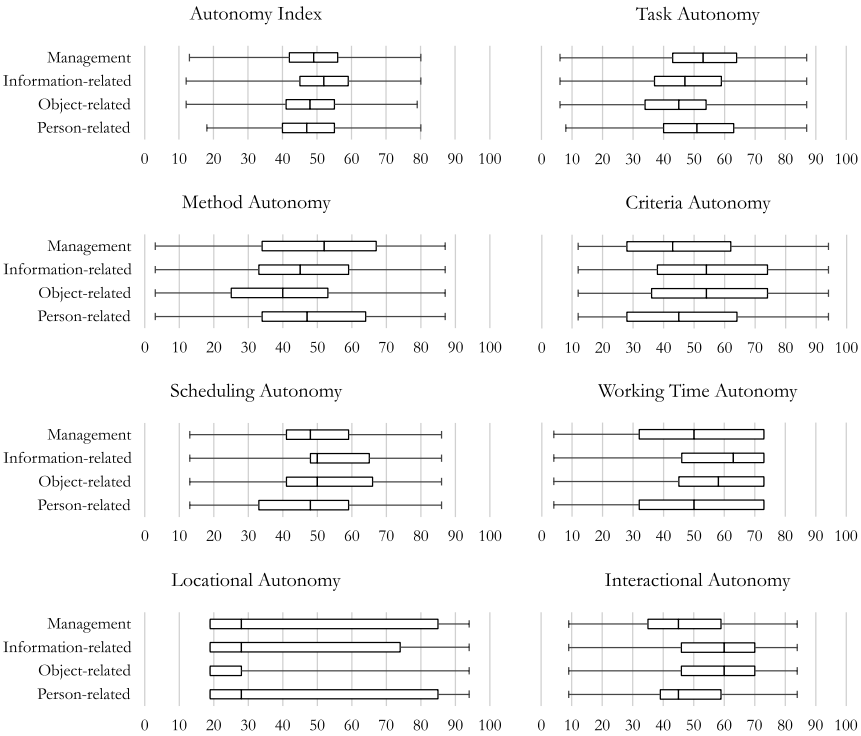
The dimensions of Working Time and Locational Autonomy indicate that only a small group of employees has the opportunity to counter this pressure to perform by means of flexibility in terms of time or place. Most employees have few opportunities to better distribute or even compensate for the pressure to perform. But even the few employees who do have these options are constantly caught between the demands and possibilities of flexibility, i.e., the fine line between setting working hours and locations according to one's own preferences and abilities. Finally, it is also evident that the dependence of one's own work on other people or the support provided at work contributes less to the varying degree of job autonomy overall by branch.

In addition to the branch analysis, the so-called *task types* can provide information about the degree of job autonomy in the service sector without the heterogeneity of a branch classification. Different task types are distinguished as management tasks, information-related tasks, object-related tasks, and person-related tasks. The following profiles can be outlined (Figure 7).

Management: The task type includes all persons with management responsibilities, regardless of the specific service. These employees are characterized by a high degree of task- and method-related autonomy. In most of the other autonomy dimensions, however, their index values are below average. They work under high performance pressure, with targets that are presumably set for them by higher hierarchical levels. It is at the interactional level that differences in autonomy are most evident. This is probably due to the fact that responsibility for other employees is assumed particularly frequently and compromises have to be negotiated.

Information-related: This task type shows the highest degree of job autonomy overall. However, these are mainly expressed in terms of working time and in an interactional sense. The possible influence on target

Figure 7: Autonomy Index by task type, 2018



		Autonomy Index		Task Autonomy		Method Autonomy		Criteria Autonomy		Scheduling Autonomy		Working Time Autonomy		Locational Autonomy		Interactional Autonomy	
	N	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*
Total	11.738	49	*11*	50	*16*	48	*20*	50	*23*	50	*16*	52	*20*	42	*30*	52	*17*
Task type																	
Management	3.493	49	*10*	53	*15*	52	*19*	45	*21*	49	*14*	49	*20*	52	*31*	45	*15*
Information-related	4.491	51	*10*	47	*16*	47	*20*	54	*23*	53	*15*	59	*16*	41	*28*	59	*16*
Object-related	1.905	48	*11*	44	*15*	41	*20*	54	*24*	52	*17*	52	*17*	32	*24*	59	*17*
Person-related	3.345	48	*11*	51	*15*	50	*19*	47	*23*	46	*16*	48	*21*	43	*31*	49	*16*

Source: BIBB/BAuA-ETB 2018. Own calculations.

parameters and corresponding performance pressure is also relatively higher. Less pronounced are task- and method-related degrees of autonomy. It appears obvious that the frequent handling of data entails structural limitations. This result is somewhat surprising, since these tasks are aimed at highly qualified employees, who are supposed to have the highest degree of freedom in this respect. Lower values for Task Autonomy could be due to less influence on the amount of work and frequent repetition of work steps.

Object-related: This refers to services that are performed directly on objects, i.e., not primarily on service recipients. These are often tied to a specific locality. Autonomy levels are lower than average in most dimensions. This is particularly true for task- and method-related autonomy. Less choice, scope for action, and influence on the amount of work, as well as more frequent repetition, could be aspects that have a negative impact. However, there are also employees who work under less intensive working conditions, i.e., they show above-average Scheduling Autonomy. It is striking that Interactional Autonomy is just as high as for information-related tasks. Thus, among task types that deal indirectly with service recipients and perform their work on inanimate objects, the perceived support at work as well as the need to assume responsibility appear to be lower.

Person-related: The Autonomy Index of the task type is below average overall. Pressure to perform and precise targets indicate Criteria Autonomy similar to people with management responsibility. In addition, work is perceived as particularly time-intensive. Direct work on and with service recipients is characterized by a more frequent unplannability of work. Likewise, the necessity of working outside of traditional time frames can occur more often. Furthermore, it is striking that the Interactional Autonomy component lags behind other task types without leadership responsibility. This can be attributed to the fact that compromises are negotiated frequently and responsibility for others must be assumed, which is hardly surprising in an intensive interaction activity. The profile of the person-related task type is characterized by high intensity, but it shows relatively high degrees of freedom in Task and Method Autonomy. The type, content, and design of work thus seem to be determined to a greater extent by these employees themselves.

8.2. By selected socio-economic aspects

In previous chapters of Part I (Chap. 1.5), it has already become clear that individual aspects of job autonomy in the service sector can differ considerably according to educational level and sex. However, structured information on the relationship between these socio-economic factors and job autonomy is rarely available. This gap is closed in the following. The analysis of the Autonomy Index according to the level of *educational attainment* clearly reveals that the perceived job autonomy of employees in the service sector relates positively with the level of education (Figure 8).

On average, employees with a university degree report higher levels of job autonomy than those with vocational training or no formal education. This is particularly true for their Task, Method, Working Time, and Locational Autonomy. The latter two trends are unsurprising given that highly skilled employees are less likely to work in branches and occupations that require them to be tied to a specific location or to work outside traditional working hours. Higher values for Task and Method Autonomy indicate that more freedom is given in the selection and execution of tasks as well as their concrete design. However, the dimensions that deviate from this trend are more revealing. Scheduling Autonomy hardly differs according to educational attainment. The intensity of work is high across the board. For Criteria and Interactional Autonomy, the positive connection between education and job autonomy is even reversed.

On the one hand, this indicates that lower-skilled employees are less likely to work under pressure or with strict work performance requirements. On the other hand, these employees also seem to receive more support in their work from colleagues and superiors and are less dependent overall on compromise and the work of others. At least in these two respects, lower-skilled workers appear to be slightly less challenged and stressed in their jobs in comparison to their higher qualified counterparts – which is an overall surprising and promising result.

Regarding the *sex* of the respondents, only minor differences can be identified. The average Autonomy Index of men is one point higher than that of women. Differences are expressed in higher levels of job autonomy for men in Method, Scheduling, and Locational Autonomy. This means that women are less able to decide how to solve a work task, perceive their work as more intensive, and are less mobile at work. Overall, this may be related to the fact that women work more often in person-related services. In contrast, women appear to be less likely to work outside of traditional working hours or to work on call, giving

Figure 8: Autonomy Index by selected socio-economic aspects, 2018

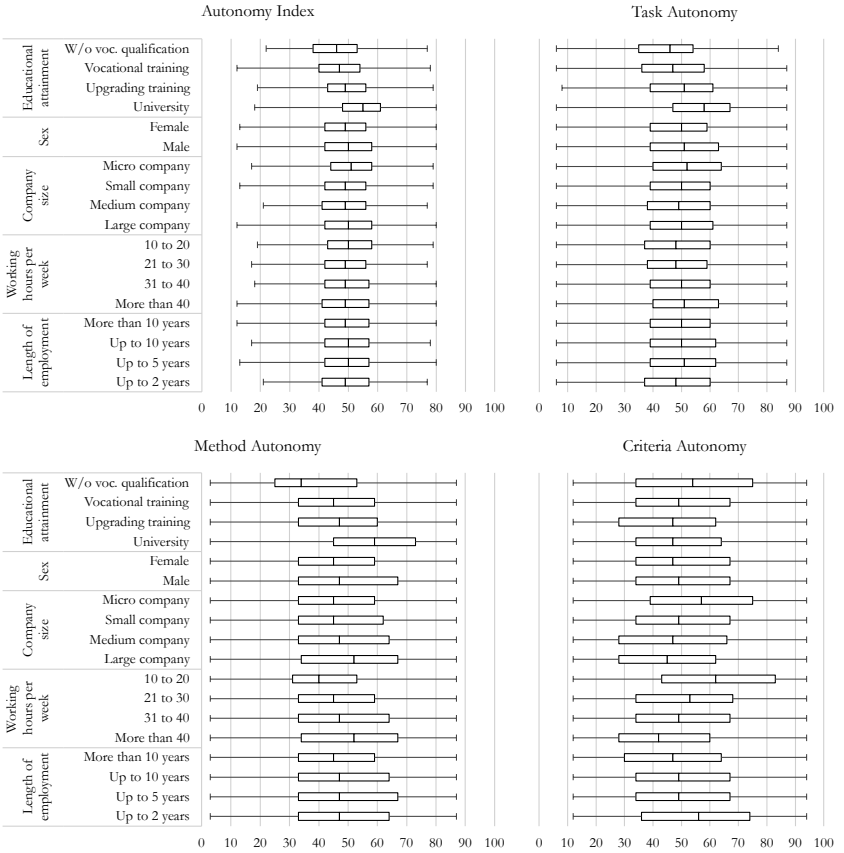


Figure 8 (continuing)

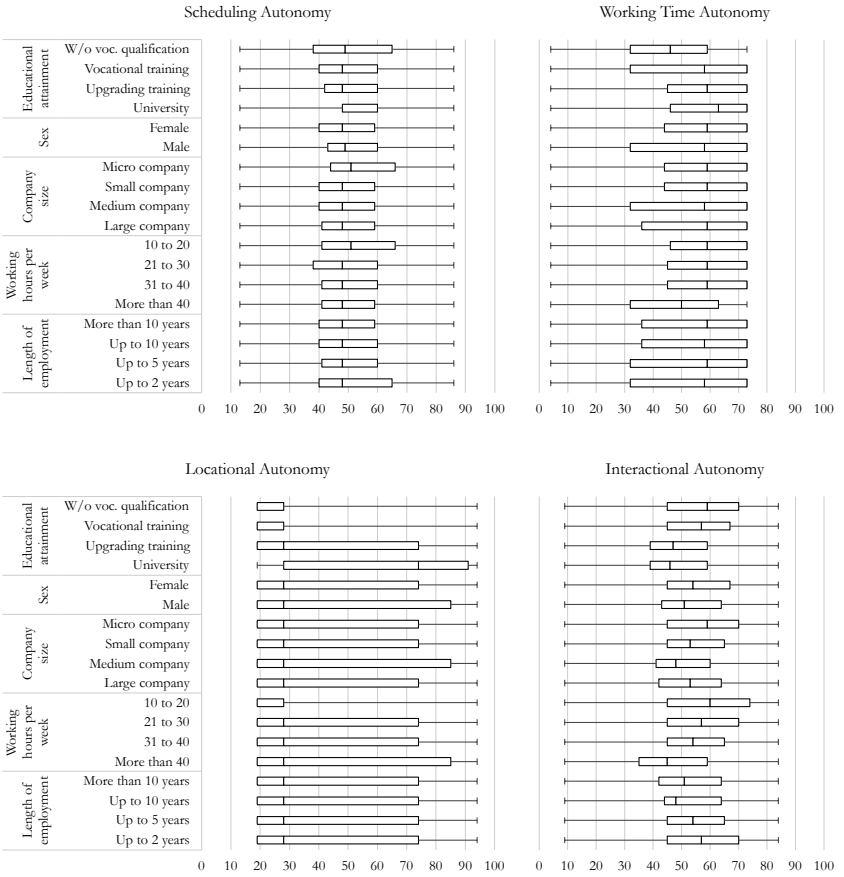


Figure 8 (continuing)

		Autonomy Index		Task Autonomy		Method Autonomy		Criteria Autonomy		Scheduling Autonomy		Working Time Autonomy		Locational Autonomy		Interactional Autonomy	
	N	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*
Total	11.738	49	*11*	50	*16*	48	*20*	50	*23*	50	*16*	52	*20*	42	*30*	52	*17*
Educational attainment																	
W/o voc. qualif.	607	46	*11*	45	*15*	39	*19*	54	*26*	50	*17*	46	*20*	31	*22*	57	*19*
Vocational training	5.594	47	*10*	47	*15*	44	*19*	50	*23*	49	*16*	51	*20*	34	*25*	54	*17*
Upgrading training	727	49	*10*	50	*15*	48	*19*	47	*23*	51	*14*	54	*19*	44	*29*	49	*16*
University	4.788	55	*10*	56	*15*	58	*19*	48	*21*	52	*14*	57	*18*	61	*31*	50	*16*
Sex																	
Female	7.164	49	*10*	49	*15*	47	*19*	50	*23*	49	*16*	54	*19*	41	*29*	53	*17*
Male	4.574	50	*11*	50	*16*	50	*21*	50	*22*	52	*15*	50	*20*	45	*31*	52	*17*
Company size																	
Micro company	1.331	51	*10*	52	*15*	45	*19*	56	*23*	53	*16*	53	*19*	40	*29*	57	*18*
Small company	3.209	49	*10*	50	*15*	48	*19*	50	*23*	49	*16*	53	*19*	40	*29*	52	*17*
Medium company	3.268	49	*10*	49	*16*	48	*20*	48	*23*	50	*15*	51	*20*	45	*31*	51	*17*
Large company	3.648	50	*11*	50	*16*	51	*21*	47	*22*	50	*15*	54	*20*	45	*29*	52	*17*
Working hours per week																	
10 to 20	1.424	51	*11*	48	*16*	42	*19*	60	*23*	53	*17*	55	*18*	37	*27*	59	*17*
21 to 30	1.971	49	*10*	49	*15*	46	*20*	52	*24*	49	*17*	55	*18*	39	*28*	54	*17*
31 to 40	4.597	49	*10*	50	*15*	48	*20*	50	*22*	50	*15*	55	*19*	41	*28*	53	*17*
More than 40	3.746	49	*11*	51	*16*	52	*20*	44	*21*	50	*15*	47	*20*	49	*32*	48	*17*
Length of employment																	
More than 10 years	6.366	49	*10*	50	*15*	48	*19*	48	*22*	50	*15*	54	*19*	44	*30*	52	*17*
Up to 10 years	2.175	49	*11*	50	*16*	49	*20*	49	*23*	50	*16*	52	*20*	43	*30*	52	*17*
Up to 5 years	1.931	50	*11*	50	*16*	49	*21*	51	*23*	51	*15*	52	*20*	42	*29*	53	*17*
Up to 2 years	1.221	50	*11*	49	*16*	49	*21*	54	*24*	51	*16*	51	*20*	39	*28*	55	*18*

Source: BIBB/BAuA-ETB 2018. Own calculations.

them more Working Time Autonomy. This trend may be driven by the high proportion of women in branches that are supportive of job autonomy in this respect, such as education or public administration, but also by the fact that women are restricted in relation to working atypical hours because of their involvement in care work.

For the analysis of some job-related aspects regarding the autonomy of workers, company size, working hours per week, and length of employment with the company are selected. The aim of this is to discuss the extent to which organizational structures of varying complexity influence individual job autonomy and the extent to which part-time work, as an essential element of the service sector, is related to changes in job autonomy. Finally, it remains to be clarified to what extent company affiliation (also as a proxy for age) and corresponding experiential knowledge can be related to job autonomy.

The *size of the company* is only minimally related to the extent of job autonomy. Two poles could be roughly sketched: micro companies, which are assumed to be less characterized by rigid structures, show higher autonomy values for Criteria Autonomy, i.e., performance pressure and target agreements. This tendency is also reflected in higher Scheduling Autonomy. Interactional Autonomy is also more pronounced in micro-companies. This could indicate that these employees are less influenced by others in their work but also receive more support. In contrast, job autonomy is higher at large companies in the areas of Working Time and Locational – this is less surprising, as it can be assumed that large companies also have company agreements on these topics and time recording is more widespread. Similarly, employees in large companies have more Method Autonomy. From a purely organizational point of view, this tendency could be explained by the fact that, with many employees, it is hardly possible to give everyone precise instructions on their work steps. Accordingly, Method Autonomy increases overall with the size of the company.

Regarding *weekly working hours*, meaningful differences emerge. The overall index initially moves in favor of fewer weekly working hours. The values of the individual autonomy dimensions again follow the pattern of smaller companies in the company size panel. This means that the lower the weekly working hours, the more pronounced the dimensions of Criteria, Scheduling, and Interactional Autonomy. This suggests, rather counterintuitively, that employees who work fewer hours also face less pressure to perform and receive more support at work. Counterintuitive implies that it would stand to reason that people with fewer hours would feel particularly rushed and would be more likely to be bound by precise target agreements to get their work done. Furthermore, there appears

to be a minor difference in autonomy between the groups of employees who work 21 to 30 or 31 to 40 hours per week. It is the group that goes beyond the classic 40-hour week and enjoys methodical and task-related freedoms but loses job autonomy in all other dimensions.

Finally, the analysis of the *length of employment* in the company reveals that individual autonomy dimensions hardly differ. A connection between job autonomy and length of employment can only be isolated at a few points. Criteria Autonomy, i.e., the perception of pressure to perform and the setting of personal goals, appears to be more pronounced with the increasing duration of employment in the respective company. Support at work and dependence on others also tend to move toward more autonomy – possibly also due to a more pronounced internal network at the workplace. Employees who have been with the same employer for many years also seem to become more immobile. However, mobility may also be more a question of age than of affiliation.

8.3. By selected ADM aspects

As already described, the use or possible influence of ADM systems can only be outlined with the BIBB/BAuA-ETB. For this purpose, the skills of employees relevant for the use of ADM following Pfeiffer (2020), knowledge intensity of tasks, changes of an organizational and technical nature in the direct work environment, and the need to make difficult decisions are used as a proxy for describing the possible influence of ADM systems on various autonomy dimensions.

The level of the Autonomy Index according to *ADM knowledge* can indicate the differences that would arise in the actual use of ADM systems. Pfeiffer (2020, p. 473) distinguishes between basic and advanced knowledge. The latter refers not only to statistical and mathematical knowledge and the need to analyze data, but also to whether computers are used only as users or beyond. In line with this division, Pfeiffer (2020, p. 473) calculates that around 4 % of all employees in Germany already have specialist knowledge and 11 % have basic knowledge of the use of ADM applications. It goes without saying that this approach can only approximate actual knowledge when dealing with ADM systems. As expected, the Autonomy Index clearly differs from the average for the total service sector (Figure 9).

With increasing ADM knowledge, job autonomy generally increases. In particular, the values for advanced ADM knowledge exceed the average values for all employees, in some cases strongly – for example, regarding Task and Method Autonomy, but also in the location- and time-

Figure 9: Autonomy Index by ADM aspects, 2018

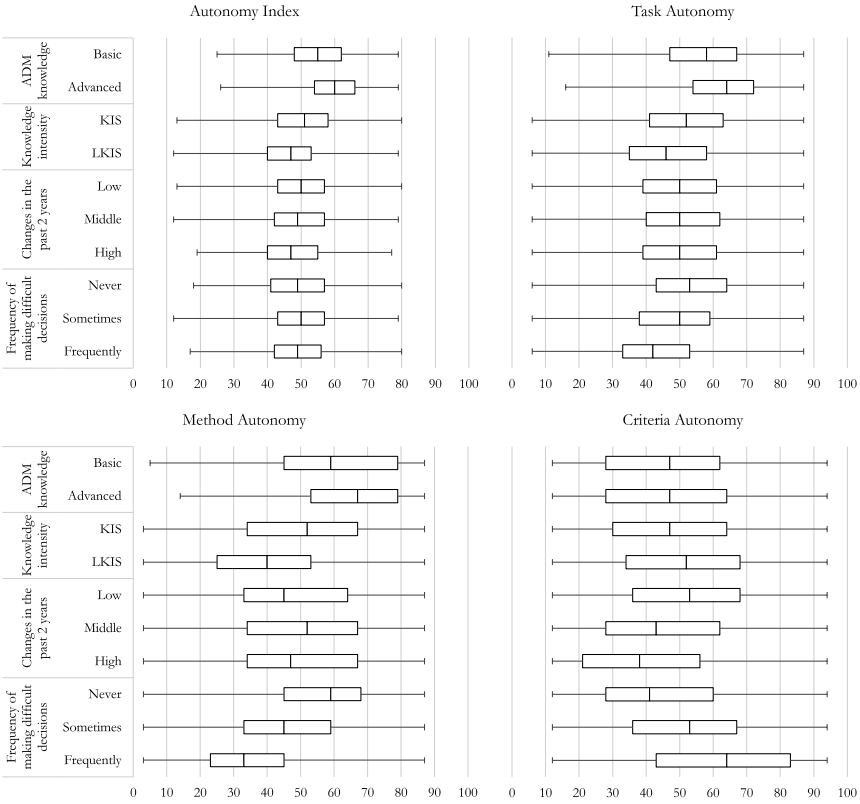


Figure 9 (continuing)

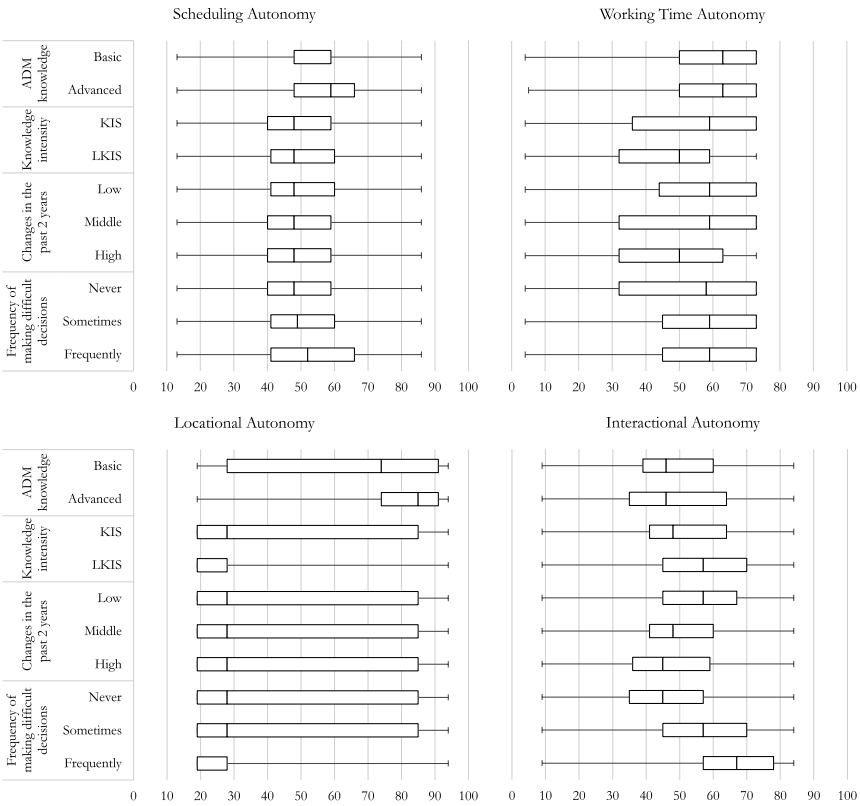


Figure 9 (continuing)

		Autonomy Index		Task Autonomy		Method Autonomy		Criteria Autonomy		Scheduling Autonomy		Working Time Autonomy		Locational Autonomy		Interactional Autonomy	
	N	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*
Total	11.738	49	*11*	50	*16*	48	*20*	50	*23*	50	*16*	52	*20*	42	*30*	52	*17*
ADM knowledge																	
Basic	1.430	55	*10*	57	*15*	59	*19*	46	*21*	52	*13*	58	*18*	62	*30*	50	*17*
Advanced	381	59	*9*	62	*13*	66	*18*	48	*21*	56	*13*	59	*16*	73	*26*	49	*18*
Knowledge intensity																	
KIS	8.643	51	*11*	52	*15*	52	*20*	49	*22*	50	*15*	54	*20*	47	*31*	51	*17*
LKIS	3.095	47	*10*	46	*15*	42	*19*	52	*24*	50	*16*	49	*18*	33	*24*	55	*17*
Changes in the last 2 years																	
Low	7.592	50	*10*	50	*16*	48	*20*	53	*23*	51	*16*	54	*19*	47	*31*	54	*17*
Middle	1.845	49	*11*	50	*16*	51	*20*	46	*21*	49	*15*	51	*20*	51	*31*	50	*17*
High	1.802	47	*11*	50	*15*	51	*20*	41	*21*	48	*15*	49	*20*	49	*31*	49	*16*
Frequency of making difficult decisions																	
Never	5.385	49	*11*	53	*15*	56	*19*	43	*21*	48	*14*	50	*21*	53	*32*	45	*16*
Sometimes	4.999	50	*10*	49	*15*	45	*19*	52	*22*	52	*16*	55	*18*	45	*30*	55	*16*
Frequently	1.350	49	*11*	43	*16*	35	*19*	61	*24*	53	*18*	54	*19*	33	*23*	66	*16*

Source: BIBB/BAuA-ETB 2018. Own calculations.

related dimensions. The difference regarding Scheduling Autonomy is much smaller. Overall, employees with these skills still seem to have only a mediocre influence on the scheduling of their work (as well as breaks/interruptions). The tendency for job autonomy to be less pronounced in the criterion-related and interaction-related dimensions is particularly exciting. The perceived pressure to perform seems to increase with growing ADM skills. The previous results indicate that this is particularly true of highly qualified employees, possibly with management responsibility, who work many hours. In terms of Interactional Autonomy, this could go hand in hand with a more frequent need to take responsibility for others or to negotiate compromises. The extent to which there is also less support at work from colleagues or superiors remains questionable for the time being. This component of Interactional Autonomy is thus increasingly isolated as a question for subsequent qualitative analyses.

The analysis of *knowledge intensity* initially fits seamlessly into previous observations. KIS describe in particular those occupations that make a special contribution to the production, dissemination, and application of scientific and technological knowledge and thus stand as an indicator of innovative work performance. They may also be the employees that are currently more likely to be involved in ADM applications from a developer perspective. KIS have higher job autonomy levels in terms of Task and Method as well as Working Time and Locational Autonomy. The design, procedure, time, and place of work execution are more in the hands of the employees. In turn, employees in LKIS are less bound by target agreements, less under pressure to perform, and have more freedom in an interactional sense. According to the present calculation, the time intensity of work performance is roughly the same for both groups. Nevertheless, there is a clear division of services into two groups regarding their degree of job autonomy.

The variable of *changes in work environment* provides information on the extent to which autonomy dimensions differ according to the degree of change in the direct work environment over the past two years. This includes organizational, technical, or product-related changes, for example, the introduction of new ADM systems. By far the largest group of employees has experienced only a few changes in this respect over the past two years. Across all dimensions, the degree of change also tends to decrease job autonomy. This may be related to the fact that the implementation of technical or non-technical changes initially takes some time until they can be integrated into existing processes without errors, until employees have become familiar with them and have developed an understanding of the changes.

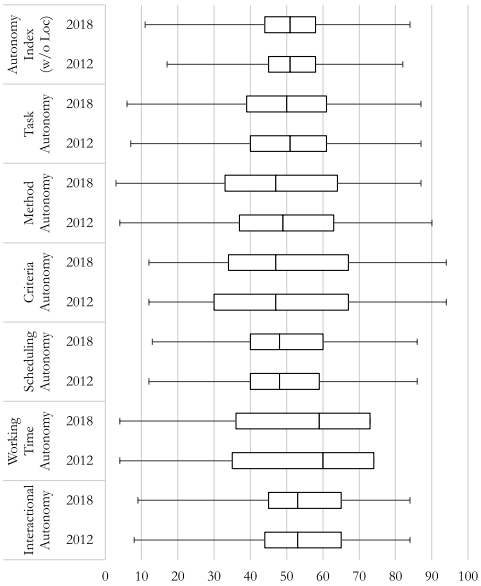
In any case, a frequent aim of such changes to the working environment is to rationalize, which can have the effect of restricting autonomy. Employees who have experienced many changes in their immediate work environment tend to report higher levels of Method Autonomy. However, overall job autonomy is lower in almost all other dimensions. These relatively inconsistent results compared to other levels of analysis can probably be explained by a high degree of discontinuity within strong change processes, which is also reflected in limited degrees of freedom at work.

The *frequency of making difficult decisions* is embedded in this analytical logic in that it can be viewed as a proxy for the degree of intervention by ADM systems at work. ADM systems replace, support, or prepare human decision-making. Thus, if difficult decisions are made frequently, the potential for using ADM systems would also increase. However, the aim of this analysis is not to determine how the use of ADM systems changes job autonomy but rather to isolate which autonomy dimensions are particularly pronounced in employees who frequently make difficult decisions and thus to find out which autonomy profile such an application corresponds to. Employees with decision-heavy tasks therefore have a particularly high degree of task- and method-related autonomy. They are also the employees who tend to work in more intensive environments from a working time perspective and sometimes work under strong target demands. Interactional Autonomy is again clearly below average for people who frequently make difficult decisions. Thus, there appears to be less support at work and more dependence on other people. This analysis can ultimately be used to classify later qualitative findings when it comes to evaluating the actual degree of intervention of ADM systems in employees' work processes.

8.4. Changes between 2012 and 2018

The comparison of the two survey waves from 2012 and 2018 of the BIBB/BAuA-ETB aims at tracing the changes in the individual job autonomy dimensions according to the already-known analysis levels. It is important to note a methodical limitation here: The Locational Autonomy dimension cannot be mapped with the 2012 data set. For the comparison between 2018 and 2012 to be successful, this dimension must therefore be omitted, and a new overall value calculated for the Autonomy Index. As expected, this is higher on average than when Locational Autonomy was included (Figure 10), which was quite low in the 2018 dataset (Figure 4). The remaining dimensions correspond to the previously calculated values for 2018. Detailed summary statistics are provided in Table 26 | Appendix.

Figure 10: Autonomy Index w/o Loc (Total, service sector), 2018 and 2012



N=11.738 (2018) N=10.896 (2012)	Year	M	*SD*
Autonomy Index (w/o Loc)	2018	51	*10*
	2012	51	*9*
Task Autonomy	2018	50	*16*
	2012	51	*15*
Method Autonomy	2018	48	*20*
	2012	50	*19*
Criteria Autonomy	2018	50	*23*
	2012	50	*22*
Scheduling Autonomy	2018	50	*16*
	2012	51	*15*
Working Time Autonomy	2018	52	*20*
	2012	53	*18*
Interactional Autonomy	2018	52	*17*
	2012	52	*17*

Source: BIBB/BAuA-ETB 2018 and 2012. Own calculations.

The aggregated comparison of the six dimensions and the new Autonomy Index (w/o Locational Autonomy) reveals that the overall values for the service sector have hardly changed between 2012 and 2018. The overall index remained at an index level of 51. However, the findings do not necessarily mean that there were no changes at the branch, task, or individual level during the observation period, but may be due to the aggregation level of this analysis.

Minimal changes are visible regarding the dimensions Task (-1), Method (-2), Scheduling (-1), and Working Time Autonomy (-1). This development provides indications of the increasing compression and intensification of work, which are expressed in lower degrees of time-related job autonomy. The results are particularly interesting regarding reduced Method Autonomy.

To describe the change in job autonomy from 2012 to 2018 in more detail, the percentage change of the index values is broken down in the form of heat maps. The changes in the Autonomy Index and the associated dimensions reveal several key branches and dimensions that are

Table 7: Changes in Autonomy Index by branch, task type, 2012–2018

	Autonomy Index (w/o Loc)	Task Autonomy	Method Autonomy	Criteria Autonomy	Scheduling Autonomy	Working Time Autonomy	Interactional Autonomy
Total, service sector	–1,1 %	–2,0 %	–2,9 %	0,5 %	–0,7 %	–1,6 %	0,4 %
Branch							
Wholes., retail trade, rep. of vehic. (G)	–3,1 %	–2,1 %	–4,4 %	–2,2 %	–2,8 %	–5,1 %	–2,0 %
Transportation, storage (H)	–1,2 %	–1,7 %	–8,9 % *	8,6 % *	–1,3 %	–5,2 %	0,7 %
Accommodation, food service (I)	–6,4 % *	–7,3 % *	–7,2 %	–3,9 %	–4,0 %	–10,9 % *	–6,2 %
Information, communication (J)	4,3 % *	0,9 %	3,5 % *	6,1 %	5,7 % *	7,4 % *	2,7 %
Finance, insurance (K)	0,6 %	–2,6 %	–3,0 %	4,5 %	1,1 %	0,9 %	2,7 %
Real estate activities (L)	3,1 %	–2,1 %	–0,5 %	11,6 %	0,3 %	5,8 %	3,9 %
Prof., scientific, technical services (M)	1,2 %	–0,5 %	0,5 %	1,1 %	1,6 %	2,2 %	2,0 %
Administrative, support service (N)	1,2 %	2,3 %	–9,5 %	11,5 %	1,2 %	–1,1 %	1,8 %
Public admin., def., social sec. (O)	0,2 % *	–1,8 %	–0,9 %	–1,0 %	–1,3 % *	2,7 % *	3,1 %
Education (P)	1,6 %	–1,2 %	–1,0 %	2,3 %	1,6 %	5,1 % *	3,8 %
Human health, social work (Q)	–2,9 %	–3,8 %	–3,6 %	–2,4 %	–2,1 %	–4,4 %	–1,1 %
Arts, entertainment, recreation (R)	–3,8 %	–4,8 % *	–5,8 %	–2,4 %	1,3 %	–11,8 %	–0,6 %
Other service activities (S)	0,0 %	–2,6 %	–5,1 %	–1,7 %	1,4 %	3,3 %	4,8 %
Task type							
Management	–1,1 %	–1,6 %	–2,3 %	0,3 %	0,2 %	–1,8 %	–1,1 %
Information-related	–0,4 % *	–0,6 %	–2,9 %	1,8 %	0,5 % *	–0,9 %	–0,2 %
Object-related	–2,1 %	–2,4 %	–5,7 %	1,4 %	–1,7 %	–3,4 %	–1,3 %
Person-related	–2,5 %	–4,8 % *	–4,0 %	–2,0 %	–2,3 %	–3,2 %	1,9 %

Notes: Significance test with Pearson Correlation, p< 0,05*.
Source: BIBB/BAuA-ETB 2018 and 2012. Own calculations.

particularly affected (Table 7): The development of individual autonomy dimensions indicates polarizing trends at almost all levels. The greatest gain in job autonomy is visible in predominantly highly qualified sectors: first and foremost, in information and communication, and to a lesser extent, in finance and insurance or professional, scientific, and technical services. The biggest losses are in LAS. These are also the branches with a high proportion of direct interaction with service recipients.

A differentiated look at the individual autonomy dimensions again distinguishes the developments predominantly between the group of autonomy winners and those in LAS, usually with a higher share of person-related tasks. Accordingly, trade, logistics, accommodation and food services, healthcare, and social work are losing ground on almost all autonomy dimensions. Particularly noteworthy are the time-related autonomy dimensions of these branches, which testify to more intensive work. Method Autonomy shows partly significant reductions, indicating that the way tasks are completed, and new tasks are approached is being restricted. In contrast, some branches surprisingly show high increases in Criteria Autonomy, i.e., a proxy for performance pressure and working toward specific targets. In transport and logistics in particular, this promising development suggests a certain easing of the tense work situation. Nevertheless, the pressure of work seems to have increased precisely in those branches where the intensity of work is already high.

These are also the branches that have seen a deterioration in the deviation from traditional working hours (Working Time Autonomy). In many respects, these results suggest that employees in branches that already have high levels of autonomy have been given more autonomy, while those with the lowest levels of autonomy would have lost. The latter, in turn, represents the vast majority of employees in the service sector. The autonomy winners could already be described as an autonomy elite. However, some of these have also suffered losses in terms of Task and Method Autonomy, such as in finance and insurance or real estate.

The overall picture of changing autonomy dimensions according to selected variables makes one thing clear at first. For most subgroups and in most dimensions of job autonomy, there have been decreases in job autonomy, while gains are evident in favor of selected groups. Thus, inequality trends are discernible. What stands out are decreases in Task and Method Autonomy in almost all subgroups and increases in intensity in the working time sense for those already pressured. In contrast, the values for Interactional Autonomy speak for an increase in job autonomy and increasingly independent work from other people – which is a questionable development in the service sector.

The analysis by *task type* shows a less heterogeneous and polarizing result, but nevertheless an alarming one, especially regarding object- and person-related tasks. Management levels and information-related tasks also show a loss of autonomy, which is only reversed in the dimensions of Criteria and Scheduling Autonomy. At least this development indicates a relaxation for these subgroups in terms of performance pressure and work intensity. Object- and person-related tasks, however, are losing scope for action at almost all levels. Particularly striking are the restric-

tions in Task and Method Autonomy, i.e., the leeway in the scope and execution of tasks. The intensive and extensive time dimensions of job autonomy also suggest trends worth considering, which could potentially aggravate the demanding conditions of work.

Similarly, the analysis according to selected socio-economic and ADM-related aspects leads to results that are noteworthy (Table 8). The differentiation according to *educational attainment* speaks a clear language. Gains in autonomy are almost exclusively observed for university graduates. The lower the level of educational attainment, the greater the loss of autonomy. The polarization of job autonomy according to educational attainment thus appears not only to be high today, but also to be increasing. The intensification of the polarization of job autonomy seems evident. The analysis by *sex* reveals only a few differences, the most striking being that the perceived pressure to perform and work according to agreed goals has increased for women and decreased for men. Both groups show significant losses in their methodical degrees of freedom. Overall, the losses of job autonomy are greater for women, which is likely to further exacerbate the discrepancy between the sexes.

The differentiation according to *company size* does not reveal any clear new findings. There is some evidence that the extent to which the overall Autonomy Index as well as Task and Method Autonomy components decrease is inversely related to company size. Thus, larger organizational structures may be more resilient to changes in certain aspects of working environments. In terms of *working hours per week*, autonomy-restricting tendencies apply above all to part-time employees with 21 to 30 hours. Their work has become more time-intensive and pressured. The same applies to employees who regularly work more than 40 hours.

The *length of employment* in the company has a less pronounced relation to the development of job autonomy. Losses in job autonomy are visible in all dimensions. It is interesting to note that younger employees, in terms of organizational affiliation, lose the most. Considerable losses in Task and Method Autonomy can be identified, in some cases, among more experienced employees.

Considering the ADM aspects of work, the subgroups with basic or advanced *ADM knowledge* are those with particularly high levels of autonomy. These have increased substantially in recent years, especially in the dimensions related to pressure to perform. Connections are clear with the above-mentioned university graduates, as these are the only groups that make relatively high autonomy gains overall. Employees with advanced ADM knowledge make the biggest leap forward in job autonomy. This could indicate a positive relationship between the potential to use ADM and job autonomy. The positive changes at various levels of

autonomy suggest more flexible work with less pressure to perform and fewer time constraints. These results are confirmed regarding *knowledge intensity*. KIS show positive trends for job autonomy. More revealing, however, are the results for LKIS, which are losing job autonomy and are thus in line with previous findings about LAS.

Table 8: Changes in Autonomy Index by socio-economic, ADM aspects, 2012–2018

	Autonomy Index (w/o Loc)	Task Autonomy	Method Autonomy	Criteria Autonomy	Scheduling Autonomy	Working Time Autonomy	Interactional Autonomy
Educational attainment							
W/o voc. qualification	–4,7 % *	–3,3 %	–5,2 %	–3,5 %	–4,9 %	–7,7 % *	–3,6 %
Vocational training	–2,1 % *	–2,5 % *	–4,9 % *	0,0 %	–1,5 % *	–3,7 % *	–0,5 %
Upgrading training	–2,4 % *	–5,0 % *	–4,0 %	–1,1 %	–1,1 %	–2,7 %	–0,6 %
University	1,4 % *	–2,2 %	–2,1 %	3,8 % *	1,9 % *	2,9 % *	5,3 % *
Sex							
Female	–1,2 %	–1,8 %	–2,1 % *	–1,0 %	–0,6 %	–2,1 %	0,2 %
Male	–0,8 %	–2,2 %	–4,0 % *	2,6 %	–0,8 %	–1,0 % *	0,7 %
Company size							
Micro company	–1,5 %	–3,0 %	–5,4 %	0,1 %	2,5 %	–5,9 % *	2,2 %
Small company	–1,4 %	–2,1 %	–2,9 %	0,2 %	–2,6 %	–0,4 %	–0,6 %
Medium company	–0,8 %	–1,6 %	–3,4 %	2,3 %	–0,1 %	–2,5 %	0,9 %
Large company	–0,3 % *	–1,5 %	–1,5 %	–0,2 %	–0,7 %	1,2 % *	0,9 %
Working hours per week							
10 to 20	–0,8 %	0,6 %	–4,6 %	0,7 %	0,6 %	–2,4 %	–0,3 %
21 to 30	–2,5 %	–3,0 %	–4,1 %	–1,2 %	–3,4 % *	–3,5 %	–0,3 %
31 to 40	–0,2 %	–0,8 %	–1,9 % *	0,4 %	0,2 %	–0,6 %	1,5 %
More than 40	–1,6 %	–3,8 %	–2,7 %	1,2 %	–0,7 %	–2,4 %	–0,5 %
Length of employment							
More than 10 years	–1,1 %	–1,7 %	–2,9 %	–1,3 % *	–1,0 %	–1,0 %	1,0 %
Up to 10 years	–1,4 %	–2,8 %	–5,7 %	2,1 %	–0,2 %	–1,9 %	0,4 %
Up to 5 years	–0,9 %	–2,8 %	–2,6 %	2,3 %	–0,5 %	–2,0 %	0,0 %
Up to 2 years	–1,5 %	–0,8 %	–0,9 %	–1,6 %	–1,3 %	–1,4 %	–3,1 %

	Autonomy Index (w/o Loc)	Task Autonomy	Method Autonomy	Criteria Autonomy	Scheduling Autonomy	Working Time Autonomy	Interactional Autonomy
ADM knowledge							
Basic	1,2 % *	–0,4 %	–3,0 %	7,3 % *	0,5 %	1,7 % *	2,8 %
Advanced	2,7 %	1,2 %	0,8 %	9,6 %	2,6 %	6,4 % *	–2,9 %
Knowledge intensity							
KIS	0,1 % *	0,0 % *	1,0 % *	0,3 %	–1,0 %	0,8 % *	–0,3 % *
LKIS	–2,8 %	–2,9 %	–4,1 %	–4,4 % *	1,2 % *	–2,7 %	–3,6 % *
Changes in work environment							
Low	–0,9 %	–1,7 %	–2,8 %	0,4 %	–0,7 %	–1,3 %	0,4 %
Middle	–2,1 %	–3,2 %	–2,2 %	–1,8 %	–1,2 %	–4,1 %	0,2 %
High	–0,4 %	–1,3 %	–3,5 %	1,8 %	1,0 %	0,7 %	–0,3 %
Frequency of making difficult decisions							
Never	–0,6 %	2,4 %	–2,8 %	0,4 %	–2,0 %	–1,6 %	–0,1 %
Sometimes	–1,0 %	–1,8 %	–5,1 %	0,6 %	0,8 %	–1,4 %	0,2 %
Frequently	–1,3 %	–3,1 %	–0,8 %	–0,1 %	–2,0 %	–1,9 %	0,4 %

Notes: Significance test with Pearson Correlation, p< 0,05*.
Source: BIBB/BAuA-ETB 2018 and 2012. Own calculations.

Technical, organizational, or other *changes in the immediate work environment* can only be marginally differentiated. The subgroup of employees who have experienced a high degree of change in the past two years has at least seen smaller gains in Criteria Autonomy and time-related dimensions. However, these forms of technical or organizational changes seem to be less systematically related to changes in job autonomy. Finally, the distinction according to the *frequency with which difficult decisions* occur reveals some interesting findings. Employees with high decision-making demands have lost autonomy, while those who never have to make difficult decisions have made some slight gains. Using difficult decision-making as a proxy for the potential use of ADM is associated with limitations in job autonomy, particularly in the areas of task variability and work quantity.

The profile of autonomy winners of recent years thus shows clear contours overall: They are university graduates, more likely to be men,

who work full-time for larger companies. They have at least basic skills in dealing with ADM and tend to work in knowledge-intensive branches such as information and communication, finance, and insurance, in consulting, or in the science and education branch in information-related activities. These job autonomy gainers benefit above all from greater freedom in the fulfillment of their tasks, in the planning of their own work, and in the working-time framework. Of course, this image is highly stylized, but it also implies the profile of the opposite group, most service workers, whose job autonomy appears at least threatened.

9. Limitations

The aim of the BIBB/BAuA-ETB analysis was to quantify job autonomy by branch, task type, or socio-economic aspect and thus allow direct comparison between branches and time. The project could initially be implemented as intended. Nevertheless, there are methodical and content-related limitations that need to be considered in the interpretation:

Several methodical hurdles can be traced back to the design of the data set. The greatest difficulty arises from differences between the two survey waves of 2012 and 2018, which are reflected in the locality-related developments in working conditions, and only permit limited interpretation of the Locational Autonomy dimension. The question of using ADM is also linked to this problem, in that hardly any questions on that matter are included in the data set, and a connection between job autonomy and ADM can only be nourished in an indirect way. Of course, the question of selecting the right data set must be raised again at this point, especially as the timeliness of data from 2018 means that there is additional potential for criticism (availability not until 2020).

From the author's perspective, the BIBB/BAuA-ETB is still considered an adequate data basis for the intended research objectives, also in retrospect. Other comprehensive data sets are either difficult to access (e.g., Mikrozensus, SOEP) and/or do not reflect the multidimensional concept of job autonomy. For example, the equally extensive BAuA working time survey only covers working time-related aspects, or the more recent DiWaBe survey includes digitalization-related items to a much greater extent, but at the expense of autonomy-related questions. The author is not aware of any more up-to-date data than the BIBB/BAuA-ETB 2018, which deals with the aforementioned job autonomy aspects in this depth.

At the content level, it is important to reflect on the extent to which the results contribute to answering the research question. They represent an essential intermediate step in gaining knowledge about the influence of ADM on job autonomy by making the underlying concept of job autonomy empirically tangible for the first time and establishing comparability within the service sector. The aim is not to establish causality but rather to gain an overview of the relationships within the sector and ultimately to provide a lead-in to the subsequent company case studies, which contrast the highly aggregated results given here with individual case analyses.

At the content level, it is always debatable to what extent the item selection can do justice to the depiction of a complex concept such as autonomy. Again, reference must be made to the attempt at approximation.

This always simplifies the issue, even if an attempt is made to cover as many aspects as possible. Although most of the construction of the individual autonomy dimensions can be based on the subjective perception of the respective item, this is not always successful, as with the approximation in the case of Working Time and Locational Autonomy, which in the objective sense rather assumes a deviation from traditional working time and place relationships. However, a satisfactory Cronbach's alpha for the overall index confirms the construct's reliability.

The consideration of the limitations inherent in the attempt to quantify job autonomy and establish comparability is not intended solely to point out its incompleteness but rather to provide an opportunity to reflect on the need for further research and the possibilities for refining the construct. First, it is obvious to apply the Autonomy Index to the 2024 wave of the BIBB/BAuA-ETB in order to fill the longitudinal comparison of the data with content. Of course, insights into the interplay between ADM skills and job autonomy could also be hoped for. Further analyses within the Autonomy Index are also tempting, especially the consideration of possible interrelationships between the individual dimensions, to identify even more sharply defined job autonomy profiles. In particular, the connections between the performance and interaction-related dimensions (Criteria and Interactional Autonomy) and other indicators could provide further insights not only into the job autonomy relationships in the service sector but possibly also reveal organizational and strategic changes in the branches.

10. Summary: solidified polarizations, less intensity for some

The analysis of job autonomy in the service sector aimed to model and quantify the seven autonomy dimensions to establish comparability between branches as well as to identify changes in the job autonomy of employees within the past decade. This step is also intended to isolate distinctive branches and autonomy situations that are suitable for an in-depth qualitative analysis in Part III.

The evaluation of the BIBB/BAuA-ETB paints an overall picture of reinforced inequalities from the point of view of workers. There is leeway for job autonomy in all dimensions and characteristics of the respondents in the service sector. The working environment for all employees is characterized by an interplay of autonomous and heteronomous moments. Particularly, Method and Locational Autonomy are less distinct, indicating that many service workers not only encounter limitations in how they carry out their duties but are also bound to a particular location of performance.

The separation into less autonomous (LAS) and highly autonomous service (HAS) branches is supported by the Autonomy Index. The area of HAS is led by information and communication, finance and insurance, real estate, professional, scientific, and technological services, as well as education. The branches with weaker autonomy dimensions are dominated by trade, logistics, accommodation and food services, and healthcare and social services. Interestingly, there are dimensions of job autonomy in which these two groups are aligned, such as Criteria, Scheduling, and Interactional Autonomy. Differences in the pressure to perform, the ability to plan tasks, or the dependence on other people are therefore blurred in these areas, or all service workers are affected to a similar extent on average. The situation is different for Task and Method as well as Working Time and Locational Autonomy. The differences are most pronounced in the latter, as personal and object-related service tasks, in particular, have to be carried out at fixed locations, detached from traditional working time relationships. In the case of Task and Method Autonomy, the great divide in the service sector is again evident, which gives some employees great freedom in shaping the content of their work and reserves more monotonous, prescribed tasks for the majority.

The comparison between 2012 and 2018 shows that the already autonomy-strong branches belong to the autonomy winners because they were able to perceive increasing degrees of freedom on almost all levels.

Branches with weak autonomy, in contrast, have lost further ground, which results in the overarching theme of increased polarization. It is worth noting, however, that both Task and Method Autonomy have seen significant declines across branches since 2012.

What is welcome, though, is that the intensity and the pressure to perform, transferred to Criteria and Scheduling Autonomy, have taken quite positive developments. At least in part, this also applies to areas of LAS. The development of Working Time Autonomy is worthy of concern, as it points to a further division of the service sector. Overall, it can be summarized that the gains in autonomy are rarely high, but the losses in autonomy are often severe and affect the majority of employees.

The final link to the (potential) use of ADM and its influence on job autonomy remains brief: there is evidence that job autonomy increases with knowledge of ADM use and the knowledge intensity of tasks. The task- and method-related dimensions of job autonomy, as well as aspects of working time and place of work, are positively related to ADM potential. For Criteria and Interactional Autonomy, by contrast, the relationships tend to be reversed. This suggests that performance pressure and the need to negotiate compromises and assume responsibility increase with ADM knowledge. Overall, however, these results only show initial trend lines, the content of which must be filled with life in more in-depth company case studies.

Overall, the results from Part II justify the division of the service sector into LAS and HAS. As already mentioned in the theoretical-conceptual considerations (Chap. 5), certain utilization mechanisms of labor power and operational strategies can be assumed to lie behind this distinction. Within the qualitative case studies, however, it is particularly exciting to fill the statistically similar dimensions of Criteria and Interactional Autonomy with further content.

For an in-depth analysis of using ADM in the service sector, several branches are fundamentally offered. However, two promising examples are isolated based on the present analysis, which are exemplary due to the partial ambiguity of the results (selection criteria in Chap. 12.1): healthcare and financial services. Both branches represent the weaker as well as the stronger autonomy areas of the service sector. They are among the branches that involve a particularly high degree of intensive interaction work, for example, care work in healthcare or advisory work in finance.

Healthcare services, admittedly an extremely heterogeneous field, does not show the typical characteristics of LAS in some autonomy dimensions. The values for Task and Method Autonomy in particular are comparatively high, which speaks for greater freedom in shaping

work. In contrast, the branch scores worst for Criteria and Scheduling Autonomy. This implies an extreme conflict scenario, which allows for methodical freedom at work but frames it through intensity and pressure to perform. This situation is exacerbated by externally determined conditions regarding working time and place. The healthcare sector also lags behind other sectors in terms of Interactional Autonomy. It is questionable whether this can be attributed to too little support at work from colleagues and superiors or whether it reflects the high degree of willingness to compromise and take responsibility. Overall, healthcare represents an autonomy situation of the extreme, which apparently tries to free itself from autonomy constraints but is not allowed to do so.

The finance branch initially assumes high levels of job autonomy and great freedom in the execution of work. However, the opposite trend is already evident in Task and Method Autonomy, which tends to favor more standardized and monotonous work. This is in fundamental contrast to the characteristics of HAS. This must also be considered in connection with clearly defined work goals and pressure in Criteria Autonomy. However, the finance branch is again among the autonomy elite in terms of time and place-related dimensions. The ability to plan one's own work seems to be given, as does the possibility of performing work within the usual time and place framework. Dependence on other people at work is a much smaller problem in the autonomy-related sense than in healthcare services. Employees in the finance branch still belong to the autonomous elite, whose position, however, appears to be based on shaky pillars, which is confirmed by the loss of autonomy or only restrained development since 2012.